



Multan City Biodiversity Action Plan



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



City Biodiversity Action Plan

Multan

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Executive Summary

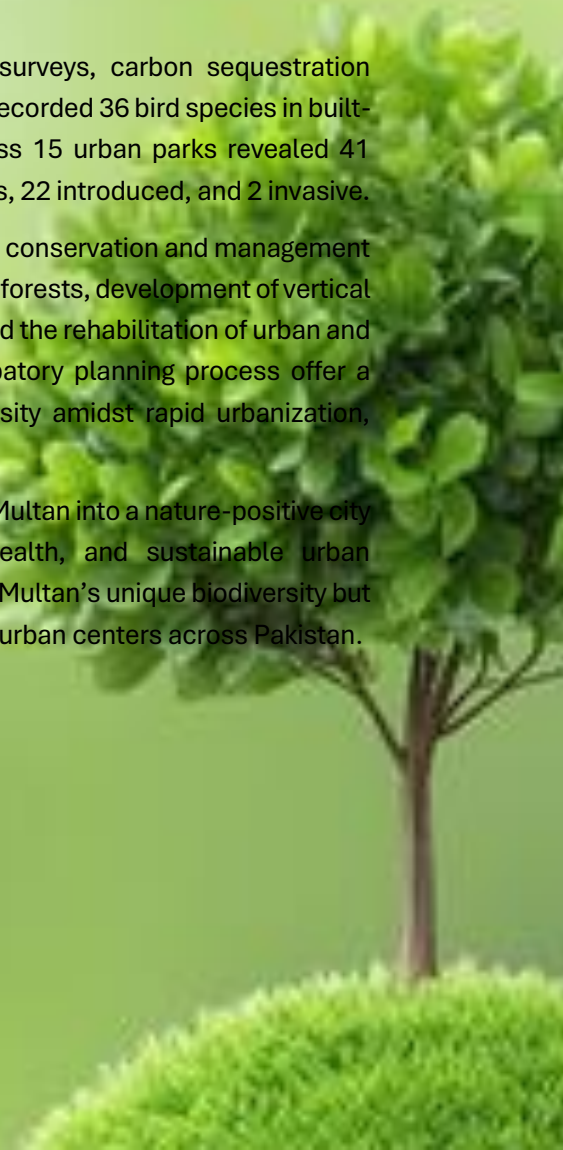
Multan, a historic urban center in southern Punjab, primarily agrarian, the city has experienced a notable shift in land use over recent decades. The agricultural land has shown declined from 76% to 66%, while urban areas expanded from 46% to 47% between 2008 and 2018. As per the 2023 census, the city's population reached approximately 5.36 million, making it the seventh-largest in Pakistan. This urban transformation has brought growing pressures on ecological systems and biodiversity within the city's expanding footprint.

In response, this Multan City Biodiversity Action Plan (MCBAP) is formulated as a strategic framework to protect the city's remaining biodiversity and ecological resources while promoting urban sustainability and resilience in the face of climate change. The MCBAP is aligned with national and global frameworks, including Pakistan's National Biodiversity Strategy and Action Plan (NBSAP), the Sustainable Development Goals (SDGs), the Convention on Biological Diversity (CBD), and the Kunming-Montreal Global Biodiversity Framework. It envisions a resilient and ecologically balanced Multan where biodiversity is protected, restored, and sustainably managed for the benefit of current and future generations.

Biodiversity in Multan was assessed through desk research, field surveys, carbon sequestration assessments, and the City Biodiversity Index (CBI). Field observations recorded 36 bird species in built-up areas and green spaces. Floral diversity surveys conducted across 15 urban parks revealed 41 woody plant species, with a total of 42 tree species identified 17 natives, 22 introduced, and 2 invasive.

A set of biodiversity interventions has been proposed in this plan for the conservation and management of Multan city biodiversity. These include the establishment of Miyawaki forests, development of vertical green layers and urban green corridors, creation of butterfly gardens, and the rehabilitation of urban and focal parks. This comprehensive ecological assessment and participatory planning process offer a strategic framework for conserving and enhancing Multan's biodiversity amidst rapid urbanization, positioning the city toward a more resilient and sustainable future.

Ultimately, the Multan City Biodiversity Action Plan seeks to transform Multan into a nature-positive city where ecological integrity underpins climate resilience, public health, and sustainable urban development. The MCBAP not only serves as a roadmap for conserving Multan's unique biodiversity but also offers a replicable model for biodiversity planning in other growing urban centers across Pakistan.



Setting The Stage



1.1 City History and Administration Profile

Multan, one of the oldest living cities in South Asia, is situated on a historic mound just east of the Chenab River. Owing to its strategic position as both a commercial and military center, Multan experienced numerous invasions, sacks, and sieges throughout its history. Historically known by various names such as Kashtpur, Hanspur, Bagpur, and Sanb, it was ultimately called Mulasthan believed to be derived from the sun god temple that once stood in the region. A magnet for Sufi mystics due to its spiritual aura and thriving trade, Multan

became a center of Islamic learning and devotion.¹ Today, its ancient skyline is defined by the majestic domes of numerous tombs and shrines belonging to revered Sufi saints, representing the city's rich spiritual and architectural heritage. The city is celebrated for its traditional arts, including intricate jewelry and vibrant blue pottery, and it boasts a lively bazaar culture².

Multan's architectural heritage reflects its diverse history, featuring notable structures such as the Jain Swaminarayan Temple, which exemplifies the detailed Mru-Gurjara architectural style.³ Over time, urban development has significantly affected land use. Agricultural land declined from 76% to 66%, illustrating the growing encroachment of urbanization.⁴ Meanwhile, urbanization rates increased, with urban areas expanding from 46% to 47% between 2008 and 2018.⁵

Multan holds a significant administrative position as the divisional headquarters of South Punjab. The district administration is led by the Deputy Commissioner Multan, overseeing a range of key government

¹ <https://mda.punjab.gov.pk/about-multan>

² Fatima, M. D., & Rehan, A. (2025). TRACING A HISTORICAL OVERVIEW OF THE MOSQUES IN MULTAN. *International Research Journal of Arts, Humanities and Social Sciences*, 2(3), 285-303.

³ Dasques, F. (2015). On Multan's built environment: Indian and Anglo-Indian architecture in Multan (1857-1947). *Journal of Historical Studies*, 1(1).

⁴ Hashim, M., Rahman, A., Qasim, M., Farooq, M. U., Muneer, S., & Ahmed, Z. (2023). The spatio-temporal analysis of land use land cover changes in Multan city, Pakistan. *Natural and Applied Sciences International Journal (NASIJ)*, 4(1), 120-134.

⁵ ul Ain, Q., Nadeem, B., Malik, S. M., & Ghaffari, A. S. (2024). Spatio-Temporal Analysis of Urban Growth and Expansion of Multan City During 1998-2020. *Pakistan Journal of Humanities and Social Sciences*, 12(2), 1917-1928.

bodies responsible for urban governance and development. Major departments include the Multan Development Authority (MDA), Municipal Corporation Multan (MCM), Water and Sanitation Services Multan (WSSM), Parks and Horticulture Authority (PHA), Divisional Forest Department, Wildlife Department, Environment Protection Department (EPD), and the Tourism, Archaeology, and Museums Department.⁶ As of the 2023 census, the city had a population of approximately 5.36 million, making it the seventh-largest city in the country.⁷ Multan, situated in southern Punjab, covers an area of approximately 1.2 km².⁸

1.2 Geographical Profile

Multan is located in the southern part of Punjab, Pakistan, positioned at 30°5' - 30°16' latitude and 71°29' - 71°31' longitude. Multan is known more for its historical and spiritual identity than its green cover; however, it features several prominent parks and recreational areas such as Shah Shams Park, Qasim Bagh, Company Bagh, Chaman Zar Askari Park, and the newer urban forest initiative launched at Bahauddin Zakariya University. These green spaces, though limited, contribute to the ecological resilience and livability of the city.⁹

Hydrologically, the city's water system is closely tied to the Chenab River, a major tributary of the Indus River. The combination of surface water from the river and groundwater resources supports domestic, agricultural, and limited industrial needs in the region.¹⁰

Climatically, Multan falls within the arid to semi-arid subtropical zone, experiencing long, extremely hot summers and short, mild winters. During peak summer months, especially in May and June, temperatures frequently rise above 45°C, while winter lows can drop to around 4°C in December and January. The annual average temperature hovers between 25°C to 26°C. Rainfall is sparse and erratic, concentrated mostly in the monsoon season from July to September, with an annual average precipitation ranging between 127 mm to 200 mm often insufficient to recharge the groundwater table adequately. This climatic extremity, coupled with rapid urbanization, underscores the need for resilient infrastructure and sustainable urban development planning in Multan.¹¹

⁶ https://multan.punjab.gov.pk/functions_work_service

⁷ Hashim, M., Rahman, A., Qasim, M., Farooq, M. U., Nadeem, B., & Muneer, S. (2023). Determination of Demographic Change and Urban Settlement Pattern in Multan City, Pakistan. *Journal of Positive School Psychology*, 7(6), 1243-1253.

⁸ Dikshit, K. R., & Dikshit, J. K. (2025). *Land, People and Economy of Pakistan: A Geographic Perspective*. Taylor & Francis.

⁹ <https://mda.punjab.gov.pk>

¹⁰ Pille, L., & Säume, I. (2021). The water-sensitive city meets biodiversity: habitat services of rain water management measures in highly urbanized landscapes. *Ecology & Society*, 26(2).

¹¹ https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/multan_pakistan_1169825

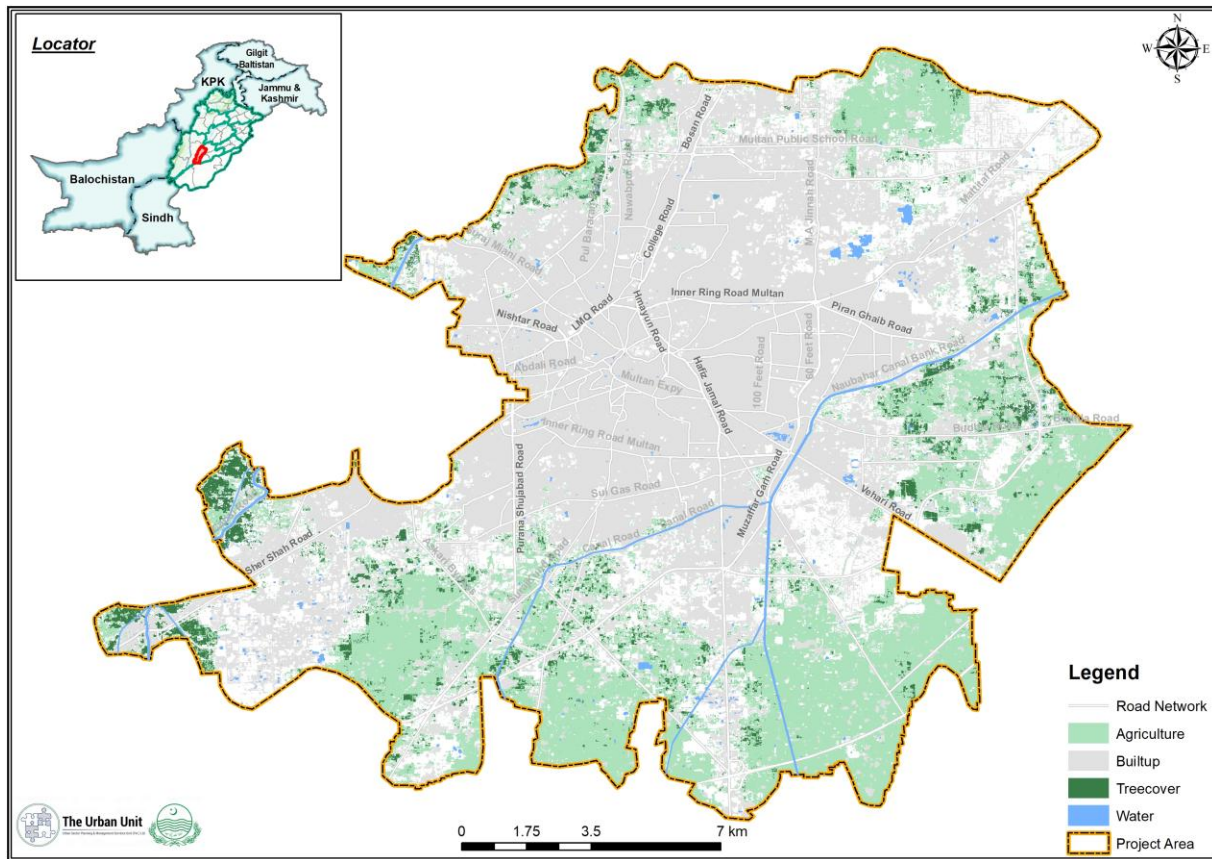


Figure 1: Geographical Location Map of Multan City

1.3 Purpose of Biodiversity Action Plan.

The core purpose of Multan Biodiversity Action Plan (MCBAP) is to protect, conserve, and restore biodiversity by identifying priority species, habitats, and ecosystems. It serves as a structured framework that sets measurable conservation targets and outlines actionable strategies to prevent biodiversity loss. At the same time, it promotes the sustainable use of natural resources to maintain ecological balance while supporting economic and social development.

This well-designed MCBAP seeks to safeguard endangered and native species by ensuring their habitats are preserved or rehabilitated. It emphasizes the importance of maintaining and restoring natural ecosystems such as wetlands, forests, grasslands, and riverine habitats that serve as life-support systems for both biodiversity and human well-being. Beyond conservation, the MCBAP aims to integrate biodiversity considerations into various sectors, including urban planning, agriculture, forestry, and infrastructure development,¹² so that these sectors operate in harmony with ecological systems rather than against them.

¹² Sarkki, S., Niemelä, J., Tinch, R., Jäppinen, J. P., Nummelin, M., Toivonen, H., & Von Weissenberg, M. (2016). Are national biodiversity strategies and action plans appropriate for building responsibilities for mainstreaming biodiversity across policy sectors? The case of Finland. *Journal of Environmental Planning and Management*, 59(8), 1377-1396.

Community participation and stakeholder engagement are vital pillars of the MCBAP. By fostering awareness and encouraging public involvement, the plan strengthens local stewardship and empowers citizens to play an active role in conserving urban biodiversity. The plan also seeks to enhance ecosystem services such as air and water purification, pollination, carbon sequestration, and climate regulation, all of which are critical for building resilient and sustainable cities. Ultimately, the MCBAP ensures that ecological integrity is preserved alongside human development, supporting a future where nature and people thrive together.¹³

The purpose of developing Multan Biodiversity Action Plan is to broader urban and regional policy and planning frameworks. MCBAP can be embedded into the core of development strategies to ensure long-term ecological sustainability. This linkage enables biodiversity conservation to become an integral part of how cities and regions grow, adapt, and respond to environmental challenges.

The MCBAP informs urban and regional planning by influencing master plans, land use strategies, zoning regulations, and infrastructure development. By doing so, it ensures that critical habitats, green corridors, and biodiversity-sensitive areas are preserved, even as cities expand. Moreover, the BAP aligns with contemporary planning models such as Smart Cities and Sustainable Urban Development by promoting nature-based solutions like green roofs, rain gardens, and permeable surfaces that enhance urban resilience.

Second, the MCBAP supports the implementation of national and provincial biodiversity commitments. In Pakistan, it aligns with the National Biodiversity Strategy and Action Plan (NBSAP), developed in response to international obligations under the Convention on Biological Diversity (CBD). At the provincial level, it complements key environmental policies such as the Punjab Environment Policy 2015, the Punjab Climate Change Policy, and sectoral strategies in forestry and wildlife. This coherence ensures that biodiversity goals are pursued consistently across all governance levels.

Third, the MCBAP contributes directly to Pakistan's climate adaptation efforts and the global Sustainable Development Goals (SDGs). It addresses issues such as heat stress, urban flooding, and water scarcity through urban greening and reforestation projects. The BAP is particularly relevant to SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 15 (Life on Land), linking local action to global agendas.¹⁴

Furthermore, the MCBAP guides sectoral planning in areas such as transportation, waste management, agriculture, and water services by embedding biodiversity safeguards into project design. This includes promoting Environmental Impact Assessments (EIAs) that specifically evaluate the ecological impact of development activities and recommend mitigation strategies to protect local ecosystems.

Lastly, the MCBAP strengthens local governance by providing municipal departments, development authorities, and civil society organizations with a clear roadmap for integrating biodiversity objectives into budgeting, monitoring, and decision-making. It encourages community-based conservation efforts, citizen science, and education campaigns that build a culture of environmental stewardship. In doing

¹³ Lovrić, N. (2019). *People and Community Engagement in Biodiversity Conservation*. In *Life on Land* (pp. 1-9). Springer, Cham.

¹⁴ Opoku, A. (2019). *Biodiversity and the built environment: Implications for the Sustainable Development Goals (SDGs)*. *Resources, conservation and recycling*, 141, 1-7.

so, the MCBAP bridges the gap between ecological science, public policy, and grassroots action by creating a unified approach to urban sustainability.

1.4 Regional Significance of Biodiversity Action Plan

Multan, located in the arid to semi-arid zone of South Punjab, faces rising temperatures, low rainfall, and urban sprawl. The MBAP plays a critical role in mitigating these effects by restoring native vegetation, improving microclimates, and enhancing soil and water retention through green infrastructure. As the administrative and economic hub of South Punjab, Multan's action plan serves as a replicable model for biodiversity conservation in other rapidly urbanizing cities like Bahawalpur, Dera Ghazi Khan, and Rahim Yar Khan, where similar environmental challenges exist.

Multan's rich cultural heritage is deeply connected to its natural environment especially in the form of sacred groves, Sufi shrines with old tree cover, and river-linked ecosystems. Protecting this biodiversity supports both ecological stability and the preservation of regional identity.

Being located along the Chenab River, a key part of the Indus River System, Multan's biodiversity actions have downstream impacts on water quality, flood regulation, and habitat conservation, making it important for the broader regional watershed management.

The MCBAP contributes to climate resilience by reducing urban heat islands and supporting pollinators, birds, and beneficial insects.^{15 16} It also supports green jobs, urban agriculture, and eco-tourism vital for sustainable livelihoods in the region. Multan's Biodiversity Action Plan plays a pivotal role in enhancing ecological health and promoting sustainable development in the Punjab region. Strategically located near vital water sources and diverse ecosystems, Multan serves as a significant hub for regional conservation efforts. The MCBAP focuses on protecting wetlands and natural habitats that serve as crucial stopover points for migratory birds, thereby supporting local biodiversity and contributing to regional conservation initiatives. By emphasizing community involvement and awareness-raising, the MCBAP encourages local communities to actively participate in conservation efforts, fostering a sense of ownership and responsibility towards environmental stewardship. MCBAP also focusses on the integration of biodiversity-friendly green spaces in housing societies and public spaces MCBAP promote establishment of ecological corridors for the movement of species between urban parks, university campuses and green belts. Furthermore, the MCBAP provides a valuable model for other cities in the region by showcasing the benefits of sustainable land-use practices, green infrastructure, and eco-friendly technologies.¹⁷ This approach not only mitigates environmental challenges but also promotes the well-being of urban populations, ensuring the continued functioning of ecological corridors and the preservation of biodiversity across the region.

¹⁵ Pierce, J. R., Barton, M. A., Tan, M. M. J., Oertel, G., Halder, M. D., Lopez-Guijosa, P. A., & Nuttall, R. (2020). Actions, indicators, and outputs in urban biodiversity plans: A multinational analysis of city practice. *PloS one*, 15(7), e0235773.

¹⁶ Butt, N., Shanahan, D. F., Shumway, N., Bekessy, S. A., Fuller, R. A., Watson, J. E., ... & Hole, D. G. (2018). Opportunities for biodiversity conservation as cities adapt to climate change. *Geo: Geography and Environment*, 5(1), e00052.

¹⁷ Smith, W. S., Silva, F. L., Amorim, S. R., & Stefani, M. S. (2018). Urban biodiversity: how the city can do its management. *Biodiversity International Journal*, 2(3), 272-277.

Methodology

Multan 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 Multan 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 Multan. The methodology adopted for the purpose of this plan is given below:

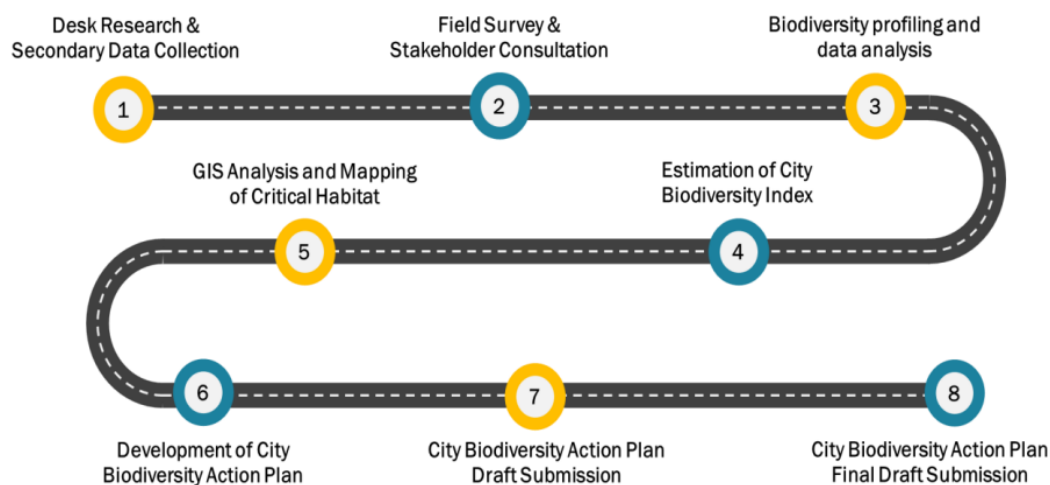


Figure 2: Methodology Map for Multan – City Biodiversity Action Plan

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 Multan city in past decades. Identification of potential survey locations were identified in Multan 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 Multan city biodiversity.

2.2 Field Visits & 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.

2.2.1 The Faunal Diversity

The diversity of vertebrates' fauna i.e. Mammals, Birds, Reptiles and Amphibians in different habitat were recorded 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 make 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 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.

2.2.2 The Floral Diversity

A systematic and scientific approach was used to evaluate the plant diversity in Multan 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 Pakistan²² 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 10m² 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.

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:

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

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

Allometric equation for Plant Biomass estimation:

$$\text{Biomass} = a \times (\text{DBH})^b$$

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

$$\text{Biomass} = 0.1 \times (\text{DBH})^{2.5}$$

This would give the above-ground biomass in kilograms through DBH in centimeters, 23, 24 while below ground biomass was calculated by multiplying above ground biomass with root to shoot factor of 0.26. 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.

Carbon Fraction is the proportion of the plant biomass that is carbon. Typically, the carbon content of plant is about 50% (or 0.5) of its biomass.



Figure 3: 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.
- 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 Multan 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. 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 Multan. SWOT analysis is very useful in strategic planning for conservation, sustainable development, and addressing biodiversity challenges.

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 was held with faculty members of the Institute of Zoology, Bahauddin Zakariya University, Multan, during which Dr. Tahira Ruby, Associate Professor of Zoology, shared several insights about the department's academic and research activities. She informed that the department currently has eight faculty members. In the previous academic year, 70 students were enrolled in the BS Zoology program, 54 in the MS program, and 6 students were pursuing their Ph.D. in Zoology.

The department is currently working on research focuses on the impact of climate change on animal species, a critical area of study given the ongoing environmental changes. The department regularly celebrates national and international days related to biodiversity and conservation, raising awareness among students and the community. Moreover, the department maintains collaborative efforts with the Punjab Fisheries Department and the Wildlife Department, further strengthening its role in applied zoological research and conservation efforts.

Prof. Dr Aleem Ahmad Khan, a renowned ornithologist shared valuable insights regarding biodiversity and bird life in Multan. He emphasized that the green areas in Multan, especially those protected from urban heat, serve as biodiversity hotspots. The ornithologist also shared his personal experience of working for four years at the Dholwala site, where he conducted extensive data collection on the White-backed Vulture, an endangered species.

During the meeting with the Department of Botany at BZU, the discussion primarily focused on plant diversity and the challenges faced by local flora. The meeting was led by Prof. Dr. Seema Mahmood, Head of the Department, who brings 36 years of experience to the table. The key points of the discussion included the replacement of *Saphada* with *Conocarpus*, a tree that is known for its deep root system and high-water consumption. This replacement has raised concerns, as *Conocarpus* is considered to

have more drawbacks than advantages, particularly in terms of its environmental impact. Dr. Mahmood emphasized the importance of local species and the danger of local extinction, which can ultimately lead to global extinction.

It was pointed out that trees like *Kikar*, *Jaman*, *Mango*, *Anar* (Pomegranate), *Shahtoot* (Mulberry), *Sohanjna* (Moringa), and *Amrood* (Guava) are fast-growing and provide more benefits without posing environmental hazards. In contrast, the population of pigeons has been in decline, and species like *Bardh Pipal* have become endangered. Furthermore, *Din ka Raja* (a plant that attracts thousands of butterflies) has seen a decrease in butterfly numbers, which could signal a decline in biodiversity.

Dr. Mahmood also highlighted the issue of mango tree cutting from a large 1200-acre area, which has further impacted the local ecosystem. The department proposed a practical solution of tree transplantation, which could be carried out over the next four years to help restore plant diversity. Additionally, the simple but impactful message of "Everyone should plant one tree" was suggested as a way to increase community engagement and environmental awareness.



Figure 4: Consultation with Zoological and Botanical Experts of Academia

3.2 Consultation With Director General PHA

During the interaction with DG PHA Multan, several initiatives and projects related to urban biodiversity and green infrastructure were discussed. The DG PHA office provided detailed data on the number of parks, trees, and various green initiatives within the district. One of the notable challenges highlighted was the absence of a compact forest or large-scale plantation area in District Multan. Despite this, significant efforts are being made to enhance urban greenery through park development and afforestation strategies. Another significant project which they intend to start is the Mango Enclave, which spans an area of 40–50 kanals.



Figure 5: Glimpse of discussion with Director General PHA Multan

3.3 Consultation With Assistant Director Wildlife, Multan

Mr. Munawar Najmi, The Assistant Director Wildlife, Multan, has informed that currently, there is no ongoing project in the Multan region specifically focused on biodiversity conservation. He further clarified that the wildlife jurisdiction of Multan is limited to two subdivisions: Shujabad and Jalalpur, making it a relatively small area in terms of biodiversity scope. Moreover, he highlighted a pressing issue regarding the illegal capture and trade of wild animals by certain shopkeepers in the area. The department is actively working to control this illegal activity and enforce wildlife protection regulations.

3.4 Consultation With Conservator Forest and DFO Multan

The Forest Department, represented by the Conservator Forest Dr. Mushtaq and the DFO Multan, acknowledged the importance of the City Biodiversity Action Plan and aligned the department's goals with the proposed initiatives for Multan. They highlighted that, although there are currently no compact plantations in the district, the department is prioritizing linear plantations along roads and canals for upcoming afforestation efforts. Addressing the issue of exotic species, the officers confirmed that no non-native trees, such as Eucalyptus, were planted during the previous fiscal year, reflecting a shift

toward more ecologically sustainable practices. In terms of community involvement, the DFO shared that the department has actively engaged in plantation drives within schools and colleges as part of broader efforts to mitigate climate change and promote public-private collaboration in afforestation.



Figure 6: Meeting with conservator and DFO Multan

Biophysical Environment Profile



4.1 Habitat & Conservation Areas of City

Although the Multan city lies in an arid to semi-arid zone with limited forest cover and declining water bodies, it still contains pockets of ecological significance that serve as vital habitats for local biodiversity and offer potential for conservation.

4.2 City Faunal Profile

A total of 36 birds' species were recorded from build-up areas, gardens and parks of Multan during our survey. Most common birds observed in build-up areas included House crow, Rock pigeon, House sparrow and Common myna. Other birds commonly present in parks and green areas include Sun Bird, Bulbul, Little Egrets, Red wattled Lapwing, Laughing Dove, Black kite, Owl, Indian Robin. Animal's diversity in captivity was also recorded consisting of Hog deer, Black Buck, Ostrich, Monkey, Chinkara deer, Geese, Dove, Parrots, Peacock, Black Partridge, Grey Partridge and Pheasants (**Annexure A**).



Figure 7: Some of Recorded Birds of Multan – (a). Myna (b). Crow (c). Ostrich (d). Bulbul

4.3 City Floral Profile

A total of 41 woody plant species have been recorded from The Parks and gardens of Multan. The surveyed areas include Ameer Abad Park, Bagh Langay Khan, Malik Salahuddin Dogar Park, Jilani Park, Kashmir Park (GT Road), Arts Council Park, Goal Bagh Park, Jalal Park, Model Town C Block Park, Khawaja Masood Park, Am Khas Park, Albadar Park, K Block Park in Shah Rukne Alam and Jinnah Park. Out of 42 tree species recoded from Multan 17 were native, 22 were introduced and 2 species were invasive. The number of tree species from different visited areas in Multan is showing that Am Khas Park recorded the highest tree diversity with 26 species, followed by Bagh Langay Khan with 22. Khawaja Masood Park and Goal Bagh Park each had 20 species, while Jalal Park had 19. Model Town C Block Park hosted 16 species, Malik Salahuddin Dogar Park 15, and Arts Council Park 14. Ameer Abad had 17 species. Jilani Park had 11, Jinnah Park 8, Albadar Park and K Block 7 each, and Kashmir Park (GT Road) had 5 species. A detail list of plants recorded from green areas of Multan is given in the Table.

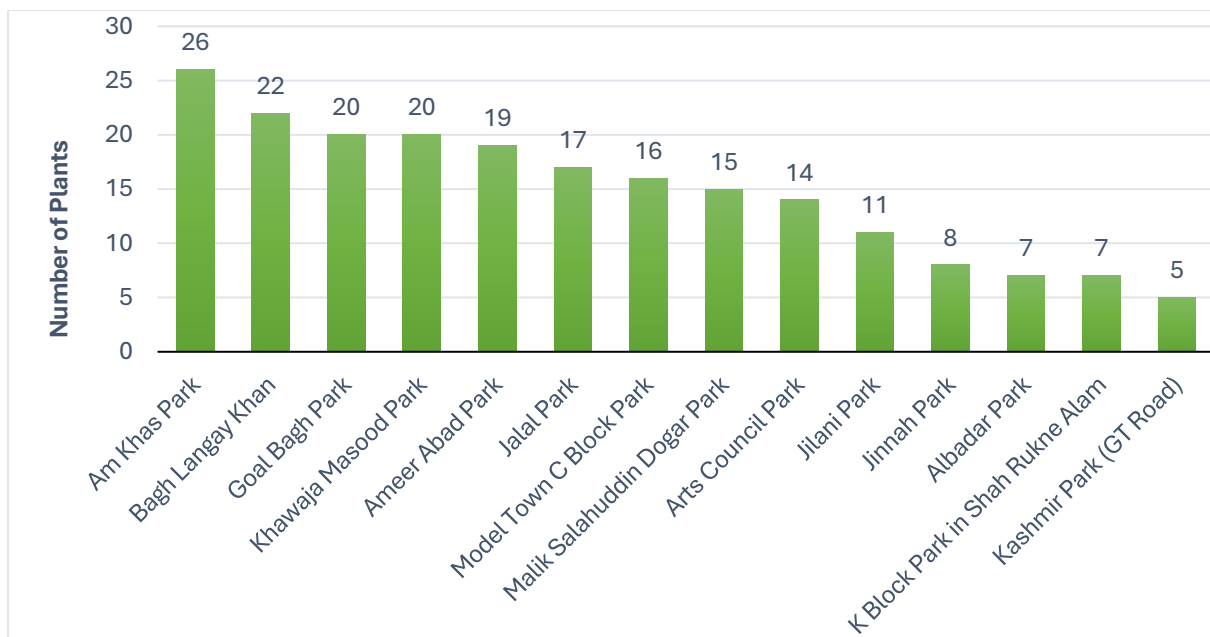


Figure 8: Trees Distribution in different Parks of Multan.

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 Multan 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 ecological assessment of parks in Multan using Menhinick's Richness Index (D), Shannon-Weaver Diversity Index (H'), and Evenness Index (E) shows a wide variation in species richness, diversity, and distribution across different locations. Goal Bagh Park (D = 2.08), Jalal Park (D = 2.07), and Khawaja

Masood Park ($D = 1.71$) exhibited high species richness, along with moderate to high values for diversity and evenness, indicating healthier and more balanced ecosystems.

Ameer Abad Park presented an unusual pattern with an extremely low richness value ($D = 0.0002$), yet it recorded the highest diversity ($H' = 4.474$) and evenness ($E = 0.987$), suggesting a highly uniform species distribution potentially dominated by a few species.

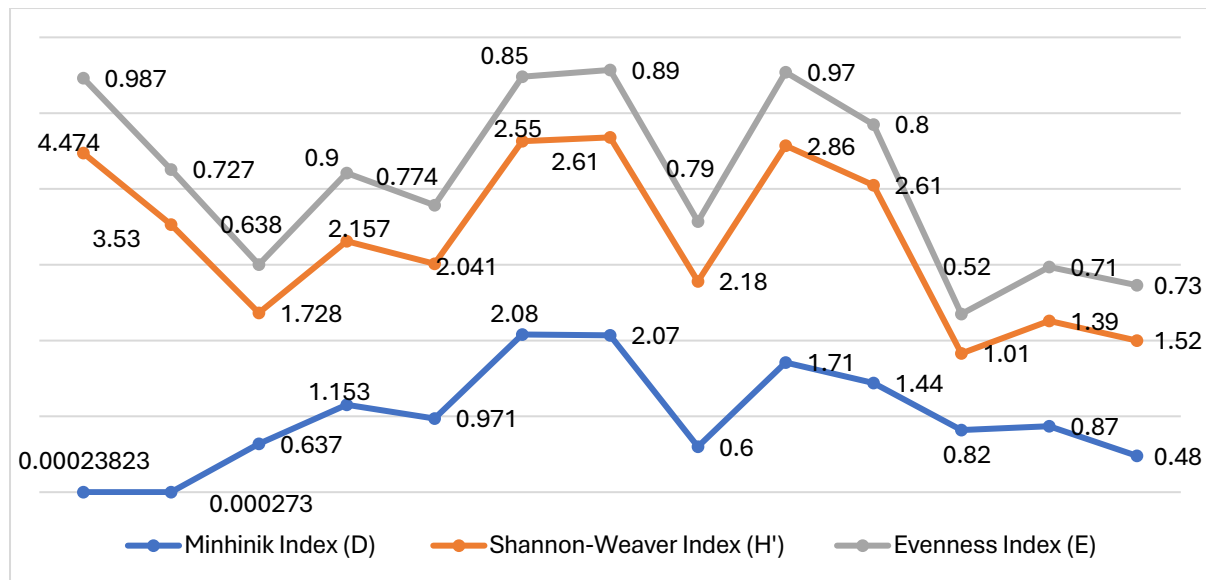


Figure 9: Biodiversity Indices of Different Sites of Multan

In contrast, Albadar Park ($H' = 1.01$, $E = 0.52$) and Malik Salahuddin Park ($H' = 1.728$, $E = 0.638$) showed both low diversity and low evenness, indicating ecological stress or limited species variety. Other parks such as Jinnah Park ($H' = 1.52$, $E = 0.73$), K Block Park ($H' = 1.39$, $E = 0.71$), and Model Town Park ($H' = 2.18$, $E = 0.79$) reflected moderate biodiversity levels.



Figure 10: Some of Common Trees of Multan (a). *Terminalia*, (b). *Ashok*, (c). *Bakain*, (d). *Shisham*, (e). *Bottle brush*, (f). *Gul Mohar*

4.4 Vegetation Dynamics

Over the past decade, Multan City in Southern Punjab, Pakistan, has experienced significant changes in its vegetation dynamics, primarily driven by rapid urbanization and land-use alterations. From 2013 to 2022, dense vegetation decreased from 31.8 km² to 12.21 km², while low-vegetation areas reduced from 112.94 km² to 105.4 km². Normalized Difference Vegetation Index (NDVI) values, derived from MODIS satellite data, have shown a declining trend in vegetation health and density across Punjab, including Multan, over the past decade. The decrease in vegetation cover in Multan is a concern for urban sustainability, affecting air quality, biodiversity, and the urban heat island effect. Continued monitoring and implementation of green infrastructure are essential to mitigate these impacts.

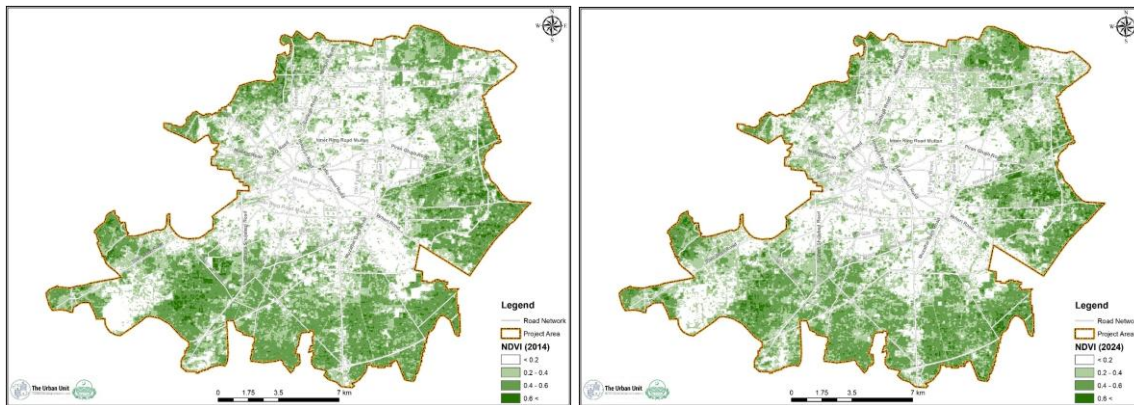


Figure 11: Land-use land cover changes from 2000 to 2020 in Multan

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 such as Peepal and Arjun show exceptionally high total biomass and carbon stock, indicating their significant role in carbon sequestration. Similarly, Sherin and Alstonia also demonstrate large biomass values, highlighting their importance in urban greenery for climate mitigation. These species 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. Medium-sized trees like Mango, Sohanjna (Moringa), and Gab have moderate biomass and carbon storage, contributing to overall ecosystem health.

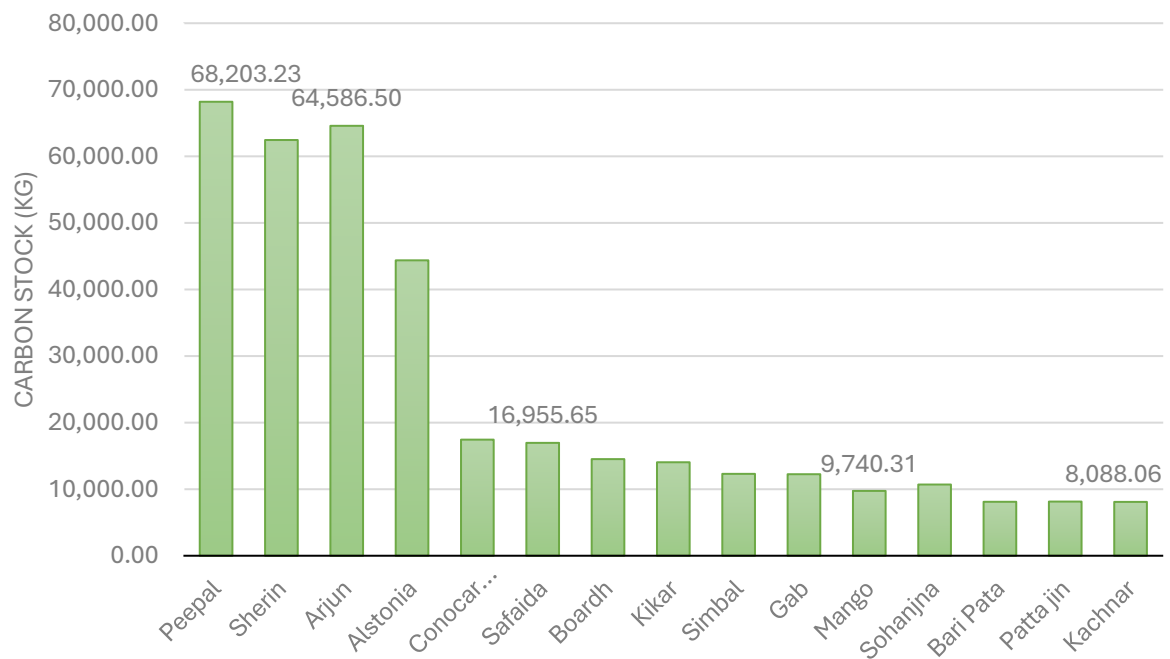


Figure 12: Tree Biomass and Carbon Stocking of different species in Multan.

On the smaller side, species like Ulta Ashok and Molsari show lower biomass but are valuable for diversity. Palms such as Date Palm and Silver Palm also contribute notable biomass. A detailed Assessment of Tree Biomass and Carbon Stocking of Plants in Multan is given in the table.

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

Common names	Scientific names	DBH (cm)	AGB (Kg)	BGB (kg)	Total Biomass (Kg)	Carbon Stock (Kg)
Pilkhan	<i>Ficus virens</i>	69.44	4018.13	1044.71	5062.84	2531.42
Peepal	<i>Ficus religiosa</i>	259.29	108259.1	28147.37	136406.5	68203.23
Bari Pata (naagh phali)	<i>Heteropharmaga adenopyllum</i>	110.6	12864.35	3344.73	16209.08	8104.54
Terminalia	<i>Terminalia mentalis</i>	49.3	1706.54	443.70	2150.24	1075.12
Conocarpus	<i>Conocarpus erectus</i>	150.28	27685.54	7198.24	34883.78	17441.89
Neem	<i>Azadirachta indica</i>	42.54	1180.30	306.878	1487.18	743.59
Bakain	<i>Melia azedarach</i>	90.34	7757.11	2016.85	9773.96	4886.98
Sukh Chaen	<i>Pongamia pinnata</i>	94.22	8617.03	2240.42	10857.46	5428.73
Shehtoot	<i>Morus alba</i>	89.45	7567.47	1967.54	9535.01	4767.50
Silver Palm	<i>Coccothrinax argentata</i>	110.32	12783.08	3323.60	16106.69	8053.34
Ulta Ashok	<i>Polyalthia longifolia</i>	23.45	266.29	69.23	335.52	167.763
Amaltas	<i>Cassia fistula</i>	95.22	8847.49	2300.34	11147.85	5573.92
Sherin	<i>Colchicum autumnale</i>	250.32	99137.71	25775.8	124913.5	62456.76
Simbal	<i>Bombax ceiba</i>	130.69	19525.67	5076.67	24602.34	12301.17
Jaman	<i>Syzygium cumini</i>	86.47	6952.86	1807.74	8760.60	4380.30

Safaida	<i>Eucalyptus camaldulensis</i>	148.59	26913.73	6997.57	33911.3	16955.65
Mango	<i>Mangifera indica</i>	119.04	15460.81	4019.81	19480.62	9740.31
Shisham	<i>Dalbergia sissoo</i>	66.76	3641.58	946.812	4588.40	2294.2
Boardh	<i>Ficus benghalensis</i>	139.63	23038.11	5989.90	29028.02	14514.01
Sohanjna	<i>Moringa oleifera</i> Lam.	123.59	16980.81	4415.01	21395.82	10697.91
Lasuora	<i>Cordia dichotoma</i>	96.34	9109.96	2368.59	11478.55	5739.27
Date Palm	<i>Phoenix dactylifera</i>	92.85	8307.20	2159.87	10467.07	5233.53
Patta jin (jia Patta)	<i>Putranjiva roxburghii</i>	110.77	12913.84	3357.59	16271.44	8135.71
Alstonia	<i>Alstonia scholaris</i>	218.34	70442.26	18314.99	88757.24	44378.62
Weeping Fig	<i>Ficus benjamina</i>	59.82	2767.68	719.59	3487.27	1743.63
Kachnar	<i>Bauhinia variegata</i>	110.51	12838.19	3337.93	16176.12	8088.06
Gab	<i>Diospyros blancoi</i>	130.46	19439.87	5054.36	24494.24	12247.12
Beri	<i>Ziziphus mauritiana</i>	87.9	7243.89	1883.41	9127.30	4563.65
Kanair	<i>Nerium oleander</i>	101.4	10353.68	2691.95	13045.64	6522.82
Molsari	<i>Mimusops elengi</i>	42.59	1183.77	307.78	1491.55	745.77
Kikar	<i>Vachellia nilotica</i>	137.8	22290.67	5795.573	28086.24	14043.12
Arjun	<i>Terminalia arjuna</i>	253.7	102518.2	26654.74	129173	64586.5
Gul e Nashtar	<i>Erythrina Suberosa</i>	43.9	1276.913	331.9974	1608.91	804.45

The remote sensing-based analysis was also conducted to estimate the above ground biomass of the Multan, further carbon stock of the city was also predicted as shown in (Figure 13). The outcomes shows that the AGBD is approximately 0.25 million tonne, with the carbon stock of 0.12 million tonne.

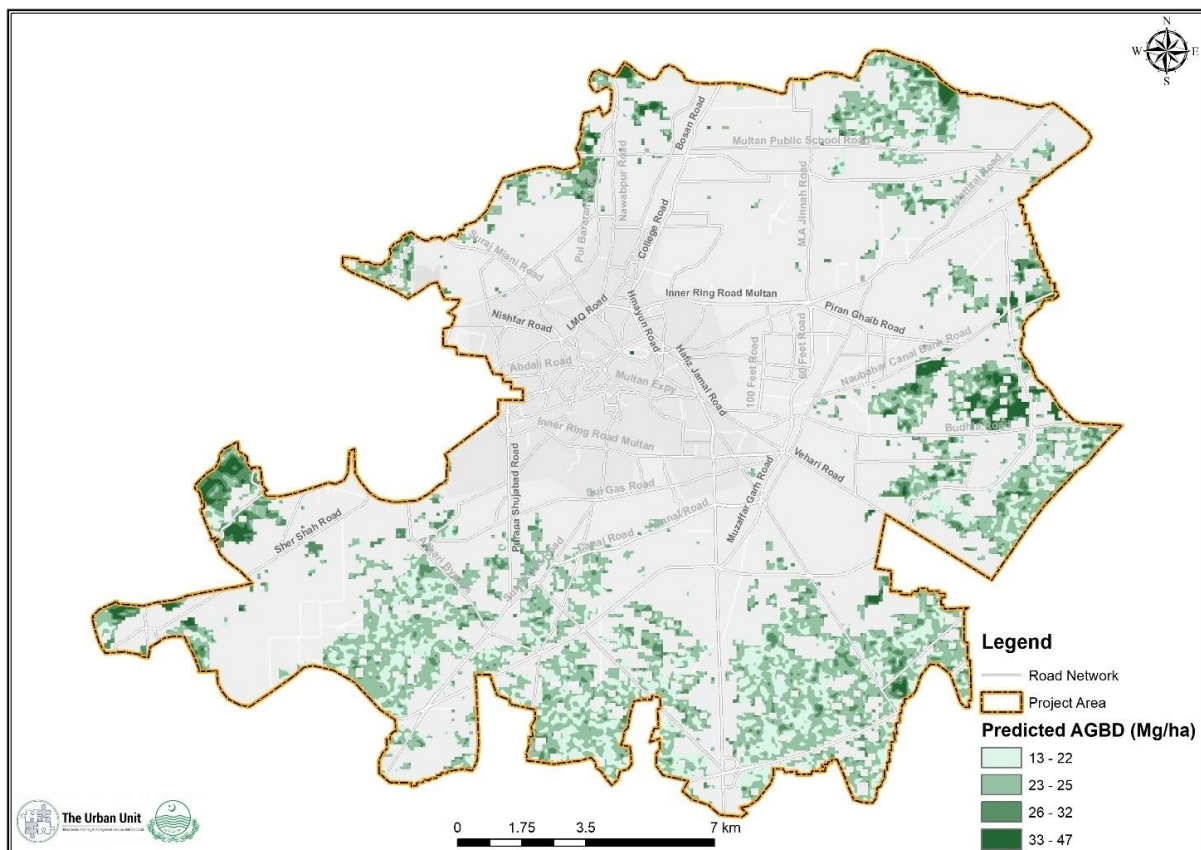


Figure 13: Predicted Above Ground Biomass (AGBD) Mg/ha

4.6 Green Spaces and Open Ground Audit

There are many historic and important parks and gardens in Multan 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 Multan. As of 2024, Multan's total green area encompasses approximately 67 parks managed by The Parks and Horticulture Authority (PHA). These parks vary in size, with some exceeding 10 acres, and are distributed across three administrative zones: A, B, and C.¹⁸

4.6.1 Ameer Abad Park

Ameer Abad Park, covering an area of 4.5 acres, is a well-maintained urban green space in Multan. The Park has an active water system and well-developed washroom facilities. Although it faces a shortage of staff, the overall condition of The Park is satisfactory. There is no entry ticket, making it freely accessible to the public. The Park is home to a variety of plant species, including 10 Pilkan, 1 Peepal, 1

¹⁸ Rehman, Z., Zubair, M., Hafiz, D. O., & Manzoor, S. A. (2023). Biodiversity and quality of urban green landscape affect mental restorativeness of residents in Multan, Pakistan. *Frontiers in Sustainable Cities*, 5, 1286125. <https://doi.org/10.3389/frsc.2023.1286125>

Bari Pata, 8 Tali, 10 Terminalia, 42 Wall Palms, 1,000 Conocarpus, 2 Naeem, 6 Bakain, 10 Sukh Chain, 1 Shatoot, 7 Silver Palms, 4 Ulta Ashok, and 6 Amaltas trees, 1 Nagphali, 1 Bismarkia, 1 Sherin.

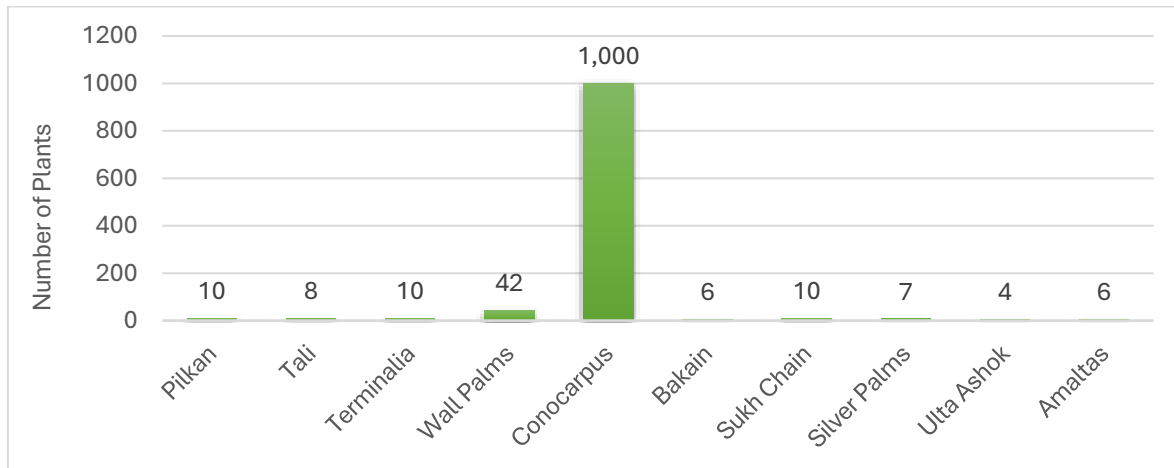


Figure 14: Most Abundant trees of Ameer Abad Park, Multan.

In terms of wildlife, The Park supports two active bird nests of kites. Artificial feeding and water sources have been installed to support urban birdlife. Commonly observed species in The Park include Myna, Sparrow, Crow, Kites, Dove, as well as bats, squirrels (gulahri), and cats. These features collectively contribute to The Park's role as a small but valuable urban biodiversity spot.

The calculated indices suggest that the tree community is not very diverse, primarily due to the dominance of Conocarpus, which makes up approximately 93% of the total population. The Minhinik Index (D) of 0.00023823 is low, indicating a high concentration of individuals in a few species. The Shannon-Weaver Index (H') of 4.474 reflects relatively high, but the dominance of Conocarpus skews this. Despite the Evenness Index (E) of 0.987 suggesting an even distribution across species, it is largely influenced by the overwhelming number of Conocarpus trees.



Figure 15: Glimpse of assessment of Ameer Abad Park

The remote sensing-based data provided in (Figure 16) shows that the total area of The Parks is 200.52 acres, with the largest coverage is 35 acres of Shah Shams Park in Multan City.

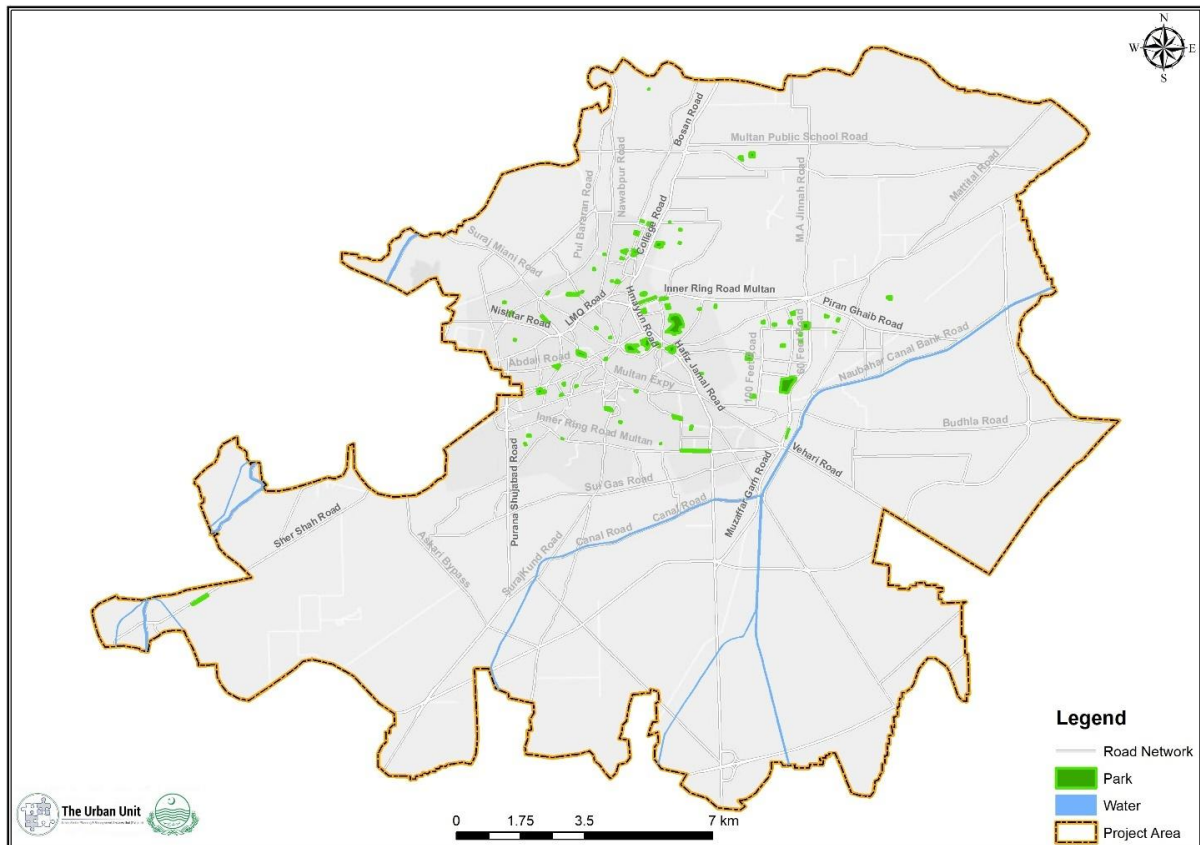


Figure 16: Spatial Distribution of Green Spaces and Open Ground in Multan

4.6.2 Bagh Langay Khan

This is a public park spread over an area of 6 acres, attracting approximately 600 to 700 visitors daily. The Park hosts a diverse collection of tree species, including: 2 Simbal, 60 Conocarpus, 140 Terminalia, 6 Jaman, 20 Safaida, 30 Pilkan, 1 Mango, 3 Amaltas, 7 Peepal, 5 Sherin, 12 Sukh Chain, 25 Bakain, 3 Shatoot, 3 Shesham, 2 Bord, 5 Sohanajna, 2 Lasuora, 4 Burna, 2 Date Palms, 1 Putajan, 1 Naeem, and 2 Alstonia trees.

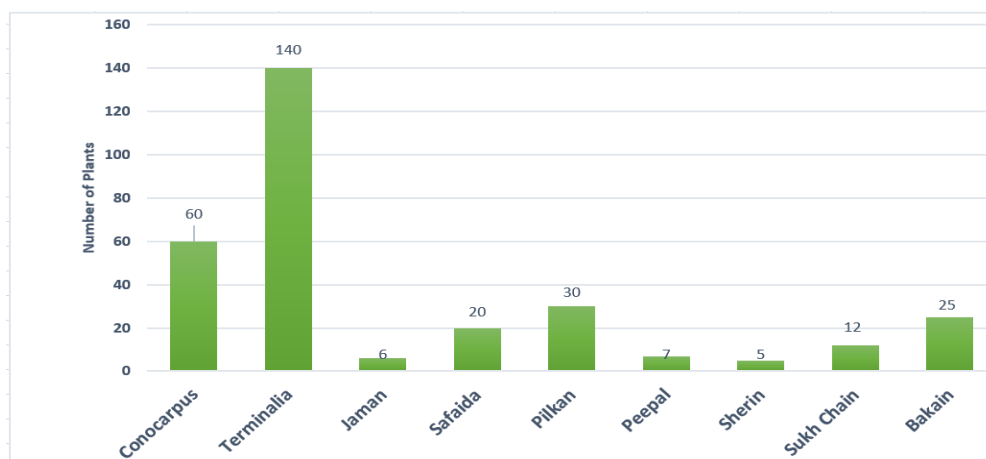


Figure 17: Most Abundant trees of Bagh Langay Khan, Multan

While basic infrastructure is present, many facilities are available but non-functional, and The Park is facing a shortage of staff, which affects maintenance and security.

In terms of biodiversity, various bird species such as crow, owl, bulbul, parrot, pigeon, sparrow, and kites are commonly observed within The Park. However, the presence of stray dogs poses a threat to both park visitors and small wildlife.

The calculated indices reveal a moderately diverse tree community dominated by a few species. The Minhinik Index (D) of 0.000273 indicates that the community is heavily skewed toward certain species, particularly *Conocarpus* and *Terminalia*, which make up a large portion of the total number. The Shannon-Weaver Index (H') of 3.530 reflects a moderate level of diversity, though the dominance of these species reduces overall diversity. The Evenness Index (E) of 0.727 suggests a relatively uneven distribution, with a few species being more abundant than others, leading to lower evenness in the population.



Figure 18: Glimpse of assessment of Bagh Langay Khan

4.6.3 Malik Salahuddin Dogar Park

This Park spans an area of 6.5 acres and receives around 150 to 200 visitors daily. The Park is well-planted with a variety of tree species, including 110 *Terminalia*, 50 *Pilkan*, 4 *Shahtoot*, 55 *Sukh Chain*, 8 *Ula Ashok*, 1 *Mango*, 12 *Bottle Brush*, 1 *Pipal*, 10 *Alstonia*, 40 *Amaltas*, 6 *Table Palms*, 11 *Bakain*, 3 *Naeem*, 1 *Jaman*, and 243 *Conocarpus* trees.



Figure 19: Glimpse of assessment of Malik Salahuddin Dogar Park

The Park has a team of 4 gardeners (mali) and 2 security guards. Facilities include a functional washroom and a gym, both of which are available to the public. Birdlife observed in The Park includes the usual species commonly found in Multan's urban parks, such as sparrows, mynas, kites, pigeons, parrots, and crows. The Park contributes positively to local biodiversity and provides a clean recreational space for the community.

The Menhinick Index (0.637) suggests low species richness relative to the number of individuals. The Shannon-Wiener Index (1.728) indicates low to moderate diversity, showing that a few species (like Conocarpus and Terminalia) dominate the population. The Evenness Index (0.638) further confirms that the species are not evenly distributed—some are abundant while others are rare.

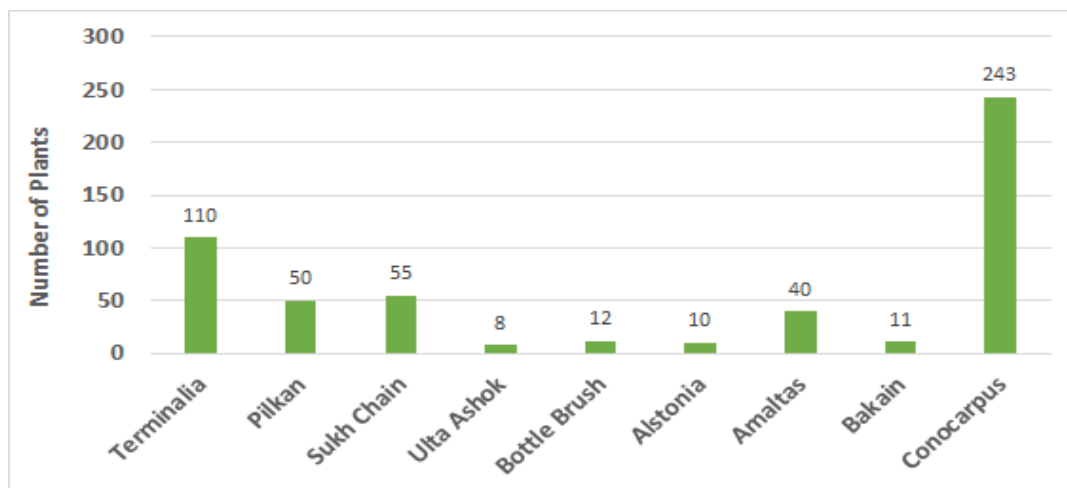


Figure 20: Most Abundant trees of Malik Salahuddin Dogar Park, Multan

4.6.4 Jilani Park

This Park covers an area of 4 acres and receives approximately 50 to 100 visitors daily. The Park is well-maintained and features a children's play area as well as functional washroom facilities, providing a comfortable recreational environment for families.

The tree diversity in The Park includes 4 Naeem, 3 Peepal, 7 Sukh Chain, 17 Amaltas, 19 Pilkan, 1 Mango, 16 Conocarpus, 3 Alstonia, 9 Bakain, 3 Jaman, and 9 Ulta Ashok trees. This variety supports local urban greenery and provides habitat for common bird species found in the area.

The Menhinick Index (1.153) indicates moderate species richness in relation to the number of individuals. The Shannon-Wiener Index (2.157) suggests a moderate level of biodiversity, with no single species overwhelmingly dominant. The Evenness Index (0.90) reflects a high degree of uniformity in species distribution, meaning most species have similar population sizes.

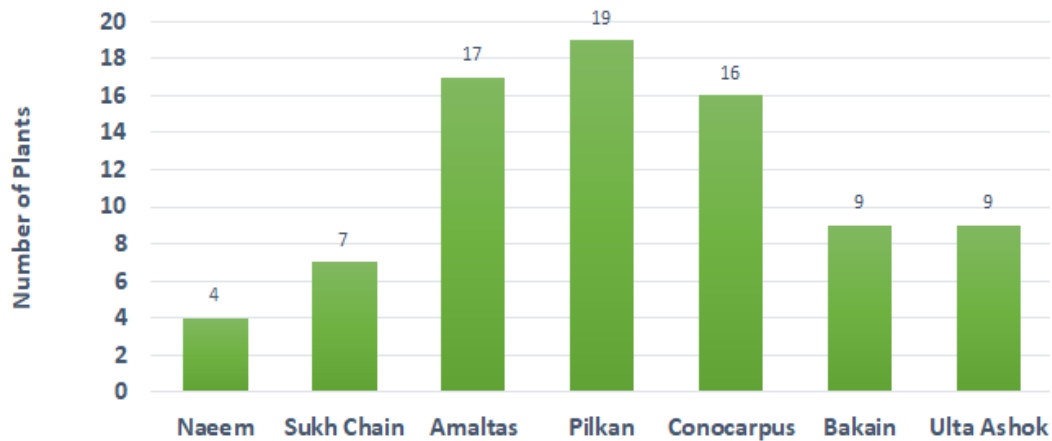


Figure 21: Most Abundant trees of Jilani Park, Multan



Figure 22: Selected trees of Jilani Park, Multan

4.6.5 Arts Council Park

This Park hosts a variety of tree species and is well-maintained, with an estimated 150 to 180 visitors daily. The Park features a collection of trees, including 50 Terminalia, 1 Mango, 8 Pilkan, 12 *Ficus benjamina*, 60 Bakain, 1 Kachnar, 4 Date Palms, 15 Alstonia, 3 Jaman, 15 Ulta Ashok, 8 Tali, 5 Sukh Chain, 6 Amaltas, and Conocarpus.

The Park also supports a diverse bird population, with species such as crows, lalis, parrots, pigeons, sunbirds, and owls commonly observed. Water facilities are available throughout The Park, ensuring that both visitors and The Park's ecosystem are well-supported.

The Menhinick Index (0.971) indicates moderate species richness relative to the number of individuals. The Shannon-Wiener Index (2.041) reflects a diverse community with no extreme dominance by a single species, though Bakain and Terminalia are more common. The Evenness Index (0.774) suggests a reasonably balanced population where species are not too unevenly represented.

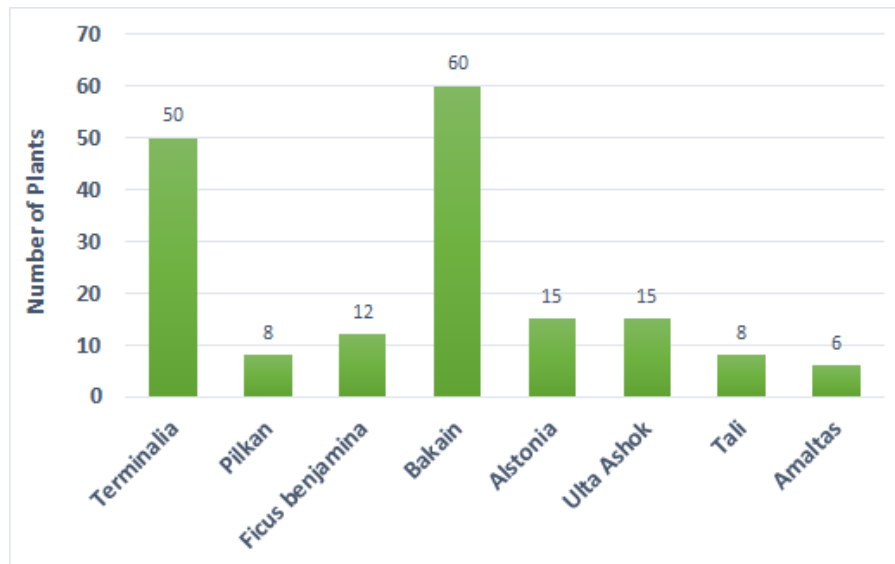


Figure 23: Most Abundant trees of Arts Council Park, Multan

4.6.6 Goal Bagh Park

Goal Bagh Park spans an area of 5.5 acres and attracts around 500-700 visitors daily. The Park currently does not have any active bird nests. The vegetation includes a variety of trees such as 1 Finus palm, 1 Abiscus, 1 Gold Mohar, 1 Sohanjna (Moringa), 4 Alstonia, 1 Gab, 1 Nagh Phali, 8 Tali, 10 Bakain, 5 Jaman (Jamun), 7 Bottle Brush, 6 Date Palms, 10 Safaidda, 19 Terminalia, 4 Amaltas, 1 Bord, 1 Pipal (Peepal), 3 Naeem, 1 Beri, 1 Date Palm, and 7 Mango trees. The Park is also home to various bird species, including crows, bulbul, parrots, and sparrows. There are 3 gardeners (Mali) employed to maintain The Park. The water body within The Park is currently non-functional, while the washrooms remain operational. Despite the challenges, Goal Bagh Park remains an important green space for the community, offering a variety of plants and wildlife to enjoy. We were also informed by the Director of PHA that the government has allocated 50 lakh rupees to Goal Bagh Park for the construction of new gates and a gazebo. This funding will significantly improve The Park's infrastructure, enhancing its accessibility and providing visitors with a more enjoyable and comfortable experience. The addition of gates will help secure The Park, while the gazebo will provide a shaded, relaxing spot for park-goers. This development is an exciting step toward further revitalizing The Park.



Figure 24: Glimpse of assessment of Goal Bagh Park

The Menhinick index measures species diversity by relating the number of species to the total individuals, showing species richness adjusted for sample size. Here, it is about 2.08, indicating moderate richness. The Shannon-Wiener index (H') quantifies diversity considering both abundance and evenness of species; a higher value (~ 2.55) means a diverse community with several species distributed relatively evenly. The Evenness index ($E5$) shows how evenly individuals are spread among species, here 0.85, meaning species are fairly evenly distributed rather than dominated by few.

4.6.7 Jalal Park

Jalal Park covers an area of 1.5 acres and attracts approximately 400-500 visitors daily. The Park features a diverse range of trees, including 9 *Terminalia* (with a trunk diameter of 37 inches), 4 *Ficus benjamina*, 6 *Pilkhan*, 8 *Shisham* (with a trunk diameter of 130 inches), 9 *Amaltas*, 3 *Bottle Brush*, 11 *Uta Ashok*, 4 *Bakain*, 1 *Bord*, 2 *Jaman* (Jamun), 1 *Sumbal*, 2 *Safaida*, 2 *Kanair*, 8 *Molsari*, 1 *Gatrofa*, 6 *Pilkhan*, 1 *Beri*, 1 *Kikar*, 1 *Shatoot*, and 3 *Naeem* trees.



Figure 25: Selected plants of Jalal Park

The Park is home to a variety of birds, including Sunbirds, crows, sparrows, bulbul, kites, owls, maynas, doves, and pigeons, along with the mentioned species. There are currently two bird nests in The Park. The water body in The Park is functional, adding to the natural beauty and providing an attractive habitat for birds. However, there are no washroom facilities available for visitors.

The Menhinick index (2.07) shows moderate species richness relative to total individuals. The Shannon-Wiener index (2.61) indicates a diverse community with good variety and balanced species abundances. The evenness index (0.89) means individuals are fairly evenly distributed across species, without dominance by few.

4.6.8 Model Town C Block Park

This Park spans 5.5 acres and sees around 200 visitors daily. The Park features a wide variety of trees, including 19 Date Palms, 38 Terminalia, 190 Pilkhan, 98 Bakin, 50 Naeem, 7 Pipal (Peepal), 25 Kanair, 100 Amaltas, Gatrofa, 15 Sohanjna (Moringa), 2 Chamerops, 99 Sukh Chan, 2 Alstonia, 50 Molsari, 20 Sedha Ashok, Pam and 2 Shatoot.



Figure 26: Selected plants of Model Town C Block Park

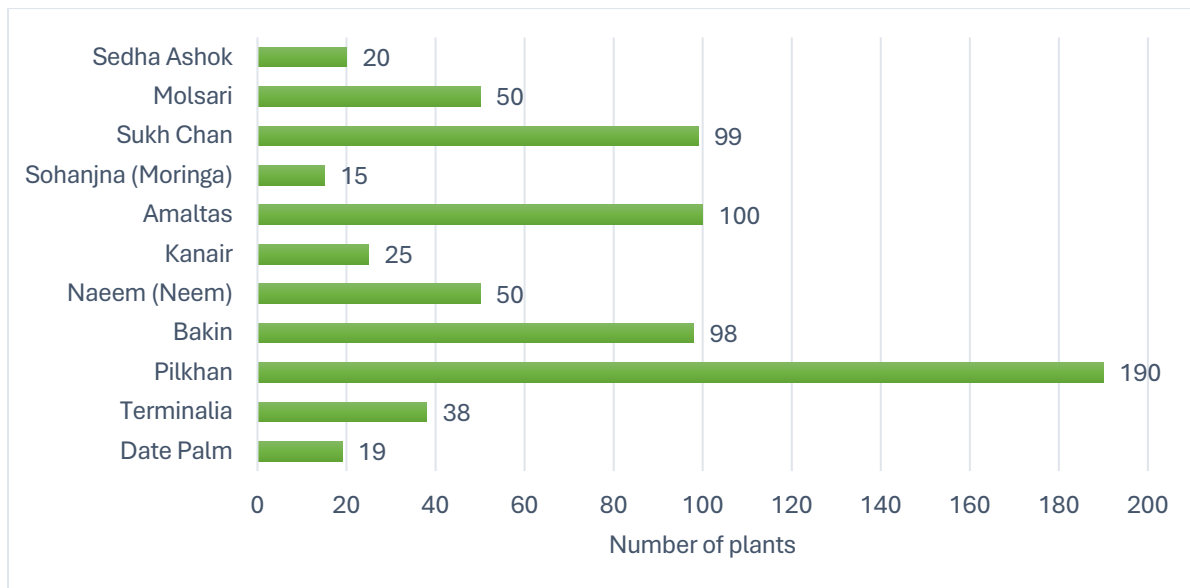


Figure 27: Most Abundant trees of Model Town C Block Park, Multan

The Park is home to a variety of birds, including owls and little egrets, and currently has 1 active nest. The Park is well-maintained, with an active water body that contributes to The Park's ecosystem, providing a pleasant environment for both visitors and wildlife. Additionally, the washrooms are functional, ensuring visitors have basic amenities.

Model Town C Block Park offers a peaceful and well-kept space for relaxation and nature appreciation. The diverse plant life, functioning water body, and healthy birdlife make it a welcoming spot for daily visitors.

The Menhinick index (0.60) shows relatively low species richness compared to the total number of individuals, indicating some species dominate. The Shannon-Wiener index (2.18) suggests moderate diversity, reflecting varied species abundance but with a few very common ones like Pilkhan. The evenness index (0.79) means the distribution of individuals among species is somewhat uneven, with some species more abundant.

4.6.9 Khawaja Masood Park

This Park covers an area of 2.75 acres and attracts around 500 visitors. The Park features a diverse selection of trees, including 4 Date Palms, 5 Jaman (Jamun), 1 Moor Pankh, 19 Pilkhan, 1 Bargdh, 1 Pipal (peepal), 1 Naeem, 12 Bakain, 11 Kanair, 7 Bottle Brush, 15 Tali, 11 Habiscus, 4 Amaltas, 10 Terminalia, 6 Ashok, 3 Mango, 2 Sukh Chain, 2 Gold Mohar, 9 Gatrofa, and 20 Alstonia.

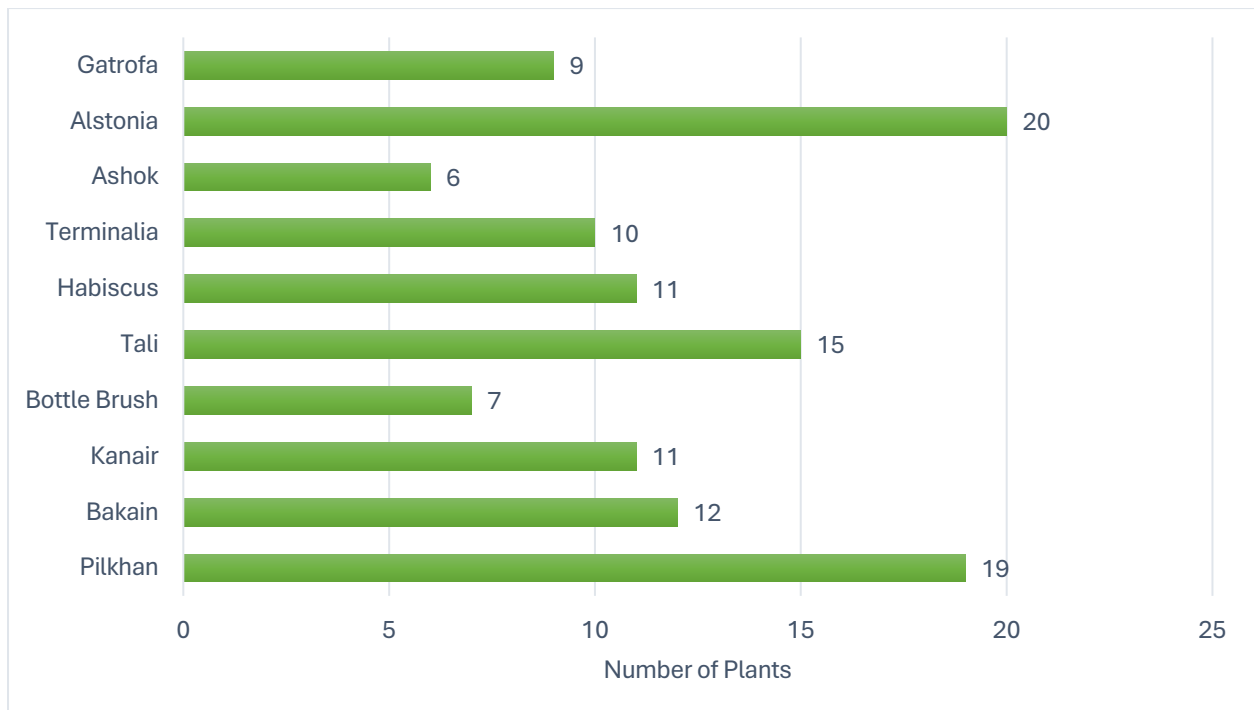


Figure 28: Most Abundant trees of Khawaja Masood Park, Multan

The Park is home to various bird species, including Red-vented Bulbul, Sparrow, Crow, Yellow-vented Bulbul, Kites, Pigeon, Dove, Owl, and Mayna. There is 1 active bird nest in The Park. The water system in The Park is functional, helping maintain a natural environment for both visitors and wildlife. However, there are no washroom facilities available.

The Menhinick index (1.71) shows good species richness relative to the total individuals. The Shannon-Wiener index (2.86) indicates high diversity with many species and balanced abundances. The evenness index (0.97) reflects an almost equal distribution of individuals among species, meaning no single species dominates.



Figure 29: Glimpse of assessment of Khawaja Masood Park

4.6.10 Am Khas Park

Am Khas Park covers an area of 7.5 acres and attracts around 700-800 visitors daily. The Park is well-maintained with 5 gardeners (Malis). It is home to a wide variety of trees, including 12 Tali, 7 Gab, 55 Ashok, 4 Mango, 12 Shatoot, 20 Sukh Chain, 2 Bord, 8 Pipal (with a trunk diameter of 188 inches), 1 Arjun, 1 Putajun, 8 Alstonia, 40 Terminalia, 12 Pilkhan, 20 Bakain, 2 Naeem, 15 Bottle Brush, 4 Jaman (Jamun), 22 Safaida, 1 Gul-e-Nashtar, 1 Date Palm, 2 Kachnar, 12 Amaltas, 6 Sohanjna (Moringa), 12 Molsari, 3 Beri, and 2 Gold Mohar.

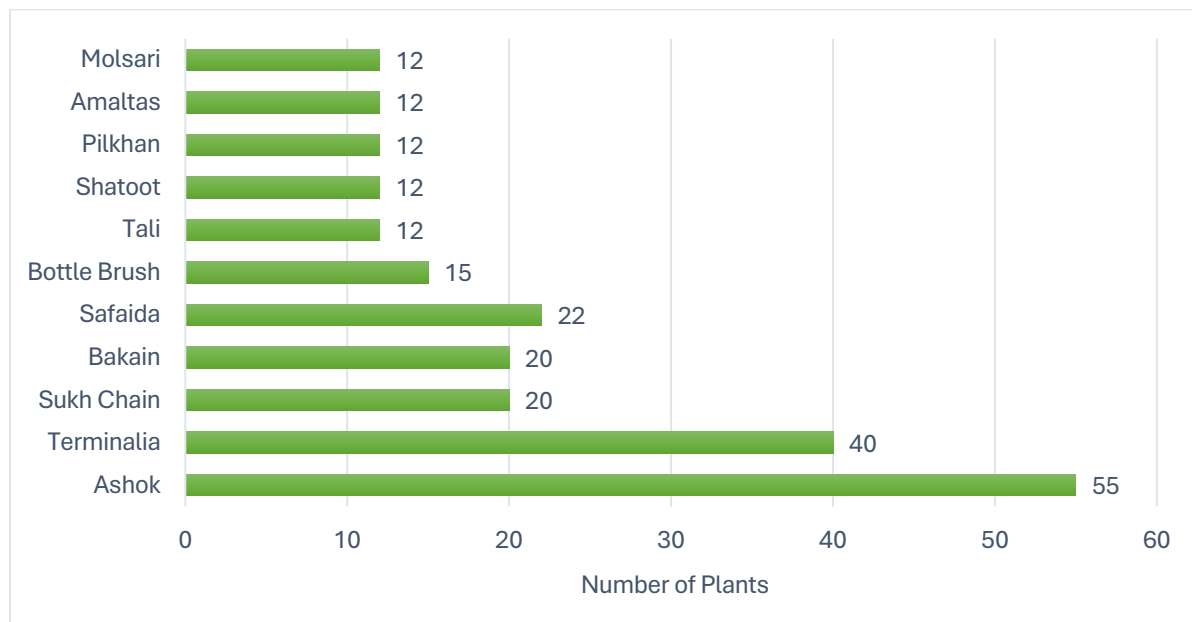


Figure 30: Most Abundant trees of Am Khas Park, Multan

The Park is home to a variety of bird species, including owls, koel, bulbul, sparrow, parrot, kites, crows, myna and others. There are currently 2 active bird nests in The Park. Additionally, there are two Miyawaki forests, which contribute to biodiversity and ecological sustainability.

The Park has a functional water system that helps maintain the natural environment, and the washrooms are operational, providing convenience for visitors. With its extensive flora, active water system, and diverse birdlife, Am Khas Park offers a great space for nature lovers and a well-maintained recreational area for the community.

The Menhinick index (1.44) shows moderate species richness relative to the total number of individuals. The Shannon-Wiener index (2.61) indicates a fairly diverse community with a variety of species and balanced abundances. The evenness index (0.80) suggests individuals are somewhat evenly distributed across species, though some are more abundant.

4.6.11 Albadar Park

This Park covers an area of 4.5 acres and features a selection of trees, including 51 Terminalia, 11 Pilkhan, 3 Sukh Chan, 2 Ulta Ashok, 1 Sohanjna (Moringa), 2 Bakain, and 2 Kanair. The Park is well-maintained with functional washroom facilities, ensuring a convenient experience for visitors. Though the tree variety is more limited compared to other parks, Albadar Park still provides a peaceful

environment for nature lovers. The presence of well-maintained amenities adds to the overall visitor experience.



Figure 31: Glimpse of assessment of Albadar Park

The Menhinick index (0.82) shows low species richness relative to total individuals, indicating few species dominate. The Shannon-Wiener index (1.01) reflects low diversity, mainly due to the overwhelming presence of *Terminalia*. The evenness index (0.52) reveals uneven distribution, with one species dominating the community.

4.6.12 K Block Park in Shah Rukne Alam

This Park spans 6 acres, but it is located on a former dumping site, which has led to challenges in its development. Due to the soil quality and The Park's history, it remains underdeveloped. The Park features a variety of trees, including 2 *Alstonia*, 21 *Terminalia*, 22 *Conocarpus*, 17 *Kanair*, 1 *Amaltas*, 1 *Pilkhan*, and 1 *Sukh Chain*. However, due to the poor soil conditions, the growth of these trees may be affected. One of the key issues identified is that the soil needs to be filled with better quality mud to improve the overall health of the vegetation.

Additionally, the washroom facilities are currently non-functional, which is another area that needs attention. Despite these challenges, The Park holds potential, and addressing the soil issue and restoring the washroom facilities could help in developing The Park into a more inviting green space for the community.



Figure 32: Glimpse of assessment of K Block Park in Shah Rukne Alam

The Menhinick index (0.87) indicates low species richness relative to total individuals. The Shannon-Wiener index (1.39) shows moderate diversity, with a few species more common. The evenness index (0.71) suggests a somewhat uneven distribution, where some species dominate but others are present.

4.6.13 Jinnah Park

Jinnah Park covers an area of 28 acres, although encroachment and construction have reduced the usable space by 3 acres. The Park is home to a variety of trees, including 60 Pilkhan, 7 Pipal, 120 Conocarpus, 12 Naeem, 55 Bakain, 16 Alstonia, 1 Gab, and 9 Date Palms. The Park also features functional washrooms and a working water body, providing a pleasant environment for visitors.

In addition to its rich flora, Jinnah Park is home to a variety of birds, including crows, sparrows, bulbul, kites, doves, and pigeons. These birds contribute to The Park's vibrant ecosystem, which is further supported by the 29 kanal Miyawaki forest—the largest of its kind in Multan. This forest, with over 50,000 plants, significantly enhances The Park's biodiversity, offering a habitat for both flora and fauna.



Figure 33: Glimpse of assessment of K Block Park in Jinnah Park

With its diverse tree species, thriving birdlife, functional amenities, and the expansive Miyawaki forest, Jinnah Park stands as a notable green space in Multan. Continued preservation and management of The Park are essential to maintaining its ecological value and ensuring it remains a valuable recreational area for the community.

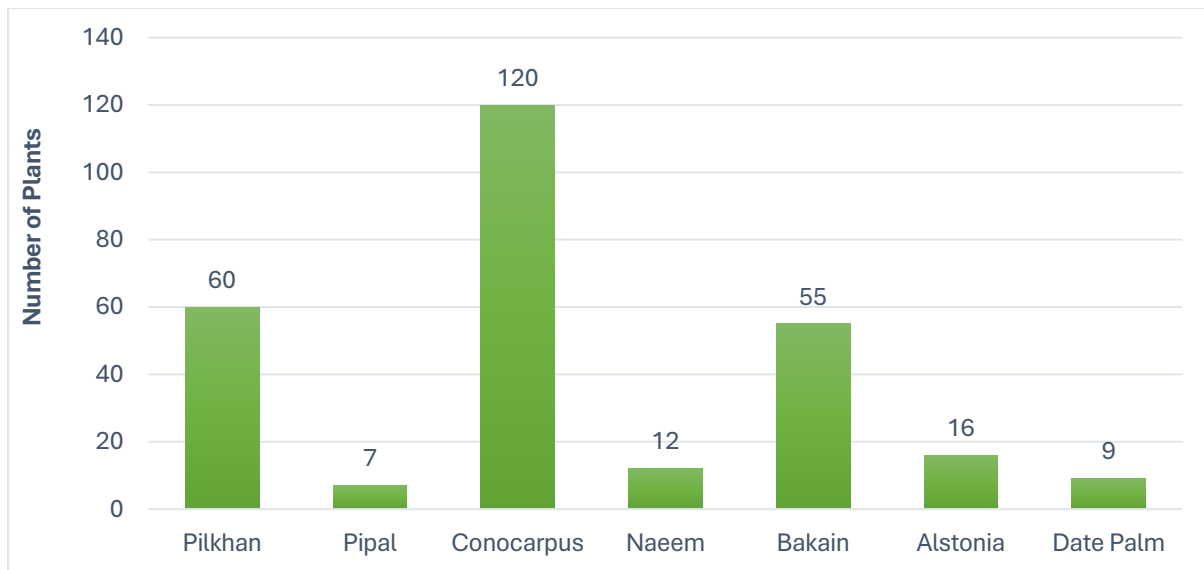


Figure 34: Most Abundant trees of Jinnah Park, Multan

The Menhinick index (0.48) indicates low species richness relative to total individuals. The Shannon-Wiener index (1.52) shows moderate diversity, reflecting dominance by a few species. The evenness index (0.73) suggests a fairly balanced distribution, though some species are more abundant.

4.6.14 Shah Shams Park

This Park is located near Eid Gah Road. This Park is among the largest parks of Multan consisting of approximately 48 Acres. Main feature of The Park is the presence of mini Zoo. Animals and captive birds are the source of public attraction in The Park. Avian diversity of The Park natural area include House Sparrow, Common Myna, Sun Bird, Bulbul, Little Egrets, Red wattled Lapwing, Laughing Dove, black kite, owl, Indian Robin. Animals and fauna diversity in captivity was also recorded consisting of Hog deer, Black Buck, Ostrich, Monkey, Chinkara deer, Geese, Dove, Parrots, Peacock, Black Partridge, Grey Partridge and Pheasants.

Park is consisting of vast area and facing issues of water distribution channels, urban transport smoke and noise pollution, exotic trees and plants introduction, Unwariness, lack of boundary protection and proper signage. Flora diversity such as Abiscus, Gold Mohar, Ashok, Amaltas, Peepal, Bottle Brush, Terminalia and many exotic ornamental plants. Big trees are present in The Park which can be proposed for nesting sites to enhance bird's fauna. Vast area is occupied by artificial lake which is completely dry. Functional lake can enhance the biodiversity of Multan.



Figure 35: Glimpse of assessment of Shah Shams Park

4.6.15 Madni Park

Madni Park is located alongside Shah Rukn-e-Alam Road covering an area of 6 Acres. Major Flora diversity of The Park is consisting of tree species such as Alstonia, Ashok, Amaltas, Sheesham, Peepal. Bird's diversity seen in The Park area is Common Myna, Sunbird, Rock Pigeon, Black Kite, Red Vented Bulbul, Yellow Vented Bulbul, Laughing Dove and Crow. Water System is nonfunctional in The Park and there is no water availability for fauna diversity. Big trees are present in The Park which can be used to introduce nesting sites. Transport Noise, smoke pollution, and solid waste are the major issues of The Park.



Figure 36: Glimpse of assessment of Madni Park

4.6.16 T-Block Park or Haji Ground (New Multan Colony)

It is small park consisting of approximately 3 Acres. There was no water availability in The Park. The existing minor water facility was nonfunctional. Tree species present include Indian Glue Berry or Lasura, Board, Pilkan, sheesham, Amaltas, Alstonia etc. Bird's diversity seen in The Park area is Common Myna, Sunbird, Black Kite, Yellow Vented Bulbul and Crow. Active kite nest was recorded during the survey. Hoopoe Species were also recorded in The Park. Presence of Lasura tree act as food materials for birds and hence The Park have hoopoe and laughing dove diversity. Water system and signage unavailability, Solid Waste, broken fencing, Native flowering and fruit trees unavailability and lack of staff are the major issues of The Park.



Figure 37: Glimpse of assessment of T-Block Park or Haji Ground (New Multan Colony)

4.6.17 Qila Kuhna Qasim Bagh

This Park is also among the largest parks of city Multan. It lies in the boundary of Multan fort. It is divided into different zones. The main feature of the Bagh is the presence of 3 Miyawaki forest areas. Miyawaki areas are the source of biodiversity richness and shelter for avian and small biodiversity. Major fauna diversity observed at the site include Black kite, Common Myna, Sparrow, Rock Pigeon, Sun Bird, Dove, Bulbul, Koel, Squirrel, Butterfly and many insects hovering over the ornamental plants. Flora diversity observed in the bagh include Alstonia, Ashok, Peepal, Amaltas, Sheesham, Molsary, and many ornamental and exotic flowering plants. Park is consisting of vast area and facing issues of water distribution channels, urban transport smoke and noise pollution, exotic trees and plants introduction, Unwariness, lack of boundary protection and proper signage. Native flowering and fruit trees unavailability and lack of staff are the major issues of The Park.

4.7 Health & Wellbeing Impact Assessment

Health and well-being assessment in Multan is essential due to the city's increasingly challenging environmental conditions, including high pollution levels, rapid urbanization, and a significant reduction in green spaces. These factors collectively have a negative impact on the physical and mental health of residents. Surveys conducted in various public parks reveal that most visitors perceive green spaces as vital to their mental restoration and physical well-being, offering relief from daily stress and enhancing their overall quality of life. Hussain et al.¹⁹ used satellite imagery and spatial analysis to estimate the green coverage across Multan, reporting that green spaces including public parks, vegetation, and tree-lined avenues cover only about 1.23% to 1.5% of the total urban area. This is significantly below the 9 square meters per person (0.9 hectares per 1,000 people) recommended by the World Health Organization (WHO) for urban areas. This disparity highlights an urgent need to expand green infrastructure across the city.²⁰

The city's green coverage is further threatened by unplanned urban expansion from 76 sq. km in 2005 to 260 sq. km in 2015 which continues to consume open and vegetated land (The Express Tribune, 2018). In response to these issues, the High Court has ordered initiatives to transform Multan into a Green City, with plans to enhance vegetation along major roadways and improve air quality.²¹ The Parks and Horticulture Authority (PHA) Multan also supports this goal, with ongoing projects to develop and restore public parks (PHA Multan, n.d.). Addressing these gaps in green space distribution and quality is crucial for advancing the health, livability, and resilience of Multan's urban environment.

The spatial relationship between population density and access to green spaces across Multan City is depicted in map provided as (Figure 38). The categorization of the availability to the population is

¹⁹ Hussain, M., Shahid, M., & Zubair, M. (2023). Biodiversity and quality of urban green landscape affect mental restorativeness of residents in Multan, Pakistan. *Frontiers in Sustainable Cities*, 5, 1286125. <https://doi.org/10.3389/frsc.2023.1286125>

²⁰ Anum, S., Fatima, S., & Khan, M. (2024). Urban forests and their contribution to sustainable urban development in a global context: A case study of Multan, Pakistan. *Frontiers in Climate*, 6, 1275102. <https://doi.org/10.3389/fclim.2024.1275102>

²¹ ProPakistani. (2025, January 11). Multan to be made Green City on High Court order. <https://propakistani.pk/2025/01/11/multan-to-be-made-green-city-on-high-court-order>

depicted, ranging from white (lowest density) to deep pink (highest density), and overlays the location of urban parks with 400-meter buffer zones to show areas within walkable access to green space. Most parks are concentrated in the central region of the city, with a few scattered in peripheral areas, while the highest population densities are also found in the central and northeastern parts of Multan. The results shows that 0.03 hectares of green space is available per 1000 persons, which is 96.67% less than the standard of 0.9 hectares per 1000 persons as per WHO.

The outcomes highlight the urgent need for urban planners and policymakers to expand the distribution of parks and green spaces, particularly in high-density residential zones. Creating new parks, introducing urban forestry, and developing pocket green spaces within walking distance of all neighborhoods can significantly improve environmental equity and support better health outcomes across Multan's urban population

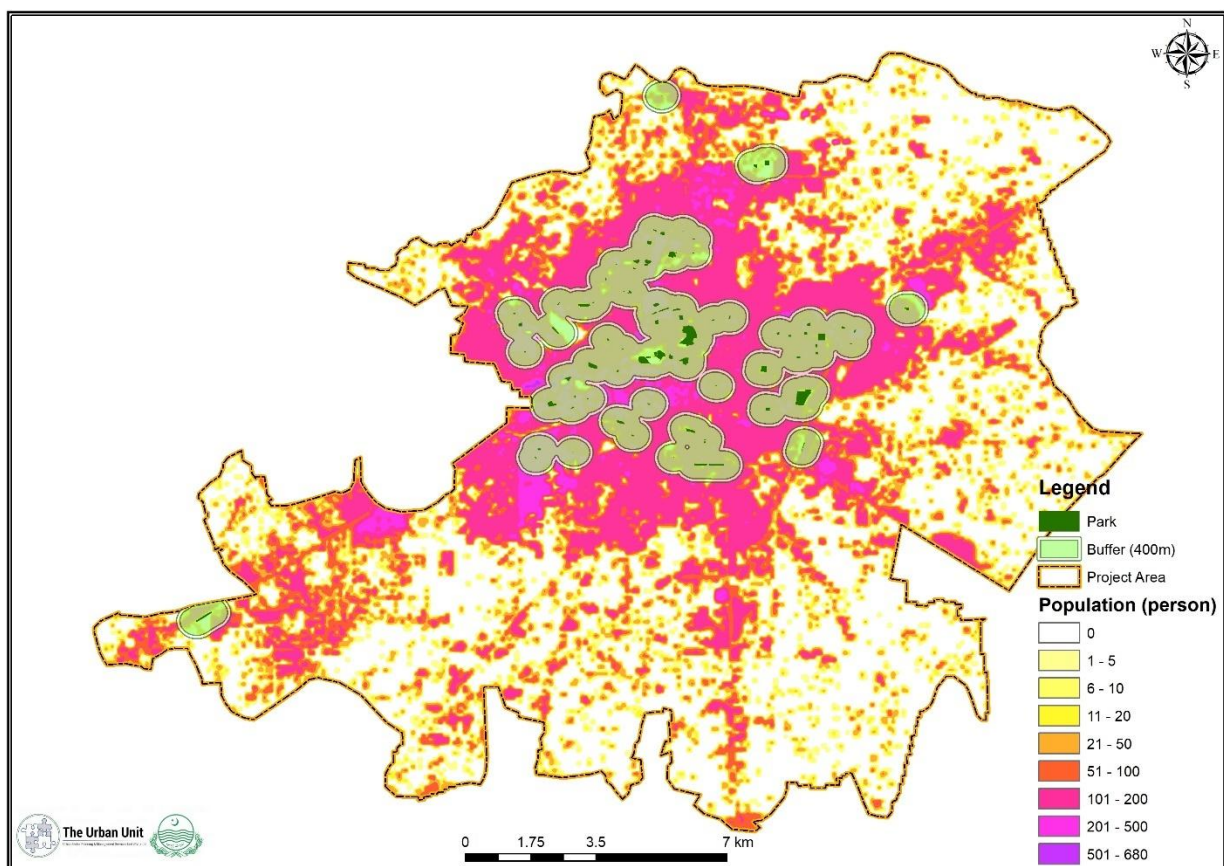


Figure 38: Population living near Green Space and Open Ground in Multan

The loss of water bodies, is reported to be 8.9% in 1990 to only 1.4% in 2020²², further exacerbates environmental challenges, including declining aquatic biodiversity, increased flood risk, and reduced groundwater recharge. This transition indicates that urbanization and land-use conversion have

²² Naeem, Engr & Farid, H. & Madni, Muhammad & Khan, Zahid & Dilshad, Aqsa & Shahzad, Huzaifa. (2022). Remotely sensed image interpretation for assessment of land use land cover changes and settlement impact on allocated irrigation water in Multan, Pakistan. *Environmental Monitoring and Assessment*. 194. 10.1007/s10661-021-09732-5

occurred at the expense of natural and semi-natural ecosystems. The reduction in agricultural and vegetative cover compromises ecosystem services such as carbon sequestration, temperature regulation, and water purification.

Succinctly putting, the comparative map (Figure 39) highlights the intensification of urban sprawl (136.72 sqkm), depletion of tree cover (5.21 sqkm), green spaces (3.35 sqkm), agriculture (70.28 sqkm) and aquatic resources (1.07 sqkm), shows growing ecological imbalance in Multan. This emphasizes an urgent need for integrated land-use planning, green infrastructure, and restoration initiatives to reverse environmental degradation and promote sustainable urban and rural development in the region.

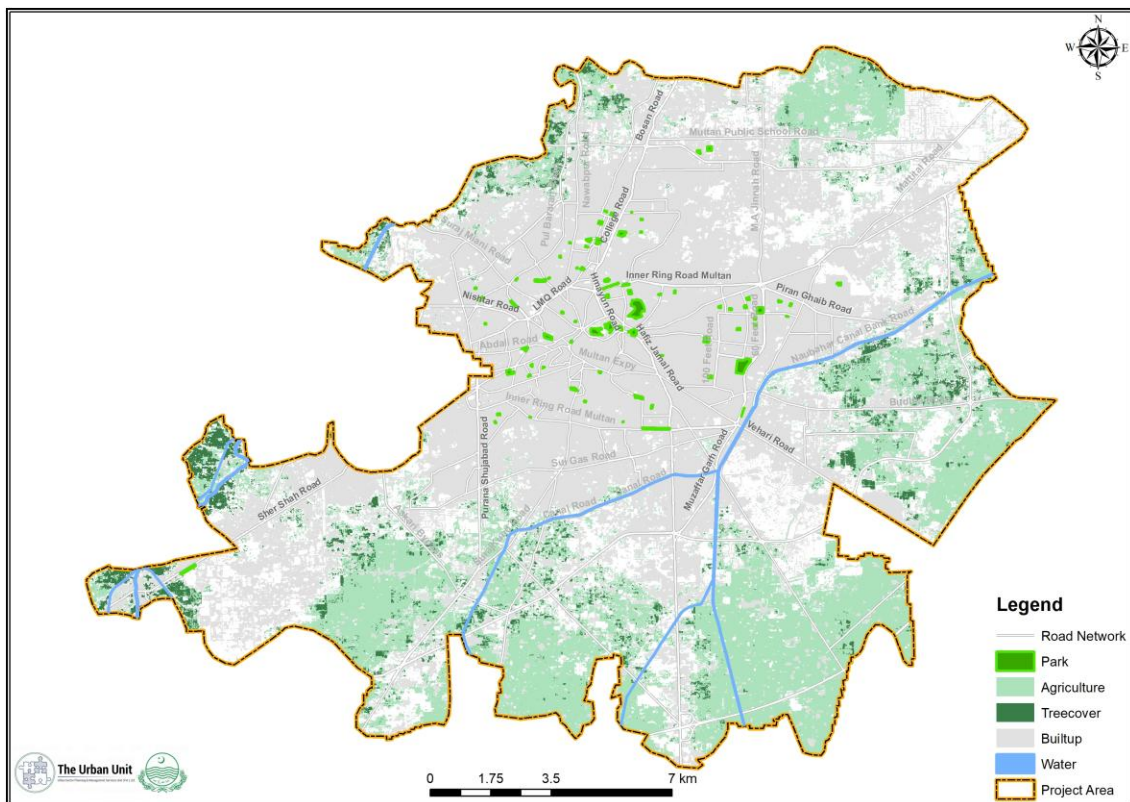


Figure 39: Water Bodies and water permeable areas of Multan

4.8 Temperature

The city experiences a temperature range from 10°C in winter to 47°C in summer, contributing to its significant solar potential for energy generation.²³ See figure below indicating maximum temperature ranges in Multan.

²³ Ahmed, M. A., Alam, S. N., Maliha, A., & Javed, S. ESTIMATION OF GLOBAL AND DIFFUSE SOLAR RADIATION FOR MULTAN, PUNJAB, PAKISTAN.

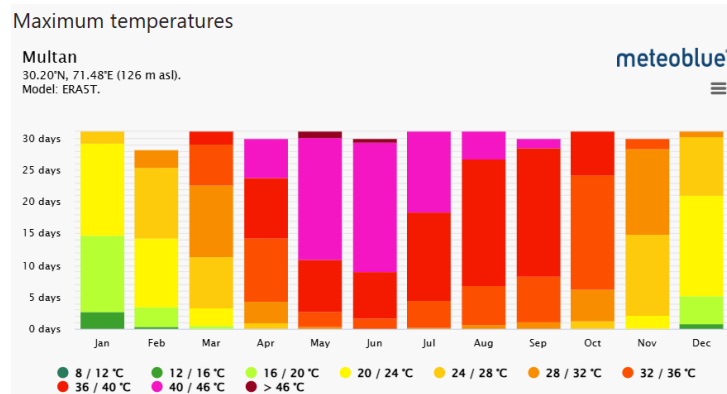


Figure 40: Temperature variation in Multan

Multan experiences a hot desert climate, characterized by extremely hot summers and mild winters. The city is widely recognized as one of the hottest regions in Pakistan. Average annual precipitation is relatively low, measuring around 186 millimeters (7.3 inches), making rainfall a rare and seasonal occurrence.²⁴

The summer season, particularly in May and June, is marked by intense heat waves, with June being the hottest month, recording an average temperature of 35.5°C. Historical extremes underline the city's extreme climate, with temperatures reaching as high as 52°C (126°F). For example, Multan recorded 50°C (122°F) in late May 2010 and 49.8°C (121.6°F) in early June 1994. Although the Indian monsoon from July to September brings some relief by slightly lowering the temperature, the absence of nearby large water bodies means that the cooling effect is limited, and conditions remain oppressively hot and humid.

Winters, spanning December to February, are generally mild but can occasionally turn chilly, especially at night, when cold air masses drift in from the north. January is the coldest month, with average temperatures around 13.2°C, though lows can drop significantly. In January 2008, the temperature plunged to -1.6°C (29°F), among the coldest ever recorded in the city. During winter, dense fog often forms at night and in the early morning, particularly from mid-December to mid-January. On such foggy days, maximum daytime temperatures may remain around 10–12°C (50–54°F), contributing to an extended period of cold discomfort.

Spring arrives with rapidly rising temperatures, transitioning quickly into the searing summer months. Rainfall during winter and spring is infrequent, typically associated with Mediterranean-origin weather systems. Overall, Multan's climate poses unique challenges for urban living, agriculture, and infrastructure due to its extreme heat, low rainfall, and seasonal weather variability.²⁵

²⁴ <https://www.climatestotravel.com/climate/pakistan/multan>

²⁵ <https://multan.punjab.gov.pk/climate>

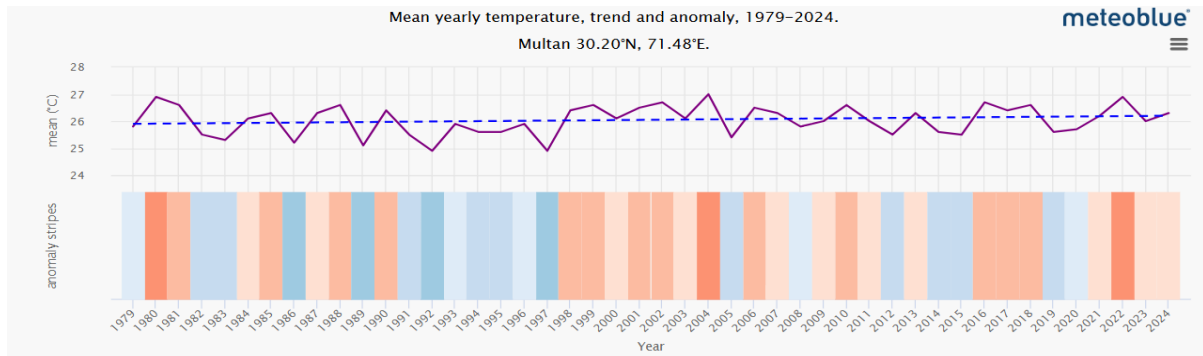


Figure 41: Mean yearly temperature, trend and anomaly (1979-2024)

The yearly temperature graph (1979- 2024) depicting mean annual temperature trends for the Multan region provides a visual representation of how the climate has evolved over time. The (Figure 41) represents an estimate of the average yearly temperatures, The climate strips show average temperature variation, with blue color indicating cooler years and red color shows signified warmer ones. In Multan's case, a shift from blue to deep red over time illustrates the clear warming pattern affecting the city. This visual evidence strongly supports the observation that Multan's climate has warmed steadily in recent decades, consistent with broader regional and global climate change trends

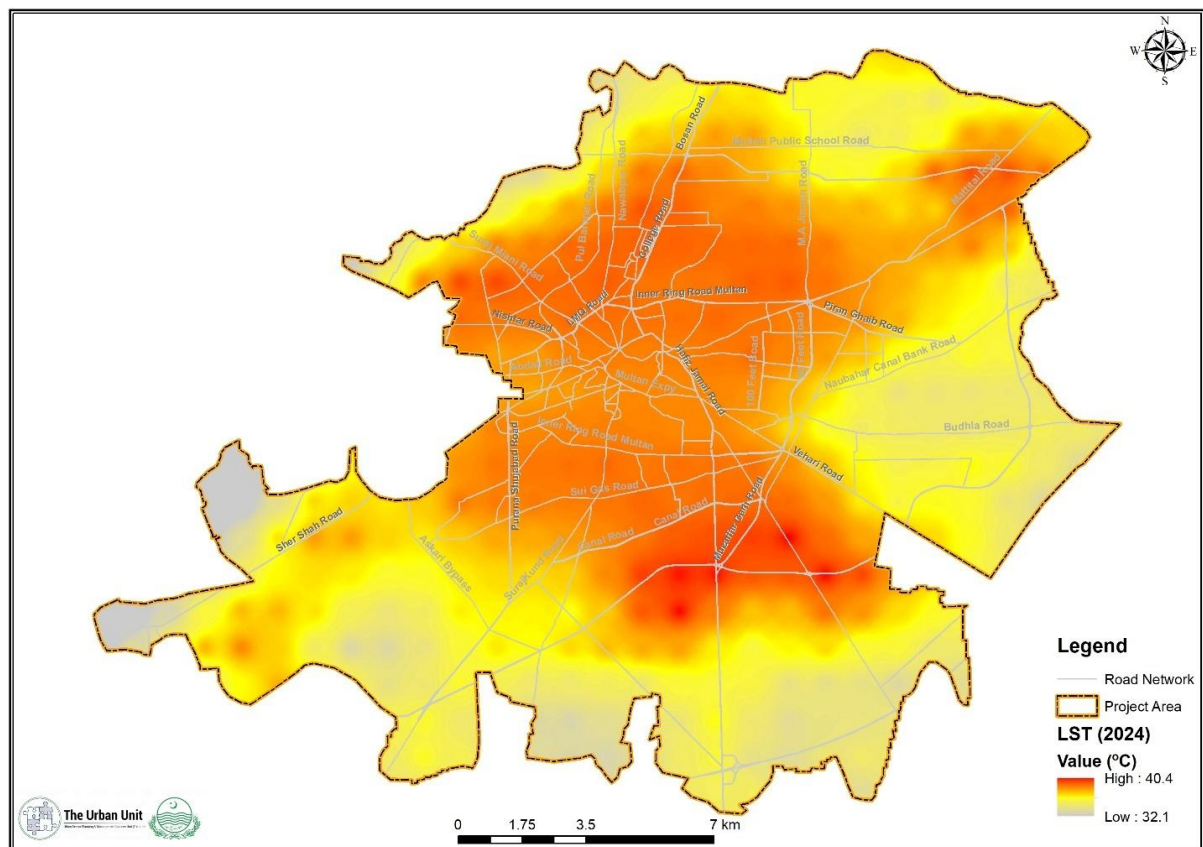


Figure 42: Land surface temperature (LST) of Multan

The (Figure 42) illustrates the Land Surface Temperature (LST) distribution in Multan City for the year 2024, depicting spatial temperature variations across the urban landscape. The map shows gradient

change ranges from yellow to deep red to represent temperature intensity, where yellow indicates lower surface temperatures (around 32.1°C) and deep red marks higher temperatures (up to 40.4°C). The overlaid road network and project area boundaries contextualize the thermal patterns within the urban fabric. The analysis reveals that central and densely urbanized zones of Multan, such as those surrounding Bosan Road, Gulgasht Colony, and areas near the city center, exhibit higher surface temperatures, forming prominent Urban heat islands (UHI). These hotspots are associated with heavy built-up areas, minimal vegetation, and high population density. Conversely, the outer peripheral regions, especially toward the northeast and southwest, exhibit comparatively lower surface temperatures, likely due to the presence of more open land, vegetation, and reduced construction density.

4.9 Precipitation

Multan's climatic profile includes an average annual temperature of approximately 25.6 °C, with mean annual rainfall around 175 mm. The city receives its highest monthly rainfall in July, averaging 50 mm, while October is typically the driest month, with only 2 mm of precipitation recorded.

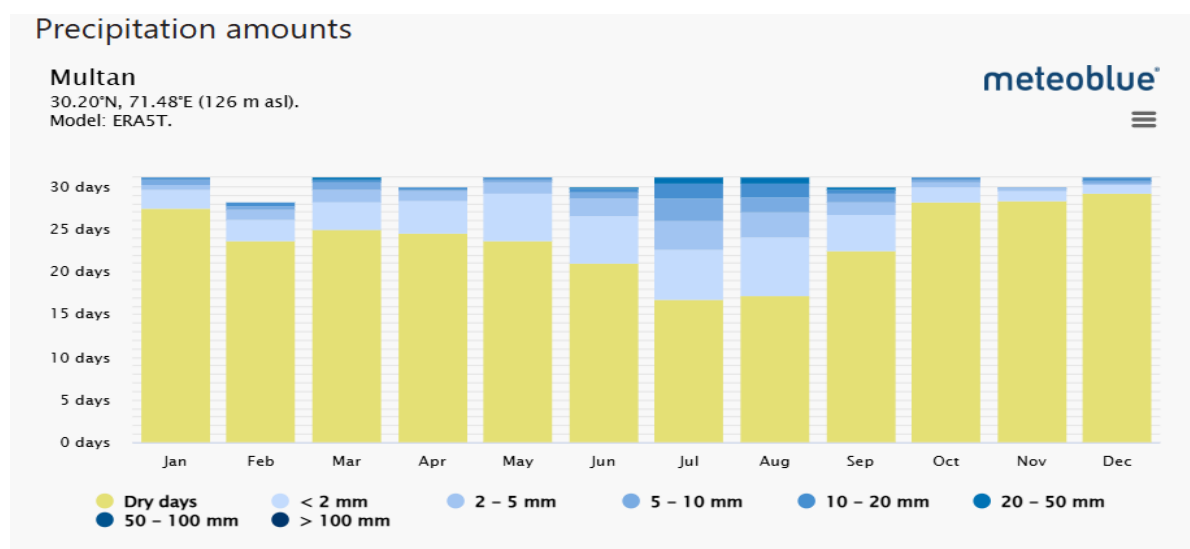


Figure 43: Annual precipitation of the Multan

In 2022, Multan experienced a total rainfall of approximately 487 mm, significantly exceeding its long-term average of 126 mm. This anomaly was largely attributed to intensified monsoon activity and persistent low-pressure systems, signaling a possible shift in precipitation patterns driven by climate change.²⁶ Over the past four decades, however, the broader trend in Multan indicates a general decline in precipitation levels, particularly during the warm-wet season. This trend has been exacerbated by rapid urban expansion, which has led to increased surface runoff and decreased groundwater

²⁶ You, X. (2023). *Climate Variability and Extreme Rainfall Events in South Asia: Evidence from Multan, Pakistan*. *Journal of Climate Dynamics*, 60(1), 89–105.

infiltration.²⁷ While certain years or seasons may witness episodic increases in rainfall, the overall climatic tendency suggests a reduction in sustained precipitation.²⁸

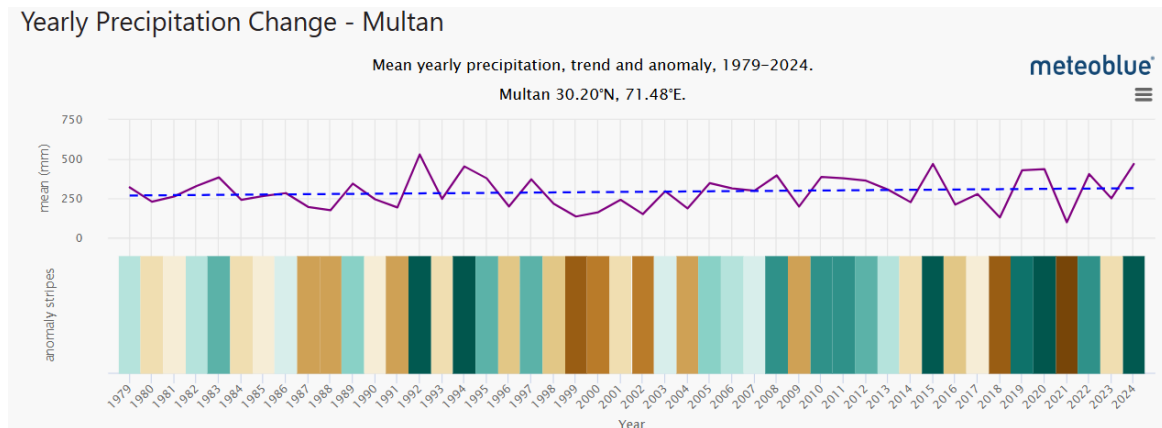


Figure 44: Annual Precipitation in Multan

The above yearly precipitation trend (1979 to 2024) graph illustrating mean total annual precipitation for the Multan provides insights into changing rainfall patterns over time. A dominance of brown shades would highlight a trend toward increasing dryness, while more green stripes would suggest intermittent or rising rainfall. This graphic presentation provides a compelling visual summary of Multan's shifting rainfall patterns, helping to understand how climate change may be affecting water availability and ecological conditions in the region.

²⁷ Abbas, A., Hussain, M., Qamar, R., & Rizwan, M. (2022). Impact of Urbanization on Hydrological Responses in Semi-Arid Regions: A Case Study of Multan, Pakistan. *Environmental Monitoring and Assessment*, 194(6), Article 412. <https://doi.org/10.1007/s10661-022-10034-9>

²⁸ Nusrat, R., Ahmed, S., & Ali, M. (2022). Trends in Rainfall and Temperature in South Punjab: Implications for Agricultural Planning. *Pakistan Journal of Meteorology*, 19(37), 12–21.

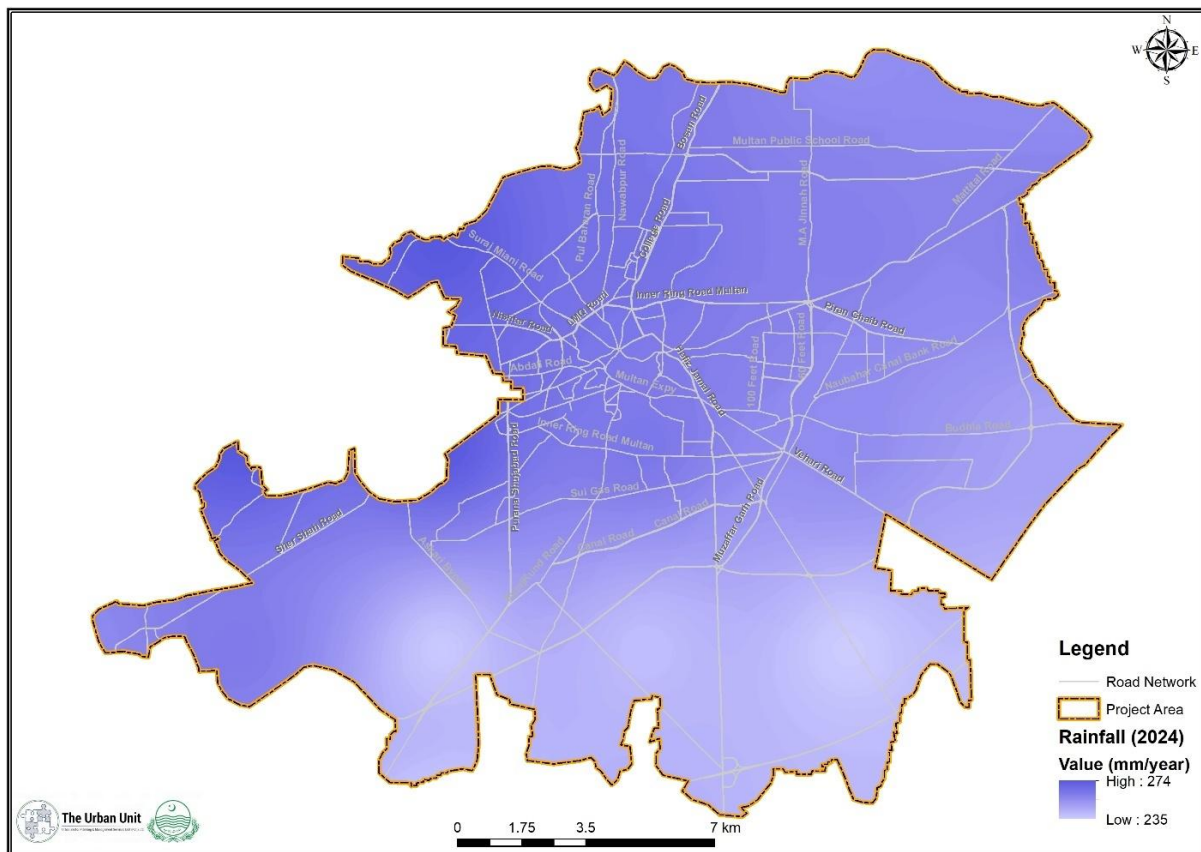


Figure 45: Rainfall pattern in Multan

The (Figure 45) illustrates the annual precipitation distribution across Multan City for the year 2024. The map represents rainfall intensity, where lighter shades indicate lower precipitation of min (235 mm/year) to the darker shades signify relatively higher rainfall of maximum (274 mm/year). Overall, results demonstrate higher precipitation levels in the southwestern pockets (i.e., Sher Shah Road, Nishtar road areas), and lowest southeastern zones (i.e., Askari Bypass, Muzafar Garh road). However, the difference in rainfall across the urban extent is modest, which aligns with Multan's typical climate characteristics of low and spatially consistent rainfall.

The low rainfall levels, when combined with high summer temperatures and rapid urbanization, increase pressure on groundwater resources and make rainwater harvesting, water-efficient urban planning, and sustainable stormwater management essential for future resilience. It also supports evidence from long-term climate analyses that show precipitation in Multan is both limited and variable, demanding proactive water resource planning in the face of climate change.

4.10 Soil

The soils of Multan predominantly consist of clay loam, characterized by a moderately calcareous nature with pH levels ranging from 8.2 to 8.4. Organic matter content is generally low, typically under 0.75%. However, variations in soil texture are observed across different areas. For instance, a study by

Akhtar et al.²⁹ found that peri-urban soils in Multan exhibited 14% sand, 65.5% silt, and 24.5% clay, classifying them as silt loam. Additionally, an analysis of heavy metal concentrations in peri-urban soils reported an average clay content of 23.51%, silt at 38.2%, and sand at 32.4%, with an average organic matter content of 1.7%. These soil characteristics influence agricultural productivity and environmental sustainability in Multan. The low organic matter content can limit soil fertility, affecting crop yields. The moderately alkaline pH may also influence nutrient availability and microbial activity. Understanding these soil properties is crucial for effective land management and agricultural planning in the region.³⁰

Illustrated Soil Profile of Multan City



The soil profile of Multan City is predominantly composed of alluvial deposits brought by the Indus River system, particularly the Chenab River, which flows near the city. These soils are formed over centuries through the deposition of fine sediments and are classified as part of the Indo-Gangetic Plains, one of the most fertile regions in South Asia. The soils in Multan are generally loamy to silty, with a mixture of silt, sand, and clay, offering good water retention and moderate drainage capacity. In some areas, particularly those under intensive irrigation or with poor drainage, salinity and sodicity can be present, which affects soil productivity. The topsoil layer, which typically ranges from 15 to 30 cm in depth, is rich in organic matter in agricultural zones but often lacks sufficient organic content in urban and barren

²⁹ Akhtar, S., Munawar, S., & Irum, S. (2016). Chelating Impact Assessment of Biological and Chemical Chelates on Metal Extraction from Contaminated Soils. *Pakistan Journal of Botany*, 48(2), 551–558. Retrieved from https://www.researchgate.net/figure/Texture-of-soil-sample-of-peri-urban-area-of-Multan-The-values-for-sand-silt-and-clay_fig1_273158081

³⁰ https://www.researchgate.net/publication/284625320_Heavy_Metal_Concentration_in_Peri-urban_Soils_and_Crops_under_Untreated_Wastewater

areas due to overuse and limited replenishment. The subsoil layers usually contain higher levels of clay and salts, which can influence root penetration and groundwater movement. These soils are highly suitable for agriculture, especially for crops like wheat, cotton, sugarcane, and mangoes, which dominate the regional economy. However, continuous cultivation, over-irrigation, and unregulated urban expansion have led to issues such as soil compaction, erosion, and declining fertility in several parts of the district. Overall, the soils of Multan provide a productive foundation for agriculture, but they require sustainable management practices including organic matter restoration, salinity control, and reduced chemical inputs to maintain their long-term fertility and ecological function in the face of environmental stress and urbanization.³¹

4.11 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 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.

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 Multan 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 Multan city obtained

a total of **46** points 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.

³¹ Aziz, M., Khan, T. A., & Ahmed, T. (2017). Spatial interpolation of geotechnical data: A case study for Multan City, Pakistan. *Geomechanics and Engineering*, 13(3), 475-488.

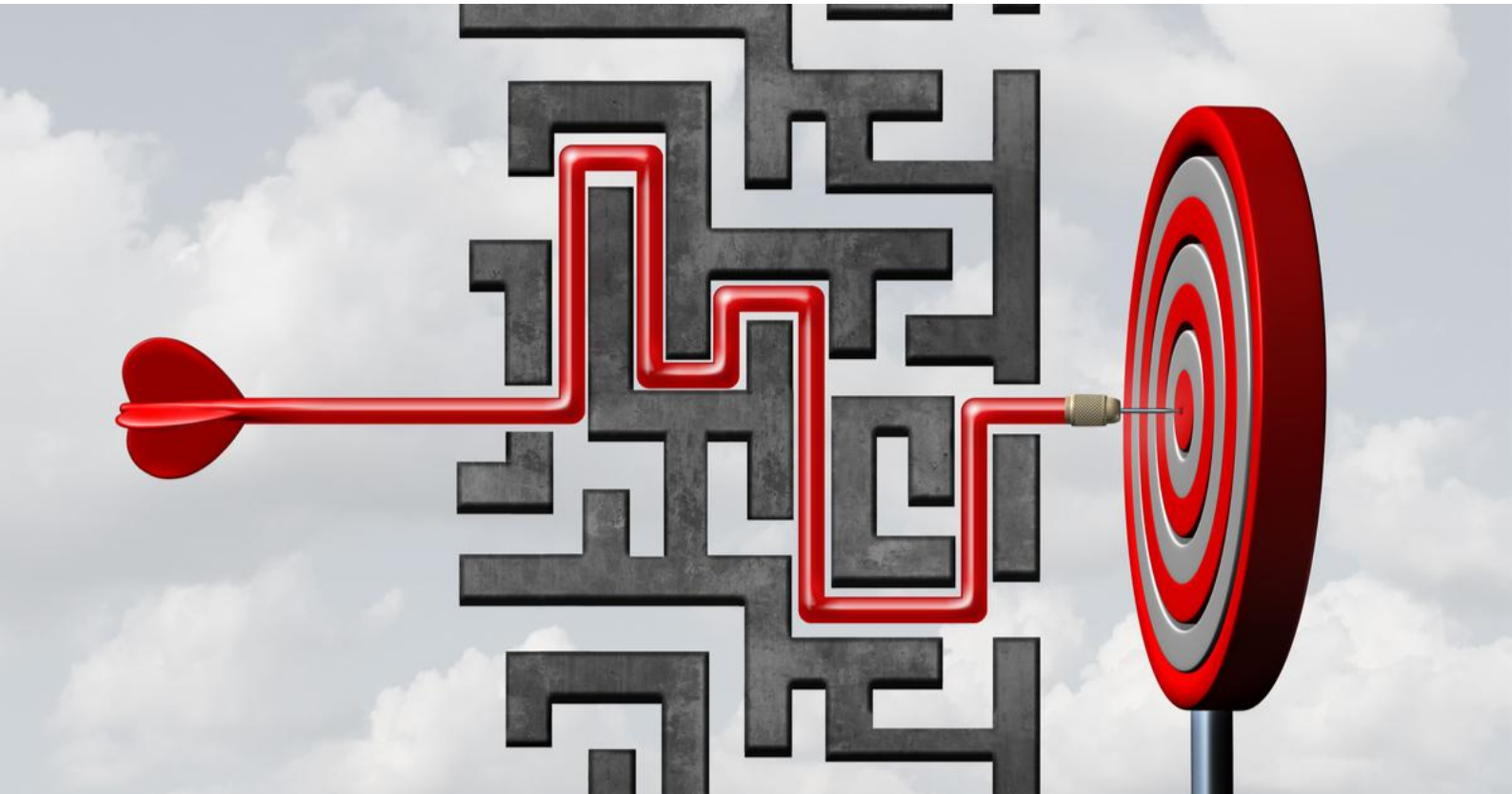
Table 2: City Biodiversity index of Multan

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	1
	3	Native Biodiversity in Built Up Areas (Bird Species)	4 Points	4
	4	Change in Number of Vascular Plant Species	4 Points	1
	5	Change in Number of Native Bird Species	4 Points	4
	6	Change in Number of Native Arthropod Species	4 Points	0
	7	Habitat Restoration	4 Points	1
	8	Proportion of Protected Natural Areas	4 Points	1
	9	Proportion of Invasive Alien Species	4 Points	2
Ecosystem Services provided by Biodiversity	10	Regulation of Quantity of Water	4 Points	1
	11	Climate Regulation Benefits of Trees and Greenery	4 Points	0
	12	Recreational Services	4 Points	0
	13	Health and Wellbeing Proximity/Accessibility to Parks	4 Points	0
	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	2
	21	Policy and/or Incentives for Green Infrastructure as Nature-based Solutions	4 Points	0
	22	Cross-sectoral and Inter-agency Collaborations	4 Points	2
	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	46



Figure 46: City Biodiversity Index of Multan

Issues & Challenges



Multan faces critical environmental challenges impacting ecosystem services, biodiversity, and ecotourism potential. Rapid urbanization, loss of green spaces, and pollution have degraded natural habitats and disrupted services like flood control and urban cooling. Biodiversity is declining due to habitat loss and wastewater irrigation. Despite its rich cultural heritage, ecotourism remains underdeveloped due to environmental neglect and poor planning. Effective management, restoration of green areas, and integrated urban policies are essential to protect ecosystem services and promote sustainable development. Addressing these issues is vital for improving urban resilience, conserving biodiversity, and realizing Multan's potential as an ecotourism destination.

5.1 SWOT Analysis

The SWOT analysis of Multan 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 • Biodiversity Presence: Parks such as Shah Shams Park, Aam Khas Park, and Qila Kuhna Qasim Bagh support a diverse range of bird species (e.g., sunbirds, bulbuls, hoopoe, kites) and even captive wildlife (e.g., ostriches, deer, pheasants). • Tree Diversity: Many parks feature rich flora, including native and ornamental species like Peepal, Amaltas, Bottle Brush, Terminalia, and Gold Mohar (e.g., Arts Council Park, Gol Bagh Park). • Public Access & Use: High footfall indicates community engagement—500 to 800 visitors daily in Aam Khas Park and 600–700 in Bagh Langay Khan. • Miyawaki Forests: Initiatives like in Jinnah Park and Qila Kuhna Qasim Bagh showcase progressive urban forestry, enhancing ecological functions and carbon sequestration. • Functioning Infrastructure in Some Parks: Parks like Model Town C Block Park, Jinnah Park, and Arts Council Park have well-maintained facilities and operational water bodies.	WEAKNESS • Infrastructure Issues: Many parks suffer from non-functional water systems, such as in Madni Park, Gol Bagh, and T-Block Park. Others lack washroom facilities (e.g., Jalal Park, Khawaja Masood Park). • Environmental Degradation: Problems such as solid waste, broken fencing, and noise/smoke pollution are common in T-Block Park, Madni Park, and Shah Shams Park. • Lack of Awareness and Maintenance: Parks like Qila Kuhna Qasim Bagh and Shah Shams Park face challenges like poor signage, introduction of exotic species, and insufficient staff. • Encroachment: Jinnah Park suffers from encroachment on 3 acres, reducing usable space. • Unutilized Ecological Features: The dry artificial lake in Shah Shams Park is a missed opportunity for enhancing aquatic biodiversity.
OPPORTUNITIES • Ecotourism Potential: Shah Shams Park's mini-zoo, historic Qasim Bagh Fort, and large green spaces present strong potential for eco-educational tourism. • Avian Conservation: Presence of active nests (e.g., in Jalal Park, T-Block Park) and diverse bird species can promote urban birdwatching and environmental education. • Native Tree Plantation: Introducing fruiting and flowering native trees can attract pollinators and birds, improving biodiversity (identified as a gap in Qila Qasim Bagh and T-Block Park). • Community Engagement: High visitor counts can be leveraged for awareness campaigns, citizen science, and volunteer maintenance programs.	THREATS • Urban Encroachment & Construction: Threatens large parks like Jinnah Park and Shah Shams Park, reducing green space availability. • Pollution: Urban noise, smoke, and solid waste pollution from nearby roads and transport hubs is degrading park environments (e.g., Madni Park, Qila Qasim Bagh). • Water Scarcity: Dry lakes and non-functional water systems limit biodiversity potential and park aesthetics (e.g., Shah Shams Park, T-Block Park). • Invasive/Exotic Species: Over-reliance on species like Conocarpus and other exotic ornamentals may suppress native biodiversity.

- | | |
|---|---|
| <ul style="list-style-type: none">• Expansion of Miyawaki Forests: Proven success in Aam Khas and Jinnah Park can inspire replication across smaller or degraded parks. | <ul style="list-style-type: none">• Lack of Security & Fencing: Stray dogs (Bagh Langay Khan), tilted infrastructure (K Block), and broken fencing reduce safety and discourage visitors. |
|---|---|

Vision & Objectives

7.1 Vision

The Multan – City biodiversity Action Plan is aimed to support the vision: Conservation and revival Multan’s natural habitats, integrated green spaces, enrich native biodiversity, support climate resilience, and sustainable, healthier, and livable urban ecosystem

7.2 Mission

The Multan 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.

7.3 Objectives

- The Multan Biodiversity Action plan is developed to achieve 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

8.1 Habitat & Conservation Areas

The goal of habitat and conservation areas in Multan is to restore, conserve, and sustainably manage key biodiversity zones and urban green spaces to maintain ecological balance and promote native species conservation. Some of the followings are the identified actions and strategies to achieve the objective of the theme.

- Planting native wild species such as Gul Mohar, Neem, Kikar, Sukhchain, Peepal, Amaltas, Pilkhan, and Ber. These native species are well-adapted to the arid conditions of Multan, providing essential shade, supporting local biodiversity, and requiring minimal water and maintenance. Their resilience and ecological benefits make them ideal choices for urban planting and reforestation efforts within the region. These plants also provide vital nectaries for insects and fruits for birds, supporting biodiversity across parks like Shah Shams Park, Qila Kuhna Qasim Bagh, and Jinnah Park. Incorporating native flora will enhance habitat quality and attract species such as bulbuls, sunbirds, and kites observed in these areas.
- Forest plantations in Multan's parks should adopt a stratified approach, promoting vertical habitat layers—from ground cover to large canopy trees—offering nesting and roosting opportunities for urban wildlife including squirrels, bats, and various bird species recorded in Aam Khas Park, Malik Salahuddin Dogar Park, and Bagh Langay Khan.
- To protect native biodiversity, it is crucial to impose strict regulations against introducing exotic species that disrupt natural ecosystems. Multan's urban parks currently host species like Conocarpus and Eucalyptus, which should gradually be replaced by native alternatives to revive indigenous flora and fauna. Retaining deadwood and leaf litter will foster decomposition, supporting insects and fungi critical for the urban food web.
- Ex-situ conservation sites, such as Shah Shams Park's mini zoo, should focus on breeding native species, supported by trained staff and adequate facilities, to promote sustainable wildlife populations. However, issues such as noise pollution and water scarcity affect animal wellbeing, highlighting the need for improved management and possibly relocating captive animals to quieter sites.
- Creating interconnected green corridors linking major parks and natural areas will reduce habitat fragmentation in Multan. This will support species movement and enhance biodiversity resilience across the cityscape. Strengthening community involvement as custodians of these green spaces will ensure ongoing protection and maintenance.

- Finally, engaging local universities, researchers, and environmental groups can foster research on native wildlife conservation and captive breeding programs. Awareness campaigns and environmental education in schools and public forums can raise the profile of biodiversity's role in ecological health and human well-being.

8.2 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.

- Promote the integration of native tree species such as *Kikar* (*Acacia nilotica*) and *Sukhchain* (*Prosopis cineraria*) alongside crops to act as windbreakers, reduce soil erosion, and protect crops from damage.
- Encourage organic farming practices to reduce pesticide use, thereby increasing pollinator diversity and improving crop productivity.
- Launch afforestation programs focusing on fast-growing, climate-resilient fruit trees like *Jamun* (*Syzygium cumini*), *Amrood* (*Psidium guajava*), and *Anar* (*Punica granatum*) to enhance food security and provide economic benefits.
- Implement training and awareness campaigns for farmers and local communities to promote the benefits and techniques of agroforestry for soil health and biodiversity conservation.
- Develop incentives such as carbon credit schemes to encourage farmers to adopt agroforestry practices on their farmland.
- Support government-led initiatives that foster agroforestry adoption to improve climate change resilience, soil quality, and sustainable agricultural practices in Multan.

8.3 Wetland and Water Bodies Management

Multan's wetlands and water bodies are vital ecological assets that play a crucial role in sustaining biodiversity, regulating local temperatures, recharging groundwater, and mitigating the impacts of urban flooding. However, urban expansion, pollution, and infrastructure development have led to the degradation of many natural aquatic systems. Therefore, under the framework of a localized Biodiversity Action Plan for Multan, the following actions are recommended to conserve, manage, and revitalize aquatic habitats in alignment with sustainable urban planning and blue-green infrastructure strategies:

- Establish buffer zones along the Chenab River and local canals to minimize pollution inflow, prevent habitat encroachment, and protect aquatic life.

- Stabilize riverbanks and canal edges through riparian plantation using native species to control erosion and increase vegetative cover along water runoff pathways, particularly in areas like Head Muhammad Wala and Shujabad Canal.
- Rehabilitate contaminated and abandoned water bodies—such as city ponds, retention basins in Model Town and BCG Chowk—using nature-based solutions like phytoremediation, floating wetlands, and constructed wetlands to improve water quality.
- Initiate community-based water protection campaigns, involving local NGOs, school groups, and citizens to carry out riverbank clean-ups, tree plantation drives, aquatic biodiversity conservation, and awareness walks along areas such as Bohar Gate and Multan Zoo pond.
- Develop blue-green infrastructure projects (e.g., rain gardens, bioswales, recharge wells) to promote groundwater conservation and climate resilience in water-scarce zones of the city.
- Desiltation and restoration of traditional water ponds and wells, especially those in older parts of Multan like Haram Gate and Qasim Bagh, to enhance water holding capacity and maintain historical water systems.
- Foster collaboration with local universities and research institutions such as Bahauddin Zakariya University to conduct applied research, species monitoring, and ecological assessments of urban water bodies.
- Implement regular surveillance and seasonal aquatic wildlife census to monitor and protect biodiversity in and around wetlands, including species of birds, amphibians, and aquatic flora observed in parks like Shah Shams and Qila Qasim Bagh.

8.4 Open Spaces Management and Conservation

Open spaces such as parks, urban forests, green belts, gardens, and natural undeveloped areas are essential for urban resilience, public health, ecological balance, and social well-being in Multan. Given the city's rapidly expanding urban footprint and limited green cover, managing and conserving these spaces is crucial to sustaining biodiversity, improving air quality, reducing urban heat, and providing recreation and cultural value. The following actions and strategies are recommended to achieve these goals in Multan:

- Promote planting of native fruiting and flowering trees such as jamun (*Syzygium cumini*), shahtoot (*Morus nigra*), ber (*Ziziphus mauritiana*), amrood (*Psidium guajava*), and loukat (*Luffa aegyptiaca*) in parks and green areas to attract pollinators and urban birds, enhancing local biodiversity and ecological interactions.
- Expand urban afforestation initiatives including Miyawaki forests, using native species to create dense, layered habitats that improve air quality, increase carbon sequestration, enhance urban biodiversity, and add aesthetic and recreational value. Examples include the Miyawaki forest in Jinnah Park and Aam Khas Park.

- Implement smart park management systems by introducing IoT-based security cameras and tracking devices in major parks like Shah Shams Park and Jinnah Park to improve surveillance, prevent vandalism, and ensure public safety.
- Adopt IoT-enabled smart irrigation systems with soil moisture sensors and automated watering to optimize water use efficiency in Multan's parks, addressing the city's water scarcity and ensuring healthier green spaces.
- Prioritize the development of new green spaces and parks, especially in underserved urban localities where approximately 35% of Multan's population lacks access to parks within a 400-meter radius, as recommended by WHO and UN-Habitat standards.
- The Multan Development Authority and local horticulture departments should ensure the establishment of native flowering beds and pollinator-friendly zones within parks to support native bee, butterfly, and bird populations.
- Identify and convert vacant or underutilized public lands in areas such as Jalalpur Pirwala Road, BCG Chowk, and near Railway Headquarters into green belts, mini-forests, or pocket parks to increase urban green cover and provide habitats for wildlife.
- Promote community engagement and awareness campaigns to encourage local stewardship of green spaces, helping to maintain cleanliness, reduce encroachments, and support conservation efforts. 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.

8.5 Grey Infrastructure & Built Environment Management

Multan's built environment—including roads, bridges, drainage systems, and expanding residential and commercial structures—is rapidly transforming due to unplanned urbanization. This has contributed to surface water runoff, air and noise pollution, urban heat islands, habitat fragmentation, and a significant decline in biodiversity. To mitigate these effects, it is essential to integrate eco-friendly, climate-resilient elements into grey infrastructure, transforming concrete-dominated areas into greener, more livable spaces. The following strategies are proposed for Multan:

- Install bird-friendly artificial nesting boxes, made from biodegradable materials, in shaded building areas across Multan's urban neighborhoods (e.g., Gulgasht, New Multan, Shah Rukn-e-Alam Colony) to provide habitat for native bird species such as house sparrows, bulbuls, and sunbirds.
- Enforce annual plantation and greening programs through private housing societies and public departments (e.g., Multan Development Authority and Parks & Horticulture Authority) to improve habitat quality around buildings and commercial centers.

- Transform rooftops and building facades into climate-resilient green infrastructure through rooftop gardens, vertical vegetation, and planters. Such practices not only enhance insulation and reduce indoor temperatures but also support biodiversity and urban food production.
- Introduce permeable pavements, bioswales, and bioretention basins in urban development projects (e.g., along Vehari Road, Bosan Road) to reduce stormwater runoff, recharge groundwater, and manage flooding during heavy rainfall.
- Convert vacant plots and temporary undeveloped lands across the city (e.g., near BCG Chowk, Old Shujabad Road, and bypass areas) into wildflower meadows with native flowering species to boost urban pollinator populations and enhance the city's visual and ecological value.
- Develop green corridors along roadsides, medians, and underpasses by planting drought-tolerant native species like *Sukhchain* (*Pongamia pinnata*), *Kikar* (*Acacia nilotica*), *Neem* (*Azadirachta indica*), and *Amaltas* (*Cassia fistula*). These corridors can connect fragmented habitats and provide shelter and food for urban wildlife.
- Promote eco-conscious urban planning that integrates biodiversity conservation with infrastructure development, ensuring future urban growth in Multan is sustainable, inclusive, and environmentally resilient.

8.6 Community Engagement And Participation

In Multan, community engagement and participation are pivotal for the successful implementation of biodiversity conservation strategies. Given the city's rich cultural heritage and strong social cohesion, empowering local communities can greatly enhance restoration, management, and protection of natural ecosystems. Involving schools, universities, local NGOs, civil society, and residents can lead to long-term sustainability and stewardship of biodiversity. The following actions are recommended to foster community involvement in Multan:

- Establish structured frameworks under Multan Development Authority (MDA) and Parks and Horticulture Authority (PHA) that integrate multicultural and community-based conservation strategies to mobilize public participation in biodiversity restoration and green space protection.
- Launch community-based volunteering programs—especially targeting youth, women, and school groups—to involve citizens in tree plantation drives, park clean-up campaigns, and local biodiversity monitoring activities in areas like Jinnah Park, Shah Shams Park, and Gol Bagh.
- Formalize partnerships with local communities for the maintenance and protection of neighborhood parks, urban forests (e.g., Miyawaki forests), and green belts. Agreements can involve training locals as eco-stewards or biodiversity ambassadors.

- Collaborate with landowners and caretakers around conservation-priority areas such as Qila Kuhna Qasim Bagh and Multan Fort to ensure that biodiversity protection measures align with community interests and do not adversely affect their livelihoods.
- Organize regular biodiversity seminars, nature walks, and awareness sessions in collaboration with Bahauddin Zakariya University (BZU), local colleges, and civil society organizations to educate residents about the importance of native flora, fauna, and green spaces.
- Encourage private sector entities and NGOs (such as WWF-Pakistan or local green initiatives) to sponsor or initiate ecological restoration projects, environmental education campaigns, and sustainability workshops across the city.
- Create expert volunteer networks, including ecologists, birdwatchers, horticulturists, and nature photographers, to contribute to biodiversity surveys, species documentation, and awareness programs, thereby strengthening the scientific foundation of local conservation actions.

Monitoring & Evaluation Plan

Monitoring and Evaluation (M&E) is a critical component of the Multan 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 Multan. 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 Multan.

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.

9.1 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 Multan 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, Multan
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, Multan

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, Multan
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	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, Multan
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, Multan

9.1.1 Monitoring Methods

Effective biodiversity monitoring in Multan 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:

- **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.

- **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.
- **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).
- **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.
- **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.
- **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.

9.2 Evaluation Plan

The Evaluation Plan for the Multan 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 Multan. Key evaluation criteria and methods are explained below;

9.3 Evaluation Criteria

- **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.

- **Control of Invasive Species:** Evaluating the success of measures taken to manage nonnative species in previous years.
- **Improvement or Decline in Habitat Quality:** Analyzing changes (positive or negative) in habitat health and green cover over the period.
- **Reduction in Pollution Levels:** Evaluating the success of pollution management efforts in targeted areas over time.
- **Community Engagement and Awareness:** Assessing the success of awareness campaigns and the level of local community participation in conservation efforts.

9.4 Evaluation Methods

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

9.5 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, Multan'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.

9.6 Reporting and Communication

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

- **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.
- **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.
- **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 Multan's biodiversity priorities into global and regional conservation agendas.
- **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 Multan's unique urban context. Participation in international biodiversity forums and conferences will further enhance Multan's standing as a leader in urban conservation initiatives.

Project Interventions

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 Multan to conserve and protect the city biodiversity. A project digest is developed for Multan from the key actions, which are potential intervention to revive the urban biodiversity and helps to mitigate the leading threats.

11.1 Establishment of Miyawaki Forests

Miyawaki forest are proposed in different areas of Multan City to enhance urban green areas for effective biodiversity action Plan. Major Parks of Multan Including Shah Shams Park, Jinnah Park, Qila Kuhna Qasim Bagh and other parks of Multan City are important for miyawaki enhancement. Maximum miyawaki parks are proposed for Multan city in The Parks and along the river Chenab. Green cover area will enhance the biodiversity richness and climate sustainability of the city. All the large and functional parks of Multan city must have maximum Miyawaki forests. Miyawaki establishment will enhance the biodiversity conservation, preservation and management of Multan urban areas. Different locations are selected to increase miyawaki initiatives in the city. These locations and conceptual designs are shown below.

Table 3:Proposed Locations:

Sr. No.	Longitude	Latitude
1	71.50912321100	30.25537863500
2	71.51233704400	30.25513128000
3	71.48257295800	30.20141734400
4	71.48208598600	30.20308374000
5	71.47197477100	30.19742782400
6	71.51540168200	30.25600525100
7	71.43965117600	30.23854437600
8	71.40241737500	30.21924916700
9	71.45028185700	30.18709497000
10	71.42762491700	30.16202086400
11	71.50175532100	30.20015946100
12	71.45761731200	30.21099251400
13	71.51520754600	30.20287816600

Miyawaki forest are crucial to promote environmental sustainability and biodiversity conservation in the city. Miyawaki produce suitable ecosystems for urban biodiversity. All non-functional and functional

parks of Multan introduce miyawaki forests to promote biodiversity survival and environmental sustainability of Multan.

Table 4: Methodology to Establish Miyawaki Forest

Sr. No.	Activity	Protocols
1	Site Assessment	- Minimum Area 200m², more area can be selected. - Site should be near to water resources or system. 6-8 hours sunlight exposure is important for effective results. - Miyawaki area must be protected from grazing.
2	Preparation Of Soils	Soil fertility and preparation conditions must be match with standards. Soil of Multan have clay matters which remains hardens and need to soften the soils to more than half meters deep. This activity will play an important role for effective miyawaki growth in Multan City.
3	Selection Of Flora Species	Neem, Keekar, Ber, Jamun, Sheesham, Siris, Date and other native plants can be selected to establish miyawaki forest in Multan City and surrounding areas as well.
4	Layout Plan For Plantation	It can be in rows or randomly. Random Technique is useful in Multan to obtain effective results especially for biodiversity effectiveness.
5	Best Season For Plantation	Multan have very harsh range of temperature and weather. It is suggested to grown miyawaki forest in during monsoon season i: e, July to August or early spring February to March. These weather conditions are best fit to establish effective miyawaki plantation in Multan.
6	Irrigation Plan	Initially, 1-3 months the miyawaki setup will be required daily water consumption, after 3 months it need 2-3 times in a week till 5-6 months, and later it required weekly water irrigation. Dripping system and sparlings are also suitable for sustainable effective growth of the forest.
7	Maintenance	Add compost if required and keep protected the forest from grazing activities and pests.
8	Monitoring Activity	- Check the birds and insects' diversity. - Check the pest and control strategy. - Check irrigation system maintenance. - Report to the concerned wing if found any issue.
9	Expected Outcomes	- Strategy will bring 10 times faster growth - Forest would be self-sustainable in 2-3 years.

- It would enhance urban biodiversity, carbon sequestration, and urban cooling.

ESTIMATE COST:

Longitude	Latitude	Area (Acre)	Amount (Millions)
71.427713	30.16186	0.6	3.0
71.45026	30.18709	0.3	1.6
71.472033	30.19742	0.3	1.2
71.482466	30.20142	0.6	2.9
71.482014	30.20292	0.3	1.5
71.515273	30.20293	1.4	7.0
71.439604	30.23844	1.4	6.7
71.515322	30.25596	2.8	13.4
71.512777	30.25521	2.3	11.1
71.509217	30.25526	0.6	2.7
71.457623	30.21102	0.2	0.9
71.402288	30.21917	2.6	12.8
Total Amount Rs			64.8

11.2 Proposal for Vertical Habitat Layers

Forest plantations in Multan should adopt a stratified approach, promoting vertical habitat layers from ground cover to large canopy trees offering nesting and roosting opportunities for urban wildlife including squirrels, bats, and various bird species recorded in various parks of Multan. Vertical flora strategies in urban areas enhance the biodiversity protection, preservation, conservation. City climate conditions are extreme in summer and have need to introduce vertical plantation strategies to overcome the issues of biodiversity decline and climate sustainability. Urban areas of Multan are facing severe issues regarding Noise, Air, Water, CFC emission and many other threats are making urban areas vulnerable for biodiversity. Green spaces enhancement and effective strategies are required to promote urban biodiversity conservation, preservation and management. Some reliable patterns and designs are shown in the fig. below to promote biodiversity and climatic sustainability through vertical habitat establishment in Multan.

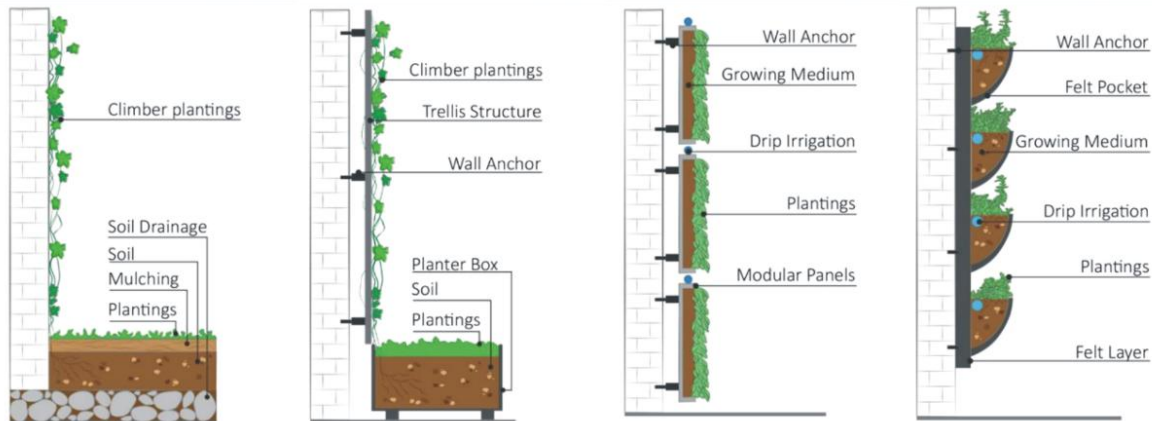
PROPOSED LOCATIONS:

All the roads, service road and parks of Multan.

CONCEPT DESIGN:

Some Examples of Vertical Plantation in Urban Areas

Design 1: Direct Greening Façade Design 2: Indirect Greening Façade Design 3: Modular Panel System Design 4: Textile Bag System



ESTIMATE COST:

Name	Km	Amount (M)
Aziz Hotel Chowk Double Phatak Flyover	2.3	5.0
Azm e Aalishan Road	0.5	1.1
Azm e Aalishan Road	0.5	1.1
Chowk Kumharanwala Level 1 Flyover	1.7	3.7
Chowk Nag Shah Flyover	2.0	4.2
Chown Rashidabad Flyover	1.3	2.7
Chungi No.9 Flyover	1.0	2.2
City Railway Station Flyover	0.5	1.1
Kachehri Chowk Chungi No.7 & 8 Flyover	3.2	6.8
Mumtazabad Flyover	0.6	1.4
Nishatar Chowk Flyover	0.4	0.8
Nishtar Road	0.0	0.0
Sher Shah Road	2.1	4.4
Sher Shah Road	0.0	0.0
Secondary Road	0.4	0.8
Secondary Road	0.0	0.1
Secondary Road	0.0	0.0
Secondary Road	0.0	0.1
Secondary Road	0.4	0.9
Secondary Road	0.1	0.2
Secondary Road	0.1	0.1

Secondary Road	0.4	0.9
Metro Bus Service	0.2	0.4
Metro Bus Service	0.1	0.2
Metro Bus Service	0.1	0.2
Metro Bus Service	0.1	0.3
Metro Bus Service	2.0	4.2
Metro Bus Service	4.8	10.2
Metro Bus Service	0.4	0.8
Metro Bus Service	5.4	11.6
Metro Bus Service	1.9	3.9
Metro Bus Service	0.3	0.7
Total Amount		70.1

11.3 Establishment of Butterfly Garden

Butterflies are very delicate and sensitive in nature. Mostly, butterflies are severely affected due to current scenario of climate change especially in the cities. Hot climate of Multan City have prevailed negative impact on butterfly population. It is proposed to establish minimum two butterfly house in Shah Shams Park and Qila Kuhna Qasim Bagh. All other green corridors and flowering beds in the city are also considered as butterfly parks. It will enhance the biodiversity conservation strategies and also will be useful for student research and public awareness. Protocols and parameters to establish butterfly house are given below:

Table 5: Parameters & Habitat Management For Butterfly House

Sr. No.	Parameter	Description
1.	Temperature:	Butterfly is very sensitive creature. Tropical areas of Pakistan especially in Punjab butterflies show 26-29 Degree Centigrade best fit temperature range for sustainable survival. It is necessary for butterfly house to provide average and ideal temperature range to make design sustainable and best fit. Favorable temperature range is not only useful for butterflies' diversity in house but also for the visitors.
2.	Humidity:	Sustainable designs make butterfly houses for long lasting persistent. Humidity is crucial parameter and sustainable designs require commonly 50-70% humidity range for better survival of butterfly mediums. High humid conditions and very low conditions both are not useful for butterfly gardens.
3.	Water:	Shallow water source should introduce in the butterfly gardens for sustainable survival. Water is crucial to life and it provides the sustainability to butterfly fauna. It also

		maintains the temperature of the butterfly house. Fresh and shallow water resources must be introduced in the butterfly house and further it is important for butterfly larva to survive in natural conditions having sufficient water resources.
4.	Light:	It needs natural light in tropical areas. But if the light is too hot which can increase the temperature above standard then it is crucial to provide indirect light to maintain the temperature of the house. Light is only a factor which prevails impacts on other parameters.
5.	Air Flow:	House should have well ventilation facilities. Fresh air is necessary for butterfly fauna and plantation as well. Fresh air and sufficient passing through the medium make the design sustainable. It is important that Airflow from one side to other must according to outer environment pattern and the native butterfly species can survive better in these conditions.

Table 6: Butterfly House Habitat Management Factors

Sr. No.	Factor	Description
1.	Natural Materials	Necessary to use natural materials for establishment of butterfly gardens like Plants, wood, Stone, ropes and baskets, natural flowing shallow water medium.
2.	Predator monitoring	It should be ensure that there should be proper protection of the house from predators of butterflies and larva. Birds often approach to butterfly sites to consume their larva. This process makes the house vulnerable and reasonable procedure must be adopted to reduce the risk.
3.	Vegetation and Plants for Pollination	Native plants including native species of grasses are also helpful to make design sustainable. Changa Manga shows diverse range of plants, trees, herbs, shrubs and grasses. The native flowering plants will make the design best fit for survival of both flora and fauna species.
4.	Rain & Wind Protection	Tropical areas in Punjab especially in Lahore, Changa Manga and surrounding areas the rainy season increases the humidity level of the environment and make unfit for butterflies and further, the high wind speed is also not favorable for butterflies and larva. The proposed design must meet the standards for maximum survival and sustainability.
5.	Safe sites for caterpillars	Plants for larva and caterpillars are crucial to generate space on the leaves near shallow water resources in corners.
6.	Awareness and signage	Awareness sign boards to guide the visitors are important to install at different points to make sure conservation and protection of house.
7.	Visitor Behavior Management	To touch and pick the butterflies sometimes is a behavior of human nature to feel the beauty. Guides and staff must be

		trained to educate the people not to perform above mentioned activities in the house.
8.	Biosafety and biosecurity	Predator birds approach to the house. Biological safety parameters can be applied to mitigate the risk and further some visitors come along with pets which may have severe diseases which can pass through the house and may be a big risk for tourists and butterfly fauna. These practices must be overcome for sustainable designs and management.
9.	No use of Pesticides, Herbicides or chemicals	There should be no pesticides, herbicides or chemicals use in the house. These activities will be harmful for butterflies and visitors as well.
10.	Separate standing points	Design can be in such a manner that there is notable distance between visitors and butterflies. The flying pattern of butterfly fauna must not be degraded or disrupted. Separate visitor's site is an important factor which makes the design sustainable for butterfly houses.

Proposed Locations

1	71.47578892100	30.19903772200
2	71.48334265300	30.204739894



MULTAN CITY BIODIVERSITY ACTION PLAN

ESTIMATE COST:

Longitude	Latitude	Area Acre	Amount (M)
71.47579	30.19904	0.8	4.2
71.48334	30.20474	0.35	1.8
Total Amount			6.0

11.4 Establishment of Nurseries

Forest Department have need to start schemes to provide free tree nurseries to the farmers and urban populations. Each individual having land should accommodate with specific number of native trees including food trees as well. The comprehensive awareness campaigns may help to enhance the plantation of these trees which will bring fruitful impact in green cover of urban and peri-urban areas of Multan City. These practices will also enhance the biodiversity of the city.

Neem, kikkar, sheesham, amrood, anar, ber, jamun, Tamarix and existing native species in Multan can play an important role in urban biodiversity conservation and climate sustainability. Forest department can initiate the schemes and projects under Green Pakistan and related projects to plant maximum trees in collaboration with public private partnership, Educational Institutes, schools, colleges, universities, NGO's and other line departments.

PROPOSED LOCATIONS:

Forest department can establish nurseries near the city at any existing place. Shah Shams Park, Aam Khas Park and Langay Khan Bagh can be utilized to enhance this initiative in Multan City.

Table 7: Nurseries Schemes for Urban Areas of Multan

Sr. No.	Parameters	Protocol / Standard Practice
1	Scheme Objectives	- Urban greenery promotion - Biodiversity Conservation and improvement - Environment improvement - Public Awareness
2	Stake Holders	FWF, PHA, Municipalities, NGO's, Educational Institutes of Multan,
3	Registration	- Registration from FWF Department. - Project approval from concerned department. - Initiate Nurseries under Green Pakistan Program or any Other Urban Green Scheme/Program.
4	Area for Nurseries	Urban Parks, Universities, Schools and Colleges, Green Belts, Public Lands, Housing Societies etc.
5	Target Areas	Nursery of flora species must provide to Public FOC basis, educational departments with specific targets under department monitoring cell. NGO, s and other sources must provide services to make sure the availability of nursery flora to the suitable place where there is need at priority.
6	Target Flora Species	Neem, Kikkar, Peepal, Ber, Jamun, Anar, Amrood, Moringa, Sukh Chain, and other suitable native flora of Multan City.

ESTIMATE COST:

Longitude	Latitude	Area Acre	Amount (M)
71.48388	30.20327	0.1	0.1
71.51005	30.18892	0.2	0.1
71.47876	30.22329	0.1	0.1
Total Amount			0.3

11.5 Agroforestry Initiatives

Agroforestry is crucial for enhancing the city biodiversity of Multan as it integrates trees and vegetation into agricultural and urban landscapes, creating diverse habitats that support a wide range of flora and fauna. In a city like Multan, where rapid urbanization and arid conditions pose significant threats to green spaces, agroforestry helps in restoring ecological balance by improving soil health, reducing heat island effects, and supporting pollinators and bird species. This sustainable land-use approach not only boosts biodiversity but also enhances food security, air quality, and resilience against climate change, making Multan's urban ecosystem more vibrant and sustainable.

PROPOSED LOCATIONS:

Sr. No.	Longitude	Latitude
1	71.54837979500	30.26052773000
2	71.53889235300	30.18661294300
3	71.54532322100	30.13214799700
4	71.50783257800	30.12221655600
5	71.45049386100	30.13543408700
6	71.41017860500	30.11199413300
7	71.42650102600	30.15356532100
8	71.40749851700	30.12843775800

ESTIMATE COST:

Longitude	Latitude	Area (acre)	Amount (M)
71.54838	30.26053	1.2	3.72
71.538892	30.18661	0.9	2.79
71.545323	30.13215	1.6	4.96
71.507833	30.12222	1.3	4.03
71.450494	30.13543	1.25	3.87
71.410179	30.11199	0.97	3.00
71.426501	30.15357	1.1	3.41
71.407499	30.12844	0.8	2.48
Total Amount			28.27

11.6 Peri-Urban and Urban Afforestation

Peri-urban forests are crucial for sustainable urban biodiversity ecosystems. Peri-Urban forests support the birds, small mammals and other urban biodiversity to keep the ecosystems thriving and sustainable. Multan City is increasing its urban area by each passing day and it is harmful that there are no much more spaces in the city to enhance green cover area. The deforestation and encroachments at natural areas are degrading the urban natural ecosystems with the passage of time. It is proposed to enhance the green cover at different sites of Multan as Peri-Urban forests which may improve the environmental and biodiversity sustainability of Multan City. Following areas of Multan city can be converted into Peri-Urban forests to reduce the risk of biodiversity loss.

Proposed Locations:

Sr. No.	Site Area
1	Shujabad Bypass Green Belt native flora plantation Approximately 5 KM long area can be converted into Peri-Urban forests.
2	Luttabad Canal strip area approximately 4-5 KM can be converted into Peri-Urban forests.
3	Muzzaffar Garh Road buffer areas along with orchards and farms can also be converted into Peri-Urban forests approximately 5-6KM area which may bring environmental sustainability of the Multan City.
4	Buffer zone area of PAKARAB Fertilizers west of PARCO can be converted into Peri-urban Forest area with the effective engagement of forest department. These Peri-Urban forests may act as carbon sink for the environmental health of this piece of Multan City.

Table 8: Methodology to Establish Peri-Urban Forests

Sr. No.	Activity	Description
1	Baseline Survey	Base line survey of above-mentioned areas in crucial to enhance the productivity of activities.
2	Stakeholder Engagement	FWF, PHA, RTA and other line department's effective collaboration may enhance the effectiveness of this project.
3	Selection of Species	Neem, Kikkar, Sheesham, Sukh Chain, Dharaik and Ber are the suitable for biodiversity promotion and sustainability.
4	Afforestation	Trench plantation, cluster plantation, miyawaki techniques are required for successful implementation.
5	Monitoring	Proper monitoring and protection of plantations is required according to rules and regulation of FWF and line departments. 5 years monitoring plan should be adopted for the successful implementation of project.

11.7 Minimum Housing Standards (Ex-Situ Conservation)

Ex-situ conservation sites, such as Shah Shams Park's mini zoo, should focus on provision of area expansion and minimum housing facilities for captive birds and animals. Area of the mini zoo can be increased according to wildlife and parks rules and regulations and Punjab Captive Wildlife Management Facility Rules 2023 with minimum housing standards as introduced by American Association of Zoos and Aquaria. The minimum housing standards are important to enhance the physical and psychological wellbeing of captive animals in urban areas. These Standards provide a pathway for the effective shelter, space and environmental management to enhance captive biodiversity especially in urban areas. Unavailability of these standards would be the source of stress, illness or behavioral issues for captive urban biodiversity. These standards are given in the table below:

Proposed Location:

Sr. No.	Longitude	Latitude
1	71.48390952400	30.20463423800

Table 9: Minimum Housing Standards for Captive Animals & Birds

UNGULATES			
Sr. No.	Species	Appropriate Group Size with Male/Female Ratio	American Association of zoos and Aquaria (AZA)
1	Chinkara gazelle	1*:6 (Visual barrier between males is mandatory)	18 sq m/ 200 sq ft per animal 200 sq. ft. (18.2 Sq. m)
2	Black Buck	1*:25 (Visual barrier between males is mandatory.	28 Sq. m / 300 Sq. ft. for each animal.
3	Hog Deer / Spotted Deer	1:10	1000 Sq. m for a Pair.
4	Sambar / Red Deer	Sambar 1:5 & Red Deer 1*:5 Visual barrier B/W males is mandatory.	1000 sq. m. for a herd of five (1000 for each extra animal)
LOVE BIRDS & SMALL PARAKEETS			
Sr. No.	Species	Minimum size of Enclosure	Guidelines
5	Love birds and small parakeets and Birds	A minimum of (32"x 20"x 20") (81x50x50cm) each	With about four perches, feed and water dishes, Cages bars should be horizontal since they are beneficial for climbing and exercise. In order to prevent from the budges from escape or injury. The bar spaces should be half an inch or less.

6	Alexadrine/ Rose ringed parakeets	3'H, 2.5'W, 4'D, Pair	Perches, Natural material, wood gnawing tend to simulate breeding and also provide extra nesting material.
7	Pheasinaids and other medium birds	80(3Wx3Hx1.6m (1:3)	The outdoor enclosure should be built on strong foundation which is dug at least 50cm deep to avoid predators digging their way into the aviary otherwise metal mesh (<1, 8mm wire width and <19mm spacing) can also be dug >50cm into the ground. Adding an extra strip of >20cm metal mesh horizontally at the bottom on outside of the aviary will add extra security against digging predators and snakes etc.

Table 10: Protocols & Parameters For Natural Barriers

Sr. No.	Protocols	Parameters
1	Site Selection	Parks near the dusty roads, industries, heavy traffic zones and open zones vulnerable to dust and wind etc.
2	Species Selection	Select native trees and plants which have fast growing ability like neem, kikkar, sukhchain, and drought tolerant plants.
3	Planting Design	Multi-layered plantation is suggested, tall trees at back area along the boundary wall in dense condition, medium plants and shrubs in the middle and front will be flowers and ornamental plants.
4	Spacing Method	Spacing between plants and shrubs is proposed 1.5-2 Meters and 2-3 meters among trees is suitable.
5	Watering Strategy	1st and 2nd week watering: Daily 3 times. Later, 2-3 times per week is suggested
6	Protection Measures	Temporary fencing initially and tree guards to avoid destruction from animals and public.
7	Monitoring	- Quarterly soil fertility assessments. - Growth rate check. - Survival Percentage of all flora species.

Important Note

All The Parks of Multan City must use this dense plantation barriers to reduce noise and traffic pollution. Urban biodiversity is facing these challenges at high level risk and have need to reduce these pressures on priority.

11.8 Invasive / Exotic Flora & Control Strategy

To protect native biodiversity, it is crucial to impose strict regulations against introducing exotic species that disrupt natural ecosystems. Multan's urban parks currently host species like *Conocarpus* and *Eucalyptus* and *Parthenium hysterophorus*, which should gradually be replaced by native alternatives to revive indigenous flora and fauna. Retaining deadwood and leaf litter will foster decomposition, supporting insects and fungi critical for the urban food web.

- To protect native biodiversity, it is crucial to impose strict regulations against introducing **exotic species** that disrupt natural ecosystems. Multan's urban parks currently host species like *Conocarpus* and *Eucalyptus*, which should gradually be replaced by native alternatives to revive indigenous flora and fauna. Retaining deadwood and leaf litter will foster decomposition, supporting insects and fungi critical for the urban food web.
- **Invasive species** in urban environment are also a hurdle in biodiversity conservation and promotion. *Parthenium hysterophorus* or Gajjar Booti is the invasive plant. This invasive plant disrupts the ecosystem and compete with native biodiversity. It is also not useful for urban biodiversity including urban populations as well. This plant have allergic impacts on humans and animals.
- ***Parthenium hysterophorus*** or Gajjar Booti is widely spread on road side, around The Parks, open areas and all over the urban undeveloped areas.
- ***Conocarpus erectus*** is exotic ornamental tree, invasive roots and pollen allergen. It is present on road sides, parks and open areas in Multan. It is also not useful for urban biodiversity.
- ***Eucalyptus*** is also an exotic tree and have diversity in nature. The diversity of eucalyptus can be seen in green areas of Multan.
- Removal control strategy for invasive and exotic species is among the priorities to enhance biodiversity promotion and conservation in urban areas of Multan as described in the table.

Table 11: Invasive / Exotic flora Removal / Control Strategy

Sr. No.	Step	Activity	Methodology / Tools
1	Manual Control	• Cutting • Uprooting	• Cutting of invasive and exotic trees and plants in harsh season before seed bearing periods. This process reduces the process of plant dispersal and growth. • Especially the invasive species in concerned area have need to apply mechanical strategy like uprooting the plants by the help of manpower. This activity will also decrease the growth of harmful plants and trees.

2	Chemical Control	• Use of herbicides • Use of Round Ups	• Glyphosate chemicals can be sprayed in early growing season of invasive plants in Multan and other chemicals like round ups and approachable herbicides can be used for the control of invasive species in Multan.
3	Disposal	• Safe disposal of biomass	• The non-toxic parts of the trees and plants can be used as growth enhancer by converting it into compost materials. This activity will perform two in one scenario. Primarily it will reduce the exotic/invasive species biomass and secondly it will enhance the growth level of native biodiversity by the use of compost materials.
4	Legal Enforcement	• Ban on future plantation of Exotic / Invasive flora	• Forest department and municipal corporations can play an important role in legal enforcement implementation strategies to overcome the issues of harmful flora species introduction and dispersal in the urban ecosystems. Strict laws, awareness and effective implementation is crucial for biodiversity conservation and management in urban areas of Multan.

Annexure-A

Common Name	Scientific Name	Status	Wild	Captive
Alexandrine Parakeet	<i>Psittacula eupatria</i>	NT	✓	✓
Asian Koel	<i>Eudynamys scolopaceus</i>	LC	✓	
Barn Owl	<i>Tyto alba</i>	LC	✓	
Black Drongo	<i>Dicrurus macrocercus</i>	LC	✓	
Cattle Egret	<i>Bubulcus ibis</i>	LC	✓	
Common Hoopoe	<i>Upupa epops</i>	LC	✓	
Common Myna	<i>Acridotheres tristis</i>	LC	✓	
Common Tailorbird	<i>Orthotomus sutorius</i>	LC	✓	
Eurasian Collared Dove	<i>Streptopelia decaocto</i>	LC	✓	
House Crow	<i>Corvus splendens</i>	LC	✓	
House Sparrow	<i>Passer domesticus</i>	LC	✓	
Indian Pond Heron	<i>Ardeola grayii</i>	LC	✓	
Indian Robin	<i>Copsychus fulicatus</i>	LC	✓	
Indian Roller	<i>Coracias benghalensis</i>	LC	✓	
Jungle Babbler	<i>Argya striata</i>	LC	✓	
Little Brown dove	<i>Spilopelia senegalensis</i>	LC	✓	
Little Egret	<i>Egretta garzetta</i>	LC	✓	
Pied Bush Chat	<i>Saxicola caprata</i>	LC	✓	
Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	✓	
Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	✓	
Rock Pigeon	<i>Columba livia</i>	LC	✓	
Rose-ringed Parakeet	<i>Psittacula krameria</i>	LC	✓	
Shikra	<i>Accipiter badius</i>	LC	✓	
Spotted Owlet	<i>Athene brama</i>	LC	✓	
White-throated Kingfisher	<i>White-throated Kingfisher</i>	LC	✓	
Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	✓	
Jungle Myna	<i>Acridotheres fuscus</i>	LC	✓	
Yellow-vented Bulbul	<i>Pycnonotus goiavier</i>	LC	✓	
Green Bee-eater	<i>Merops orientalis</i>	LC	✓	
White Wagtail	<i>Motacilla alba</i>	LC	✓	
Black kite	<i>Milvus migrans</i>	LC	✓	
Ostrich	<i>Struthio camelus</i>	LC		✓
Geese	<i>Anser anser</i>	LC		✓

Peacock	<i>Pavo cristatus</i>	LC	✓	
Black Partridge	<i>Melanoperdix niger</i>	VU	✓	
Pheasants	<i>Phasianus colchicus</i>	LC	✓	
Mammals	Scientific Name	Status	Wild	Captive
Asiatic Lesser Yellow House Bat	<i>Scotophilus kuhlii</i>	LC	✓	
House Mouse	<i>Mus musculus</i>	LC	✓	✓
House Rat	<i>Rattus rattus</i>	LC	✓	✓
Indian Grey Mongoose	<i>Herpestes edwardsii</i>	LC		✓
Jungle Cat	<i>Felis chaus</i>	NT	✓	
Blackbuck	<i>Antelope cervicapra</i>	LC		✓
Squirrel	<i>Funambulus pennantii</i>	LC	✓	
Rhesus Macaque	<i>Macaca mulatta</i>	LC		✓
Hog Deer	<i>Axis porcinus</i>	EN		✓
Chinkara	<i>Gazella bennettii</i>	LC		✓
Monkey	<i>Macaca mulatta</i>	LC	✓	
Indian Palm Squirrel	<i>Funambulus palmarum</i>	LC	✓	
Reptiles	Scientific Name	Status	Wild	Captive
Indian Cobra	<i>Naja naja</i>	V	✓	
Oriental Garden Lizard	<i>Calotes versicolor</i>	LC	✓	
Yellow-bellied House Gecko	<i>Hemidactylus flaviviridis</i>	LC	✓	
Indian Flapshell Turtle	<i>Lissemys punctate</i>	V	✓	
Bengal Monitor lizard	<i>Varanus bengalensis</i>	V	✓	
Common Rat Snake	<i>Ptyas mucosa</i>	LC	✓	
Russell's Viper	<i>Daboia russelii</i>	LC	✓	

Annexure-B: Pla

Common Name	Scientific Name	Status
Hibiscus	<i>Hibiscus rosa-sinensis</i>	Introduced
Alstonia	<i>Alstonia scholaris</i>	Native
Amaltas	<i>Cassia fistula</i>	Native
Bakain	<i>Melia azedarach</i>	Introduced
Beri	<i>Ziziphus mauritiana</i>	Native
Beri Patta (nagh phali)	<i>Heteropharmaga adenopyllum</i>	Native
Bismarkia	<i>Bismarckia nobilis</i>	Introduced
Bord	<i>Ziziphus nummularia</i>	Native
Burna	<i>Crataeva religiosa</i>	Introduced
Chamerops	<i>Chamaerops humilis</i>	Introduced
Conocarpus	<i>Conocarpus erectus</i>	Invasive
Date Palm	<i>Phoenix dactylifera</i>	Introduced
weeping fig	<i>Ficus benjamina</i>	Introduced
Finus Palm	<i>Phoenix sylvestris</i>	Introduced
Gab	<i>Diospyros lotus</i>	Native
Gatrofa	<i>Jatropha curcas</i>	Native
Gold Mohar	<i>Delonix regia</i>	Introduced
Gul-e-Nashtar	<i>Erythrina Suberosa.</i>	Introduced
Jamun	<i>Syzygium cumini</i>	Native
Kachnar	<i>Bauhinia variegata</i>	Native
Kanair	<i>Nerium oleander</i>	Introduced
Kikar	<i>Vachellia nilotica</i>	Native
Lasuora	<i>Cordia dichotoma</i>	Native
Mango	<i>Mangifera indica</i>	Introduced
Molsari	<i>Mimusops elengi</i>	Introduced
Moor Pankh	<i>Thuja orientalis</i>	Introduced
Naeem	<i>Azadirachta indica</i>	Introduced
Peepal	<i>Ficus religiosa</i>	Native
Pilkan	<i>Ficus virens</i>	Native
Putajan	<i>Ehretia laevis</i>	Native
Safaidda	<i>Eucalyptus camaldulensis</i>	Invasive
Sherin	<i>Albizia lebbeck</i>	Introduced
Shisham	<i>Dalbergia sissoo</i>	Native

Shatoot	<i>Morus alba</i>	Introduced
Silver Palm	<i>Coccothrinax argentata</i>	Introduced
Simbal	<i>Bombax ceiba</i>	Native
Sohanjna	<i>Moringa oleifera</i>	Introduced
Sukh Chain	<i>Holoptelea integrifolia</i>	Native
Terminalia	<i>Terminalia spp.</i>	Introduced
Ula Ashok	<i>Saraca asoca</i>	Introduced
Wall Palm	<i>Wallichia spp</i>	Introduced



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