Regional Development Plan

MULTAN

Environment

The Urban Unit

Environment Sector

Multan Regional Development Plan

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Table of Contents

Figures

Tables

01 Setting the Context

Rapid urbanization, population expansion in urban centers and massive economic activities are among certain challenges that Punjab province is facing. To tackle these issues and improve Punjab's population's livability, development and planning at the regional level have been brought to attention.

> There is a multifaceted way to express the terminology **"Region"** depending upon the scale of analysis. It could be any land that has common natural and artificial features. It could also be any basic administrative unit that either encompasses an area, division, or district for local government. More distinctively, it could be any administrative or politically/economically/spatially defined area that may cover different states/countries or could be at a national/sub-national/local scale and has a role in a certain level of development[1].

Punjab Spatial Strategy 2047 outlines division as a good region for achieving larger development goals in harmony with districts and cities as well as for assessing the comparative advantages at a macro scale. **The strategy identifies division as a 'region' which forms the economic units based on a regional vision and development plans that not only enhance competitiveness and productivity of the region but also enable efficient resource allocation and more economic returns.** In an international context, China has successfully achieved its economic transition from an agrarian economy to an industrialized economy by focusing on regional developments and integrated planning frameworks.

Multan Division (Region), is the central economic hub of Southern Punjab as well as the largest agrarian territory of Punjab. The region has a high potential for economic growth and providing higher opportunities for investments. However, this region is also facing various natural and anthropogenic hazards which include abrupt variations in temperature, industrialization, urbanization, deforestation and depletion of water resources. This situation thus, demands a

Figure 1: Divisions of Punjab Province

[1] Schmitt-Egner, P. 2010. The Concept of 'Region': Theoretical and Methodological Notes on its Reconstruction. *Journal of European Integration*. 24(3): 179-200.

number of interventions with a range of amenity green structures and improved environmental quality in order to develop a proportion between grey and green areas of the region. Therefore, a regional development plan of the environment sector is being prepared for the spatial, economic and environmentally sustainable development in the region. It also helps in managing the challenges, disparities and competition for development resources between cities in a region as well as keep the goods and resources available to them as per their needs.

02 Multan Regional Profile

Geographically, the Multan Region lies form 30°11'52" North latitudes and 71°28'11" East longitudes covering a total area of about 17,935 km².[2] According to Pakistan Population and Housing Census 2017, the Region has a population of about 12,268,173.[3] The average elevation of the Multan Region is about 122m above sea level. The Region basically comprises of 04 districts viz; City District Multan, Khanewal, Lodhran and Vehari.[4] Multan district is the largest district among others and considered as the economic center of Southern Punjab. Geographically, Multan Region is bounded by districts Toba Tek Singh and Jhang from the North, by Pakpattan District on the East, by Bahawalnagar and Bahawalpur Districts on the South and by Muzaffargarh district on its Western side.[5]

Topographically, Multan region comprised of flat, rich fertile plains dissected by rivers or canals. and its soil is generally comprised of alluvial deposits. There is a substantial urban-rural population size differences within the Multan Region. According to 2017, Census of Pakistan, the annual growth rate of Multan Region is 1.98. Moreover, the divisional level analysis shows that the ratio of Urban and Rural population is 27.85% and 72.15% respectively for Multan Region. The detailed demographic profile of Multan Region is given below:

Table 1: Demographic Profile of Multan Region[6,7]

Multan Region					
Sr. #	**Particulars**	**Multan District**	**Khanewal District**	**Vehari District**	**Lodhran District**
1.	**Location**	30.1951° N, 71.4774° E	30.4550° N, 72.0468° E	29.9719° N, 72.4258° E	29.6869° N, 71.6673° E
2.	**Area (km²)**	3,720	4,349	4,364	2,778
3.	**Population (2017)**	4,746,166	2,920,233	2,902,081	1,699,693
4.	**Population Density (**per Sq. Km**)**	1275.85	671.47	665.00	611.84
5.	**Urban Proportion**	43.38	20.08	17.44	15.63
6.	**No. of Tehsils**	**04** (Jalalpur Pirwala, Multan City,	**04** (Khanewal, Mian Channu, Kabirwala	**03** (Burewala, Mailsi and Vehari)	**03** (Lodhran, Kehror Pacca and Dunyapur)

[2] https://en.wikipedia.org/wiki/Divisions_of_Pakistan
[3] Pakistan Population and Housing Census, 2017.
[4] https://multan.punjab.gov.pk/geography
[5] Hussain, S., Mubeen, M., Ahmad, A., Masood, N., Hammad, H. M., Amjad, M., ... & Waleed, M. (2021). Satellite-based evaluation of temporal change in cultivated land in Southern Punjab (Multan region) through dynamics of vegetation and land surface temperature. Open Geosciences, 13(1), 1561-1577.
[6] https://www.pbs.gov.pk/sites/default/files/population/2017/tables/punjab/Table01p.pdf
[7] DISTRICT_WISE_CENSUS_RESULTS_CENSUS_2017.pdf

		Multan Saddar and Shujabad)	and Jahanian)		
7.	**Average Household Size**	6.17	6.22	6.43	6.28

By 2027, it is likely that the population of Multan Region will grow by 21.7%. District-wise population projection is provided in the below table;

Table 2: Projected Population[8]

Districts	Growth Rate (1998-2017)	2017	2027	2037	2047
Multan Region	1.98	12,268,173	14,925,537	18,158,503	22,091,750
Multan District	2.23	4,746,166	5,917,340	7,377,516	9,198,007
Khanewal District	1.83	2,920,233	3,500,862	4,196,936	5,031,411
Vehari District	1.74	2,902,081	3,448,473	4,097,738	4,869,244
Lodhran District	1.97	1,699,693	2,065,830	2,510,839	3,051,709

As the population grows over the next decade, the Multan region may become even greater. Thus, demanding a regional-level development plan where development efforts are focused on the creation of a system of cities that fosters intercity networking, creates more jobs and increase productivity as well.

2.1. Climate Profile of Multan Region

According to Köppen Climate Classification, BWh, the climate of Multan Region can be classified as hot desert climate[9] and arid climate, with mild-cold winters and very hot summers[10]. The region generally experiences extreme weather conditions, owing to its geographic location, and thus is under the threat of heat waves, dust storms, high drought risk, and urban flooding. However, generally the summer season in Multan Region starts from April and end on mid-October. May – July is considered as the hottest months in which average temperature may reaches up to 46^{0}C. The winter season generally begins from October and continues till the middle of March and the recorded average low temperature in winter is 05°C.[11] However, it is worth-mentioning here that, maximum and minimum temperatures of Multan were recorded in 2010 i.e., 52^{0}C and -1^{0}C, respectively.

[8] Based on the Statistical Analysis done by the Urban Unit
[9] https://multan.punjab.gov.pk/climate
[10] Ibid at 4.
[11] Environmental Impact Assessment Report on Power Distribution Enhancement Investment Project (PDEIP) – Tranche – IV (Savings) by Multan Electric Power Company Limited Government of Pakistan

Multan receives an annual average rainfall of about 200 – 300 mm most of which is received during monsoon season (particularly July)[12]. The area of Multan Region close to the Chenab River is generally flooded during the Monsoon season. An analysis of average temperature and precipitation in Multan was conducted for 30 years, i.e., 1990 – 2020. The results are given in Figure 1 which depicts that maximum recorded average annual Temperature is 42.2^{0}C in June while minimum recorded is 6.1^{0}C in January. Moreover, average humidity (57%), average solar radiation (20 MJ/m^2/day), and average wind (184 km/day), were also recorded during 1990-2020[13].

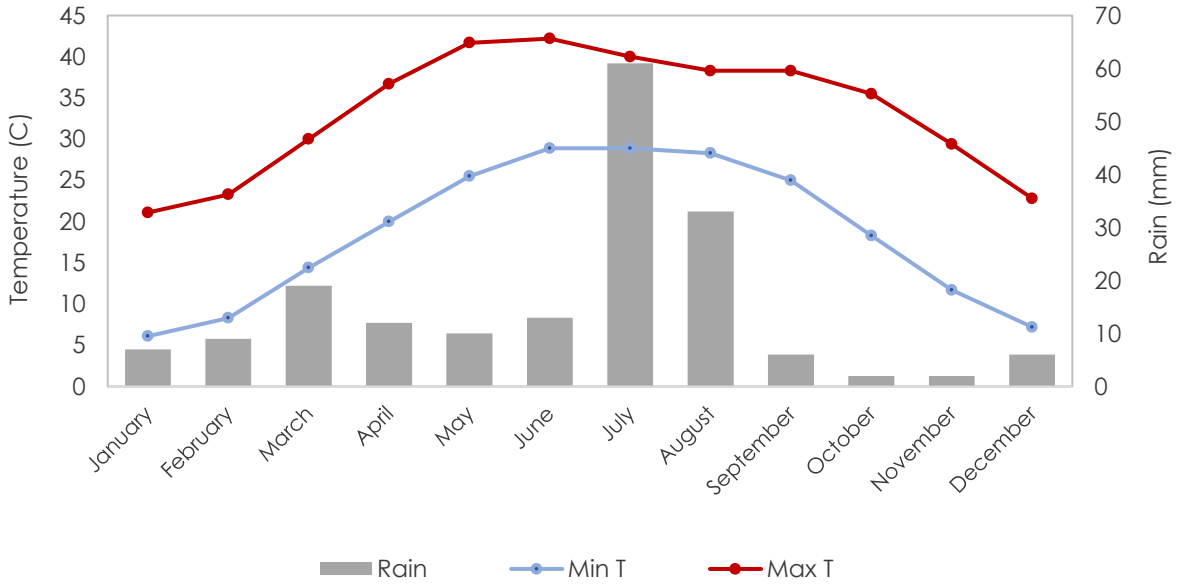


Figure 2: Average Annual Temperature and Precipitation of Multan (1990 - 2020)

As per the **Global Climate Risk Index 2021**, ranking by Germanwatch, Pakistan ranked in the top ten countries that suffered the most from extreme weather events[14]. The analysis of the climate profile of Multan using land surface temperature, vegetation indices, and precipitation indices, during 1961-2010, reported an increase in the precipitation intensity and average temperature, with consequent increase in the frequencies of floods and droughts[15]. In addition, the land cover change analysis shows that the production of wheat, rice, cotton, and sugarcane declined by 5.3%, 1.6%, 6.6%, and 2.9%, respectively[16]. These studies show that the Multan Region is highly vulnerable to climate change, which is influencing its environmental and socio-economic

[12] Ali, A., Khalid, A., Butt, M. A., Mehmood, R., Mahmood, S. A., Sami, J., ... & Azhar, M. (2018). Towards a remote sensing and GIS-based technique to study population and urban growth: a case study of Multan. Advances in Remote Sensing, 7(3), 245-258.

[13] Hussain, S., Mubeen, M., Ahmad, A., Masood, N., Hammad, H. M., Amjad, M., ... & Waleed, M. (2021). Satellite-based evaluation of temporal change in cultivated land in Southern Punjab (Multan region) through dynamics of vegetation and land surface temperature. Open Geosciences, 13(1), 1561-1577.

[14] Eckstein, D., Künzel, V., & Schäfer, L. (2021). The global climate risk index 2021. Bonn: Germanwatch.

[15] Ali, S. M., Khalid, B., Akhter, A., Islam, A., & Adnan, S. (2020). Analyzing the occurrence of floods and droughts in connection with climate change in Punjab province, Pakistan. Natural Hazards, 103, 2533-2559.

[16] Hussain, S., Mubeen, M., Ahmad, A., Masood, N., Hammad, H. M., Amjad, M., ... & Waleed, M. (2021). Satellite-based evaluation of temporal change in cultivated land in Southern Punjab (Multan region) through dynamics of vegetation and land surface temperature. Open Geosciences, 13(1), 1561-1577.

conditions. Such impacts are likely to worsen in the coming decades. The Report by the Asian Development Bank on the Climate Profile of Pakistan ranks the four districts of Multan Region on the basis of vulnerability to different climate-related hazards. The ranking is given in Table 1.

Table 3: Vulnerability of Multan division to climate-related hazards

Rank	Districts	Flood Risk	Landslide Risk	Earthquake Risk	Drought Risk	Cyclone Risk	Cumulative Risk Level
46	**Multan**	4	1	4	5	2	Medium
85	**Khanewal**	3	1	3	4	2	Medium
94	**Vehari**	3	1	3	3	2	Low
82	**Lodhran**	3	1	3	4	2	Medium
Scoring Key							
Very High		High		Medium	Low	Very Low	
5		**4**		**3**	**2**	**1**	

According to this ranking, Multan district is most vulnerable to climate disasters, as compared to other districts in the region[17], particularly, with respect to drought hazard. However overall, the Region faces high drought risk, followed by earthquake ad flood risks. Additionally, wind and dust storms are also common in the Multan Region in summer season.

2.2. Environmental Quality of Multan Region

Multan Region is considered as the central economic hub of Southern Punjab. Despite being the country's largest agrarian territory as well as one of the major contributors to the country's annual GDP through industrial development, the region is affected badly in terms of air & water quality and well-being of local resident. Whole region has been grappling with significant air pollution issues, in which particular sources are industrial activities, vehicular emissions, brick kilns, burning of crops residues & solid waste.

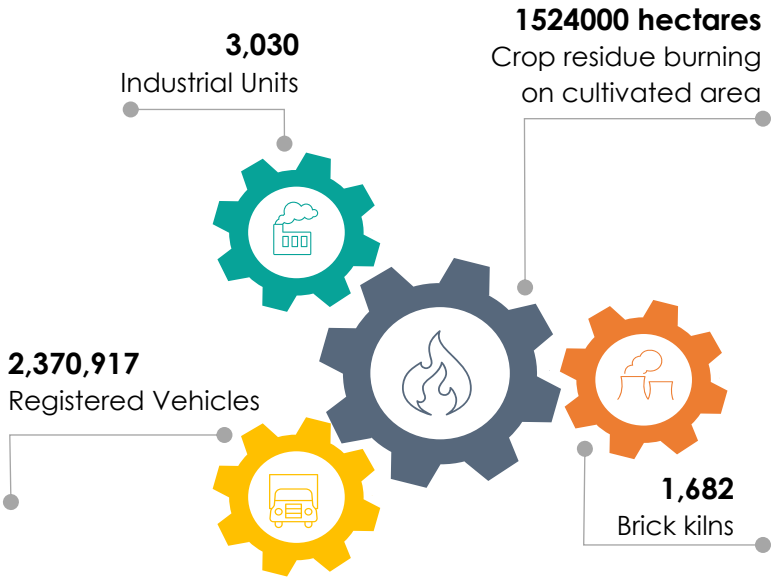


Figure 3: Key factors affecting Environmental Quality of Multan Region

[17] Chaudhry, Q. 2017. Climate Change Profile of Pakistan. Asian Development Bank, Philippines. doi.org/10.22617/TCS178761

2.2.1. Air Quality

Air quality in the Multan division is influenced by poor traffic management and inadequate transport infrastructure, insufficient availability of energy-efficient fuels, fuel adulteration, outdated technologies, industries, absence of air quality monitoring equipment, open burning of wastes and crop residues, non-availability of resources for enforcement of regulations in emissions control, and ineffective implementation of legislations. Moreover, Multan is present between in two deserts, i.e., Thal and Cholistan, located at a distance of 200 km to the north and south. Mineral dust from these nearby deserts also affects the ambient air quality of Multan[18].

There are 3 industrial estates in the Multan Region, i.e., **Multan Industrial Estate** (Phase-I: 743 Acres, and Phase-II: 667 Acres), **Vehari Industrial Estate** (277 Acres), and **Khanewal Industrial Estate** (64 Acres). Multan Region is the major producer of Cotton in Punjab; thus, Cotton Industries are the key industrial units in Multan (115 in Vehari; 132 in Multan, 59 in Khanewal and 65 in Lodharn). Other major industrial categories in the Region include rice mills, flour mills, textile mills, and agricultural products/machinery. The total number and categories of industries in all districts of the Multan Region are given in Figure 4.

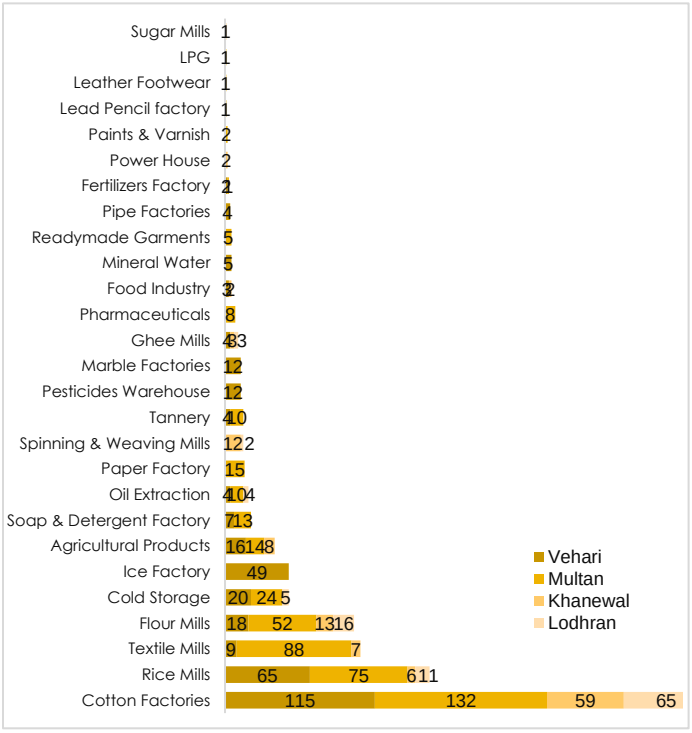


Figure 4: Major Industrial Units in Multan Region

According to the Punjab Brick Kilns Census 2016, the 3rd highest number of brick kilns in Punjab is present in the Multan district. Vehari and Multan districts are amongst the most prominent regions for brick kilns infrastructure in Punjab[19]. Most brick kilns use a mixture of coal and green fuels (including; rice husk, crop straw, animal manure, and wood shavings)[20]. The burning of coal emits oxides of carbon (CO, CO_2) and sulfur (SO_2),

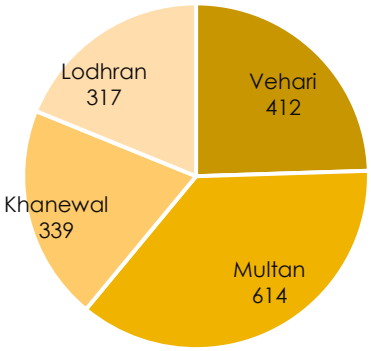


Figure 5: Number of Brick kilns in Multan Region

[18] Vuillermoz, E., Cristofanelli, P., Putero, D., Verza, G., Alborghetti, M., Melis, M. T., ... & Bonasoni, P. (2014). Air quality measurements at Multan, Pakistan. Sustainable Social, Economic and Environmental Revitalization in Multan City: A Multidisciplinary Italian–Pakistani Project, 137-147.

[19] Punjab Brick Kilns Census (PBC). Brick kiln census. Labor and Human Resource Department, Government of Punjab, Lahore. 2016. Available from: http://dashboards.urbanunit.gov.pk/brick_kiln_dashboard/.

[20] Observations and Assessment during Field Survey (March13-18, 2023)

particulate matter (PM_{10}, $PM_{2.5}$), Polycyclic aromatic hydrocarbons (PAHs), and Volatile organic compounds (VOCs). Whereas, burning of green fuels emits methane (CH_4), Oxides of Nitrogen (NO_2, N_2O), Oxides of Carbon (CO & CO_2), Sulfur (SO_2), VOCs, Ammonia (NH_3), dioxins and furans[21]. In addition, solid waste burning, power sector, crop residue burning, and other industrial processes also emit pollutants in the air[22].

The transport sector is reportedly the major contributor to atmospheric emissions in Punjab. It emits CO, CO_2, NO_2, N_2O, SO_2, and PM. About 2.4 million vehicles have been registered in Multan Region, the majority being in the Multan district[23]. Old vehicles, inefficient vehicular engines, and poor-quality fuel are also responsible for traffic-related emissions. Multan ranks 3rd in Pakistan for the greatest number of flyovers in a city[24]. While construction of flyovers reduces traffic load on major roads and streets, however, ineffective planning can lead to an increase in urban congestion, travel time, and road blockades during rush hours[25].

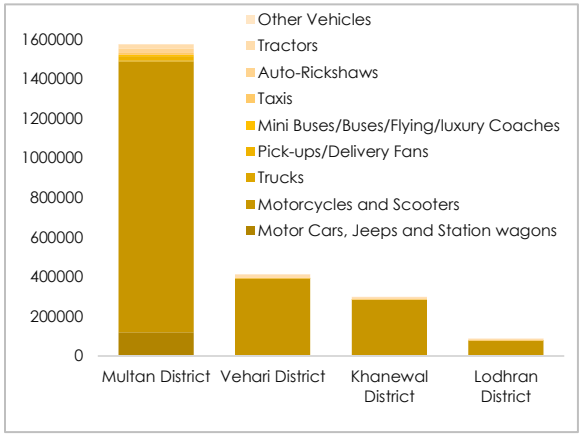
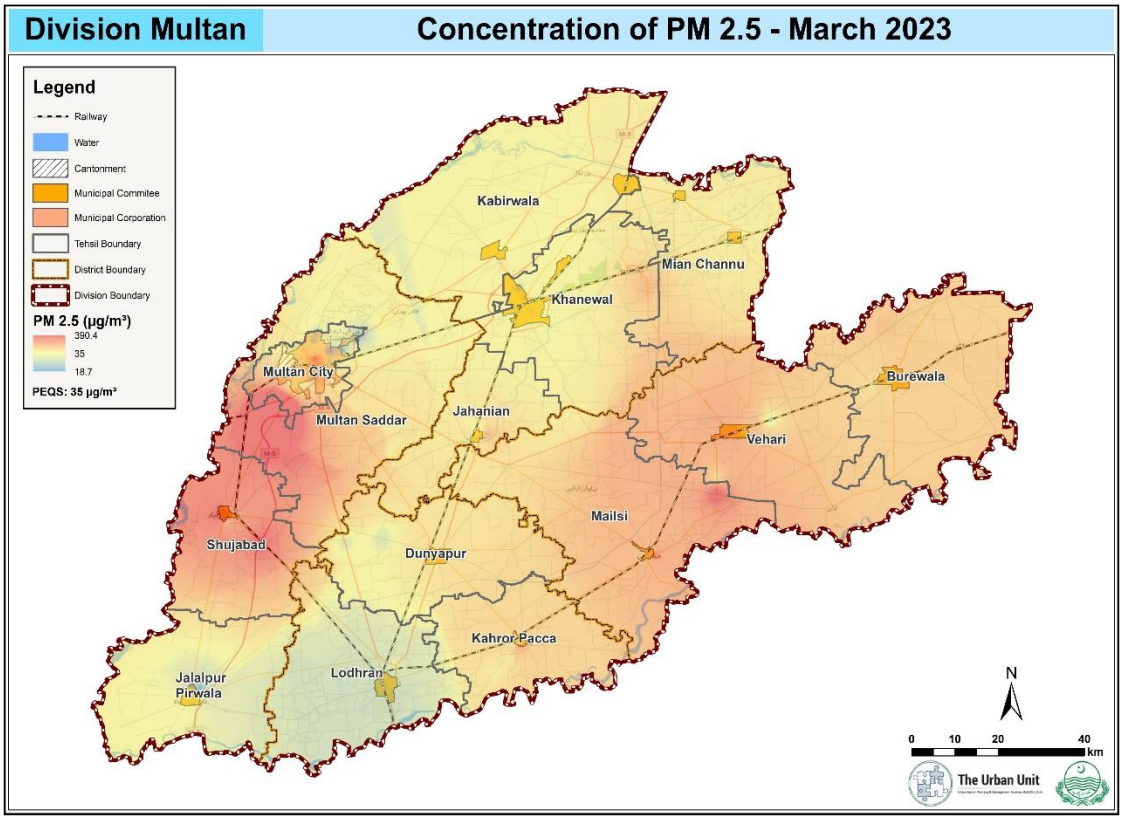


Figure 6: Registered Vehicles in Multan Region

The environment team also monitored particulate matters ($PM_{2.5}$ and PM_{10}) in the field with the help of portable air quality monitoring instruments in Multan Region. The monitoring results showed that the concentrations of $PM_{2.5}$ were recorded above the Punjab Environmental Quality Standards i.e., 35 µg/m^3 near the industrial estates of Multan and Vehari. This is mainly due to unpaved roads, traffic congestion, emissions from industries & brick kilns, and stubble burning in fields. A study on the assessment of the air quality scenario of Pakistan reported that Multan is among the top 6 most polluted cities based on $PM_{2.5}$ concentrations, and the second-most polluted city based on AOD[26]. Similarly, the monitoring done in the field showed that the concentrations of PM_{10} are recorded higher than the permissible limit of PEQS i.e., 150µg/m^3 mostly at the eastern and western borders of the Region (i.e., Multan and Vehari Districts) due to fugitive dust from unleased roads, construction activities, agriculture waste and solid waste burning, and wind-blown dust particles on the roads. The effect of these pollutants is localized and temporarily affects the air quality of the Region. The results of survey-based monitoring of air quality are depicted in below Figure 7.

[21] Pervaiz, S., Khan, F., Javid, K., Altaf, A., Aslam, F., Tahir, M., … & Hayat, S. (2022). Development of air quality and brick kilns during the onset of COVID-19: An Analysis. Biological and Clinical Sciences Research Journal, 2022(1).
[22] Tabinda, A. B., Ali, H., Yasar, A., Rasheed, R., Mahmood, A., & Iqbal, A. (2020). Comparative assessment of ambient air quality of major cities of Pakistan. Mapan, 35, 25-32.
[23] Bureau of Statistics. Population Development Statistics Report, 2022. Government of Punjab.
[24] List of Flyovers, bridges, underpasses in Multan. May 17, 2011. http://travelmultan.blogspot.com/2011/05/list-of-flyovers-bridges-and.html
[25] Khan, O. (2021). The Obsession with Flyovers in Pakistan–Roundabouts are Cheaper (No. 2021: 37). Pakistan Institute of Development Economics.
[26] Bilal, M., Mhawish, A., Nichol, J. E., Qiu, Z., Nazeer, M., Ali, M. A., ... & Ke, S. (2021). Air pollution scenario over Pakistan: Characterization and ranking of extremely polluted cities using long-term concentrations of aerosols and trace gases. Remote Sensing of Environment, 264, 112617.



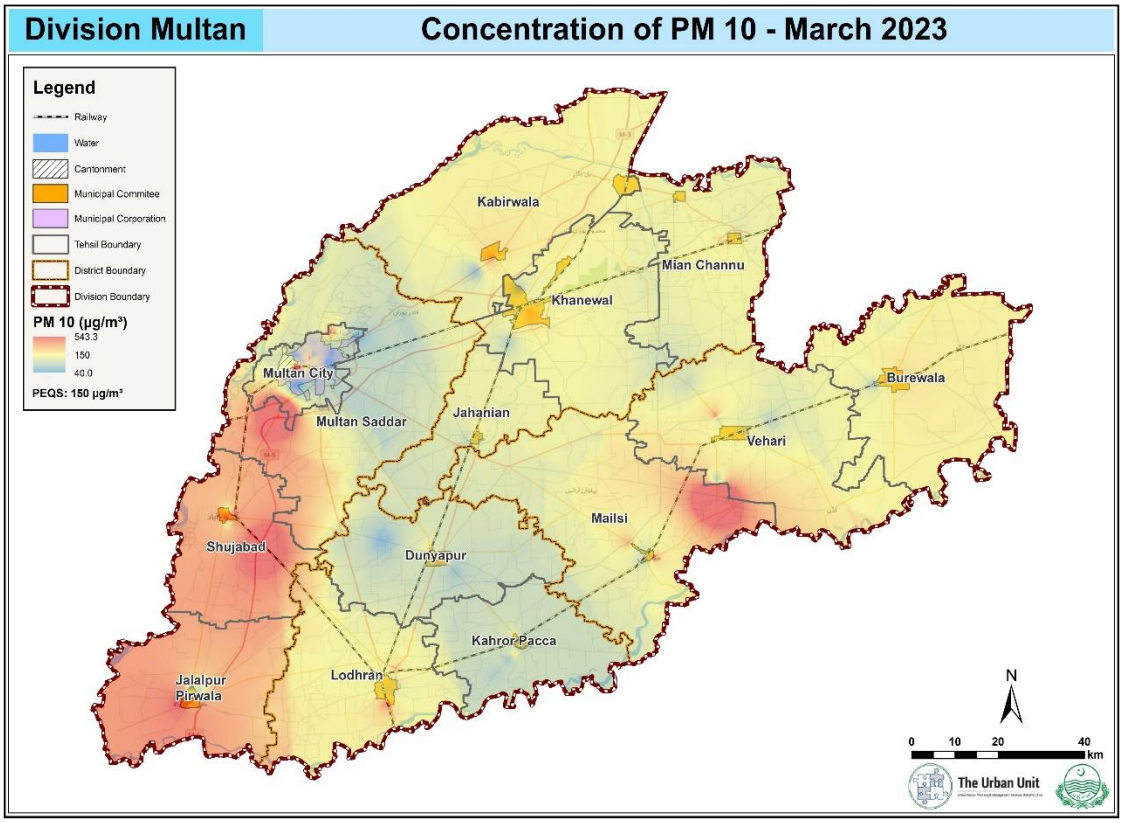


Figure 7: $PM_{2.5}$ and PM_{10} Concentrations of Multan Region

To compliment air quality monitoring in the field, the research team at the Urban Unit uses remote sensing and satellite data to evaluate the pollution concentrations of Aerosol Index, Sulfur Dioxide and Nitrogen Dioxide in the region. The results of these spatial analyses are represented below.

This shows that Multan City is the most-polluted city in Multan Region, with respect to the concentrations of all pollutants.

- **AI:** Aerosol Index is only higher in Multan City and Jalalpur Pirwala Tehsils.
- **NO_2:** The concentration of NO_2 is moderate in Khanewal district, but lower in all other areas.
- **SO_2:** Sulfur Dioxide pollution is distributed throughout the entire division. The concentrations are moderate to high, mainly in Multan and Khanewal districts due to the presence of a large number of industrial units.
- **CO:** Carbon Monoxide (CO) is the major pollutant, with high concentrations in Multan, Vehari, and Khanewal Districts due to fumes from the burning of fuel in cars or trucks, fireplaces, or furnaces.

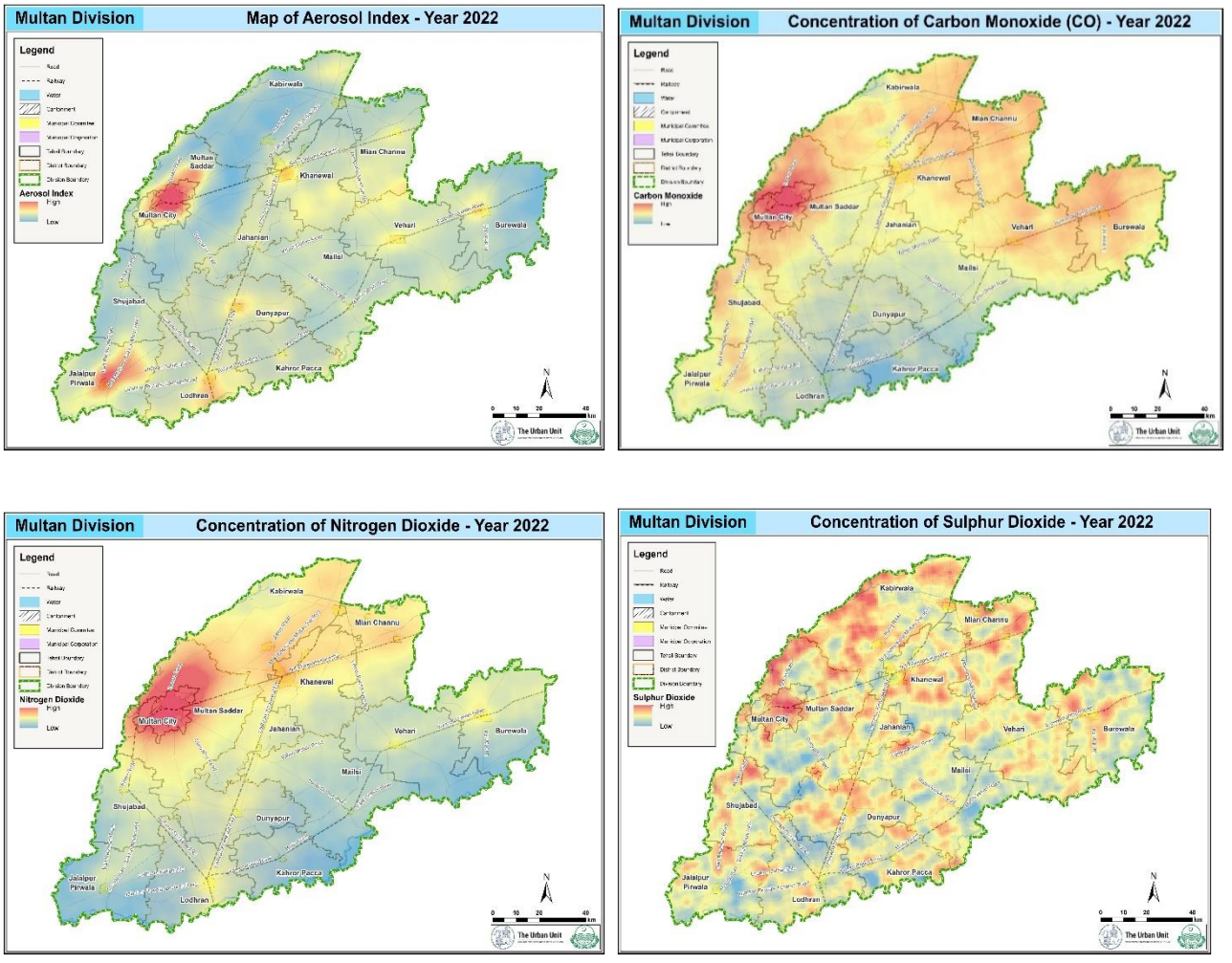


Figure 8: Concentration of AI, SO_2, NO_2 and CO in Multan Region

2.2.2. Noise Quality

Noise Quality of Multan Region was also monitored using portable equipment. Noise Intensity was higher near the industrial estates of Multan and Vehari, as well as near the major roads of urban areas. Noise Quality was below the permissible limits of PEQs in the Lodhran and Khanewal districts. Low traffic and scattered settlements were observed in these areas. Most of the land was agricultural. Noise Intensity was slightly higher than the defined limits for residential and commercial areas in the vicinity of major roads in Vehari, Burewala, Shujabad, Jalalpur Pirwala, and Multan Saddar Tehsils. Mailsi City is a highly congested urban locality with a dense population and poor road infrastructure. The noise level was monitored to be higher than the residential standards. The results of the field monitoring are depicted in Figure 8.

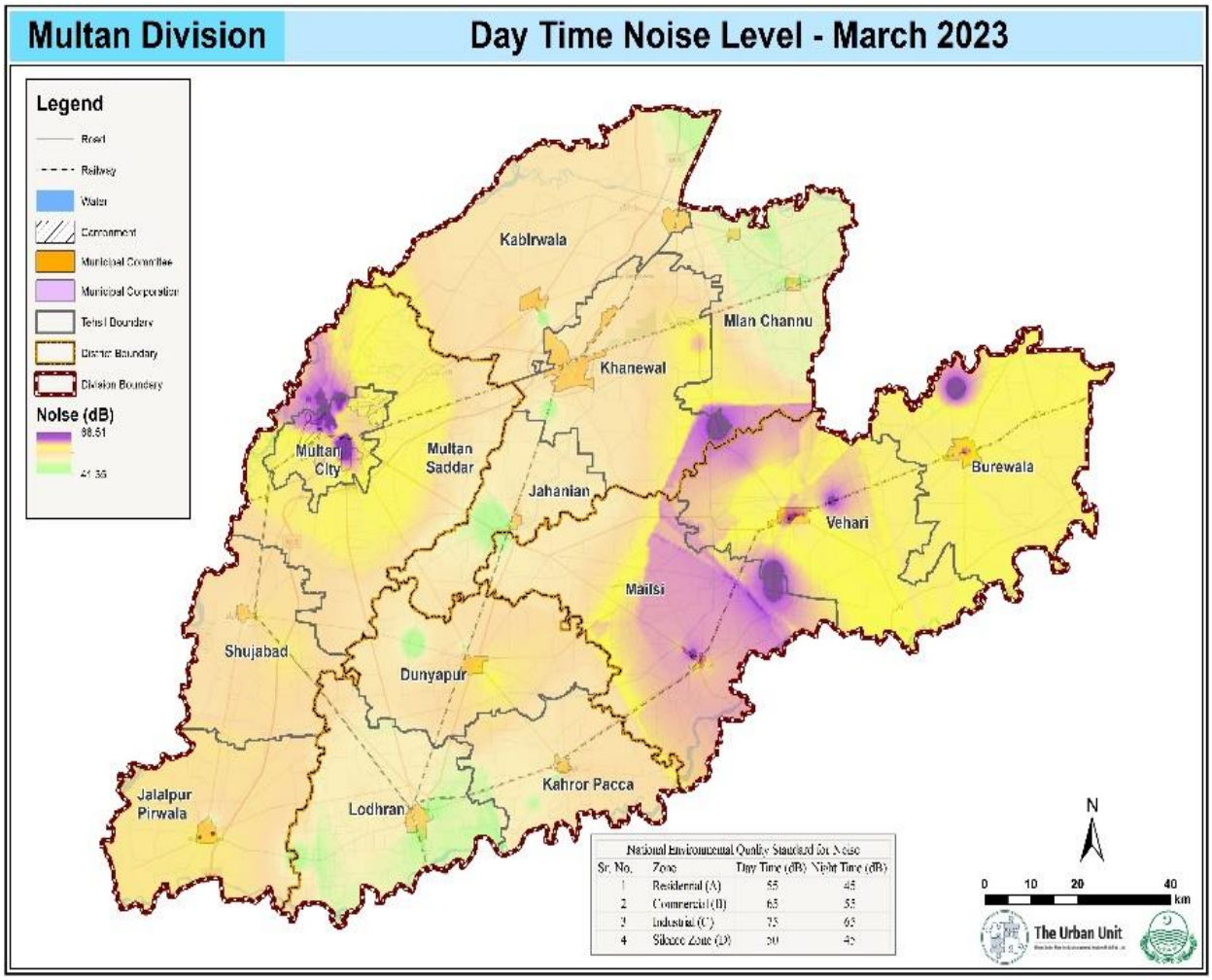


Figure 9: NoiseQuality of Multan Region

2.2.3. Water Quality Assessment

Water Quality of Multan Region was also assessed during field visit by obtaining water samples from different sources, including hand pump, motor pump, household connection, RWSS source, irrigation tube well, toba/well, and any other water source. The samples were then analyzed to determine the concentrations of Arsenic and Total Dissolved Solids.

The permissible limit of TDS for drinking water quality specified by WHO and Punjab Environmental Quality Standards is 1000 mg/l. Figure 9 shows that the concentration of TDS in the water sample obtained from the irrigation tube well exceeds the permissible limit in Jalalpur Pirwala. All other samples exhibit lower than 1000 mg/l values of TDS, however, the results indicate that the water is brackish in Multan, Shujabad, Jalalpur Pirwala, Vehari, Mailsi, and Dunyapur. High TDS in water is responsible for kidney and stomach-related diseases.

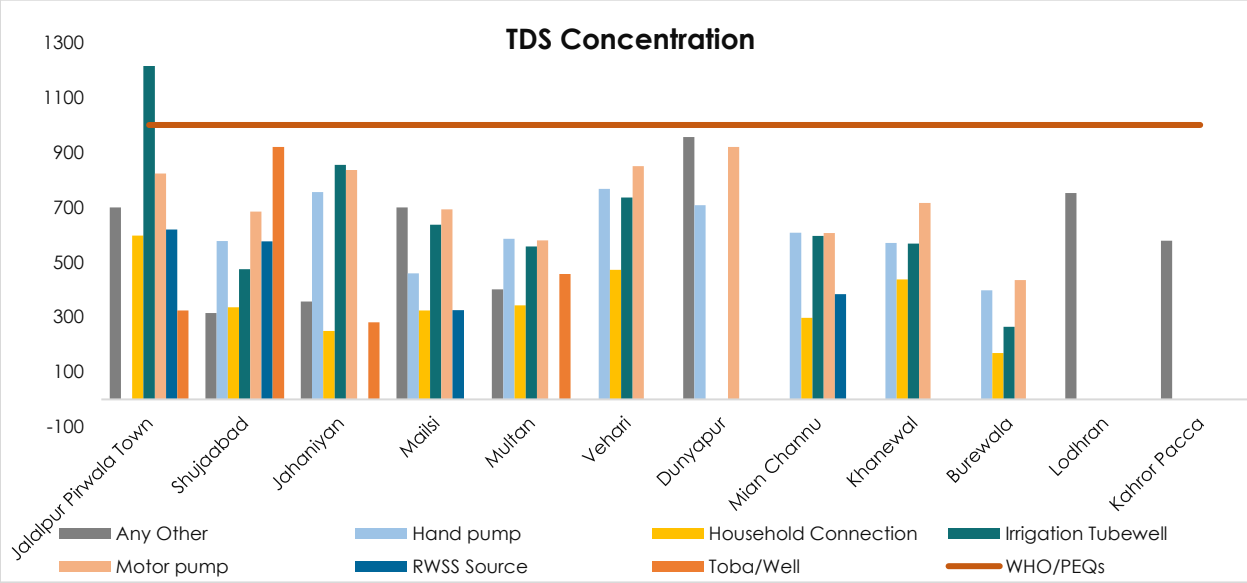


Figure 10: Concentration of TDS in water samples from different sources

World Health Organization (WHO) and Punjab Environmental Quality Standards (PEQs) specify the permissible limits of 10 ppb and 50 ppb, respectively for Arsenic concentration, for drinking water quality. Below Figure 10 represents Arsenic contamination higher than WHO limits in the majority of water samples, however, the concentration exceeds in water samples obtained from toba/wells in Multan

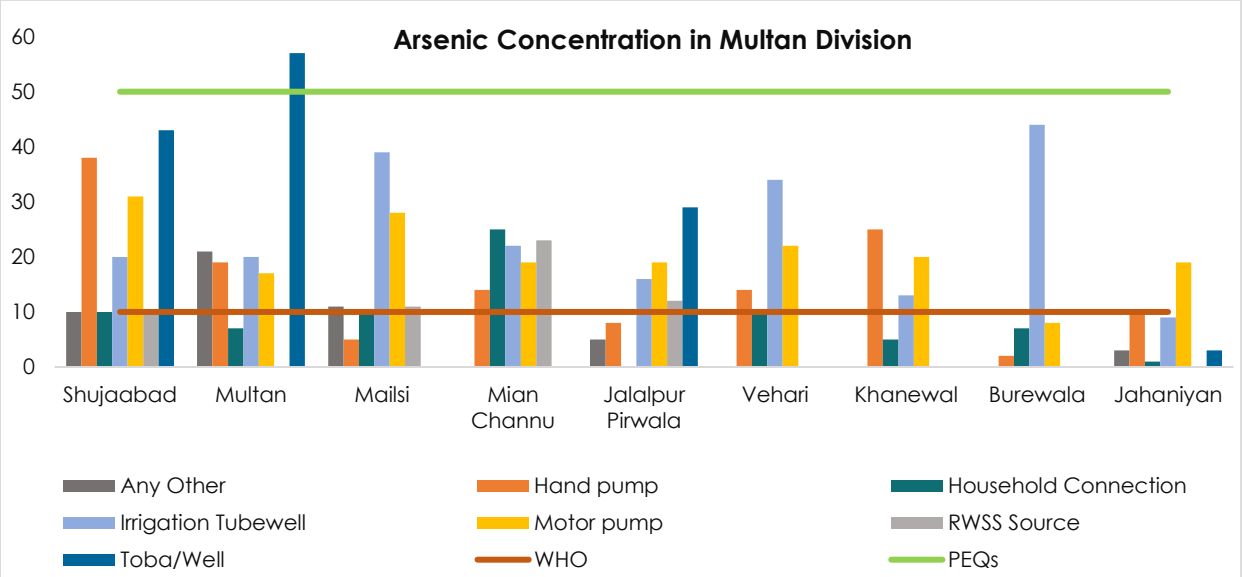


Figure 11: Concentration of Arsenic in water samples from different sources

The overall assessment of Arsenic and TDS concentrations in the Multan Division is presented spatially in Figure 13. The findings from stakeholder consultation and field survey in the Multan division indicated that industrial and domestic water is drained into open water channels without treatment, and used for irrigation purposes. The findings are also consistent with the reported literature[27]. Moreover, model-based assessment of Multan reported an aquifer decline rate of 0.3 m/year, projected aquifer declines in future, increased surface runoff, increased Arsenic contamination, open dumping of industrial waste, and unplanned urban expansion, over the last 40 years[28]. The insufficient availability of wastewater treatment plants and the absence of combined effluent treatment plants at the industrial estate are the causes of water contamination.

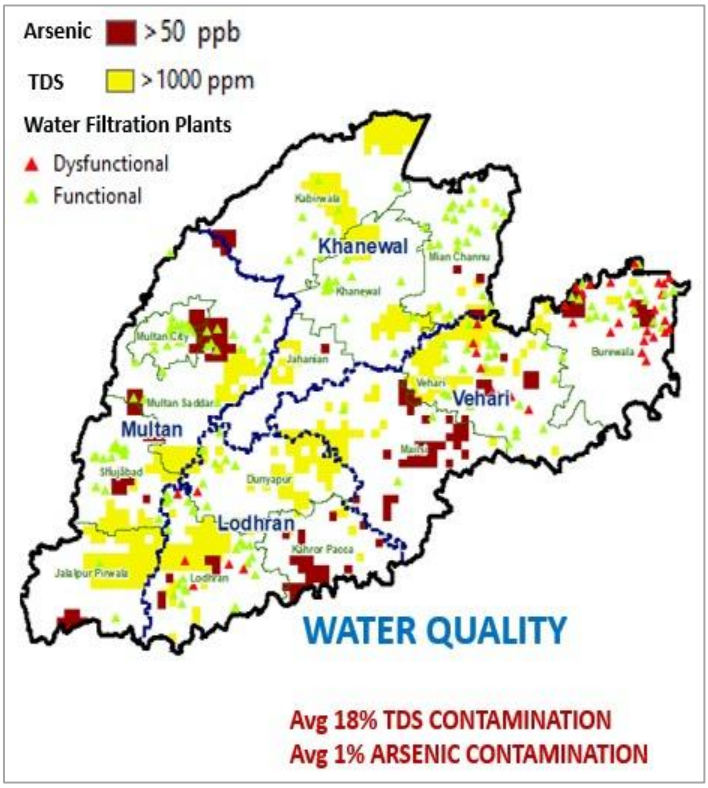


Figure 12: Water Quality of Multan Region

[27] Khan, Z. M., Asif Kanwar, R. M., Farid, H. U., Sultan, M., Arsalan, M., Ahmad, M., ... & Ahson Aslam, M. M. (2019). Wastewater Evaluation for Multan, Pakistan: Characterization and Agricultural Reuse. Polish Journal of Environmental Studies, 28(4).
[28] Abbas, M., Atangana Njock, P. G., & Wang, Y. (2022). Influence of Climate Change and Land-Use Alteration on Water Resources in Multan, Pakistan. Applied Sciences, 12(10), 5210.

An assessment of contamination in vegetation irrigated by water from Sikandria drain, Naubahar Canal, and Wali Muhammad Distributary in Multan reports that untreated household and industrial waste caused Copper and Nickel contamination[29].

2.3. Green Spaces Assessment of Multan Region

2.3.1. Vegetation Dynamics 2001 – 2022

Vegetation cover is vital for the sustainable urban ecosystems; however, this cover has been experiencing substantial changes in urban areas[30]. Urban vegetation can be highly dynamic due to the occurrence of complexity of different anthropogenic drivers. Quantifying vegetation variations is greatly important as it is a prerequisite to understanding its social and ecological consequences [31]. Therefore, timely understanding vegetation dynamics is widely concern for stakeholders of urban design and management.

NDVI is considered as the most common indicator in monitoring vegetation dynamics over large-scale areas and thus, it has been used to monitor vegetation greenness. The NDVI dataset for the Multan Region acquired from Moderate Resolution Imaging Spectroradiometer MOD13A1(500 m) used in this study.

Vegetation trends in the Multan region based on MOD13A1 NDVI showed varied substantial significant greening trends during different vegetation classes based on NDVI threshold values, low vegetation (0.1-0.2), moderate vegetation (0.2-0.4), high vegetation (>0.4). Spatially, high vegetation showed highest percentage during dry-summer (93.52%). Moderate vegetation was found highest in the winter season with rate of 12.18%. However, low vegetation was found highest in the Autumn season with the rate of 12.38% respectively (Figure.13)

[29] Afzal, H., Ali, M., Sajjad, A., Nawaz, F., & Saeed, S. (2023). HEAVY METAL CONCENTRATIONS OF COPPER AND NICKEL IN PERI-URBAN VEGETABLE AGRO-ECOSYSTEM OF MULTAN, PAKISTAN. JAPS: Journal of Animal & Plant Sciences, 33(2).

[30] Jin, K., Wang, F., & Li, P. (2018). Responses of vegetation cover to environmental change in large cities of China. *Sustainability*, *10*(1), 270.

[31] Yu, W., Zhou, W., Dawa, Z., Wang, J., Qian, Y., & Wang, W. (2021). Quantifying Urban Vegetation Dynamics from a Process Perspective Using Temporally Dense Landsat Imagery. *Remote Sensing*, *13*(16), 3217.

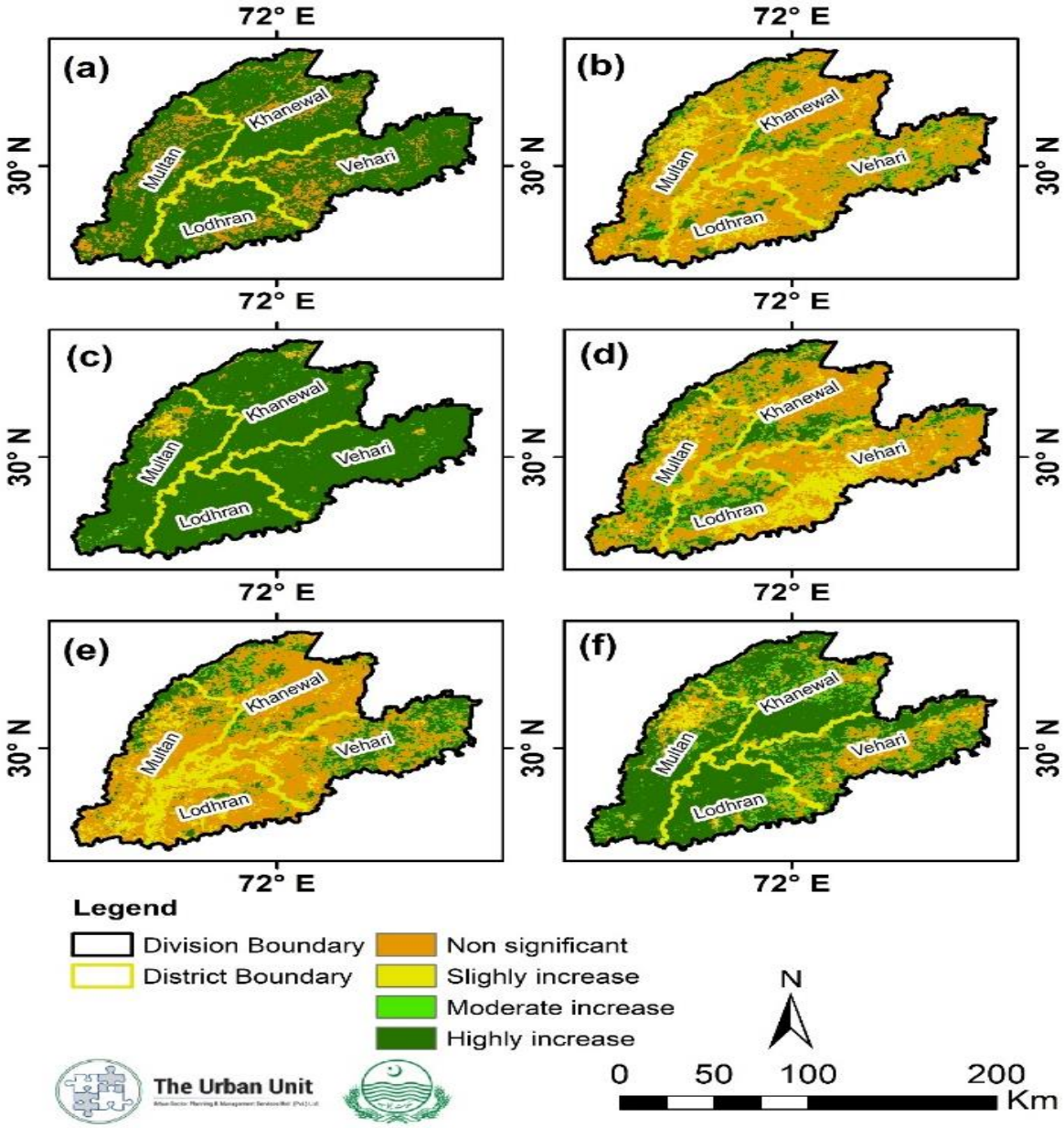


Figure 13: Spatial trends of NDVI of Multan division during 2001 – 2022; (a) Inter-annual, (b) Spring (c) Dry-Summer, (d) Wet-Summer, (e) Autumn, (f) Winter

The spatial pattern of NDVI extracted from Landsat data showed significant improving green trend from 1992 – 2022. The low vegetation increased by 1164 km^2 during first time interval (1992 – 2002). Then, it decreased by 1093 km^2 during second time interval (2002 – 2013). In the third time interval (2013 – 2022), high proportion (2135 km^2) of low vegetation decreased. Similarly, like low vegetation, moderate vegetation showed the opposite trend. During first time interval, it decreased by 718 km^2, then it increased by 2331 km^2 during second time interval and finally the moderate vegetation reduced by 1161 km^2 during third time interval. The high vegetation depicts different patterns compared with the above-mentioned vegetation types. The high vegetation found decrease during the first-time interval by 1212 km^2 and then, it improved by 3111 km^2. During the third time interval, high vegetation increased by 1079 km^2 respectively (Figure.14 & Figure. 15).

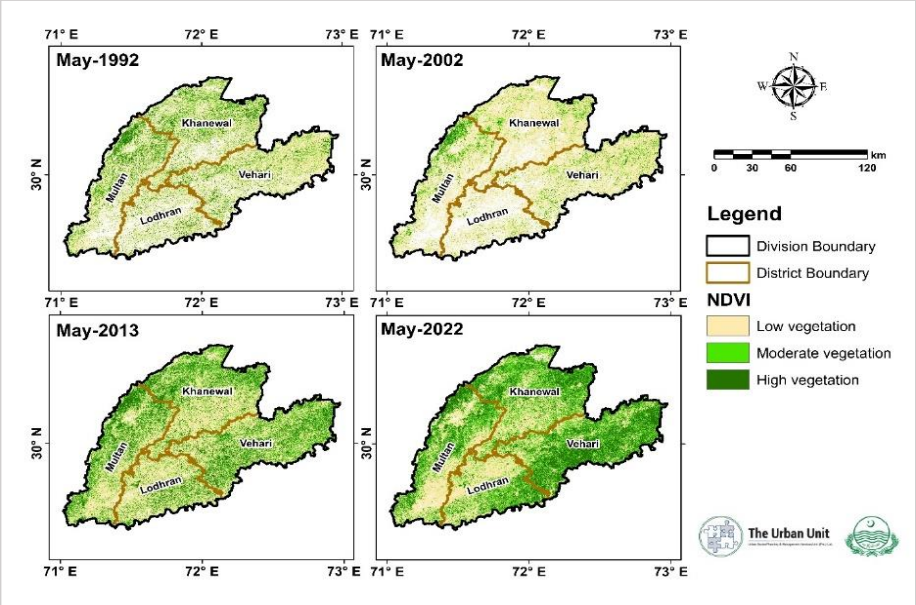


Figure 14: Spatial patterns of vegetation dynamics of Multan division from 1992 – 2022

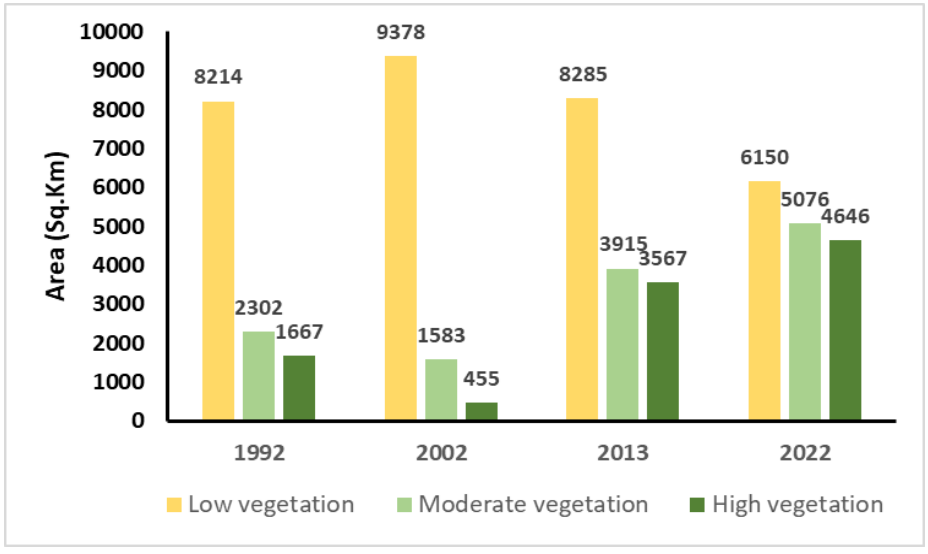


Figure 15: Area statistics of vegetation types during 1992 - 2022

2.3.2. Land Surface Temperature

The rapid pace of urbanization and urban development has been linked with energy-intensive land use that replaces natural land cover. Urban infrastructures, such as buildings, road networks, and asphalt greatly contributes in rising surface temperatures. The study of land surface temperature (LST) provides information of both surface energy balance and land surface activities. The investigation of climate change significantly helps from an understanding of the geographical and temporal fluctuations of LST[32].

The rapid transformation of unattended urbanization has triggered the urban heat island phenomenon, due to which the United Nations SDGs agenda 2030 calls for immediate actions for "sustainable cities and communities". In this context, the case of the Multan Region has been focused due to its dry and extremely hot climatic conditions during summer season for its regional developmental discourse vis-à-vis associated environmental problems[33].

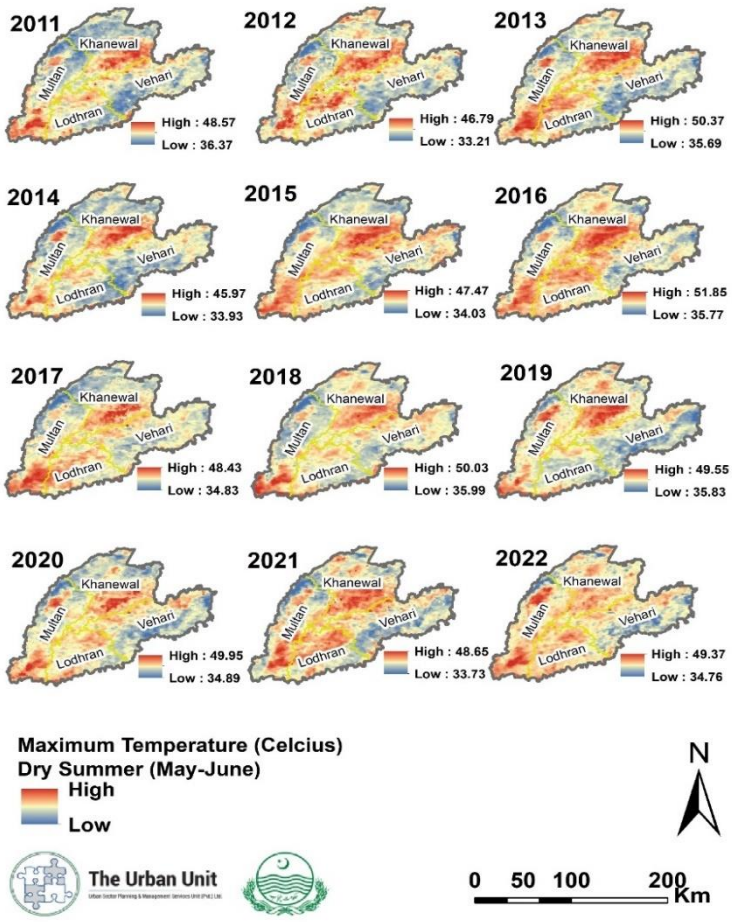


Figure 16: Spatial Pattern of Land Surface Temperature in Multan division during 2011 - 2022

Spatio-temporal trends of time-series of land surface temperature were analyzed by investigating the change in maximum variability derived from MODIS LST data (1km spatial resolution) during dry summer season (May-June) from 2012-2022. The spatial patterns of LST in Multan Region revealed that the maximum temperature during the dry summer season from 2011 2022 found at extreme levels with spatial heterogeneity. 2016 and 2018 was the highest hottest years and the maximum temperature was 51.58°C and 50.03°C respectively. Furthermore, Khanewal had the major hot spots of extreme temperatures, followed by Multan, Lodhran and

[32] Abbasi, B., Qin, Z., Du, W., Fan, J., Li, S., & Zhao, C. (2022). Spatiotemporal Variation of Land Surface Temperature Retrieved from FY-3D MERSI-II Data in Pakistan. Applied Sciences, 12(20), 10458.

33 Wasif Ali, N. U. A. B., Amir, S., Iqbal, K. M. J., Shah, A. A., Saqib, Z., Akhtar, N., & Tariq, M. A. U. R. (2022). Analysis of Land Surface Temperature Dynamics in Islamabad by Using MODIS Remote Sensing Data. Sustainability, 14(16), 9894.

Vehari which indicates that strong actions must be taken to mitigate the rising land surface temperatures in the region for sustainable development (Figure.16).

Increasing LST in Multan division is alarming climatic condition that affect and restrain climate change in various ways. Governmental concerned departments and policy makers for environment must pay close attention to the variations in the LST, in order to mitigate the urban heat island effects.

2.3.3. Assessment of Urban Recreational Parks

Recreational parks in urban centers of the Multan Region were surveyed to assess their existing conditions and identify areas for improvement. Urban recreational parks are the source of various beneficial ecosystem services, contributing to reducing atmospheric and water contamination, carbon sequestration, climate regulation, habitat for local biodiversity, maintenance of human health, and increasing human-biodiversity interactions. These services are significant for ensuring the functional continuity of natural ecosystems[34]. A total of **36 Parks** were surveyed in Multan Region. The location map is given in Figure 18. Parks Assessment was done on the basis of the following criteria;

- Ownership
- Status of Maintenance
- Category of Parks
- Availability of various facilities

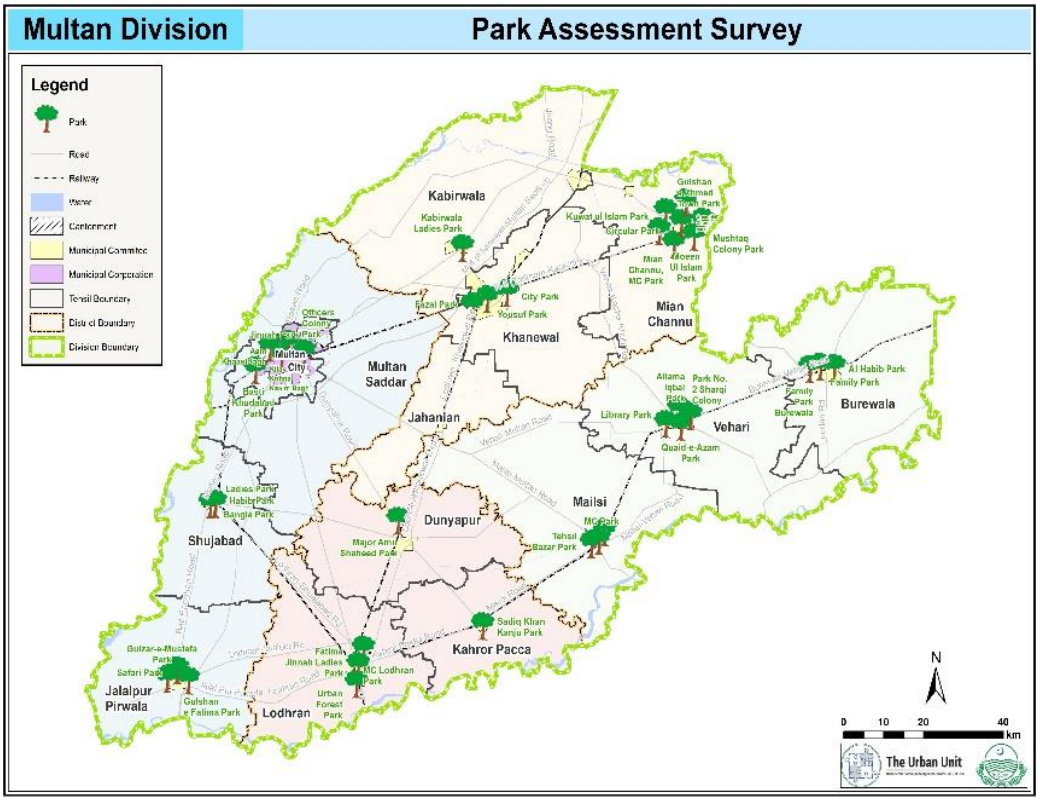


Figure 17: Location map of Parks Assessment Survey

[34] Xie, Q., Yue, Y., Sun, Q., Chen, S., Lee, S. B., & Kim, S. W. (2019). Assessment of ecosystem service values of urban parks in improving air quality: A case study of Wuhan, China. Sustainability, 11(22), 6519.

The parks present in the Multan City Tehsil were owned by Punjab Horticulture Authority, while all other parks in the entire Region were owned by the relevant Municipal Corporations. Only about 28% (10) of the total surveyed parks were well-maintained with the availability of all facilities. Out of the total surveyed parks, 83% are general parks and 14% are ladies' parks. Most of the parks require different types of recreational facilities to attract more public. The detailed observations are given in Figure 18.

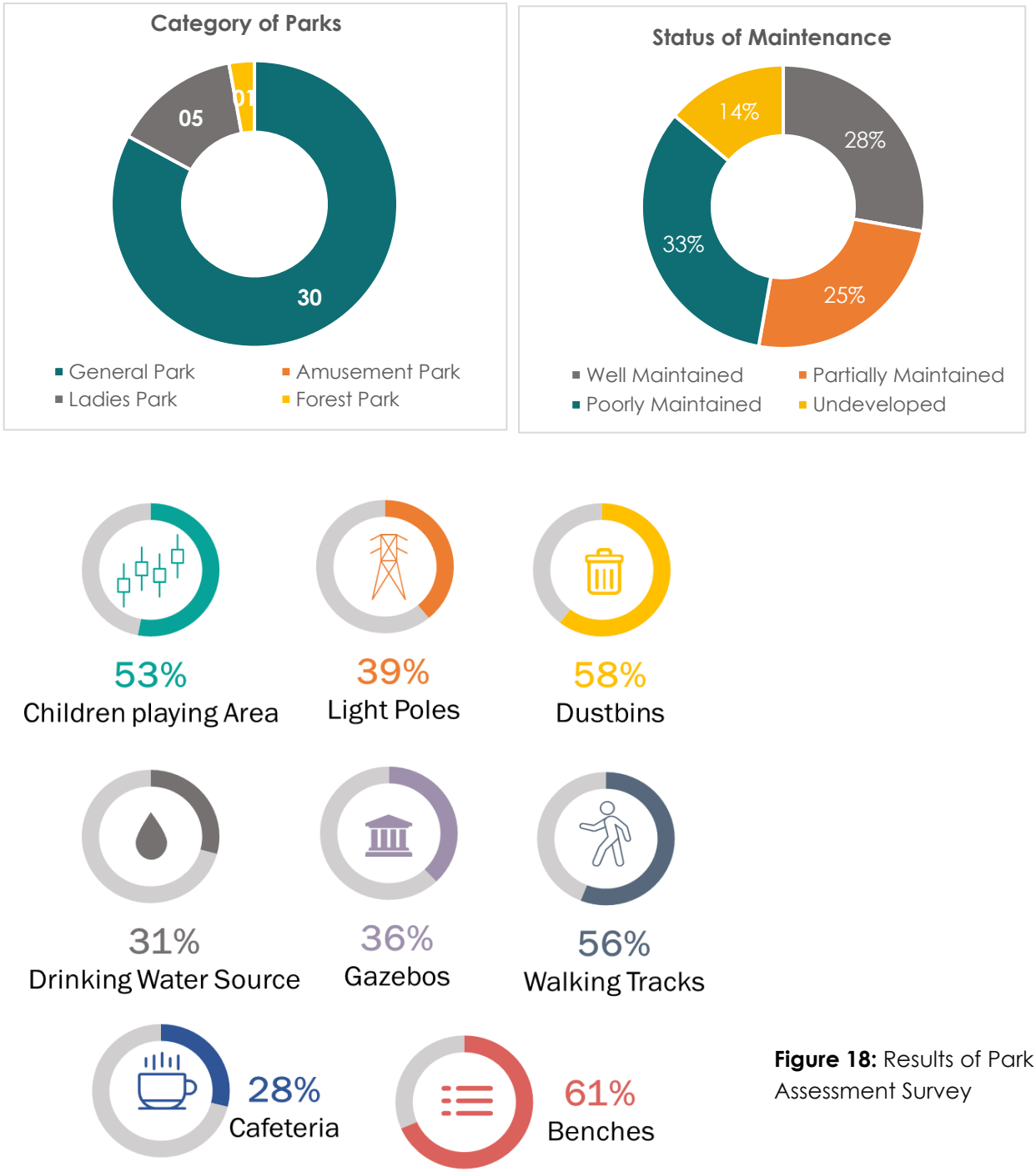


Figure 18: Results of Park Assessment Survey

2.3.4. Local Community Perception Survey – Green Spaces

To compliment Environment & Social Safeguard's Team survey, a perception survey with local community of Multan Region was also conducted in order to assess the local community perception regarding Green spaces of Multan Region.

The planning team thus visited each tehsil of four districts of Multan (Multan, Khanewal, Lodhran, and Vehari) in April 2023. A Survey form (Attached as Annexure – A) was formulated to record people's perceptions and attitudes regarding urban green spaces as well as their willingness to pay for these services in their areas. The empirical analysis of the survey helped to conclude the perception and expectations of local community regarding urban green spaces in Multan Region.

The public effectively participated in the survey. The sample size was assigned on the basis of the population of districts of Multan Region; overall ***23%*** were ***females*** and ***77%*** were ***male*** participants in the perception survey. The data from the perception survey was analyzed and the results were considered in the prioritization of need-based development projects.

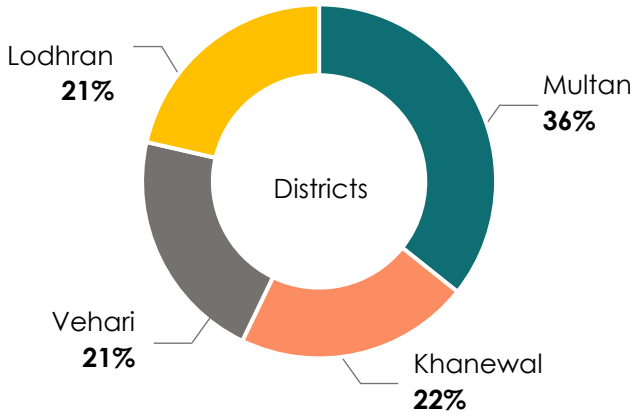


Figure 19: Demographics of Public Perception

Availability of Parks and Green Spaces in the Urban Areas

In Multan Region, the availability of Parks is generally limited and are usually present at a distant apart from residential areas. However, most of the parks are usually crowded all day more particularly in the evening. It is also worth mentioning here that the number of ladies parks is also significantly low in Multan Region to accommodate huge number of female populations.

Furthermore, the facilities present in the existing parks are also limited thus required urgent attention and proper management.

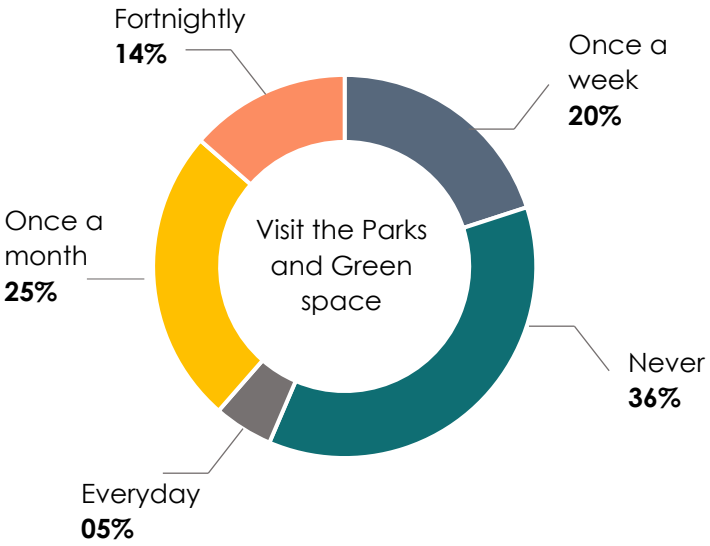


Figure 20: Local Community Visited Parks & Green Spaces

The most pressing concerns were the lack of drinking water, cafes, washrooms, insufficient lighting, and broken light poles, long distances, inadequate or missing play areas, damaged benches, and other infrastructure.

Community Participation and their Willingness to Pay

It is pleasing to comprehend that community of Multan Region know the fact that their active participation is much important to improve the existing condition of green spaces and parks. 81% of the total respondents expressed their opinion that their active participation in maintaining health of green spaces is essential. Moreover, they also suggested that greening of vacant spaces and plantations along the roadsides can enhance the vegetation cover in their cities. It is reported in the study of Riaz *et al*., that the local communities that are involved in the activities to manage the green spaces and plantations are more sustainable communities.[35] Similarly, another study also revealed that public participation is required to improve green spaces.[36]

Another crucial component of the survey is the determination of a hypothetical value to find the respondents' willingness to pay for existing and future environmental resources, such as parks and green spaces. After inquiring and analyzing the survey results, it is affirmed that more than 50% of respondents are willing to pay 50-100 Rs for increasing and improving the green spaces in their area and 36 % of low-income groups are willing to pay Rs. 50/-. The survey highlighted that those who are willing to pay can contribute a small share of their income for the enhancement or provision of green spaces which is a dire need in the rapid urbanization of Multan Division.

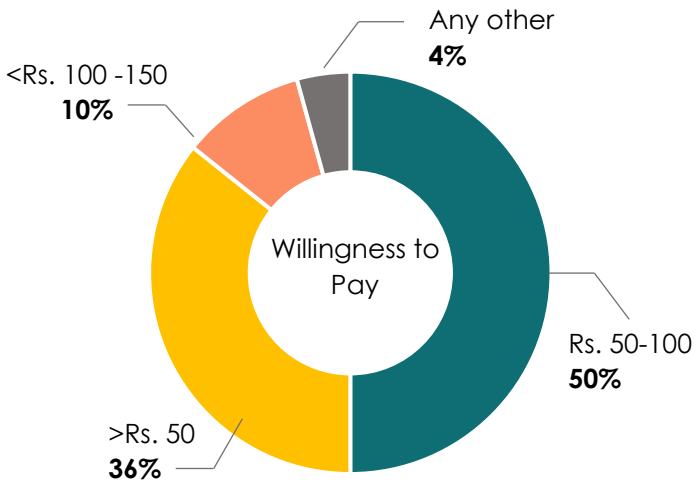


Figure 21: Community's Willingness to Pay for improvement of Parks and Green Spaces

[35] Riaz, A., Younis, A., & Naveed, S. (2010, August). Impact analysis of urban and rural landscapes as perceived by respective communities: a case study of Faisalabad city, Pakistan. 954 (pp. 99-107).

[36] Fors, H., Molin, J. F., Murphy, M. A., & van den Bosch, C. K. (2015). User participation in urban green spaces–For the people or the parks? Urban Forestry & Urban Greening, 14(3), 722-734.

2.4. Key Environmental Challenges – Multan Region

Key Environmental Challenges and Issues that Multan Region is experiencing are:

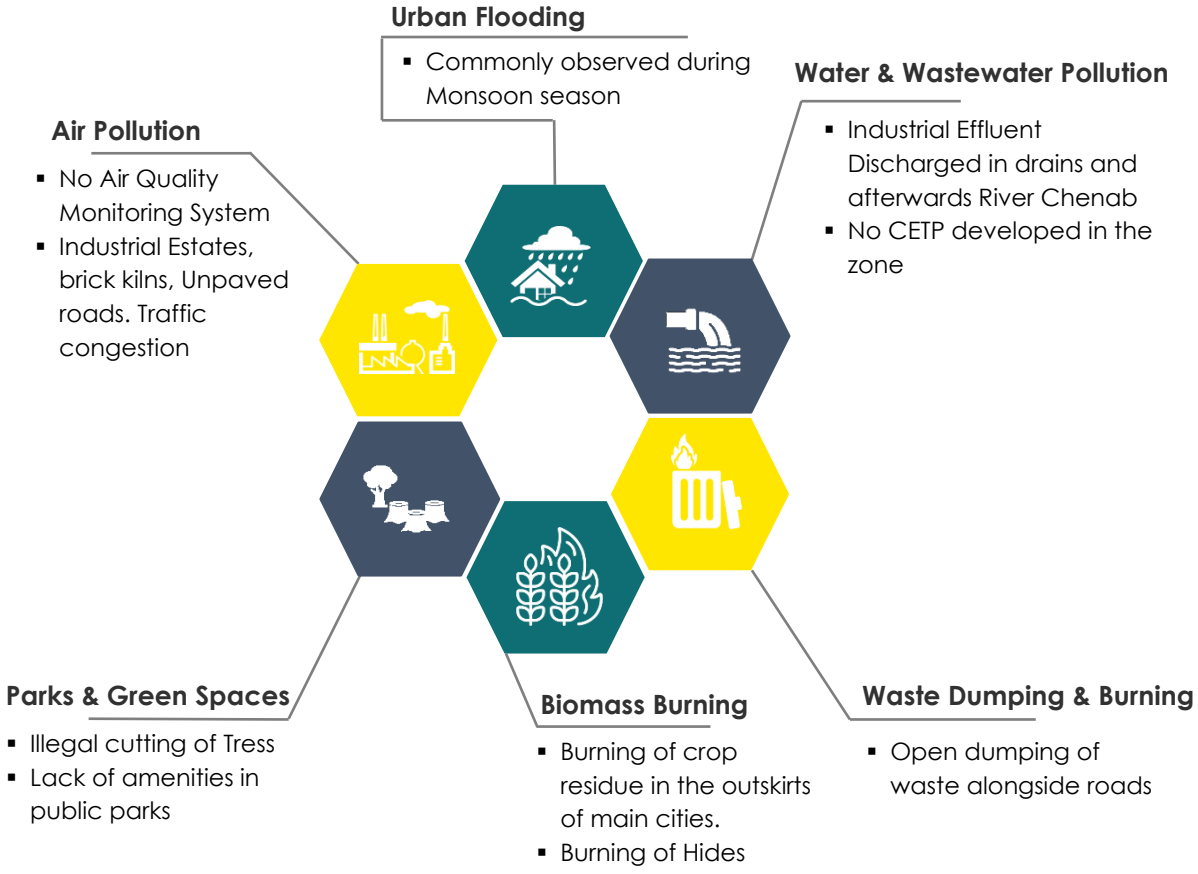


Figure 22: Key Challenges & Issues of Multan Region

To compliment Environment & Social Safeguard's Team findings, the local community of Multan Region is also consulted. Around 140 respondents (108 males; 32 females) from Multan Region were consulted. It is observed that almost 40% of total respondents have reported that air pollution and smog is the major issue in their respective areas. 37% of the respondents claimed that Waste Burning & dumping is the chief environmental challenge they are facing every day. 25% of the total respondents expressed their displeasure towards Traffic congestion & Vehicular pollution. 18% of the total respondents expressing their concerns on Noise pollution while 07% reported that lack of tree shades & green spaces is the highest environmental issues in their respective areas of the Multan Region due to overpopulation and urbanization

2.5. Biodiversity Conservation Area

Multan Region has forest and wildlife areas (in Khanewal, Lodhran and Vehari Districts) under different categories of forest and protected areas act of Punjab. Forests are determined both by the presence of trees and the absence of other leading Land use areas. The Forest is a broader terminology used for the conservation, protection and production of natural resources e.g., Forest cover in National Parks to conserve habitats, natural reserves and other protected areas.

Forest is referred to as land with a tree cover occupying **>0.5 hectares (FAO, 2018)**

The Urban Unit team visited **08** environmentally sensitive and high conservation value areas during the field visit of Multan Region. These includes:

- Rakh Jamlera, Vehari
- Head Islam Garh, Vehari
- Wildlife Park, Vehari
- Rakh Aqil & Dangra, Khanewal
- Priowal Wildlife Park, Khanewal
- Pirowal Plantation, Khanewal
- Miranpur Reserved Forest, Lodhran
- Urban Plantation Lodhran

Detailed assessments of these visits were conducted which provides a basis to understand the basic challenges of biodiversity in the region. Details of forest lands in each district, key field observations and threats of these sites are presented in the subsequent sections.

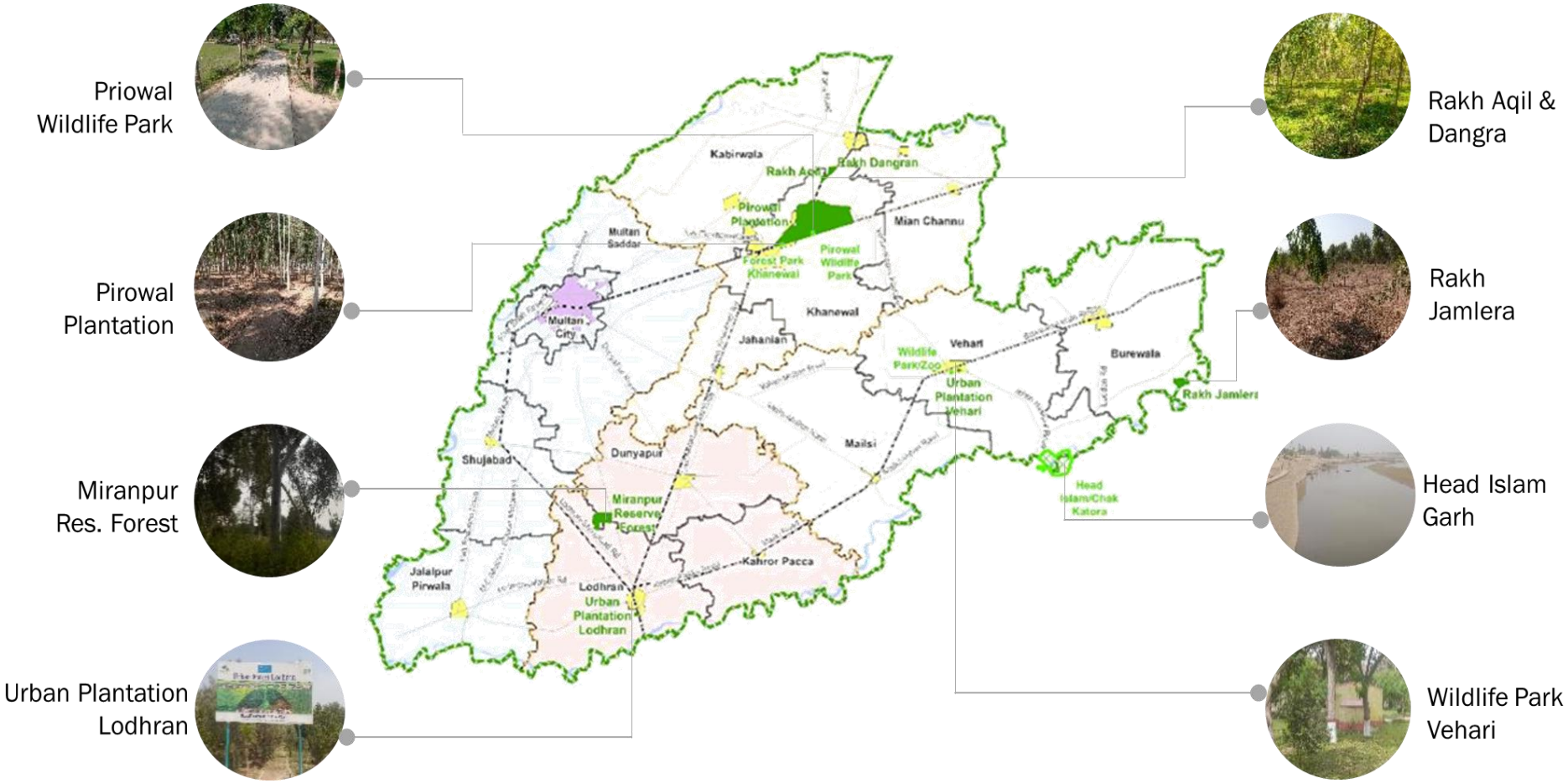


Figure 23: Conservation sites of Multan Region

2.5.1. Multan Conservation Areas

Multan is a cultural district of Punjab Province which is ground to a diversified agricultural crop and known to produced mango varieties and also date palm trees, which are dominant fruit crops. These fruiting crops are not only source of food but also have cultural importance within district. Some of the other tree's species in the region include *Acacia nilotica* (Kikar), *A. modesta* (Phulai), *Eucalyptus camaldulensis* (Sufaida), *Albizia lebbeck* (Siris), *Ficus religiosa* (Peepal), *F. benghalensis* (Bhor), *Dalbergia sissoo* (Tahli), *Ziziphus nummularia* (Beri) and *Prosopis juliflora* (Musqat), etc.

Figure 24: Linear Plantation along Canal, Multan

Key Observations & Threats

- Within district Multan, there is no compact plantation.
- The fruiting trees like mango and others also reducing in number due to rapid urbanization.
- Linear Plantation is very limited and outside to city and only planted along the canal.
- Monoculture plantation and low density of forest covers leading to decreasing urban biodiversity.
- Tree cutting is observed at planted areas.

Figure 25: (a) Tree Cutting (b) Blank Plantable Area

2.5.2. Khanewal Conservation Areas

Khanewal is the District within Multan Region which occupied comparatively more forest land under Reserved and Protected Forest which is ground to variety of animal and plant diversity and participating to regulate the ecosystem values and environment stability of the region. The forest of Khanewal dominantly planted with *Eucalyptus camaldulensis* (Sufaida) followed by *Acacia modesta* (Phulai), *Albizia lebbeck* (Siris), *Ficus religiosa* (Peepal), *Dalbergia sissoo* (Tahli), *Ziziphus nummularia* (Beri) and *Prosopis juliflora* (Musqat). These areas are supporting variety of animals like Brown Partridges, Greater Coucal, Wild hare, Wild boar, Porcupine and other native birds.

Figure 26: Forest of Khanewal

The Pirowal Wildlife Park is one of the important recreational and Biodiversity conservations site within Khanewal District; which is famous for providing captive breeding ground for variety of deer species. Apart from that, mammalian captive animals include Hog deer, Mouflon sheep, Black buck, chinkara, Nilgai and monkey as well as birds captive animals viz Ostrich, Parrot, Duck, Pheasants and Peacocks are also found there.

Figure 27: Pirowal Captive Animal and Birds

Key Observation & Threats

- The forest area of Pirowal plantation is dominantly planted with exotic species i.e., *Eucalyptus camaldulensis*. *Eucalyptus camaldulensis* is well known as reducing the soil surface moisture which is threat to native flora and fauna of the region.

- Some of the compartments are planted with indigenous plantation including Siris, Kikar, Phulai and Shisham, where the diversity of animals resides.
- Increase in invasive alien species i.e., *Prosopis juliflora* which also effecting the diversity of region.

Figure 28: Pirowal Reserve Forest

- Rakh Aqil & Dangra is the protected forest within Khanewal district occupying approx. 309 acres land out of which 27 acres area planted with mixed plantation.
- Quadrate method was used to access the species richness of the planted area, which show that the five different species are common.

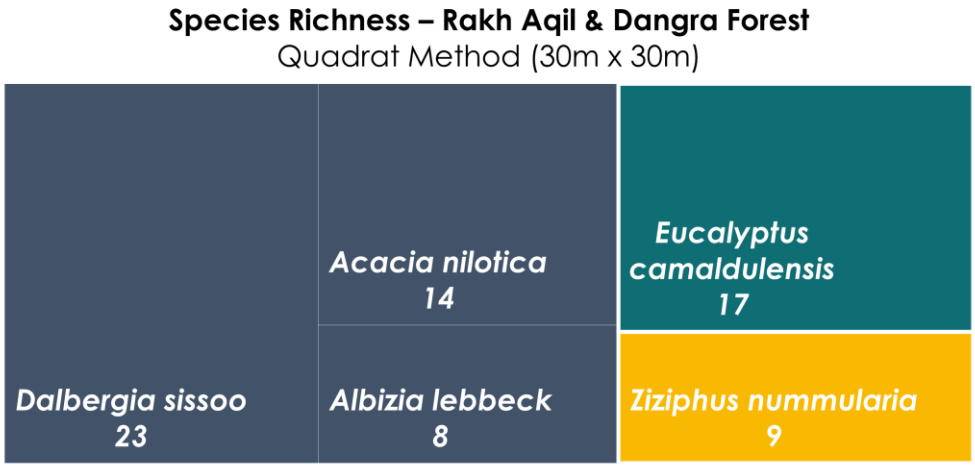


Figure 29: Species Diversity at Rakh Aqil & Dangra Forest

2.5.3. Lodhran Conservation Area

The Lodhran district have only around 1843 acres of land under Miranpur Reserve Forest which is planted with Sufaida (*Eucalyptus camaldulensis*) and some of animals like porcupines and Brown Partridges are resident of the area.

Key Observation & Threats

- The planted area is dominantly planted with exotic species i.e., *Eucalyptus camaldulensis*. *Eucalyptus camaldulensis* is well known as reducing the soil surface moisture which is threat to native flora and fauna of the region.
- Planted area has other exotic species as well, which includes weed, which is also destroying the soil demography and degrading the natural habitat for native biodiversity.

Figure 30: Eucalyptus camaldulemsis Plantation and Prosopis Juliflora

2.5.4. Vehari Conservation Areas

Vehari is the district where aquatic and terrestrial habitat are the home ground for different animals and plants. Rakh Jamlera forest which spread over 489 acres of land out of which 250 acres of land planted with Shisham and Sufaida under TBTTP. Head Islam is another conservation site within district which ground to seasonal aquatic birds, some of the key birds includes Little egrets, Bank myna, Common myna, Pond heron, Grey heron, Kingfisher, Black Dragon, Kites and Eagles which are common to this area.

Key Observation & Threats

- Monoculture plantation is the leading threat to the native diversity of Rakh Jamlera forest.
- Most of the Head Islam land under encroachment where agricultural and orchard practice performed by local resident.
- Surface Water unavailability is also an issue for the native flora and fauna of the region which reducing the species richness.

Figure 31: Head Islam Orchard Plantation and Land Enchroachment

2.5.5. Major Threats to Conservation Sites in Multan Region

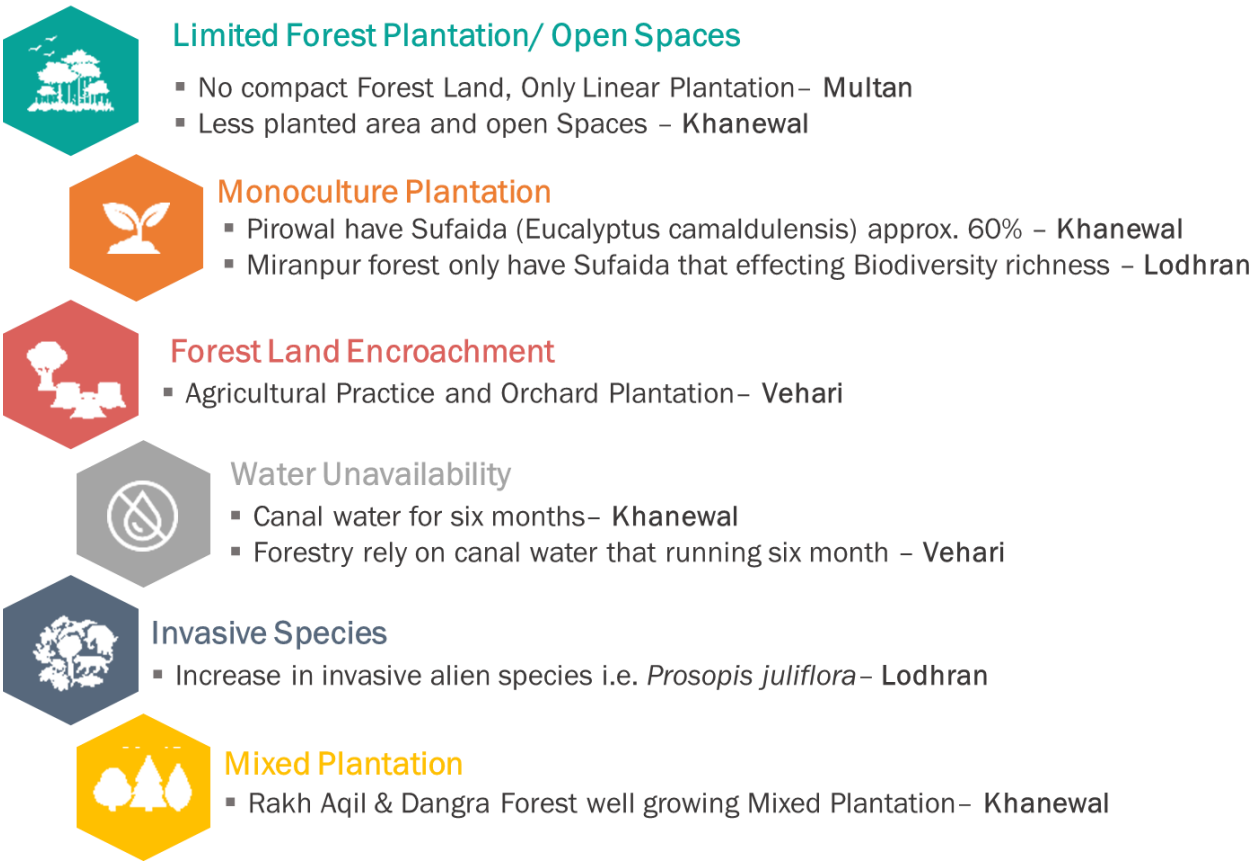


Figure 32: Major Threats to Conservation Sites

03 Legal Landscape

The constitution of Pakistan has substantially altered the allocation of legislative powers between the National and Provincial Assemblies, resulting in more Provincial autonomy. Powers have been assigned to provincial Environmental Protection Agencies/Departments (EPAs/EPDs) Some of the key national/provincial regulations that are considered related to the Regional Development Plan of Multan is enlisted below:

National Framework	Provincial Framework
▪ Pakistan Climate Change Act, 2017	▪ Punjab Environment Protection Act, 2017
▪ Forest Act, 1927	▪ Policy on Controlling Smog, 2017
▪ Pakistan Environmental Protection Act, 1997	▪ Punjab Environmental Protection (Delegation of Powers for Environmental Approvals) Rules, 2017
▪ National Climate Change Policy, 2012	▪ Punjab Hospital Waste Management Rules, 2014
▪ Framework for Implementation of Climate Change Policy, 2013	▪ Punjab Environmental Protection Motor Vehicle Rules, 2013
▪ National Sustainable Development Strategy, 2012	▪ Punjab Environmental Protection Administrative Penalty Rules, 2013
▪ National Disaster Risk Reduction Policy, 2013	▪ Regulation of Disclosure of Environmental Information and Citizen Engagement, 2020
▪ National Forest Policy, 2015	▪ Environmental Sampling Rules, 2001
▪ National Rangeland Policy, 2010	▪ Pollution Charge Rules, 2001
▪ Review of IEE / EIA Regulations, 2000	▪ Environmental Tribunal Rules, 2012
▪ National Conservation Strategy, 1992	▪ Punjab Forest Policy, 2019
▪ Biodiversity Action Plan for Pakistan, 2000	▪ Punjab Environmental Quality Standards (municipal and liquid effluents, drinking water, motor vehicles, ambient air, noise, treatment of liquid and disposal of biomedical waste and Industrial gaseous emission), 2016
▪ Guidelines for sensitive and critical areas, 1997	

04 Vision, Goals & Objectives

4.1. Vision

A vibrant and internationally competitive region with sustainable development in conducive environment whilst protecting and improving biodiversity where ecological resources are proficiently managed and conserved, cleaner environment, climate resilience and recreational facilities may be important indicators of the region's macro-level socio-economics.

4.2. Goals

To protect, conserve and retain the ecological values as well as sustainable development of the region for current and future generations, predominantly as a derivation of glory, inspiration, education, recreation and enhance the local community's livelihood.

4.3. Objectives

This plan helps to prioritize development projects at the regional level based on current conditions and future growth needs. Specific objectives of the plan are as follows:

- To identify potential projects & programs that can contribute to the economic growth, environment protection, conservation, employment opportunities and exploit competitive benefits of region.
- Improve the overall state of environment in Faisalabad Region.
- Project Prioritization and capacity needs for improve livability and competitiveness.
- Such a plan will fulfill a longstanding demand of local officials to have a document that can provide them a strategic vision for the development of the region and have a voice in the overall planning process in the province.

05 Methodology

Multan Regional Development Plan for the Environment sector was developed to prioritize the most resilient and sustainable solutions for the mitigation of the baseline environmental issues. The plan focuses on adopting a combined approach of data collection from field visits and literature while involving all regional and provincial stakeholders (government organizations and local community) and using modern remote sensing technology for impacts assessment on the ground scale. It provides a framework of interventions for environmental improvement, divided into short, medium, and long-term plans spanning from three to ten years. The methodology adopted for the purpose of this plan is given below:

Figure 33: Methodology Map for MRDP

5.1. Desk Research for Secondary Data Collection

A comprehensive desk research was conducted in order to understand the state of environment in the Multan Region during the past decade. Existing legal landscape, administrative and institution set-up, South Punjab ADP Schemes, relevant reports and journals as well as similar projects and programs executed in the previous years for the improvement of environmental conditions and green spaces were also assessed.

5.2. Primary Data Collection

5.2.1. Field Visits

For on-ground information, the team of experts consisting of environmental scientists, environmental engineers, biodiversity professionals, and archaeological experts from the Environment and Social Safeguards Division visited the Multan Region. Field Visits were conducted in three phases;

Inception Visit:

The inception visit of Multan region was conducted between March 7th, 2023 – March 10th, 2023 by the senior officials of the Environment Team. During this visit, meeting with key stakeholders which include; meetings with the Commissioner of Multan Region as well as Deputy Commissioners of Multan, Khanewal, Lodhran and Vehari Districts were conducted.

Rapid Assessment Visit:

After inception visit, a team of experts from the Environment & Social Safeguards Team conducted Rapid Assessment Survey of Multan region between March 13th, 2023 – March 18th, 2023. During this course, a series of meeting with various stakeholders as well as Rapid assessment surveys of the major urban centers of Multan, Khanewal, Lodhran and Vehari Districts were conducted.

The institutional hierarchies, inter-linkage of departments, key concerns of the stakeholders, and technical and capacity-building issues were identified during this survey. In addition, air quality and noise quality were monitored, key sources of air and water pollution were identified, and existing biological, cultural and archaeological conditions were also assessed in major urban centers of Multan Region. Apart from that, key areas of interventions for environmental improvement were also identified and documented.

Public Perception Survey/ Community Consultation:

The Environment & Social Safeguards Team also held a detailed Public Perception visit between April 03rd, 2023 – April 08th, 2023. This survey mainly focused on assessing the concerns of local inhabitants regarding public and green spaces as well as existing environmental conditions. The community recorded their perception about current changes in the environmental quality over the years, sources of air and water pollution and causes of the negative environmental impacts due to development and construction activities in the region. All of these issues have been considered during the development of this regional plan in order to ensure the benefit of the community.

Stakeholder Consultation:

A total of 20 Consultation Meetings with key government officials in the Multan Region were conducted by the Environment & Social Safeguards team. During these meetings, the key concerns of relevant departments and suggestions for environmental improvements were documented. In addition, institutional capacities were also examined. All key stakeholders

provided complete support in the development of a practical and attainable regional development plan.


MOI Khanewal, Tehsil


AD Env, Khanewal


DFO, Multan


CO MC, Mian Channu


AC, Mian Channu


MC, Kahror Pacca


EPA, Vehari


EPD, Multan


PHA, Multan


AD Env, Lodhran


MC, Dunyapur


RFO Lodhran & Dunyapur


MC, Mailsi


MDA, Multan


MC, Lodhran

Figure 34: Stakeholder's Consultation

5.2.2. Environmental Quality Assessment

Air Quality Assessment

Data of four air quality parameters (AI, NO_2, SO_2 and CO) were downloaded from ***Copernicus website*** for year 2022, to analyze their spatial pattern over Multan Region.

Land Surface Temperature Assessment

MODIS LSTs were extracted from the MODIS LST/Emissivity Daily L3 Global 1 km V005 product. Data was obtained from both the Terra (MOD11A1) satellite and downloaded from http://reverb.echo.nasa.gov/. The MODIS LSTs are derived from measurements in the thermal infrared channels 31 (10.78 to 11.28 μm) and 32 (11.77 to 12.27 μm) using the day–night split-window algorithm.

Vegetation Cover Assessment

To assess the vegetation dynamics of Multan Region, two different satellite datasets were used.

Table 4: Satellite data used to assess the vegetation dynamics in Multan Region

Sr. No	District	Satellite/Sensor	Spatial Resolution	Date of Acquisition	Path/Row	Bands Used
1	Multan	Landsat 5 (ETM)	30m	April - 1993	149/38	4 & 3
2		Landsat 7 (ETM+)	30m	April - 2003		4 & 3
3		Landsat 8 (OLI/TIRS)	30m	April- 2013		5 & 4
4		Landsat 8 (OLI/TIRS)	30m	March-2023		5 & 4
5		MOD13A1	250m	2001 - 2022		

The pixels where mean yearly NDVI values was found to be less than 0.1 were masked out to exclude the soil moisture, baren land etc. The inter-annual and seasonal pixel-wise NDVI trends were calculated. The seasons were primarily categorized as Spring (March–April), Dry-Summer (May–June), Wet-Summer (July – September), Autumn (October–November) and Winter (December – February).

- **Linear Regression Model (LRM)**

To conduct the time series analysis of NDVI, the linear regression model was employed by using the least squares linear regression method for each pixel, which reflects the spatial characteristics of the rate of change per time step (e.g., for monthly data: rate of change per month) at a pixel level. The linear slope method was used to examine interannual and seasonal trends of NDVI. The equation of the linear regression model was used by many previous studies for pixel to pixel-based analysis as given below,

$$\text{Slope} = \frac{n \times \sum_{i=1}^{n} X_1 Y_1 - \sum_{i-1}^{n} X_i \sum_{i=1}^{n} Y_i}{n \times \sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_1)^2} \qquad (1)$$

In this equation, slope (p) of the regression shows the average temporal change in NDVI; n represents the total number of years of the study period, whereas Y1 and X1 are the values of dependent and independent variables in the ith year. Generally, slope increases with the increasing of variable values and vice versa.

5.3. Development of Short-Medium-Long term plan

Based on the exercise discussed above, schemes / projects were identified and prioritized for each district. This ten-year plan provides short term (up to 3 years), Medium Term (3 to 6 years) and long term (up to 10 years) projects focusing on improved service delivery, better environmental quality, enhanced climate resilience along with increased economic growth of the region.

5.4. Development of RDP Bahawalpur

Finally, a sectoral plan for Environment component was developed for Multan Region with a comprehensive investment Plan for the period of 10 years (2023-2033). Each project contains its title, cost, category (short/medium/long term) and mode of investment (Government / Donor / PPP).

5.5. Feedback visit

Consultation is an essential step to engage the multi-stakeholders and get their feedback and ownership in finalizing the project digest for the Multan Region. Therefore, a feedback visit will be conducted for final consent from the relevant department before submitting it to the Planning and Development Board, Government of Punjab.

06 Regional Development Plan

6.1. Framework

Punjab is the most vibrant as well as the populous province of the Pakistan. However, from past few decades the province is facing challenges not from the economic front but also from the ecological side. The Government of Punjab is well cognizant to the myriad problems that the province is facing. Therefore, in order to tackle these challenges Government of Punjab has taken series of initiatives and drafted various regulation/policies/strategies that address such issues (viz., rapid urbanization, unreliable service provision, low municipal service recovery, high environmental pollution and so forth) and create a regionally equitable economy across the province. As in the province, the public spending is distributed on the basis of administrative jurisdiction i.e., division (region), districts and tehsils, it is desired to consider spatial and socio-economic dimensions for improved service delivery and environmentally sustainable development at a macro scale

Keeping in view of all the facts; such as present challenges, risks, gaps, needs and priorities for future economic development, a Framework for Environment Sector of Regional Development Plan of Multan Region is designed. Each component of this framework is passed through a lens of existing infrastructure, governance and population factor. Comparative advantage is gained by using credible mapping resource and Geographic Information Systems (GIS) for spatial representation of relevant data along with current state of environmental conditions. Consultation is another keystone of the RDP drafting process which is done through meetings, data collection forms, field visits, planning exercises and feedback sessions. Finally, the framework is drafted which enlisting the priority projects at district level which are consolidated as one broader plan/project digest of Multan Region.

6.2. Project Digest/ Investment Plan

Based on the framework of regional development plan, desk review/secondary information, on-ground survey, perception and expectation survey, consultations with local community and meetings with local authorities, a Project digest is developed for Multan Region, which can also call as Investment Plan. These projects are divided based on their urgency / priority for a ten-year span and divided in to short, medium and long term.

The total cost of the environmental sector project digest for Multan Region is **Rs. 1,336 million**.

6.3. Proposed Projects

The proposed projects for the improvement of environmental values and biodiversity conservation of Multan Region are as follows:

A. Short – Term Plan (Up To 03 Years) Estimated

Sr. No.	Proposed Projects	Government Entity	Estimated Cost (PKR million)
1.	Installation of Air Quality Monitoring System in Multan & Vehari Districts (2 BAM & 50 Low cost equip)	EPD	23.4
2.	Green urban Corridor in Burewala city (1 km)	MC	24.8
3.	Forest Plantation (850 acres) in:		
	- Pirowal Forest (700 Acres), Khanewal	FWF	210
	- Rakh Aqil & Dangra (150 acres), Khanewal	FWF	45
4.	Restoration of Parks and placement of missing facilities in 11 parks of Multan Region: (84.95 Acres)	PHA	50
5.	Agroforestry in:		
	- Multan 10 Av. Miles	Agriculture & FWF	3.3
	- Khanewal 10 Av. Miles	Agriculture & FWF	3.3
6.	Phytoremediation: Effluent Drainage Canals & Wastewater Ponds		
	- Multan Canal Plantation (50 Av. M)	Irrigation & WASA	16.7
	- Multan Industrial Estate: 2 Acres	Irrigation & WASA	3.8
	- Jahaniyan City, 4 Acres	Irrigation & MC	7.6
	- Wali Muhammad Distributary, Multan	Irrigation & WASA	2.9
	- Naubahar Canal, Multan	Irrigation & WASA	4.0
	- Abdullah Chowk Sewerage Drain Shujaabad	Irrigation & WASA	2.4
	- Kala Pull Sewerage Drain Shujaabad	Irrigation & WASA	2.9
7.	Railway Track beautification & Plantation in:		
	- Multan Railway Track: 16km	Irrigation & FWF	7
	- Khanewal Railway Track: 16km	Irrigation & FWF	7

	- Inter-City Civil Railway Line: 4.73 km	Irrigation & FWF	2
	- Mian Channu: Railway Line: 5 km	Irrigation & FWF	2.2
8.	Underground Reservoir for Management of Urban Flooding	WASA	50
9.	Ecological Corridor along Canal		
	- PI Link Canal, Burewala: 1.1 kilometers	Irrigation	0.48
	- Pakpattan Canal Vehari, Length: 17.7 km	Irrigation	7.8
	- Dhamaki Canal, Mailsi: 5.1 km	Irrigation	2.2
		Total	**620**

B. Medium – Term Plan (Up To 05 Years) Estimated

Sr. No.	Proposed Projects	Government Entity	Estimated Cost (PKR million)
1.	Installation of Air Quality Monitors in Khanewal District (1 BAM & 25 Low cost Equip)	EPD	17.2
2.	Green urban Corridor in Vehari city (30 km)	MC	13.2
3.	Development of Safari Park/ Wildlife Park Jalalpur Pirwala (27 Acres)	FWF	100
4.	Forest Plantation in:		
	- Pirowal Wildlife Park (15 Acres), Khanewal	FWF	4.5
	- Miranpur Reserved Forest (200 Acres), Lodhran	FWF	6.0
5.	Improvement of 23 semi-developed Parks of Multan Region	PHA	150
6.	Agroforestry in: Lodhran 20 Av. Miles	Agriculture & FWF	6.7
7.	Canal Plantation and Phytoremediation		
	- Lodhran Canal Plantation (50 Av. M)	Irrigation	16.7
	- Nullah channel and Minor Canal Lodhran (5 km +5 km)	Irrigation	6.1
	- Kahror Pacca Dunyapur Canal (5 km)	Irrigation	3.05
8.	Railway Track beautification & Plantation in:		
	- Lodhran Railway Track: 16 km	Irrigation & FWF	7
	- Mailsi: Railway Line: 5.47 km	Irrigation & FWF	2.4
	- Dunyapur: Railway Line: 10 km	Irrigation & FWF	4.4

9.	Underground Reservoir for Management of Urban Flooding		50
10.	Urban Farming in Burewala		100
		Total	**521.3**

C. Long – Term Plan (Up To 10 Years) Estimated

Sr. No.	Proposed Projects	Government Entity	Estimated Cost (PKR million)
1.	Installation of Air Quality Monitoring System Lodhran District (1 BAM & 25 Low cost equip)	EPD	17.2
2.	Forest Plantation in: - Rakh Jamlera (200 Acres), Vehari	FWF	60
3.	Agroforestry in: - Vehari 20 Av. Miles	Agriculture & FWF	6.7
4.	Canal Plantation and Phytoremediation:		
	- Khanewal Canal Plantation (50 Av. M)	Irrigation	33.3
	- Pakpattan Canal Vehari (100 Av.M)	Irrigation	66.6
5.	Railway Track beautification & Plantation in:		
	- Vehari Railway Track: 16km	Irrigation & FWF	7.5
	- Burewala: Railway Line: 8.17 km	Irrigation & FWF	3.5
		Total	**194.8**

D. Proposed Interventions Map

- Ambient Air Quality Equipment
- Urban Green
- Development of Safari Park
- Forest Plantation
- Development & Restoration of Parks
- Agroforestry
- Railway Track Plantation
- Canal Plantation and Phytoremediation
- Urban Farming
- Underground Reservoirs (for Management of Urban

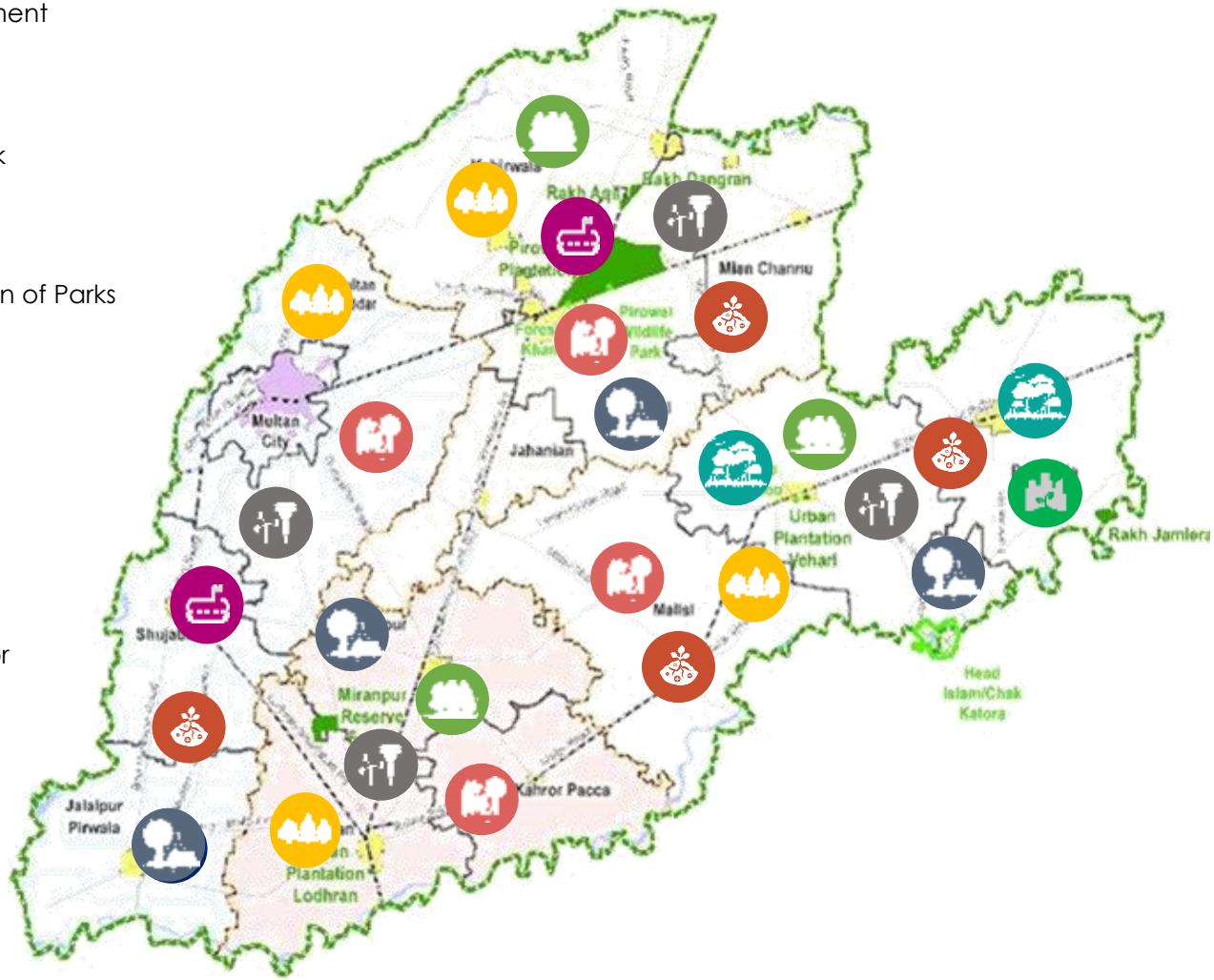


Figure 35: Proposed Interventions in Multan Region

6.3.1. PROJECT 1: Installation of Air Quality Monitoring Equipment

Multan is one of the largest cities in Punjab with a population of three million inhabitants. Air pollution is thought to be predominantly a major urban issue in Multan due to vehicular emissions and industrial emissions. Due to its proximity of adjacent desert areas, mineral dust is considered to be the secondary source of high concentrations of particulate matter. Urban air quality in this area is being deteriorated, due to ineffective traffic plans and transportation management, the use of antiquated technology, such as fuel substitution, the lack of less polluting fuels (like low sulfur fuels and CNG), and a lack of management tools for the effective implementation of emission control legislation.

Air Quality Monitoring is an important factor in enabling effective monitoring decision-making on air quality issues. One of the biggest challenges in air quality management is proper access to air quality data. The Pakistani government has started to respond to this air pollution challenge. The proposed project is to establish an air quality monitoring system in major hot spot areas of particulate concentration in the Multan Division.

Scope of the Project

This project aims to record particulate matter concentrations ($PM_{2.5}$ and PM_{10}) in Khanewal, Multan, Lodhran and Vehari district of the Multan Region.

ACTIVITIES

Installation of air quality monitoring equipment (US-EPA Approved BAM 1025) and low-cost sensors in hotspot areas of Multan Region.

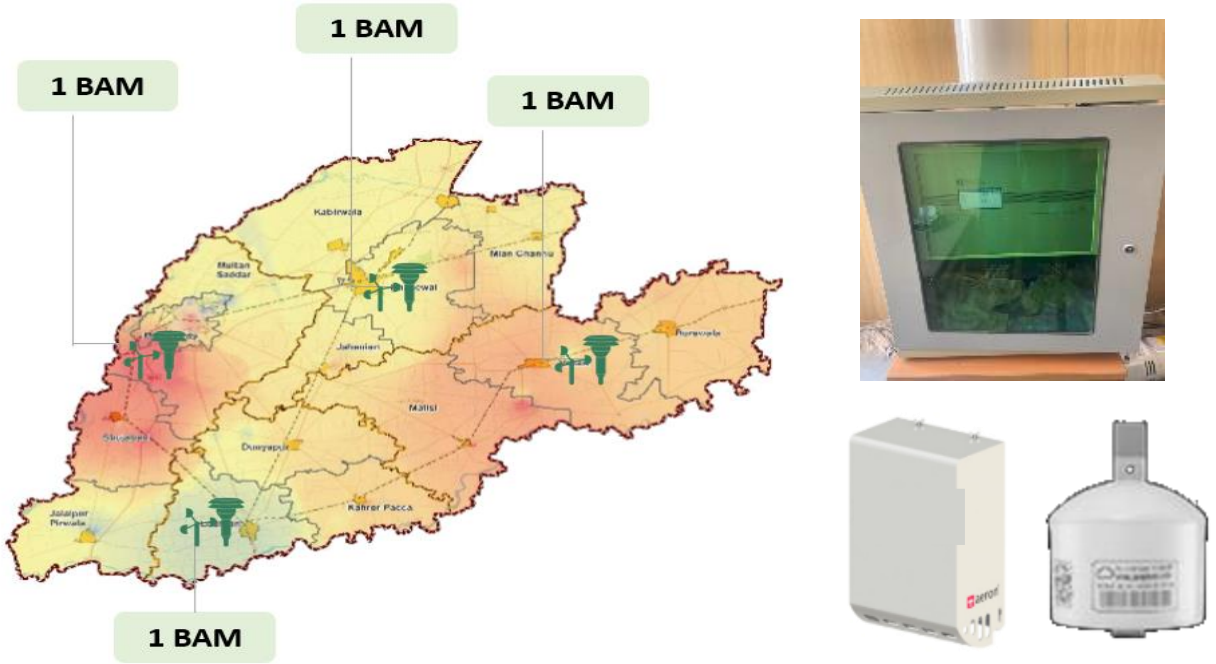


Figure 36: (a) Air Quality Monitoring Stations (b) Air Quality Monitoring Equipment's

6.2.2. PROJECT 2: Green & Urban air Corridor

The networks of urban green corridor which are connecting pathway among linear parks, green belt, green spaces and linear plantation along roads, canals and tracks are designed to improve the environmental qualities of cities. Green corridors are especially beneficial for urban biodiversity as they create cool air pathways that cool cities and improve air quality. Additionally, green corridors help to improve the aesthetic view of metropolitan areas and offer locals recreational opportunities. In order to improve the environmental values of cities, the networks of urban green corridors are need of cities to frequently developed along green belts and increase the green infrastructure.

Scope of the Project

To develop a Green Corridor with a larger collection of trees and other vegetation along Streets, Water features, in Parks, and Open spaces to provide a green solution to Urban Heat Island.

Proposed Site

- Burewala City: 56.0 km (62,000 Plants)
- Vehari City: 30.0 km (33,000 Plants)

Conceptual Design

- The green corridor should be a connected network of green cover and green spaces
- The plantation along water channel should be planned and based on stratification to enhanced the beauty of the region.
- Number of rows based on the availability of spaces along the planting area.
- The placement of vegetation around developments and the maintenance of larger, interconnected green spaces throughout regions should be done to promote air quality improvement.

Estimate Cost

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Rs. Million)
1	Burewala City 56.0 km	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	62,000	400.00	**24.80**
2	Vehari City 30.0 km	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	33,000	400.00	**13.20**
					Total Amount	**38.00**

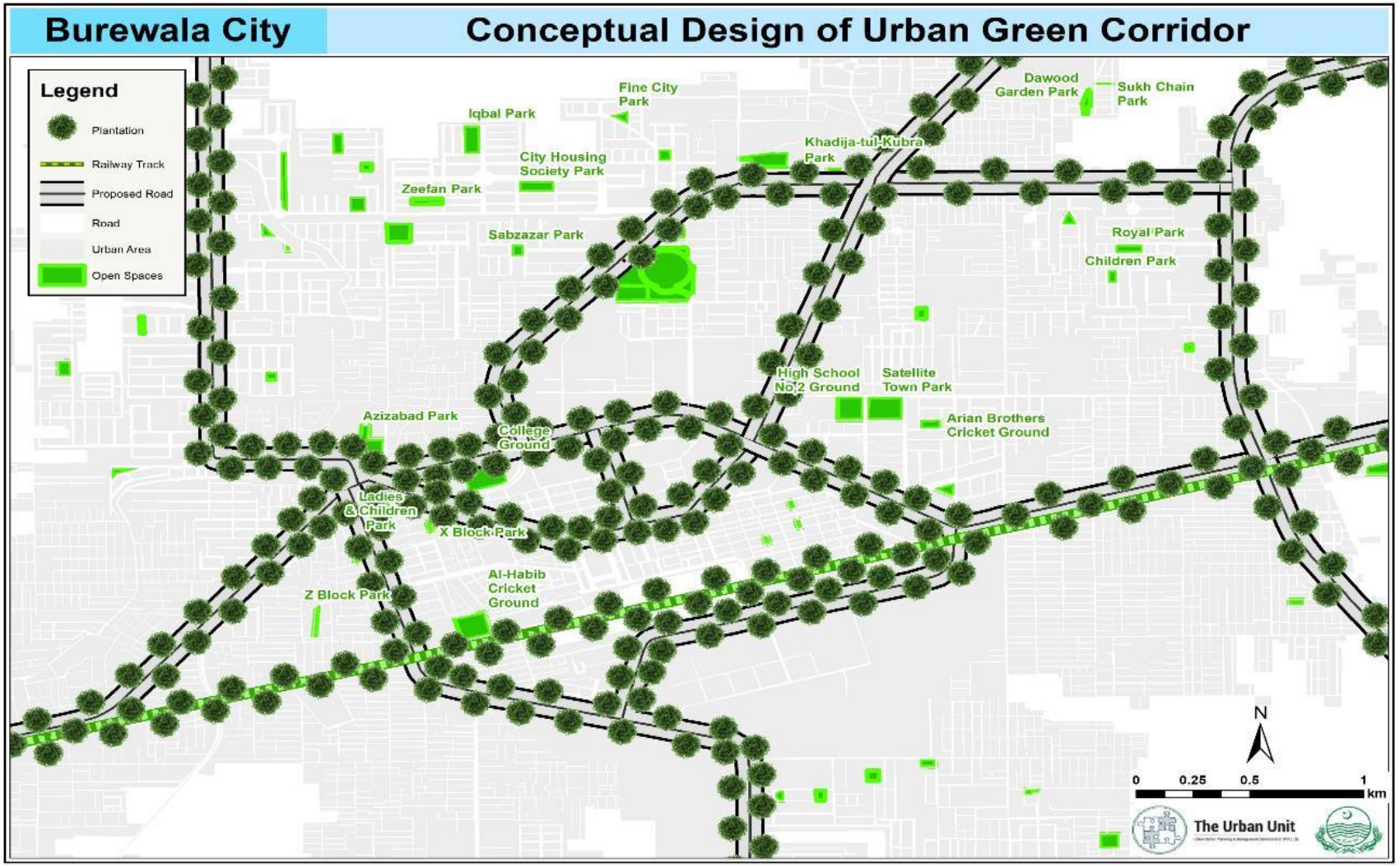


Figure 37: Proposed Conceptual Design for Green Urban Corridor

6.2.3. PROJECT 3: Wildlife/Safari Park

The Wildlife Park is the ex-situ conservation and protection strategy to conserve the native animals and provide the ground for breeding within suitable habitat. The aim to provide safe and natural habitat for native threatened wildlife species by implementing breeding program and conducting research on behaviour, ecology and genetic diversity of animals. The wildlife park is ground of recreation and educational scientific research opportunity which attract wildlife lovers and researchers, also enhance tourism opportunity for the local residents.

Lodhran wildlife park will support scientific research and join forces with universities, conservation organizations and research institutes to advance conservation strategies and help the conservation efforts. This wildlife conservation site will also accommodate the injured and rescued wildlife of the district and provides the rehabilitation facilities. The reintroduction of animals to natural habitat will also be possible through this conservation and breeding program.

Proposed Sites

- Lodhran Wildlife Park, 25 Acres (29.510" N, 71.630" E)
- Jalalpur Pirwala Safari Park, 27 Acres (29.535" N, 71.226" E)

Conceptual Design

- Establishment of Animal enclosure i.e., Chinkara, Hog Deer, Black Buck, Nilgai, Mouflon Sheep, Lion and Monkey house.
- Establishment of Bird aviary and cages i.e., Pheasants, Paecock, Common crane, Ducks, Ostrich, Perret and Partridges.
- Indigenous plantations and Provision of Lawns.
- Establishment of Walking tracks, Admin block and cafeteria facilities.
- Provision of Gazebo, huts and recreational facilities.

Estimate Cost

Sr. No	Description	Millions
1	A-Black Buck Enclosure	5.16
2	B-Hog Deer Enclosure	3.24
3	C- Mouflon Sheep Enclosure	4.01
4	D- Nailgai Enclosure	3.14
5	E- Pheasant Enclosure	2.24
6	F- Duck Enclosure	4.34
7	G-Lion Enclosure	5.04
8	H- Ostrich Enclosure	5.74
9	I- Tiger Enclosure	5.01

10	J- Guinea Fowl Enclosure (Cage)	0.61
11	K- Bird Aviary Enclosure (Cage)	1.23
12	L- Common Crane Enclosure	4.11
13	M- Peacock Enclosure	3.00
14	N- Parrots House (Cage)	0.61
15	O- Chinkara House Enclosure	7.24
16	P- Chinkara Enclosure	3.74
17	Q-Parking Area	18.36
18	R- Children Play Ground Area	1.00
19	S-Admin Block	3.10
20	T- Cafeteria	3.28
21	U- Toilet Block	1.56
22	V- Entrance	3.00
23	Plantation	1.82
	Sub- Total Amount	**90.58**
	Add Contingencies Cost (2%)	**1.81**
	Add PST (5%)	**4.53**
	Grand Total Amount with Contingencies and PST	**97**

Figure 38: Proposed Conceptual Design for Safari Park at Jalapur-Pirwala

6.2.4. PROJECT 4: Forest Plantation

Forest plantation in Multan Region has the primary objective to increase the forest cover by planting trees on barren lands, degraded areas and other suitable sites of forest land. Forest plantation helps to improve native tree species richness that are suitable to the local climate, soil conditions, and ecological requirements. Forest plays a significant role in conserving biodiversity of any region, the scope of forest plantation includes the selection of tree species that support local biodiversity, provide habitat for wildlife and contribute to the ecological services.

Planting diverse tree species and creating forest corridors can help to maintain connectivity between habitats and support the survival of various plant and animal species. Forest plantation key source to environment stability, which contribute to carbon sequestration and helps to mitigate climate change. Forest plantation in Multan division will also be focused to mitigate the key issues like deforestation by replanting trees in areas that were once covered by forests but now been degraded due to human activities or natural causes.

Proposed Sites

Locality	District	Area (Acres)	No. of Plants
Pirowal Plantation Khanewal	Khanewal	700	525,000
Rakh Aqil & Dangra	Khanewal	150	112,500
Pirowal Wildlife Park	Khanewal	15	11,250
Miranpur Reserve Forest	Lodhran	200	150,000
Rakh Jamlera Reserve Forest	Vehari	200	150,000
Total Proposed Area or No. of Plants		**1265 Acres**	**948,750**

Conceptual Design

- The forest plantation design should be based on mix plantation or polyculture design to attract and conserve the wild diversity of the region.
- The species selection based on indigenous plant species which are native to the division like:
  - *Albizia lebbeck* (Siris)
  - *Acacia modesta* (Phulai)
  - *Acacia nilotica* (Kikar)
  - *Dalbergia sissoo* (Shisham)
  - *Morus alba* (Shehtoot)
  - *Morus nigra* (Toot)
  - *Ziziphus nummularia* (Beri)
- The spacing of line and trees are 10 x 6 feet for the well managed and better growth of plant.
- The gradual thinning of forested land for better growth of plantation and removal of weed like *Prosipis julifora* which is the very common weed in forestry.

Figure 39: Conceptual Design for Forest Plantation

Estimate Cost

Sr. #	Site	Description	Unit	Qty	Rate (Rs)	Amount (Rs. Million)
1	Pirowal Plantation Khanewal	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	525,000	400.00	**210.0**
2	Rakh Aqil & Dangra	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	112,500	400.00	**45.0**
3	Pirowal Wildlife Park	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	11,250	400.00	**4.5**
4	Miranpur Reserve Forest	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	150,000	400.00	**60.0**
5	Rakh Jamlera Reserve Forest	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	150,000	400.00	**60.0**
					Total Amount	**380**

6.2.5. PROJECT 5: Development & Restoration of Urban Parks

Urban parks are defined as delineated open space areas, mostly dominated by vegetation and water, and generally reserved for public use.

Urban parks are a significant component of urban amenity green spaces. These are significant key tools for measuring the sustainability of cities. Green spaces in the cities facilitate sustainable urban planning. Unplanned urban growth with limited green spaces / open public spaces not even decrease the sustainability of the area but also negatively impacts human health and well-being. The provision of urban green spaces is one of the major priorities in the livable city. The total number of green spaces in a city is one of the important indicators of a sustainable urban ecosystem and quality of urban life

Scope of the Project

The scope of the project aims to provide the following facilities in the parks:

- Children's Play Area ▪ Gazebo
- Walking Track & Pathways
- Drinking Water faucets Fountain
- Rest areas/washrooms
- Parking area
- Cafeteria
- Benches

Proposed Site for Development of New Parks:

- 13 Parks – Multan District
- 06 Parks – Vehari District
- 03 Parks – Khanewal District

Proposed Site for Restoration & Improvement of Parks:

- 06 Parks – Multan District
- 03 Parks – Vehari District
- 01 Parks – Khanewal District
- 01 Parks – Lodhran District

Conceptual Design (Public Park, Ladies Park, Recreational Park and Park Arab Fertilizer Park)

Public Park

Ladies Park

Recreational Park

Pak – Arab Fertilizers

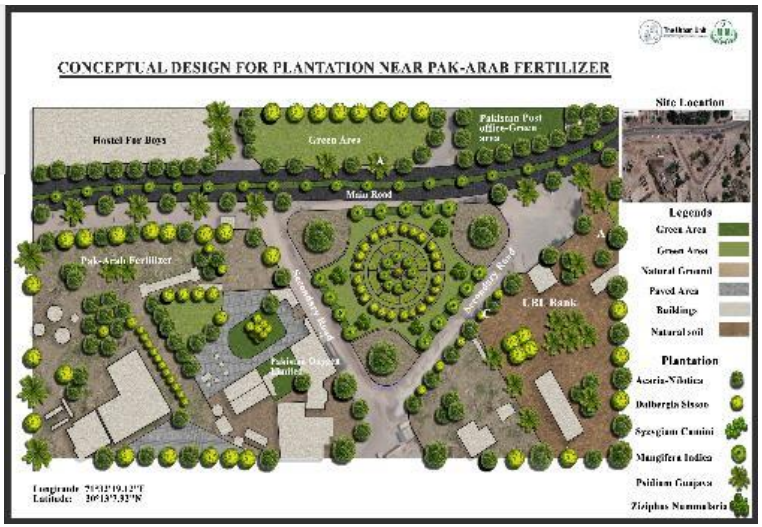


Figure 40: Conceptual Design for Development & Restoration of Parks (*Public Park, Ladies Park, Recreational Park and Park Arab Fertilizer Park)*

6.2.6. PROJECT 6: Agroforestry

Agroforestry is to socialize the forestry by integration of trees at agricultural lands and farm land of the area. Agroforestry is the best practice adopted by the developing countries where forest cover is less than the required statistics. It involves to planting trees alongside crops to provide multiple benefits such as improved soil fertility, enhanced water retention, reduces soil erosion and also diversify the income sources for farmers. Social forestry initiatives aim to involve local communities in tree planting and forest management activities, providing them with direct benefits and promoting their participation in conservation efforts. Agroforestry also act as wind barrier for weak crops which drop down due to wind flow and cause the great loss of farmers, trees along crops protect ten times larger area's crops than their height from drop down by wind.

Proposed Location:

Locality	District	Area (Av. Miles)	No. of Plants
Pirowal Plantation Khanewal	Multan	10	8,330
Rakh Aqil & Dangra	Khanewal	10	8,330
Miranpur Reserve Forest	Lodhran	20	16,660
Rakh Jamlera Reserve Forest	Vehari	20	16,660

Conceptual Design

- Reed bed and planting bed prepared for water purification

Estimate Cost

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Rs. Million)
1	Multan Farmland	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	8,330	400.00	**3.3**
2	Khanewal Farmland	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	8,330	400.00	**3.3**
3	Lodhran Farmland	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	16,660	400	**6.7**
4	Vehari Farmland	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	16,660	400	**6.7**
					Total Amount	**20.0**

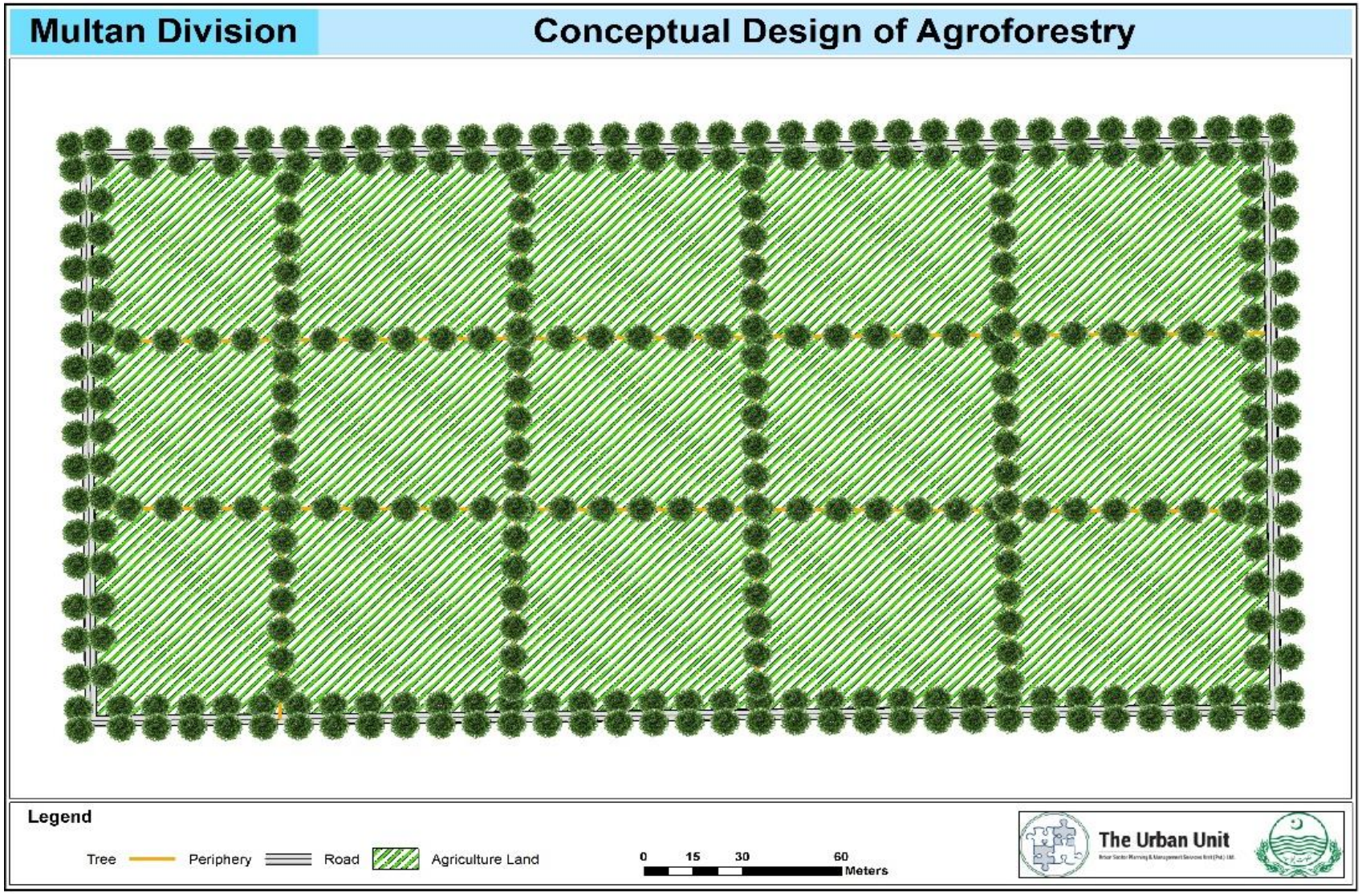


Figure 41: Conceptual Design for Agroforestry

6.2.7. PROJECT 7: Phytoremediation at Canal

The abundance of heavy metals has increased in the environment with the rapid increase of urban sprawl and Industrialization in the past few decades, which raised serious concerns globally. The disposal of residuals and waste products into water bodies may have devastating effects on aquatic ecosystems, posing serious threats to the natural environment and human health. Natural treatment of wastewater systems is the most suitable treatment technology for various types of wastewaters, which has attracted much attention in recent years.

The use of plants to purify water supplies makes it both helpful to surrounding employees and communities and environmentally benign. By using plants, bacteria, or other related microbial organisms to absorb toxins from water, it is feasible to purify water and wastewater.

"Phytoremediation is a plant-based technique used to eliminate or extract surplus nutrients in contaminated waters and lowers the possibility of penetration of heavy metals in the soil"

Plants extend their root systems into the soil matrix and build a rhizosphere ecosystem to accumulate heavy metals and regulate their bioavailability, thus reclaiming the contaminated soil and alleviating soil fertility.

The creation of a low-cost bio-remediation technology was made possible by the natural process of phytoremediation, which takes place in an ecosystem through the involvement of organic or inorganic constituent cycles. This process allows for the remediation to be carried out by retention, removal, or degradation. The constructed wetland is the most commonly used type of phytoremediation for wastewater treatment

There are many advantages of using Phytoremediation listed as follows:

Economically viable – Phytoremediation is an autotrophic system that runs on solar energy, so it is easy to manage and has low installation and maintenance costs.

Eco-Friendly Technique: It reduces the exposure of pollutants to the ecosystem and environment. It prevents metal leaching and soil erosion by stabilizing heavy metals, reduction of risk, by addition of organic matter increase the soil fertility conditions

Scope of the Project

This project aims to treat the wastewater of canals, distributaries, and drains of Multan District, Shujaabad, Duniya Pur, Lodhran, and Multan Industrial State by constructing wetlands.

Proposed Sites for Phytoremediation

- Wali Muhammad Distributary, Multan (4.7 km)
- Naubahar Canal, Multan (6.6 km)
- Abdullah Chowk Drain Shujaabad (4 km)
- Kala Pull Sewerage Drain Shujaabad (4.8 km)
- Minor Canal Lodhran (5 km)
- Nullah channel Lodhran (5 km)
- Kahror Pacca Dunyapur Canal (5 km)

- Jahaniyan City, 4 Acres
- Multan Industrial Estate: 2 Acres

Conceptual Design

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

(A)

(B)

Phragmites karka
(Common Reed)

Typha latifolia
(Cattail)

Potamogeton perfoliatus
(Redhead Grass)

Pistia stratiotes
(Water Lettuce)

Nelumbo nucifera
(Indian Lotus)

Lemna minor
(Duckweed)

Figure 42: Conceptual Design for Phytoremediation (a) Floating Bed Wetland; (b) Proposed Plant species for Constructed Wetland

6.2.8. PROJECT 8: Railway Track Plantation

Railway track plantation is the techniques to social the forestry and promote the conservation awareness by involvement of local. The trees along railway tracks offer several significant advantages like filtration of atmospheric air which lower the air pollution and improve air quality of the region. The plantation along track helps to stabilize the soil along the track which is important for the track infrastructure. Socially trees can enhance the railway track aesthetic view by making it more beautiful for the locals and traveller.

Proposed Sites:

Locality	District	Area on Both Sides (km)	No. of Plants
Multan Railway Track	Multan	15	16,500
Lodhran Railway Track	Lodhran	15	16,500
Khanewal Railway Track	Khanewal	15	16,500
Vehari Railway Track	Vehari	15	16,500
Mian Channu Railway Line	Khanewal	5	5,500
Mailsi Railway Line	Vehari	5	5,500
Inter-City Civil Railway Line	Multan	5	5,500
Dunyapur Railway Line	Lodhran	10	11,000
Burewala Railway Line	Vehari	8	8,800

Conceptual Design

- Plantation along track in mix plantation design.
- The tree spacing based on 10 x 6 feet.
- Native tree species are important to plant.
- Ornamental species for aesthetic view.

Estimate Cost

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Rs. Million)
1	Multan Railway Track	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	16,500	400.00	**6.6**

2	Lodhran Railway Track	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	16,500	400.00	**6.6**
3	Khanewal Railway Track	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	16,500	400.00	**6.6**
4	Vehari Railway Track	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	16,500	400.00	**6.6**
5	Mian Channu Railway Line	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	5,500	400.00	**2.2**
6	Mailsi Railway Line	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	5,500	400.00	**2.2**
7	Inter-City Civil Railway Line	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	5,500	400.00	**2.2**
8	Dunyapur Railway Line	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	11,000	400.00	**4.4**
9	Burewala Railway Line	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	8,800	400.00	**3.5**
					Total Amount	**40.9**

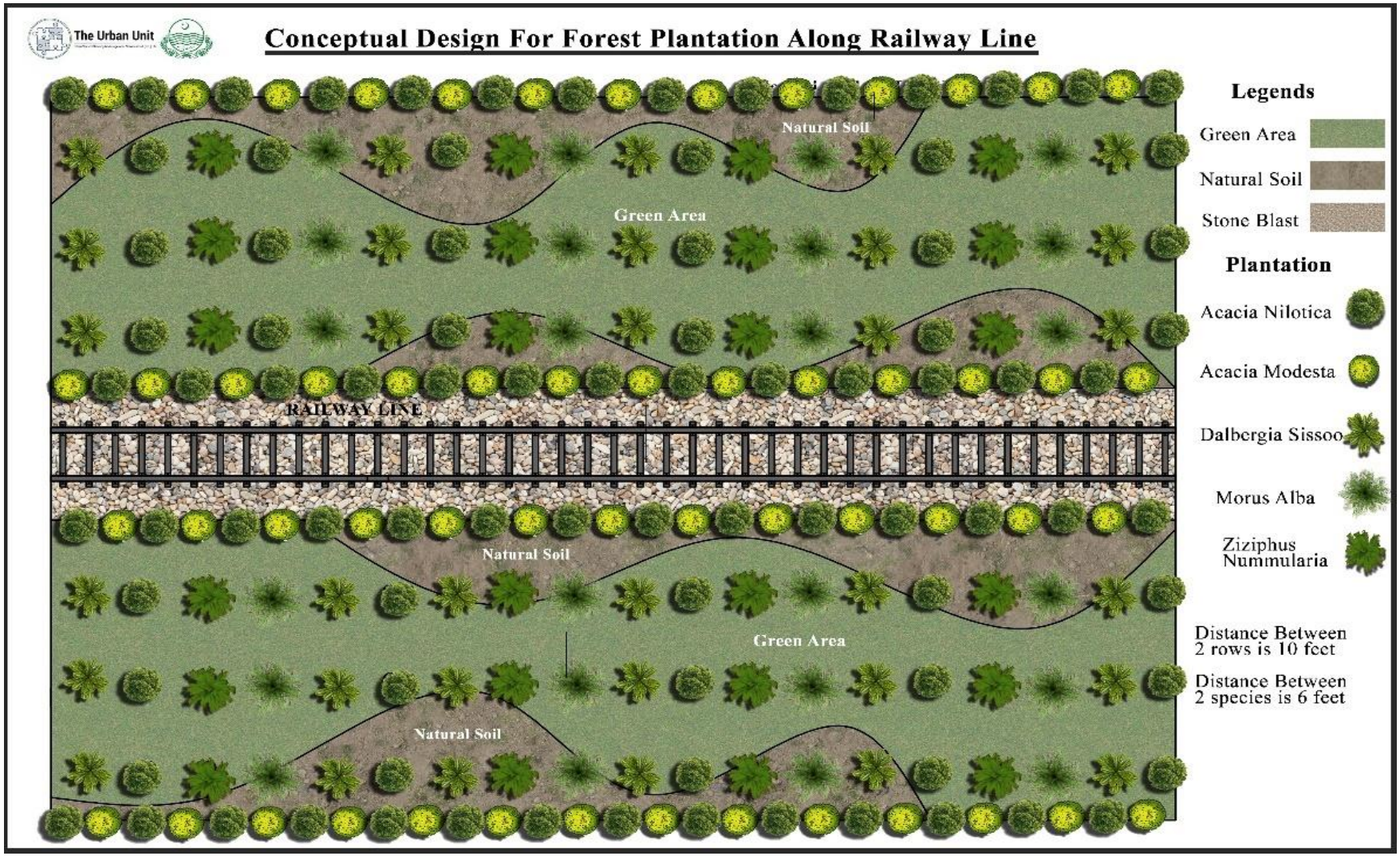


Figure 43: Conceptual Design for Railway Plantation

6.2.9. PROJECT 9: Underground Reservoir for the Management of Urban Flooding

Pakistan is one of the countries which is included in the water-stressed countries. Major factors contributing to this water scarcity situation in Pakistan are the rapid increase of urban population, agriculture, climate change, and water mismanagement. Rainwater harvesting is one of the methods to compensate for shortage in the water supply worldwide, if effectively implemented., it can enhance water storage.

It can also prove to be an affordable solution to Pakistan's water scarcity situation. Traditional urban flooding management strategies are going to shift towards an integrated approach with a focus on the reduction of flood vulnerabilities, risks, ecosystem preservation and community involvement.

Rainwater harvesting is the general practice of collection and storage of precipitation water for later consumption of water. Recently Government organizations are doing large-scale implementation of this technology for groundwater restoration in affected areas due to climate change or urban sprawl.

Figure 44: Existing Condition of Multan during Monsoon season

Proposed Sites for Rainwater Harvesting

- Rasheedabad Chowk Khanewal Road Multan city
- Bhutta Zafarullah Chowk, Ghazi Abas Road Khanewal
- Arif bazar Joya Road Tehsil Burewala, District Vehari

Estimated Cost:

Proposed Sites	Proposed Capacity of tank	Estimated Cost
Storage tank under Rasheedabad Flyover Khanewal Road Multan	48,000 gallons	25.366 million Rs. (Including pumping station)
Storage Tank at Rasheedabad Grassy Playground Khanewal Road Multan	50,245 gallons	26.423 million Rs. (Including pumping station)

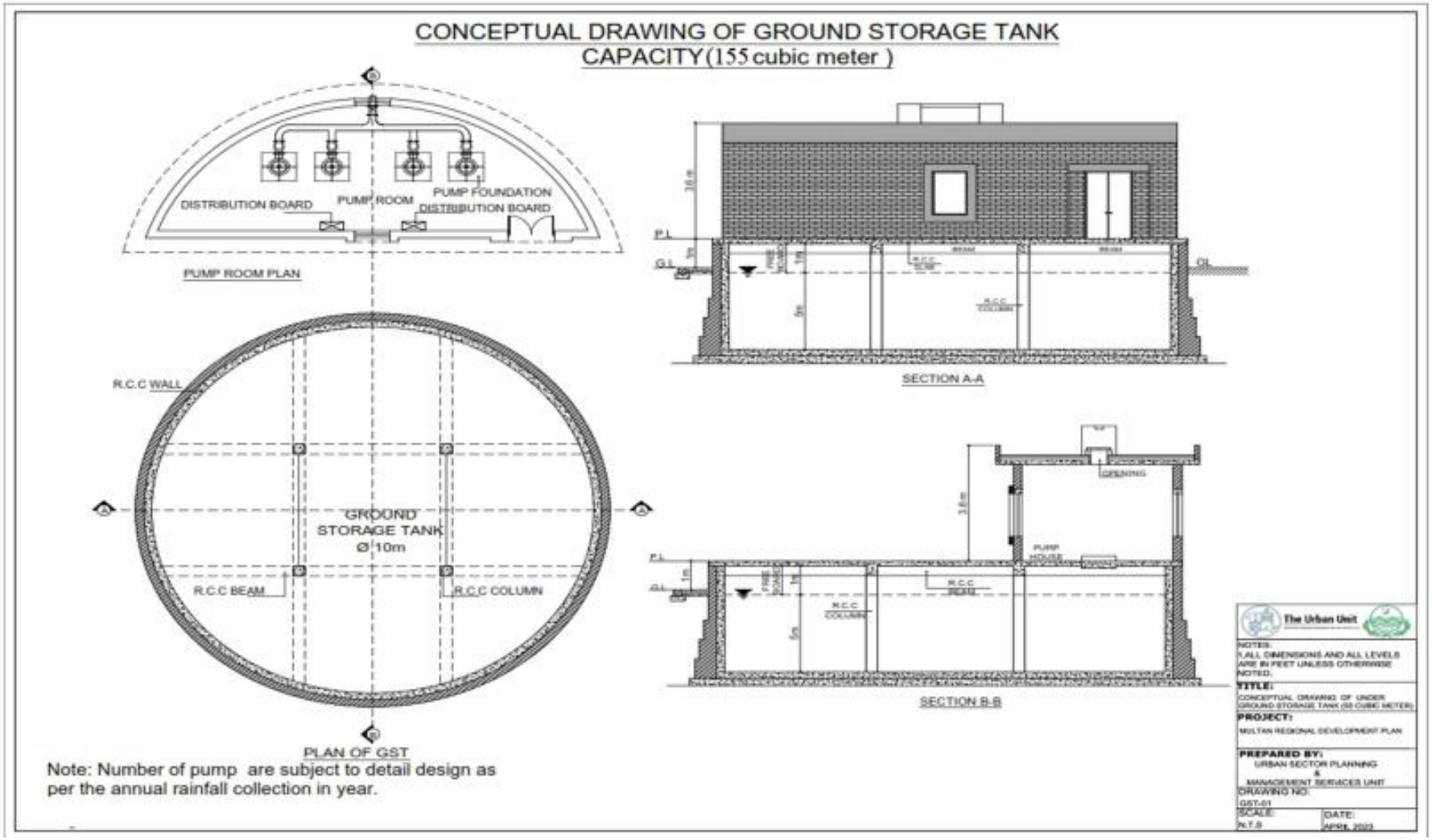


Figure 45: Conceptual Design of Storage Tank

6.2.10. PROJECT 10: Urban Farming

The practice of cultivating crops, fruits, or any other ornamental plantation in an urban environment is called Urban Farming. According to the US Department of Agriculture, primary types of urban farming included Community Farms, Community Gardens, Commercial Farms, Institutional Farms, and Gardens.

The rapid increase of urbanization is broadly perceived mutually a viciousness and virtue globally and poses pressure on urban social services. The valuable ecosystem turned into impervious surfaces and a major cause of increasing pollution in the cities. Sustainable and climate-resilient cities increasingly require locally produced fruits and vegetables.

Urban Farming Benefits

- Benefits for the climate, city-dwelling people, and local ecosystem.
- Along with providing distinctive employment opportunities and high-quality output, urban farming places a strong emphasis on consumer and environmental health and education

Proposed Site for Urban Farming

- Burewala, Vehari Pakistan

Plantation Proposed for Urban Farming

Seasonal Vegetables:

Lady Finger, Bitter Gourd, Brinjal, Tomato, Pumpkin, Mustard, Pulses

Seasonal Fruits:
Mango, Dates

Conceptual Design for Urban Farming

Figure 46: Conceptual Design for Urban Farming

6.2.11. PROJECT 11: Canal or Water Channel Plantation

In Multan Division, there is vast and extensive canal systems to fulfil the need of irrigation. The banks or embankments of canals are important to protect for water runoff in designed way. These embankment shoulders must be protected from erosion that gradually effect the capacity of canals and also effect the water flow. Tree plantation along canal protect the aquatic habitat and reduced the canal's water evaporation. The suitable plant species for water channel plantation are includes:

- *Acacia nilotica* (Kikar)
- *Acacia modesta* (Phulai)
- *Dalbergia sissoo* (Shesham)
- *Morus alba* (Shehtoot)
- *Ziziphus nummularia* (Ber)

Proposed Sites

Locality	District	Area on Both Sides	No. of Plants
Multan Canal Plantation	Multan	50 Av. miles	83,300
Lodhran Canal Plantation	Lodhran	50 Av. Miles	83,300
Khanewal Canal Plantation	Khanewal	50 Av. miles	83,300
Pakpattan Canal Vehari	Vehari	100 Av. miles	166,600
PI Link Canal Burewala	Vehari	1.1 km	1,210
Dhamaki Canal Mailsi	Vehari	5.1	5,610

Estimate Cost

Sr. #	Proposed Location	Description	Unit	Qty	Rate (Rs)	Amount (Rs. Million)
1	Multan Canal Plantation	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	83,300	400.00	**33.3**
2	Lodhran Canal Plantation	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	83,300	400.00	**33.3**
3	Khanewal Canal Plantation	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering complete in all respect.	No's of Plants	83,300	400.00	**33.3**

4	Pakpattan Canal Vehari	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	166,600	400.00	**66.6**
5	PI Link Canal Burewala	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	1,210	400.00	**0.5**
6	Dhamaki Canal Mailsi	Providing and planting of trees including the cost of pitting, digging, fertilizer, watering completes in all respect.	No's of Plants	5,610	400.00	**2.2**
					Total Amount	**169.3**

Conceptual Design

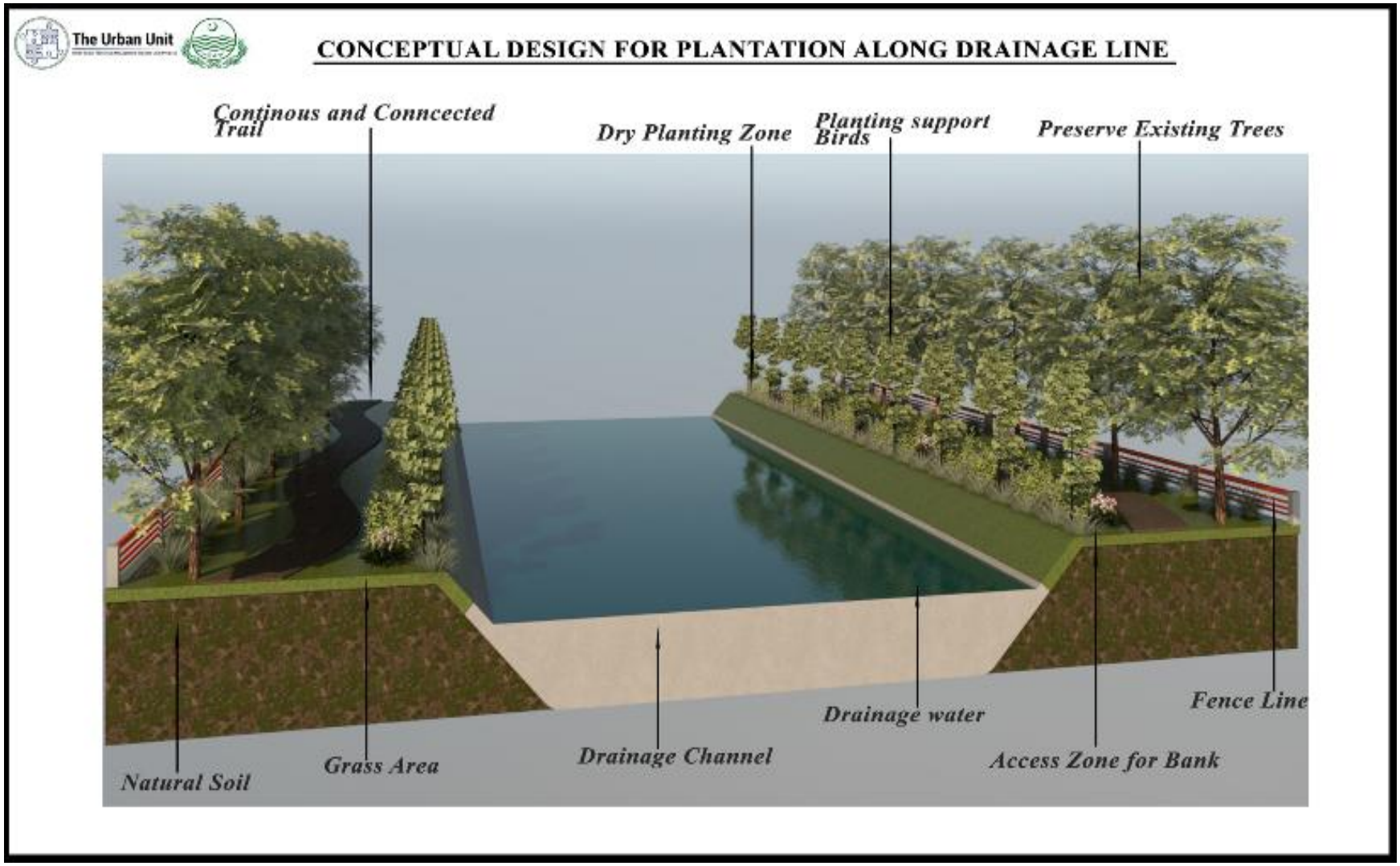


Figure 47: Conceptual Design for Plantation along Canal

The Urban Unit

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