

# (DRAFT) PUNJAB'S STATE OF ENVIRONMENT REPORT, 2022

Punjab's State Of Environment Report, 2022



Environment  
Protection Department  
Government of the Punjab

Draft SOE Report for Comments only



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## Message from the Secretary

I am pleased to present the seminal Punjab's State of Environment (SOE) Report for the year 2022, thereby accomplishing one of the major functions of EPA Punjab as listed in the Punjab Environmental Protection Act, 1997 (PEPA) under §6(1)(d). This report follows the structure stipulated in the World Bank assisted Punjab Green Development Program (PGDP).

The report starts by narrating a glance of the Punjab province, highlighting key features including topography, population, geography, ecosystems, major socioeconomic sectors and climate change. Thereafter, the report presents detailed analyses of air, water and soil quality of Punjab (based on both primary and secondary data), along with their originating pollution sources and management practices. Finally, the report highlights the actions taken by the Government of the Punjab to control and manage pollution, and improve environmental quality in the province.

This report presents evidence-based findings to the general public, policymakers, non-governmental organizations, community groups, businesses, and other stakeholders to facilitate informed decision-making related to environment. The report delineates key achievements of EPD/EPA/PGDP including but not limited to anti-smog campaign, establishment of EPD Control Room, notification of Health Advisory system for critical air pollution events, assessments of environmental performance of solid waste management and wastewater treatment facilities, state-of-the-art air and water quality monitoring stations and establishment of Environmental Endowment Fund (EEF).

The assessments carried out in this report depict that overall quality of Punjab's environment is not what it should be. The outlook is not optimistic unless we accelerate the implementation of actions chalked out in the Environmental Action Plan.

The department envisions the publication of future state of environment reports on regular basis. Learning lessons from the gaps identified in the instant report and undertaking apt interventions for their addressal, EPD aims to report increasingly 'better' state of environment in the province with time.



## Acknowledgement

With the blessings of Almighty Allah (ﷻ), the first report on Punjab's State of Environment has been launched. This piece of work is a product of diligent effort of a dedicated team especially constituted for the purpose, comprising of multifarious technical experts with extensive field experience, building upon insights from institutional memories, stakeholder consultations and public feedback.

We are thankful to The World Bank for generously supporting the Government of the Punjab in execution and implementation of Punjab Green Development Program, which has enabled Environment Protection Department to compose the State of Environment Report in a well-organized manner.

The continuous support and motivation proffered by the Secretary, EPD has been pivotal during the undertaking of this endeavour. His concerted encouragement in this regard has been invaluable and highly appreciated. Right from the start, a Committee under the Chairpersonship of Samia Saleem, the Additional Secretary, EPD has been notified comprising on Dr. Amir Farooq, Director (P&C), EPA, Dr. Anber Raheel, Director (EPP), SPIU, Noor Ahmad, Director (ML&I), Farooq Alam, Deputy Director (Labs), EPA, Dr. Asim Rehman, Deputy Director (EPE), SPIU, Azmat Naz, Deputy Director (I&S), EPA, Dr. Shazia Pervaiz, Deputy Director (Tech), EPA and Ahad Khan (Deputy Program Manager, PCU, Planning & Development Board), Lahore to overall supervise the activities to adhere timelines for preparation and publishing of state of environment report. The Committee worked tirelessly and carried out all necessary measures duly required for the timely completion of this task. Ghulam Sughra, Deputy Director (SS), SPIU, Rabeya Yasmeen, Deputy Director (EPE), SPIU, Khurram Waqas Malik, Deputy Director (EE), SPIU and Mr. Hassan Siddique Deputy Director (CS) has provided the support during write-up of the report. The profound support of Mr. Shakir Abbas, Assistant Director (GIS), SPIU – right starting from preparation of GIS maps and graphs to the development of database for data entry – was unparalleled. The services of support staff particularly Computer Operators especially Hafiz Umer Daraz and Muhammad Adnan Mushtaq (OS) for data entry etc. are highly appreciated.

The facilitative role of EPD and EPA throughout this endeavour cannot be overstated. Without their constant support, it would have been extremely difficult to take it to completion. In this regard, Moreover, the dedicated field officers of EPA made remarkable contributions in provision of field level data and information for the purpose of this report, as and when required. Moreover, Muhammad Tahir Deputy Secretary (Tech.), EPD and Dr. Sana Bashir SO (Tech.), EPD provided administrative and technical support. This would never be achieved without patronage of the Director General, EPA.



## Acknowledgement

The report is not solely a product of the tireless efforts of EPD personnel; a number of key government departments collaborated therein through consultations and provision of data/analyses. It is pertinent to appreciate the facilitation extended by several key departments of the Government of the Punjab – including Excise, Taxation & Narcotics Control Department, Industries, Commerce, Investment & Skills Development Department and Irrigation Department – and associated public sector agencies/entities including Pakistan Meteorological Department (PMD), Pakistan Council of Research in Water Resources (PCRWR), Water and Sanitation Agency (WASA) Faisalabad, WASA Gujranwala, WASA Lahore, WASA Rawalpindi, The Urban Unit and Ayub Agricultural Research Institute (AARI), Faisalabad. The overall guidance and facilitative role of Representative from Environment & Climate Change Wing, P&D Board is also highly lauded for their insightful feedback and coordination facilitation.

The role of the Strategic Planning and Implementation Unit (SP&IU), EPD, under the able guidance of Waqar-ud-Din Butt (Project Director), has been instrumental to oversee effective completion of the SoE report. The Environmental Planning & Policy Cluster of SP&IU, headed by Dr. Anber Raheel (Director, EP&P), devoted key resources to lead this endeavour in a professional manner. In addition, Asif Iqbal (Director, AF&P) ensured smooth provision of requisite logistical support to the team.

This report would not have been possible without the concerted and gracious support of all the abovementioned stakeholders

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## ACRONYMS

|          |  |
|----------|--|
| ADP      | Annual Development Program                             |
| AJK      | Azad Jammu & Kashmir                                   |
| AQI      | Air Quality Index                                      |
| AQMS     | Air Quality Monitoring System                          |
| ATHA     | Public Health Association                              |
| AtmP     | Atmospheric Pressure                                   |
| BOD      | Biochemical Oxygen Demand                              |
| BRBD     | Bambawali-Ravi-Bedian Canal                            |
| BTK      | Bull's Trench Technology                               |
| CFY      | Current Fiscal year                                    |
| CMW      | Communication and Works                                |
| COD      | Chemical Oxygen Demand                                 |
| DCAPEC   | District Critical Air Pollution Events Committee       |
| DHQ      | Divisional Headquarter                                 |
| DLI      | Disbursement Linked Indicator                          |
| DLR      | Disbursement Linked Result                             |
| EEF      | Environmental Endowment Fund                           |
| EIA      | Environmental Impact assessment                        |
| EMC      | Environmental Monitoring Center                        |
| EP & CCD | Environment Protection & Climate Change Department     |
| EPA      | Environmental Protection Agency                        |
| EPC      | Environmental Policy Center                            |
| EPD      | Environment Protection Department                      |
| ETC      | Environmental Technology Center                        |
| FAO      | Food and Agriculture Organization                      |
| FBR      | Federal Board of Revenue                               |
| FIRs     | First Investigation Reports                            |
| GAINS    | Greenhouse gas air pollution interaction and synergies |
| GCISC    | Global Change Impact Studies Centre                    |
| GHG      | Greenhouse gases                                       |
| GIS      | Geographic Information System                          |
| GoP      | Government of the Punjab                               |



|            |   |
|------------|---|
| HES-CEPs   | Health Advisory System for critical                         |
| HQ         | Headquarter   |
| HUD & PHED | Housing, Urban Development and Public Health Engineering    |
| ICT        | Islamabad Capital Territory                                 |
| IEE        | Initial Environmental examination                           |
| IOD        | Indian Ocean dipole   |
| JICA       | Japan International Cooperation Agency                      |
| LDPE       | Low-density polyethylene                                    |
| LG&CD      | Local Government & Community Development                    |
| LUMS       | Lahore University of Management Sciences                    |
| LWMC       | Lahore Waste Management Company                             |
| MAF        | Million Acre Feet   |
| MCs        | Municipal Corporations                                      |
| MEAs       | Multilateral Environmental Agreements                       |
| MOCC       | Ministry of Climate Change                                  |
| MSW        | Municipal Solid Waste                                       |
| NASA       | National Aeronautics and Space Administration               |
| PAK-EPA    | Pakistan Environmental Protection Agency                    |
| PCRWR      | Pakistan Council of Research & Water Resources              |
| PDMA       | Provincial Disaster Management Authority                    |
| PDU        | Project Delivery Unit                                       |
| PEPA 1997  | Punjab Environmental Protection Act 1997                    |
| PEPC       | Punjab Environmental Protection Council                     |
| PERI       | Provincial Environmental Reference Lab                      |
| PGDP       | Punjab Green Development Program                            |
| PIEDMC     | Punjab Industrial Estate Development and Management Company |
| PIMH       | Punjab Institute of Mental Health                           |
| PITB       | Punjab Information Technology Board                         |
| PM         | Particulate Matter  |
| PMD        | Pakistan Meteorological Department                          |
| PPP        | Public Private Partner                                      |
| PSDF       | Provincial Sustainable Development Fund                     |
| PSIC       | Punjab Small Industries Corporation                         |
| RECP       | Resource Efficient and Cleaner Production                   |
| ROF        | Right of Way  |



|         |   |
|---------|---|
| SMEDA   | Small and Medium Enterprises Development Authority      |
| SOPs    | Standard operating procedures                           |
| SPIU    | Strategic Planning & Implementation Unit                |
| SUP     | Single Use Plastic                                      |
| SUPAPCO | Pakistan Space and Upper Atmosphere Research Commission |
| SWMF    | Solid Waste Management Facilities                       |
| TDS     | Total Dissolved Solids                                  |
| TSS     | Total Suspended Solids                                  |
| UC      | Unburnt Carbon  |
| UNICEF  | United Nations International Children's Emergency Fund  |
| USD     | US Dollar   |
| WASA    | Water and Sanitation Agency                             |
| WHO     | World Health Organization                               |
| WQI     | Water Quality Index                                     |
| WWF     | World Wide Fund for Nature                              |
| WWTP    | Waste Water Treatment Plant                             |

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## EXECUTIVE SUMMARY

The Environmental Protection Agency (EPA) is mandated under the Punjab Environmental Protection Act, 1997 to prepare and publish an annual State of the Environment (SoE) report on an integrated assessment of Punjab's environment outlook. Since everything is connected in our social environment, we need to understand and assess the impact, potential and extent of human activities to affect the environment using a holistic systems approach, while considering interconnections and co-dependencies therein.

The overall analyses suggest that the overall quality of the environment is not as desired. The outlook is more pessimistic unless drastic measures are undertaken to redress the environmental concerns across all sectors and the society-at-large, and alleviate the adverse impacts therein. The myriad of environmental challenges is complex and systemic, and necessitate an integrated approach for remediation to lead towards sustainable development in the province.

The report commences with a broad overview of the province at large, depicting key facts on its demography, climate, geographical patterns, natural habitats and land use including major socioeconomic infrastructure (irrigation, industry, urban development, etc.). Thereafter, it dwells upon reporting of general weather patterns in the province, providing an abridgement of monthly weather monitoring undertaken by PMD (5 parameters). It was observed that – mostly – the weather trends followed “expected behaviour”; however, a few exceptional deviations were also noted therein. This section concluded with a brief description on the rationale of the report as it is intended to provide empirical evidence for informed decision-making “for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development.”

Thereafter, the report dwelled into sectoral environmental assessments, delineating the state-of-affairs viz-a-viz air, water and soil quality throughout the province. Each of these sections commence with a brief description of the underlying reasons for assessing quality of each sector. Subsequent to this, the prevalent regulatory framework for its management was narrated which forms the basis of the assessments conducted therein. Assessment of sectoral quality based on (currently available) data for CY 2022 was undertaken next, followed by identification of prime pollution sources affecting their quality. Each section concluded with depiction of various noteworthy management practices undertaken by different stakeholders to improve quality of the underlying component.

In terms of air quality, ambient air was the point of discussion being the most polluted and within the ambit of public intervention. Clean air is a public good, and – as such – is the core responsibility of the state to provide such to its subjects. Its need is further highlighted with the fact that Punjab has been engulfed with severe smog crisis for over a decade now, with large costs towards health, mobility and associated socioeconomic aspects attributed therein. PEPA and associated PEQS relating to ambient air quality form the crux of the regulatory framework herein. EPA, along with its dedicated field offices, served as the primary data source for air quality assessment. Lack of province-wide data was a key highlight in this regard; however, given the fact that 30 state-of-the-art AQMS are in the process of being procured for installation across the province, better quality



monitoring is expected thereafter. In Lahore, 2 fixed and 1 mobile AQMS monitor ambient air quality on a daily basis. Overall, only  $\approx 4.24\%$  of the AQI readings conform to extant PEQS threshold levels; the rest mostly resonated with the 'unhealthy' to 'very unhealthy' band in the EPA AQI Index spectrum. Association of AQI with general weather patterns was also examined and a strong relationship was observed in most cases. Air quality management initiatives undertaken by several departments were listed as planned measures to curb air pollution. The section concluded by noting deficiencies in both data collection and regulatory standards, thereby necessitating strengthening of measures therein.

With regards to water quality, the section started with a depiction of the geographic spread (including rivers and canals) and seasonal aspects therein. As was the case with ambient air, PEPA and associated PEQS relating to water quality form the crux of the regulatory framework herein as well. Primary data sources for water quality assessment included PCRWR, regional WASAs and EPA along with its dedicated field offices. PCRWR monitors monthly levels pertaining to 20 physical and biochemical parameters in 2 rivers (surface-water), 8 drains (surface-water) and nearby (deep and shallow) groundwater samplings. Given this reduced dataset, it was observed that the general pattern remained similar, with drains being the most polluted (obvious), followed by groundwater samplings (shallow followed by deep) and rivers respectively. Causal modelling of these surface and groundwater sources was undertaken using correlation analysis and structural equation modelling, wherein it was inferred that drains do enhance pollution levels in groundwater and rivers. Furthermore, a ranking of all the monitored sources was also undertaken on basis of a source-wise water quality index, where Madvana Drain was noted as the most polluted drain in the province (as per monitored data). Regional WASAs are responsible for provision of water supply service to their local inhabitants. Monthly quality is assessed by WASAs themselves, where an overwhelming majority was deemed 'fit for drinking.' EPA monitored 571 analyses of wastewater in the province reporting on the quality of 'used water.' Various initiatives undertaken by different departments to monitor and manage water quality were listed thereafter. This section also concluded by noting deficiencies in both data collection and regulatory standards, thereby necessitating strengthening of measures therein especially given the vital significance of water towards life.

From the viewpoint of soil quality, the section started off with a description of the existing land cover and soils throughout Punjab. Primary data sources for water quality assessment included analyses by EPA certified laboratories, wherein physical and biochemical aspects were studied in samples across Punjab; however, data on soil quality in Punjab is scant. Agro-industrial effluents and municipal wastes form the bulk of soil contamination. Several soil management initiatives relating to safeguarding and preserving soil quality are noted as being undertaken by different department across the province. Like previous sections, this section also concluded by noting deficiencies in both data collection and regulatory standards, thereby necessitating strengthening of measures therein.

For the first time in the province, active assessments of environmental performance relating to wastewater treatment plants (WWTPs) and solid waste management facilities (SWMFs) are undertaken. In terms of WWTPs, analyses of several physical and biochemical parameters are performed to assess their compliance with PEQS. Landfills and incineration facilities located in four major districts were assessed for environmental performance based on their emissions and discharges in air, water and soil.



Having reported on the state of environmental sectors across the province, the report thence dwelled upon measures taken to control pollution and improve environmental quality. In the former regard, the role of measures undertaken by EPA were first discussed including the role of prior environmental approvals to guard against uncontrolled industrial pollution, public anti-smog campaign to raise awareness and regulatory enforcement actions taken therein, formulation of anti-smog squads in major polluting hubs to halt and discourage polluting activities, establishment of a dedicated control room within EPD for real-time reporting of ambient air (including smog) monitoring, and institution of a concerted mobile dashboard and complaint facility for public facilitation. EPD has also facilitated therein through different measures including formulation of a concerted clean air policy and action plan, multifarious initiatives under PGDP umbrella and planned measures like revision/development of existing/missing PEQS, development of Industry-specific Environmental Quality Standards, piloting for low-cost wastewater treatment plants and apportionment study of pollution sources to investigate sources of particulate matter for informed decision-making in the province. Progress by other departments was also noted in this regard. Numerous, novel initiatives under PGDP – jointly implemented by EPD along with provincial Energy, Industries, Transport and Finance Departments – are also listed as relating to strengthening environmental governance and promoting green investments in the province. With regards to measures taken to improve environmental quality in the province, EPA has undertaken numerous measures as prescribed in PEPA from planning/policymaking, legal/regulatory and operational standpoints. These include activities taken for hospital waste management and tree plantation (plantations under Clean & Green Pakistan Initiative, Environmental Approvals and Spring Tree Plantation Campaign). Several regulatory and institutional reforms were promulgated with regards to strengthening environmental governance in the province including steps taken to further EPD structuring and creation of 4 new entities (EPC, EMC, ETC, EEF), development of Health Advisory System for Critical Air Pollution Events and formulation of provincial regulations on EIA/IEE, Hazardous Substances Rules and Plastic Management Strategy and Regulations on Single-use Plastics. EPD has also capitalized of EEF to the tune of US\$42 Million thus far, and initiated an automation regime to promote e-governance. The department has also undertaken significant measures to redress climate change via development of a seminal climate change policy and action plan. There is though a pressing need to build technical and regulatory capacities of the department to bring it in line with modern requirements.

Environmental complaints are a key modicum for redressing environmental issues affecting the complainant and a tool for grievance redressal mechanism therein. Several avenues exist for filing complaints with relevant authorities that are thence assessed for validity (including non-compliance with PEQS/applicable legal covenants/etc.) and processed for remedial action therein as stipulated under PEPA. In the past year, out of 1091 such complaints, an overwhelming majority ( $\approx 47\%$ ) related solely to air pollution. A multitude of remedial actions are available with EPD at various tiers within EPD (including EPA Headquarter offices, EPA field formation offices and Punjab Environmental Tribunal). A majority ( $\approx 63\%$ ) of actionable complaints were resolved through imposing of fines on the violator. In addition, FIRs, arrests of violators and sealing/desealing of industry units were amongst the major actions taken therein. Effective monitoring of this grievance/complaint resolution mechanism is essential to ensure its efficacy to address and alleviate concerns of the affectees.

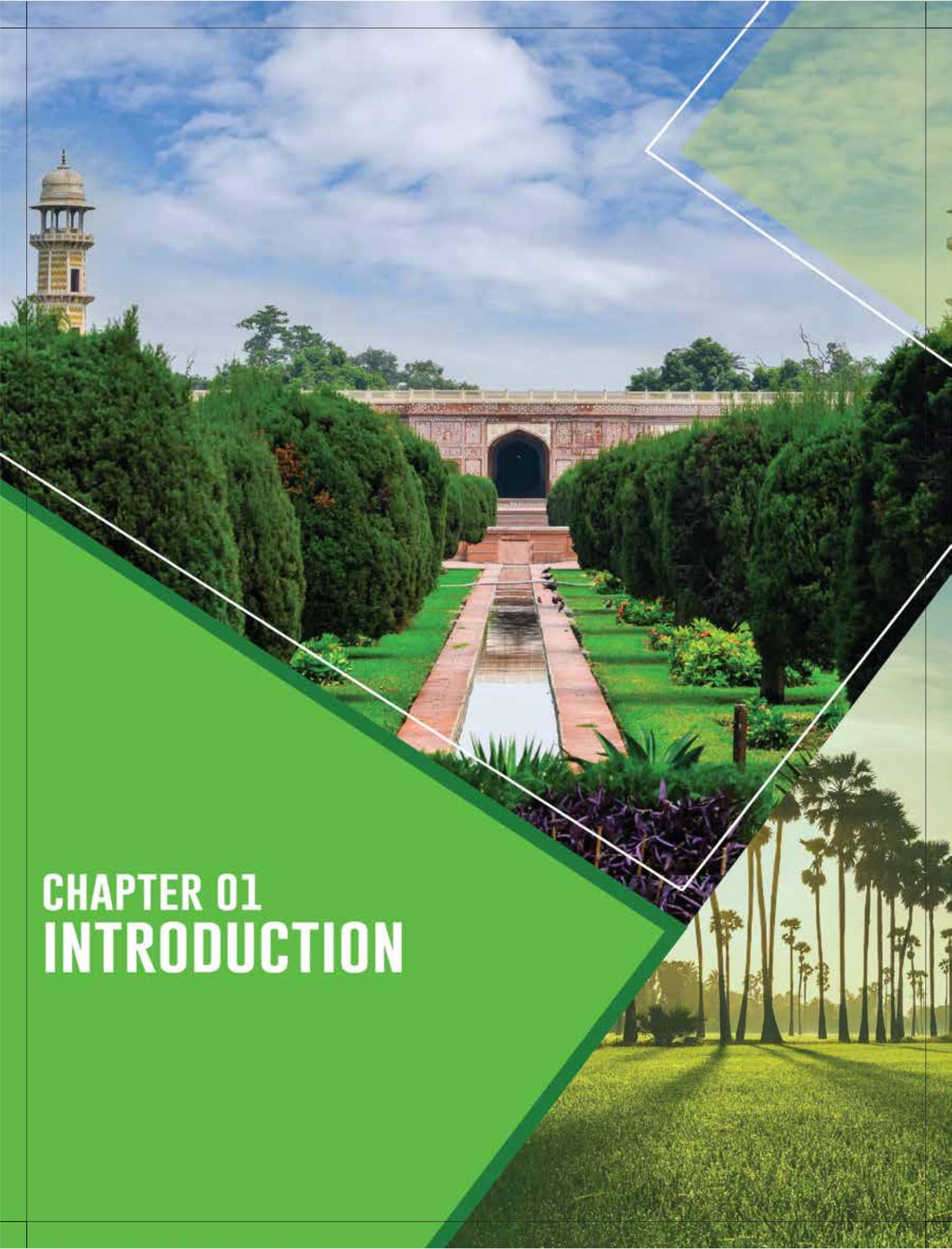
During the course of development of this report, several avenues were exercised to source public feedback thereof. An initial round of stakeholder consultations/public hearing was held with relevant public and private sector entities to finalize proposed contents and structure of the said report. A further public hearing will be held with relevant stakeholders upon completion of the draft report.



A concerted, multi-stakeholder Environmental Action Plan is devised by EPD to strengthen environmental governance regime in the province. EPD lacks in regulatory and technical capacities to keep pace with modernity of industrialization, rapid urbanization and increasing complexity of environmental issues. There is thus a pressing need for strengthening of environmental governance to achieve the overall objectives of sustainable development. The said action plan is systematically classified into 11 key intervention areas including legislation, citizen engagement, industries, transport, monitoring, water & wastewater, solid waste & hospital/industrial waste, mobilization of PSDF/EEF, fugitive dust control, remodeling environmental governance and others. A multitude of actions are delineated therein with shared/specific responsibilities attributed to relevant GoPb departments.

It is imperative to note that the Punjab's State of the Environment Report, 2022 was prepared after thorough and mutual collaboration with concerned provincial government departments. Lack of data is noted as a principal impediment in the development of this report and thereby constituted an earnest limitation in painting a true picture of state of environment in the province. Since all requisite (and primary) data was not available with EPA, several relevant public sector entities were approached to fill the data gaps. Despite initiating such linkages, there remained massive gaps in data availability as little data is collected with special cognizance to environmental considerations. This is especially true in the case of soil quality and solid waste management facility assessment. The assessment of pollutions sources is generally devoid of pollutant inventory, detailing time and intensity thereof. Consequently, assessments of pollution sources and their impacts on environment were not completely carried out. Assessments of ambient air quality, liquid effluents and stack emissions were undertaken owing to the availability of data with EPA. Moreover, collection and collation of disparate data from 8 district laboratories and 36 districts offices of EPA was a huge task given unavailability of a centralized database.

This report is intended to provide the policymakers and public sector administrative formation with empirical evidence to inform and facilitate informed policy and decision-making so as "to provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development." It will also provide relevant socioeconomic stakeholders and the general public with awareness of environmental state-of-affairs and impacts thereof. The report being a seminal enterprise in its own accord is intended to provide a valuable and informative policy and advocacy device therein.



**CHAPTER 01  
INTRODUCTION**



# 1. CHAPTER ONE

## 1.1 Introduction

The Punjab's State of Environment Report, 2022 is the first state of environment report for the Punjab in over 25 years. This report is prepared in accordance with the guiding principles as elucidated in Program Appraisal Document of Punjab Green Development Program. Furthermore, under Section 6(1)(d) of the Punjab Environment Protection Act, 1997, it is the function of the Environment Protection Agency, Punjab to prepare and publish an annual Punjab Environment Report on the State of the Environment.

The report outlines the qualitative and quantitative descriptions of the assessments carried out by the Agency and other departments like (Pakistan Council of Research in Water Resources and Water and Sanitation Agencies etc.). Data from others Government departments like Excise & Taxation Department, Pakistan Metallurgical Department etc. was obtained. The report briefly discusses the province of Punjab, Pakistan with regards to its history, people, geography, population, topography and land use, irrigation system, forest and wild life, industry and urban infrastructure, mineral profile, and climate. The report identifies the prevailing ambient air, water and soil quality. Further, the report contains the detail of assessments for the pollution sources both in terms of Stack emission as well as the liquid effluents. Furthermore, assessment of Wastewater treatment plants and solid waste management facilities has also been appropriately discussed. Details about the environmental complaints, their classification based on their types as well as the action taken with regards thereto, is also present.

The report signifies the measures taken by the Environment Protection Department and Environmental Protection Agency for the control of pollution and to improve the environmental quality. In addition, the best management practices carried out by the government departments as reflected in their Annual Development Program, have been added. Uniquely the report has the public feedback, both on the draft contents and draft report – which were duly shared for one month for public feedback and comments. The report also contains a detailed environmental action plan with timelines as well as the respective responsibility for its execution.

The report is going to set a baseline for the prevailing environmental conditions regarding air, water, and soil and various pollution sources. This baseline will translate into preparation of informed policy as well as in informed decision-making.

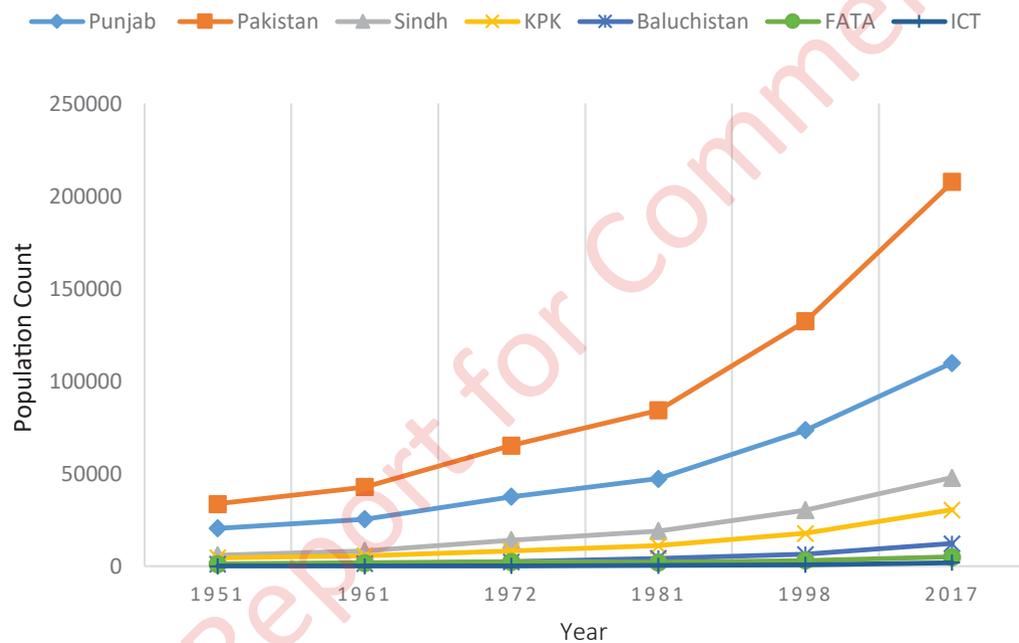
## 1.2 Punjab – at a glance

The land of five river tributaries of the Indus River, population-wise the largest, and once known as the granary of east, Punjab is the lifeline of Pakistan. Today, Punjab remains the heartbeat of the nation and is at the center of all political and economic progress.



### a. Geography and Population

The province spreads over a geographical area of 205,345 square kilometers and is, geographically, the second largest province of Pakistan, after Baluchistan<sup>2</sup>. It occupies 25.8% of the total landmass of Pakistan. Within country, it shares boundaries with Khyber Pakhtunkhwa to the north-west, Sindh to the South and Baluchistan to the south-west, Islamabad Capital Territory to the north-west and Autonomous Territory of AJK to the North. It shares the international border with Indian states of Rajasthan and Punjab to the east and Indian-administered Kashmir to the north-east. Punjab is the part of transnational Punjab region, divided between India and Pakistan. The province has been divided in 09 divisions namely Bahawalpur, Dera Ghazi Khan, Faisalabad, Gujranwala, Lahore, Multan, Rawalpindi,



**Figure 1: Population Growth Trend in Pakistan and Provinces**

Sargodha and Sahiwal divisions, covering 36 districts, with one district entitled as ‘divisional headquarter’ in each division.

Punjab, with the 109,989,655 (approx.110 million) people residing in it, is the most populous province of Pakistan<sup>3</sup>. It is the world's fifth-most populous subnational entity, and the most populous outside of China and India. The comparative analysis of population growth trends in the Punjab with rest of the country depicts that Punjab has the highest population growth trend among all other provinces and ICT (Figure 1)<sup>4</sup>. The population density of the province has raised to 1.4 in 2017 from 0.5 recorded in 1972<sup>5</sup>.

District Lahore in Punjab has the highest population (11,119,985), population density (6275.39 per square kilometer), and urban proportion (100.00) amongst ten divisional headquarters. The excerpts of population census are tabulated as follows (Table 1).

<sup>2</sup> Statistical Pocket Book of the Punjab (2022), Punjab Bureau of Statistics (Page 51)

<sup>3</sup> Final Results of Punjab Population Census (2017), Punjab Bureau of Statistics

<sup>4</sup> Data Source: Statistical Pocket Book of the Punjab (2022), Punjab Bureau of Statistics (Page 313)

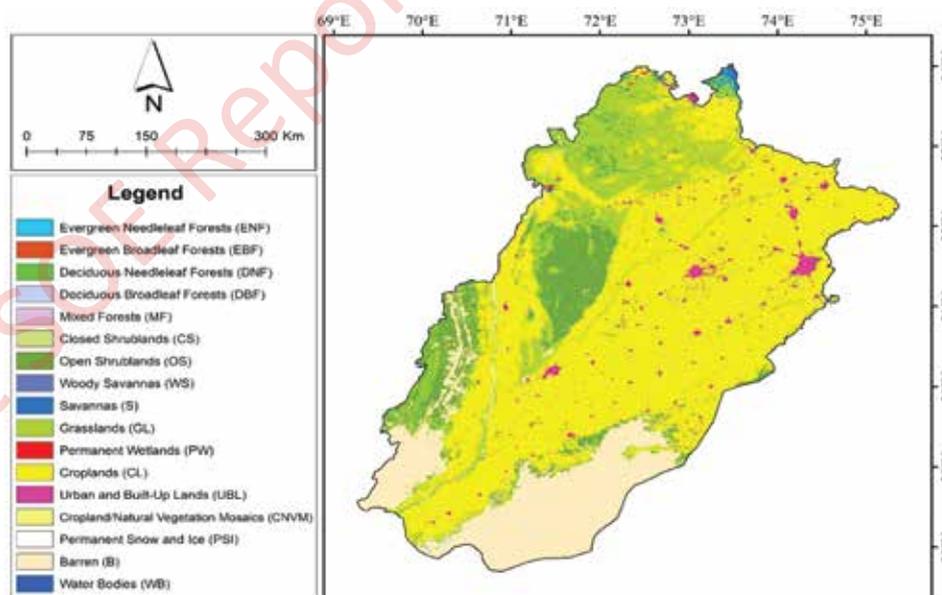
<sup>5</sup> Statistical Pocket Book of the Punjab (2022), Punjab Bureau of Statistics (Page 314-315)

**Table 1:** Population Density in Divisional Headquarters of Punjab (Population Census, 2017)

| Sr. No. | Name                | Area (Sq. Km.) | All Genders | Population Density Per Sq. Km. | Urban Proportion | 1998-2017 Average Annual Growth Rate |
|---------|---------------------|----------------|-------------|--------------------------------|------------------|--------------------------------------|
| 1.      | Bahawalpur District | 24,830         | 3,669,176   | 147.77                         | 31.95            | 2.18                                 |
| 2.      | Gujranwala District | 3,622          | 5,011,066   | 1383.51                        | 58.85            | 2.06                                 |
| 3.      | Gujrat District     | 3,192          | 2,756,289   | 863.50                         | 30.02            | 1.57                                 |
| 4.      | Rawalpindi District | 5,285          | 5,402,380   | 1022.21                        | 55.64            | 2.52                                 |
| 5.      | DG Khan District    | 11,922         | 2,872,631   | 240.95                         | 19.01            | 2.98                                 |
| 6.      | Lahore District     | 1,772          | 11,119,985  | 6275.39                        | 100.00           | 3.00                                 |
| 7.      | Sahiwal District    | 3,201          | 2,513,011   | 785.07                         | 20.52            | 1.64                                 |
| 8.      | Faisalabad District | 5,857          | 7,882,444   | 1345.82                        | 47.79            | 1.98                                 |
| 9.      | Multan District     | 3,720          | 4,746,166   | 1275.85                        | 43.38            | 2.23                                 |
| 10.     | Sargodha District   | 5,856          | 3,696,212   | 631.18                         | 29.44            | 1.73                                 |

### b. Topography and Land Use

The land of Punjab is blessed with a diverse topography (Figure 2), mainly comprising the cropped alluvial plains. There are some mountainous areas lying in the north west and



**Figure 2:** Topography Map of Punjab

extreme south west. The province also has a desert belt in its South East and is named as Cholistan desert.



Land utilization in the province has been categorized as the Cropped area, cultivated area and un-cultivated Area. The uncultivated area is further categorized as the forest area, area not available for cultivation and the culturable waste. Punjab accounts for 10.7% of forest area, 12.85% area not available for cultivation, 18.3% culturable waste land, 56% cultivated area, 69.1% net area sown and 72.83% cropped area of the country<sup>6</sup> (Figure 3).

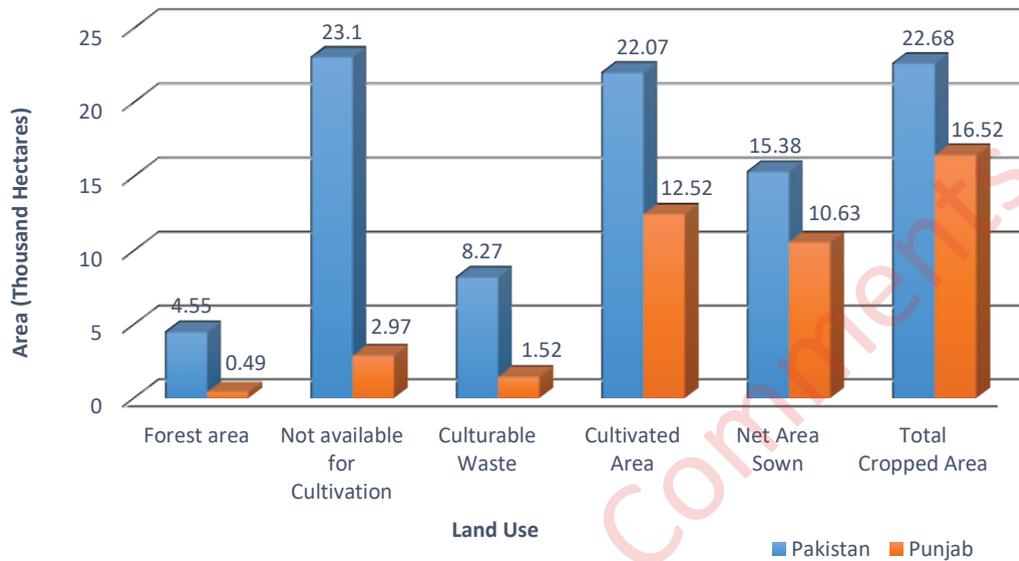


Figure 3: Percentage land-use in Punjab

### c. Irrigation System

The Irrigation system of Punjab comprises five perennial riverine and numerous seasonal streams<sup>7</sup>. All major rivers originating from Himalayas pass through the province. The flow and volume of water increases in the summer after the monsoon rains, resulting, in floods at times. Punjab is blessed with a largest natural drainage system in the country, with about 3,000 irrigation channels and an extensive irrigation network, with 15,013 thousand hectares of irrigated area<sup>8</sup>. Irrigated area has more percentage than the un-irrigated land in each division of the province (Figure 4).

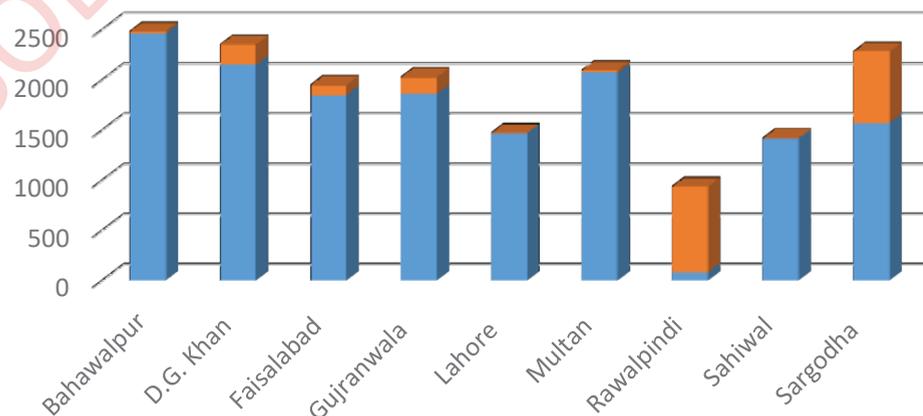


Figure 4: Irrigated and Un-irrigated Land in Punjab (Thousand Hectares)

<sup>6</sup> Land Utilization Statistics, Pakistan Bureau of Statistics

<sup>7</sup> Landcover Atlas Of Pakistan\_ The Punjab Province, A Joint Publication By FAO, SUPARCO And Crop Reporting Service, Government Of The Punjab

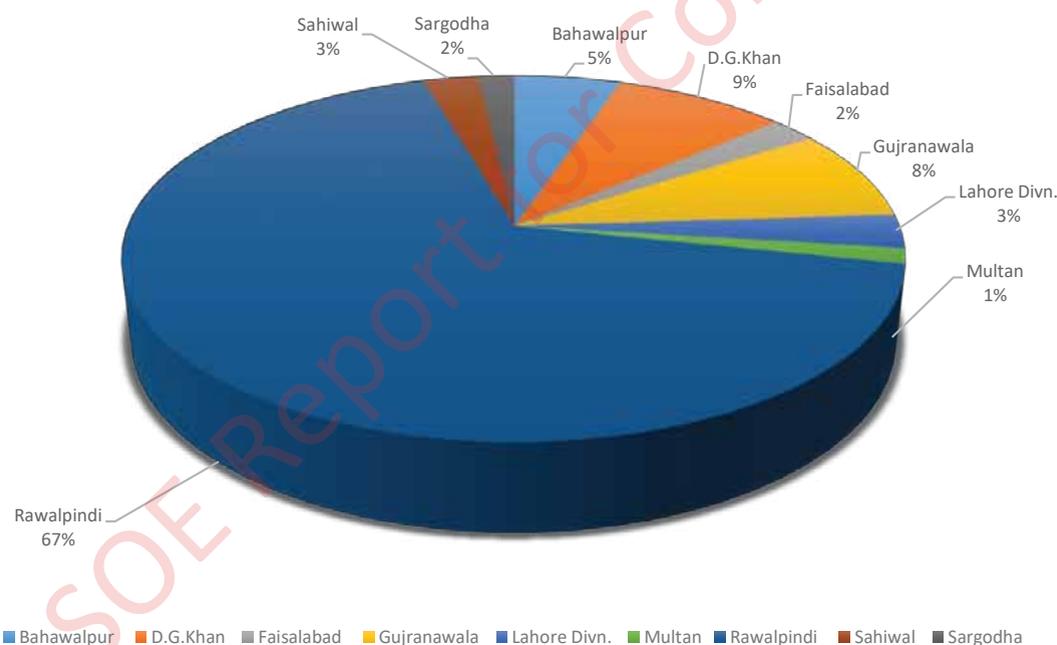
<sup>8</sup> Statistical Pocket Book of the Punjab (2022), Punjab Bureau of Statistics (Page 68)



### d. Agriculture, Forests and Wildlife

Punjab, known as the ‘breadbasket’ of Pakistan is an agrarian province, sharing about 68% to the annual food grain production in Pakistan. Cotton and rice are the cash crops that contribute substantially to the national treasury. The sown area of the province spreads over 17,130 thousand hectares<sup>9</sup>. Major crops include the wheat, rice, cotton, sugarcane, corn, pulses, millets, and oilseeds. A variety of vegetables and fruits are grown e.g., oranges, mangoes, potatoes, onions, chillies, etc.

In addition to the vast agricultural areas, Punjab is also enriched with the green and dry forest cover, with a total compact forest area of 1,648,648 acres. The forests have been categorized as protected forests, reserved forests, unclassified forests, and others. 67% of reserved forests fall in Rawalpindi Division (Northern Punjab)<sup>10</sup> (Figure 6). The province also exhibits a diverse range of dry forests, which are categorized as Subtropical dry scrub forests, Tropical dry thorn forest (flood plain), Tropical dry thorn forest (desert) and Tropical dry broadleaved forest with *Butea monosperma* as dominant species. These dry forests fall in districts Attock, Rawalpindi, Jhelum, and Gujrat, mainly covering the temperate and subtropical sub-Himalayan regions to the south, tropical Indus plains<sup>11</sup>.



**Figure 6:** Division wise distribution of Reserved Forest area (%), Punjab

The forests are enriched with diverse flora and fauna. Among mammals, jungle cat, jackal, Indian gerbil, fruit bat, porcupine, fruit bats, palm squirrel, mongoose, white hare, wild boar, and field mouse, among reptiles, lizards, Viper, Varanus, Uromastic, Krait, and Cobra are reported<sup>12</sup>. The province also has a network of wildlife conservation facilities (Figure 5).

<sup>9</sup> Maan, M., Chaudhry, Aleem, 2001, Wildlife Diversity in the Punjab (Pakistan), Journal of Biological Sciences.

<sup>10</sup> Statistical Pocket Book of the Punjab (2022), Punjab Bureau of Statistics (Page 216)

<sup>11</sup> Pakistan Climate Risk Country Profile, 2021, The World Bank.

<sup>12</sup> Maan, M., Chaudhry, Aleem, 2001, Wildlife Diversity in the Punjab (Pakistan), Journal of Biological Sciences.

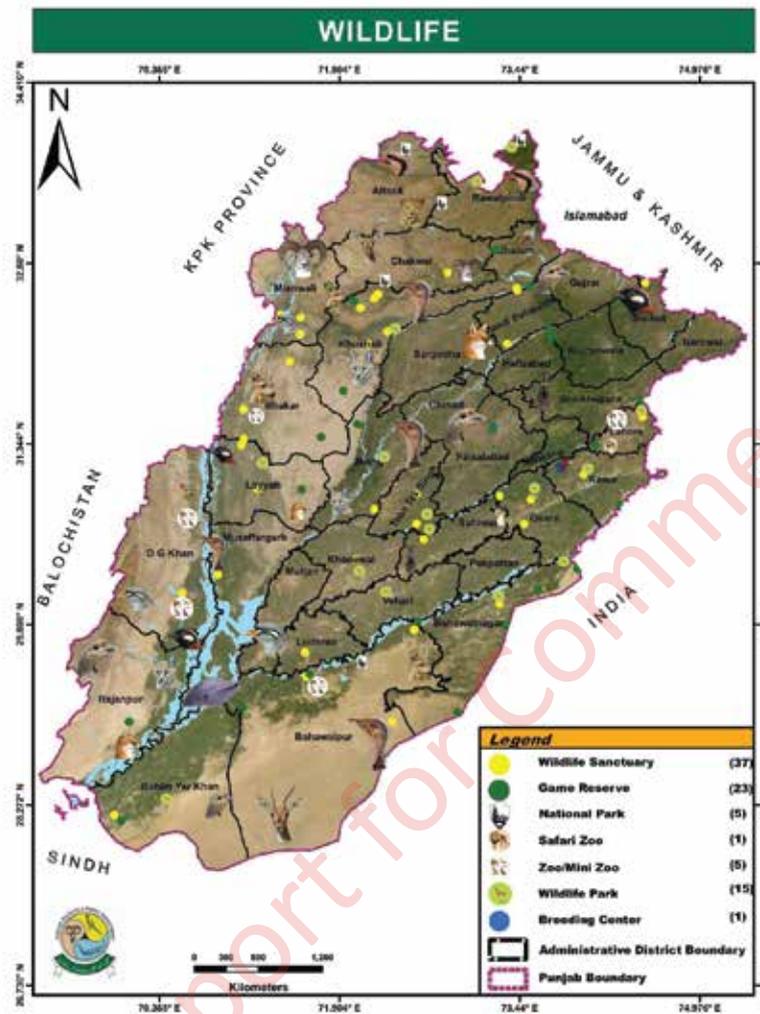


Figure 5: Wildlife Conservation Facilities in Punjab Pakistan

### e. Industry and Urban Infrastructure

The urban areas of the province are well-developed with a cluster of industries, broad road infrastructure, vast metropolitans, equipped with healthcare facilities, educational institutions, commercial area, offices, cultural heritage and much more. Main manufacturing industries include the textiles, sports-goods, Heavy machinery, electrical appliances, surgical instruments, construction material, vehicles, metals and autoparts, sugar mills, cement plants, agricultural equipment, auto-rickshaws, floor coverings, and processed foods etc.

The System of Cities Model developed by The Urban Unit in continuation to the Punjab Spatial Strategy (2047) identifies economic hubs in the province, categorized on the basis of population. According to this classification, there is one Mega hub (Lahore), 8 divisional headquarter hubs, and 8 regional hubs. These hubs are linked with different smaller neighboring cities for the economic activity, transportation of goods, healthcare facilities, social services and contribution to the regional supply chain. Each hub, with the cities in its vicinity, forms a "cluster"<sup>13</sup>. (Figure 7)

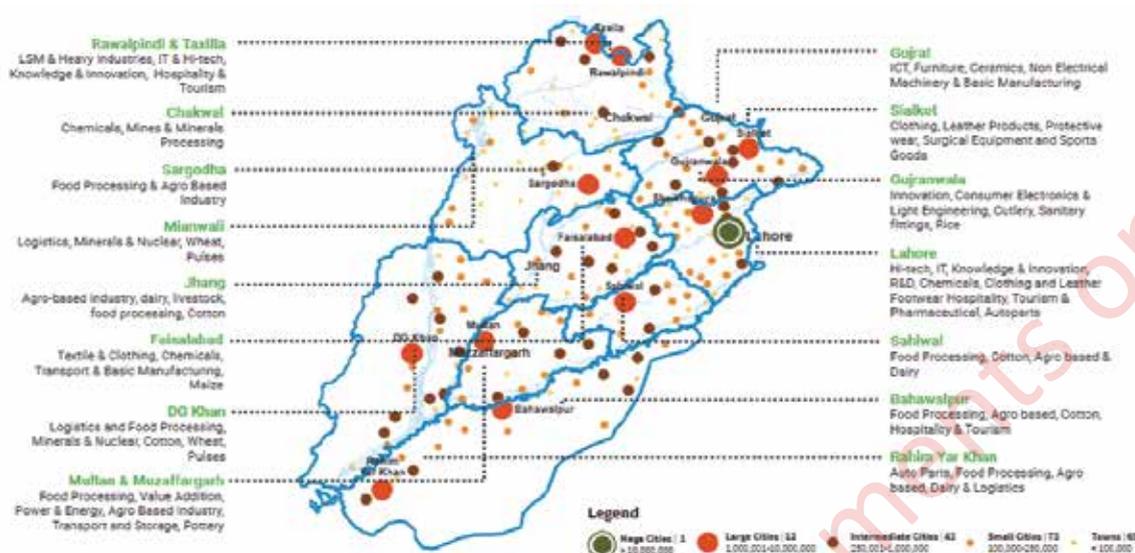


Figure 7: Economic Hubs in Punjab

### f. Mineral Profile

Punjab has also rich mineral reserves of argillaceous clay, bauxite, bentonite, building material, calcite, celestite, chalk, China clay, coal, dolomite, fireclay, fuller's earth, gypsum, iron ore, laterite, lime stone, rock salt and silica sand. Vast sub-bituminous coal reserves are found in the Salt Range. The main Districts with coal deposits are Attock, Jhelum, Chakwal, Khushab and Mianwali. In Punjab, the coal seams are a few centimeters to 1.5 meters thick.

In addition to coal, sand and gravel are considered as important mineral deposits in the province, with their major use in construction industry. A mixture of gravel and sand is commonly found near the foothills. The banks of rivers and streams are rich with pure sand deposits. The pure sand can also be found 4-5 feet below the earth crust, in the old river's courses.

The land of Punjab is also blessed with iron ores. The "Kalabagh iron ore deposits", the largest known iron deposits in the country, are found in District Mianwali in the Surghar Range, and near Sakesar in the Salt Range<sup>14</sup>.

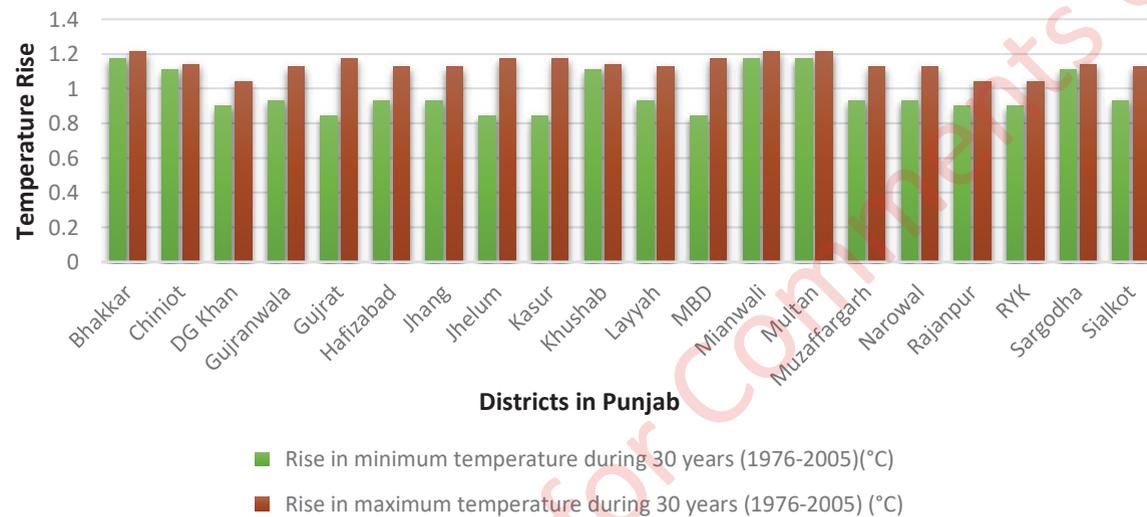
### g. Climate

The Climate Profile of the Punjab province range from semi-arid to arid zone in South to the cool and humid zone in northern parts (such as the north of Salt Ranges). The province usually experiences extreme weathers ranging from the hot summers to cold winters with a temperature variation of -2°C to 45°C, at times, touching the record rise of 50°C. Punjab is situated at the western edge of tropical monsoon (summer rain from the winds arising from Bay of Bengal) and at the eastern edge of western depressions (winter cyclone system originating over Mediterranean Sea).

<sup>14</sup> Mines & Minerals Department, Government of the Punjab



Being most populous, central province of Pakistan, a country ranked 8th in the list of countries most vulnerable to climate change, Punjab is experiencing the climate variations and subsequent impacts in context of extreme weather events, heatwaves, torrential flooding, increased concentration of air pollutants due to greenhouse effect and so on. A study conducted by Provincial Disaster Management Authority (PDMA), Punjab, covering 57% of the area of the province, confirms an average rise of 0.97 °C and 1.14 °C in minimum and maximum temperatures (Figure 8) with an increase in the Annual Summer Days while a decline in cool nights during last 30 years (1975-2005)<sup>15</sup>.



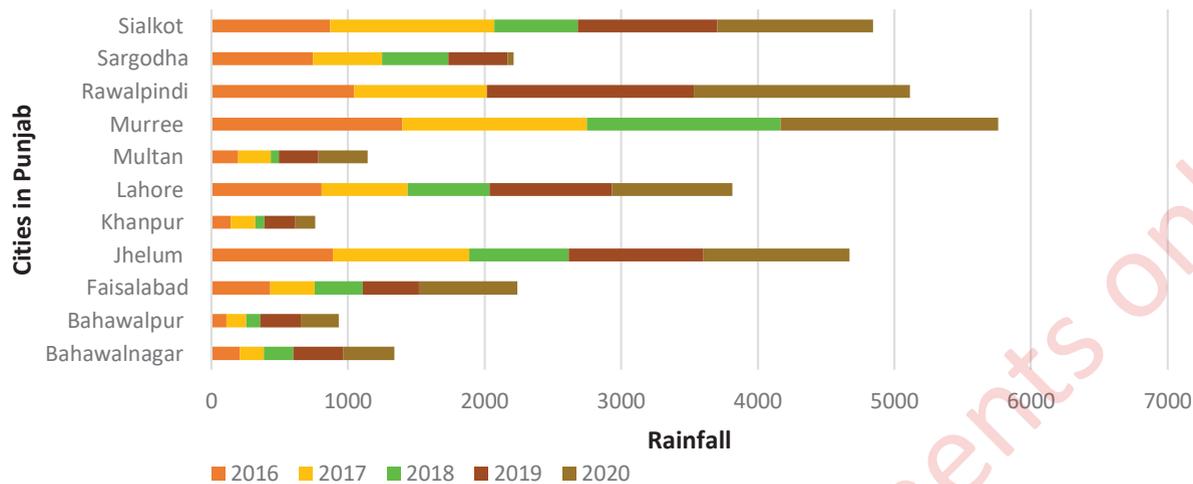
**Figure 8:** Average rise in minimum and maximum temperatures (1975-2005)

Pakistan Meteorological Department reports that during 2022, the monsoon season set on 30th June 2022 over Pakistan, a day earlier of its normal date (1st July) and withdrew during third week of September 2022. The precipitation during this period was recorded largely above average over Punjab (+70%)<sup>16</sup>. The torrential rain caused massive devastating flash floods in southwest Punjab. PMD further reports that the unprecedented Rainfall of 2022 in Indian Sub-continent resulted mainly from following:

- i. Persistent triple-dip La Nina
- ii. Negative IOD (Indian Ocean Dipole)
- iii. Deepened Heat/seasonal-low pressure area, resulted by the Heatwaves occurring during April - June, over south Pakistan leading to a strong pull of monsoon winds to the high heat-low pressure center.
- iv. Climate change, causing more frequent extreme weather events.

Punjab Bureau of Statistics also confirms the increasing trends of rainfall in different parts of the Punjab province (Figure 9). According to the World Bank’s Climate Risk Country Profile of Pakistan (2021), the projected increase in precipitation for the Southern Punjab exceeds 10% by 2050 in the month of September, October, and November. Frequent and extreme weather patterns over a shorter period have become a yearly norm for many parts of Punjab, especially to its Southern region.

<sup>15</sup> Multi-Hazard and Vulnerability Assessment (MHVRA) Reports, PDMA, Punjab  
<sup>16</sup> Monsoon Report (2022), Pakistan Meteorological Department



**Figure 9: Rainfall Trends in Punjab (2016-2020)**

Punjab is vulnerable to three types of floods: riverine, flash and urban floods. Riverine floods pose risk to all river-side districts of Punjab. Flash Floods pose risk to southern districts in the forms of hill torrents and urban flood is a risk for mega cities.

### 1.3 General Weather Pattern

The following analysis is based on the average monthly weather data – corresponding to the period from January to December 2022 – shared by PMD, as collected by their monitoring stations located within the province of Punjab. This dataset includes averaged data on the following weather parameters for the months of January to June 2022:

- Station level pressure (monitored at 0300 and 1200 hours) [measured in hPa]
- Relative humidity (monitored at 0300 and 1200 hours) [measured as % of saturation vapor pressure]
- Mean wind speed (monitored at 0300 and 1200 hours) [measured in knots]
- Mean wind direction (monitored at 0300 and 1200 hours)

This dataset also includes averaged data on the following weather parameters for the months of January to December 2022:

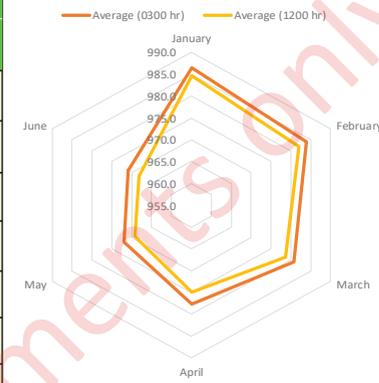
- Mean maximum monthly temperature [measured in °C]
- Mean minimum average monthly temperature [measured in °C]
- Monthly rain (total/cumulative) [measured in millimetres]

General weather patterns are depicted in Annex-I. The atmospheric pressure (or air pressure, hereon denoted by AtmP) indicator, monitored at the station level throughout Punjab, depicted a general steady declining trend from January to June (2022), with an average AtmP of 978.6 hPa (monitored at 0300 hours; minor decrease was noted at 1200 hours with an average AtmP rating of 976.3 hPa). Rahim Yar Khan station reported the highest AtmP recorded for a particular month (January 2022, both times), while Murree station reported the lowest AtmP recorded for a particular month (June 2022, both times) (Table 2). Furthermore, as expected, it is also evident that AtmP decreases gradually as the day progresses



**Table 2:** Station Level Pressure

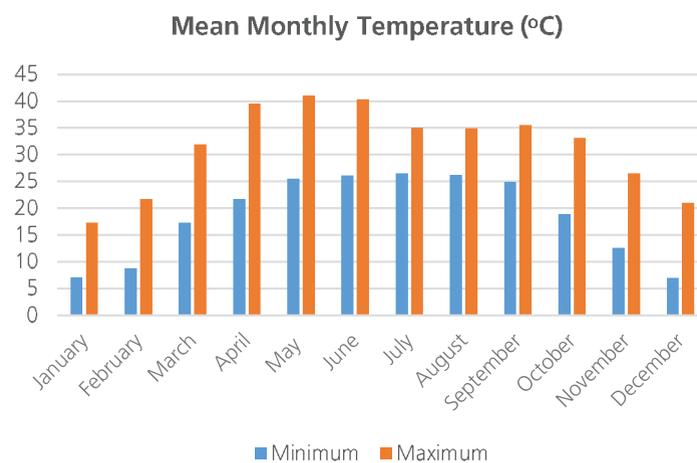
| Month          | Station Level Pressure (hPa) |              |              |                |                |              |
|----------------|------------------------------|--------------|--------------|----------------|----------------|--------------|
|                | Average                      |              | Maximum      |                | Minimum        |              |
|                | at 0300                      | at 1200      | at 0300      | at 1200        | at 0300        | at 1200      |
| January        | 986.4                        | 986.4        | 984.7        | 1,007.4        | 1,005.0        | 795.7        |
| February       | 984.0                        | 984.0        | 982.0        | 1,004.1        | 1,001.6        | 794.9        |
| March          | 980.8                        | 980.8        | 978.6        | 1,001.2        | 998.1          | 798.0        |
| April          | 977.5                        | 977.5        | 974.9        | 996.4          | 993.2          | 797.1        |
| May            | 972.0                        | 972.0        | 969.2        | 990.9          | 987.8          | 794.4        |
| June           | 970.8                        | 970.8        | 968.2        | 990.3          | 986.9          | 793.5        |
| <b>Average</b> | <b>978.6</b>                 | <b>978.6</b> | <b>976.3</b> | <b>1,007.4</b> | <b>1,005.0</b> | <b>793.5</b> |



Regarding average temperature recordings (pertaining to both minimum and maximum temperature readings), a general inverted parabola-shaped trend was observed: temperatures rising at the start of the year continuing till the mid of the year (June). Thereafter – starting July – the temperatures began to dwindle, a trend that continued till the end of the year (Table 3). This is expected as temperatures are lower in the Winter/cooler months as compared to the Summer/warmer months. Temperatures rise as the year progresses into Summer, thereby bringing an increase in average temperatures reaching maximum levels around mid-year. Thereafter, temperatures decrease as the weather delves into the Winter season, reaching minimum levels around the end of the year. This is also evidenced by the increasing trends in both monthly maximum and minimum average temperature values around the year. Rahim Yar Khan station reported the highest average temperature recorded for a particular month (May,

**Table 3:** Mean Monthly Temperature

| Mean Temperature (°C) |         |         |
|-----------------------|---------|---------|
| Month                 | Minimum | Maximum |
| January               | 7.04    | 17.28   |
| February              | 8.75    | 21.75   |
| March                 | 17.28   | 31.96   |
| April                 | 21.67   | 39.60   |
| May                   | 25.55   | 41.03   |
| June                  | 26.13   | 40.36   |
| July                  | 26.51   | 35.00   |
| August                | 26.23   | 34.99   |
| September             | 24.91   | 35.58   |
| October               | 18.86   | 33.13   |
| November              | 12.62   | 26.54   |
| December              | 7.02    | 21.01   |
| Overall               | 18.55   | 31.52   |



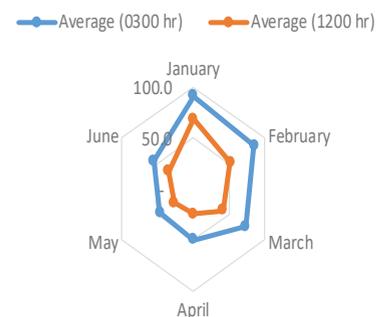


44.7 °C), summer season), while Murree station (being located in a high-altitude/hilly area) reported the lowest average temperature recorded for a particular month (January, winter season, -0.5 °C).

With regards to relative humidity, a general declining trend was observed herein too that appeared to taper off towards the end of the monitoring period, especially true for monitoring at 0300 hours. Alongside, a rising trend in general was also noted at the end of the monitoring period in several monitoring stations as the day progressed, as evidenced through 1200 hourly recordings. Multan City (@ 0300 hours) and Narowal (@ 1200 hours) stations reported the highest average relative humidity levels recorded for a particular month (January 2022), while Rahim Yar Khan station reported the lowest average relative humidity levels recorded for a particular month (April 2022, both times) (Table 4). Furthermore, as expected, it is also evident that the average relative humidity levels decrease gradually as the day progresses.

**Table 4:** Relative Humidity

| Month          | RELATIVE HUMIDITY (%) |         |         |         |         |         |
|----------------|-----------------------|---------|---------|---------|---------|---------|
|                | Average               |         | Maximum |         | Minimum |         |
|                | at 0300               | at 1200 | at 0300 | at 1200 | at 0300 | at 1200 |
| January        | 90.8                  | 68.3    | 96.0    | 80.0    | 69.0    | 50.0    |
| February       | 85.0                  | 51.6    | 94.0    | 65.0    | 55.0    | 36.0    |
| March          | 73.3                  | 41.8    | 84.0    | 53.0    | 41.0    | 26.0    |
| April          | 50.2                  | 24.4    | 65.0    | 39.0    | 37.0    | 13.0    |
| May            | 46.6                  | 26.6    | 54.0    | 46.0    | 41.0    | 18.0    |
| June           | 55.0                  | 34.7    | 66.0    | 46.0    | 47.0    | 28.0    |
| <b>Average</b> | 66.8                  | 41.2    | 96.0    | 80.0    | 37.0    | 13.0    |



Regarding cumulative/total monthly rain measurements, a general inverted parabola shaped trend was observed during the monitoring period (like ), higher in January, declining to low levels before sharply rising and reaching peak levels around mid-year (incorporating the effects of monsoons around mid-year). Following a sharp peak, the cumulative rain levels exhibit a declining trend to low levels in the later months. This is expected and in accordance with the general weather pattern of lesser rain in winters compared with more in summers. Gujranwala station reported the highest cumulative monthly rainfall recorded for a particular month (494.0 mm in July) in the summer season; Narowal station reported the most cumulative monthly rainfall (203.1 mm in January) in the winter season), while several stations reported the lowest cumulative monthly rainfall recorded for a particular month (0 mm or traces) in both summer and winter seasons. Furthermore, on average, the highest average cumulative rain for a single month was observed in July (252.4 mm) observed the most rain on average (followed by August (136.9 mm)), while April (2.9 mm) observed the least average rainfall in the province (with December (4.6 mm) trailing close). Cumulatively, Murree station recorded the most rainfall (573.2 mm) while Khanpur station recorded the least (53.3 mm) during January-June (for those stations where data was available). For the period of July-December, Murree station recorded the most rainfall (999.2 mm) while Faisalabad Airport station recorded the least (176.9 mm) (for those stations where data was available) (Error! Reference source not found.).

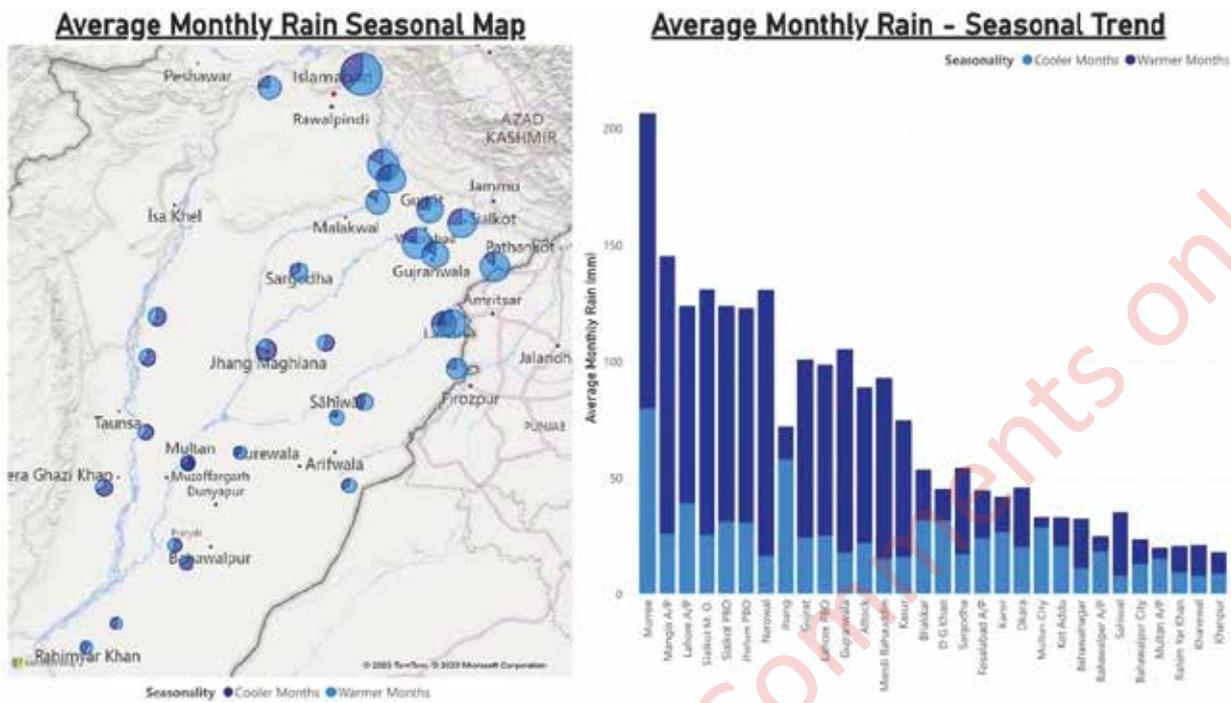
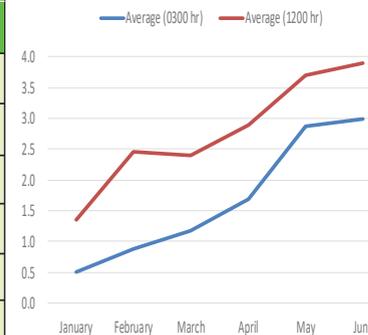


Figure 10: Average Monthly Rain

Regarding wind speed recording, a gradual rising trend was observed herein in general throughout the monitoring period. This is expected as the monitoring period advanced into summer, thereby bringing an increase in average temperatures leading to increased wind speed levels as the year progresses. Lahore A/P station reported the highest average wind speeds recorded for a particular month (May 2022, summer season); several stations reported the lowest average wind speeds (0 knots) recorded for a particular month (reported in the winter season) (Table 5).

Table 5: Mean Wind Speed

| Month          | MEAN WIND SPEED (knots) |         |         |         |         |         |
|----------------|-------------------------|---------|---------|---------|---------|---------|
|                | Average                 |         | Maximum |         | Minimum |         |
|                | at 0300                 | at 1200 | at 0300 | at 1200 | at 0300 | at 1200 |
| January        | 0.5                     | 1.4     | 1.8     | 4.0     | 0.0     | 0.1     |
| February       | 0.9                     | 2.5     | 2.9     | 7.1     | 0.0     | 0.4     |
| March          | 1.2                     | 2.4     | 5.5     | 9.8     | 0.1     | 0.3     |
| April          | 1.7                     | 2.9     | 6.5     | 9.9     | 0.1     | 0.1     |
| May            | 2.9                     | 3.7     | 9.6     | 10.1    | 0.4     | 0.5     |
| June           | 3.0                     | 3.9     | 8.9     | 10.1    | 0.3     | 0.9     |
| <b>Average</b> | 1.7                     | 2.8     | 9.6     | 10.1    | 0.0     | 0.1     |



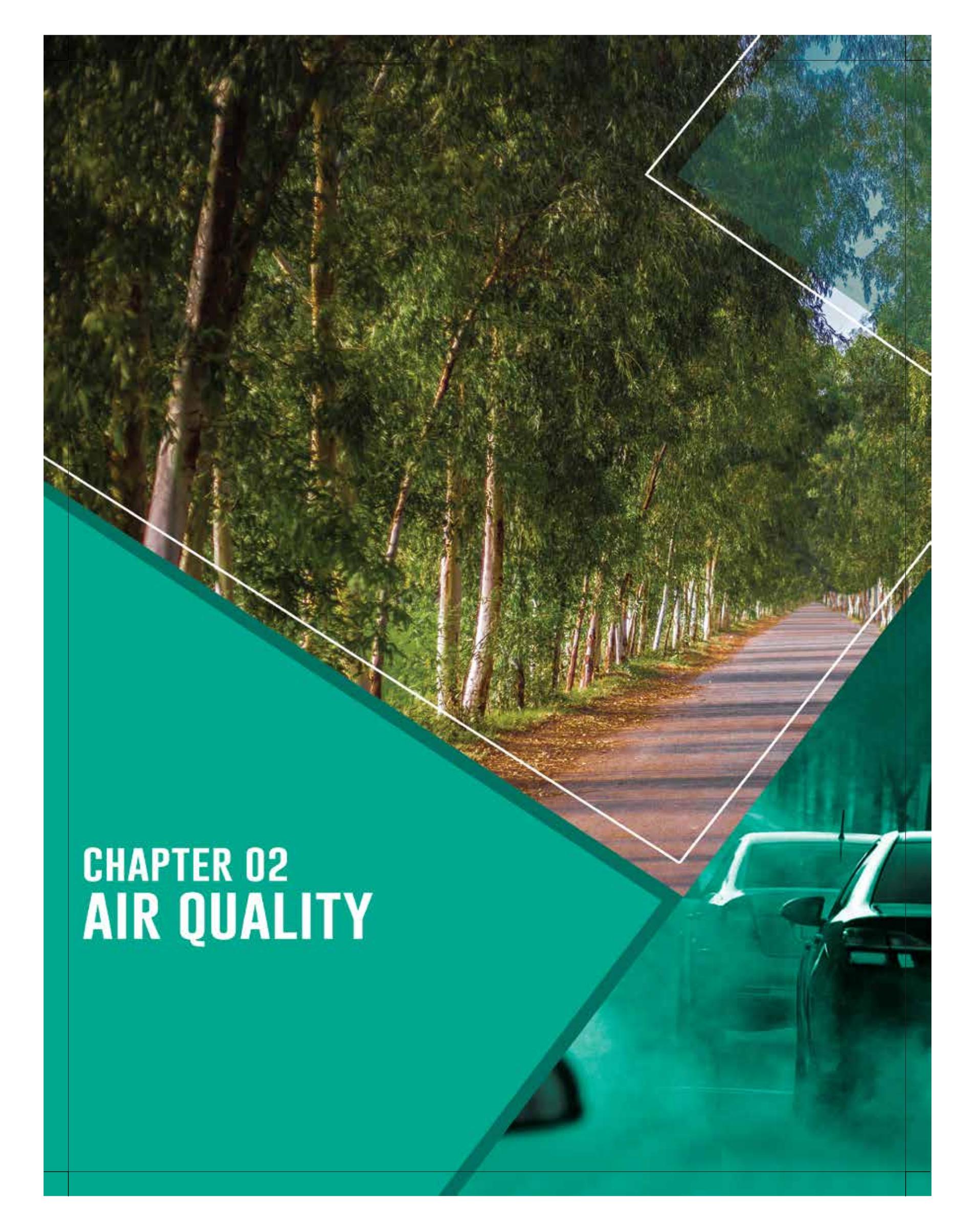


## 1.4 Context to Protecting Punjab's Environment

Resolution adopted by the Human Rights Council on 8th October 2021 48/13 is "The human right to a clean, healthy and sustainable environment". Therefore, much attention needs to be paid to safeguard this human right.

Punjab's State of Environment Report 2022 is a milestone as well as a baseline for establishment of data related to the weather pattern, air, water and soil quality as well as assessments of waste water treatment plants and solid waste management facilities. The report also contains the data related to the environmental complaints, public feedback in the report obtained after due consultation and Government of Punjab Environmental Action Plan.

The state of environment report provides information about environmental conditions, trends and pressures on the environment. This report will play a critical role in promoting environmental sustainability and will help to ensure that decision making is informed by the best available scientific information. The report uses state and trend indicators to evaluate the state conditions impact on the environment. Maximum efforts have been made to holistically deal with the definition of environment including but not limited to air, water and land, all layers of atmosphere, the ecosystem and ecological relationships. The report has adequately identified the current environmental issues along with possible potential solutions for addressing the concerns by providing the baseline data and tracking changes over time. This report will help in monitoring progress towards sustainable environmental progress. This report will also help in taking informed policy and decision making. Lastly this report will help in increasing public awareness by presenting clear and concise information about the state of the environment and raise public awareness about environmental issues and will encourage public engagement.

The image features a photograph of a paved road lined with tall, thin trees, possibly birches, with their green foliage creating a canopy overhead. The road leads into the distance. In the bottom right corner, the front of a white car is visible. The entire image is overlaid with a teal-colored geometric shape that points towards the bottom left. The text 'CHAPTER 02 AIR QUALITY' is printed in white, bold, sans-serif font on this teal background.

## CHAPTER 02 AIR QUALITY



## 2. CHAPTER TWO

### 2.1 Air Quality

Air is the requirement of every living one. Environment Protection Department, with its limited capacity, is striving hard for taking appropriate action in this regard. There is a definite provision given in the Punjab Environmental Protection Act, 1997 and further Punjab Environmental Quality Standards have been notified for the Ambient Air as well as for the Gaseous Emissions. There are two aspects related to air quality. One relates to measurement of ambient air and second relates to measurement of pollution sources both mobile and stationary.

EPA Punjab has a monitoring network of the ambient air quality monitoring stations. Furthermore, with the help of mobile AQMS, the ambient air quality of divisional headquarters has been carried out. EPA Laboratories established in the eight districts have carried out the monitoring of point source i.e., industries. District offices of EPA Punjab as well as EPA laboratories carried out vehicle inspection with the help of traffic police. The mobile sources, only limited to commercial vehicles, have been checked by the Transport Department through Vehicle Inspection Certification System.

### 2.2 Regulatory Framework

The Punjab Environmental Protection Act, 1997 (XXXIV of 1997) is an Act to provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. The environment is defined § 2(x) of the Act ibid and means (a) air, water and land;(b) all layers of the atmosphere;(c) all organic and inorganic matter and living organisms;(d) the ecosystem and ecological relationships;(e) buildings, structures, roads, facilities and works;(f) all social and economic conditions affecting community life; and(g) the inter-relationships between any of the factors in sub-clauses (a) to (f). The Act ibid defined pollution § 2(xxxiii) which means the contamination of air, land or water by the discharge or emission of effluents or wastes or air pollutants or noise or other matter which either directly or indirectly or in combination with other discharges or substances alters unfavorably the chemical, physical, biological, radiational, thermal or radiological or aesthetic properties of the air, land or water or which may, or is likely to make the air, land or water unclean, noxious or impure or injurious, disagreeable or detrimental to the health, safety, welfare or property of persons or harmful to biodiversity;

The Act ibid further emphasized the air pollutant § 2 (iii) which means any substance that causes pollution of air and includes soot, smoke, dust particles, odor, light, electro-magnetic, radiation, heat, fumes, combustion exhaust, exhaust gases, noxious gases, hazardous substance and radioactive substances. In addition to gauge the pollution levels the Agency has to notify emission standards as defined § 2(ix) of the Act ibid. Furthermore, standards have also been defined § 2(xli) of the Act ibid which means qualitative and quantitative standards for discharge of effluents and wastes and for emission of air pollutants and noise either for general applicability or for a particular area, or from a particular production process, or for a particular product, and includes the Punjab Environmental Quality Standards, emission standards and other standards established under this Act and the rules and regulations made there under.



Function of the Agency § 6(1) of the Act ibid is to establish standards for the quality of the ambient air, water and land, by notification in the official Gazette and § 6 (h) is to take samples of any materials, products, articles or substances or of the effluents, wastes or air pollutants being discharged or emitted or of air, water or land in the vicinity of the discharge or emission. Furthermore, the Act ibid § 11 impose prohibition of certain discharges or emissions including air pollutant in an amount, concentration or level which is in excess of the Punjab Environmental Quality Standards or, where applicable, the standards established under clause (g) of sub-section (1) of section 6. Regulation of motor vehicles regarding air pollutant is also carried out § 15 of the Act ibid.

The Act ibid provides a mechanism against the violators of the Act ibid through issuance of Environmental Protection Order § 16. Whoever contravenes or fails to comply with the provisions of sections 16 or any order issued thereunder shall be punishable with fine which may extend to five million rupees, and in the case of a continuing contravention or failure, with an additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues and where such contravention or failure continues.

The Punjab Environmental Quality standards were approved by the Punjab Environmental Protection Council in exercise of the powers conferred under clause (C) of sub-section (1) of section 4 of the Act Ibid. Environment protection department notified the following standards pertaining to the air i.e. the Punjab environmental quality standard for industrial gaseous emissions, for Treatment of Liquid and Disposal of Bio-medical Waste by Incineration, Autoclaving, Microwaving, and Deep Burial, for Ambient Air; and for motor vehicle exhaust and noise.

### 2.3 Ambient Air Quality

Air Pollution is one of the rapidly growing problems in Punjab Province. The pollutants are emitted from different sources directly or indirectly to the ambient atmosphere. Air pollution, particularly in large urban centers, damages the populations' health and quality of life and contributes to environmental degradation. The Indo-Gangetic Plains, composed of the Indus (areas in Pakistan, and parts of Punjab and Haryana in India) and the Gangetic Plains (Uttar Pradesh (UP), Bihar, and West Bengal in India, Nepal and Bangladesh (Figure G.6), have been identified as one of the most polluted regions due to high aerosol concentration and related episode of haze, fog, and smog. These plains have humid subtropical climates. Winters are typically mild, dry and relatively short and tend to be foggy. Summers tend to be long and very hot, with high temperatures sometimes exceeding 40 °C. They also tend to be extremely dry, accompanied by dust storms. This is followed by the monsoons where the region experiences heavy rains. This results in hot and humid conditions, similar to summers in humid subtropical climates. Indian cities such as New Delhi, Lucknow and Kanpur and Pakistani cities Islamabad, Rawalpindi, Lahore, Sheikhpura, Gujranwala, exhibit this peculiar form of the climate. The Indo-Gangetic basin is characterized by high pollutant levels, visible smoke, dense smog/fog, and haze events especially from October to April each year. Dense smog/fog follow the path of Indo-Gangetic basin hampering the normal life and livelihood of millions of people<sup>17</sup>. During management of air quality, the impact of transboundary movement of air pollutants has to be taken into the consideration.



### a. PEQS for Ambient Air

EPD, Punjab vide Notification No. SO(G)/EPD/7-26/2013 dated 05.08.2016 has notified the Punjab Environmental Quality Standards (PEQS) for Ambient Air for the nine air pollutants with their time-weighted average, concentration in the ambient air along with their method of measurement (Table 6).

**Table 6:** Punjab Environmental Quality Standards for Ambient Air, 2016

| Pollutant                                       | Time-weighted average | Concentration in Ambient Air | Method of measurement  |
|---|-----------------------|------------------------------|--|
| Sulfur Dioxide (SO <sub>2</sub> )               | Annual Average*       | 80 µg/m <sup>3</sup>         | Ultraviolet Fluorescence method  |
|   | 24 hours**            | 120 µg/m <sup>3</sup>        |  |
| Oxides of Nitrogen as (NO)                      | Annual Average*       | 40 µg/m <sup>3</sup>         | Gas Phase Chemiluminescence  |
|   | 24 hours**            | 40 µg/m <sup>3</sup>         |  |
| Oxides of Nitrogen as (NO <sub>2</sub> )        | Annual Average*       | 40 µg/m <sup>3</sup>         | Gas Phase Chemiluminescence  |
|   | 24 hours**            | 80 µg/m <sup>3</sup>         |  |
| Ozone (O <sub>3</sub> )                         | 1 hour                | 130 µg/m <sup>3</sup>        | Non dispersive UV absorption method  |
| Suspended Particulate Matter (SPM)              | Annual Average*       | 360 µg/m <sup>3</sup>        | High Volume Sampling,(Average flow rate not less than 1.1m <sup>3</sup> /min). |
|   | 24 hours**            | 500 µg/m <sup>3</sup>        |  |
| Respirable Particulate Matter PM <sub>10</sub>  | Annual Average*       | 120 µg/m <sup>3</sup>        | Preferable β-Ray absorption method   |
|   | 24 hours**            | 150 µg/m <sup>3</sup>        |  |
| Respirable Particulate Matter PM <sub>2.5</sub> | Annual Average*       | 15 µg/m <sup>3</sup>         | Preferable β-Ray absorption method   |
|   | 24 hours**            | 35 µg/m <sup>3</sup>         |  |
|   | 1 hour                | 15 µg/m <sup>3</sup>         |  |
| Lead (Pb)                                       | Annual Average*       | 1 µg/m <sup>3</sup>          | AAS Method after sampling using 2000 or equivalent Filter paper                |
|   | 24 hours**            | 51.5 µg/m <sup>3</sup>       |  |
| Carbon Monoxide (CO)                            | 8 hours**             | 5 mg/m <sup>3</sup>          | Non Dispersive Infra-Red (NDIR) method   |
|   | 1 hour                | 10 mg/m <sup>3</sup>         |  |

\*Annual arithmetic mean of minimum 104 measurement in a year taken twice a week 24 hourly at uniform interval.

\*\*24 hourly / 8hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

These air pollutants include the “criteria air pollutants” viz, sulfur dioxide, nitrogen dioxide, ground-level ozone, particulate matter, lead, and carbon monoxide. The criteria air pollutants are some of the significant air pollutants that are more strongly supposed to be hazardous to human health, and plant life and may cause structural damage. Prolonged or heavy exposure to hazardous air can result in severe health issues including asthma, lung damage, bronchial infections, and heart problems, and shortened life expectancy thus putting at risk people’s rights to life and to health, as well as the right to a healthy environment.

The impact of urban air pollution has a variety of focuses on urban ecology, human health, economy, etc. But human health is always given priority. Air pollution is a threat to the lives of people living in big cities of Punjab. The main causes of air pollution include abrupt increase in the number of vehicles, inefficient automotive technology, use of unclean fuels, uncontrolled emissions of industrial units, emissions of brick kilns, rice husk, the burning of garbage and the presence of dust, etc.

### b. Measurement of Ambient Air Quality

One of the critical challenges associated with poor air quality faced in Punjab is the lack of air quality monitoring systems. There are different sets of air quality monitoring systems available with EPA Punjab. Three of these are received in aid from JICA and other six are purchased by EPA Punjab. The ambient air quality monitoring stations require continuous repair and maintenance.

At present there are three Air Quality Monitoring Stations in Lahore i.e., one mobile and two fixed AQMS (Installed at Town Hall & Township) (Figure 11).



**AQMS Town Hall,  
Lahore**



**AQMS Township,  
Lahore**



**Mobile AQMS**

**Figure 11: AQMS Stations in Lahore**

Air Quality index is calculated by using the following formula. However, the breakpoints as given below (Table 7) are being used for the calculation AQI.

$$AQI = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} * (Cp - BP_{Lo}) + I_{Lo}$$

- Where AQI = the index for pollutant p or air quality index
- Cp = the truncated concentration of pollutant p
- BPHi = the concentration breakpoint that is greater than or equal to Cp
- BPLo = the concentration breakpoint that is less than or equal to Cp
- IHi = the AQI value corresponding to BPHi
- Ilo = the AQI value corresponding to BPLo



**Table 7:** : Breakpoints for calculation of AQI

|   | PM10<br>( $\mu\text{g}/\text{m}^3$ ) | PM2.5<br>( $\mu\text{g}/\text{m}^3$ ) | SO2<br>( $\mu\text{g}/\text{m}^3$ ) | NO2<br>( $\mu\text{g}/\text{m}^3$ ) | O3<br>( $\mu\text{g}/\text{m}^3$ ) | CO<br>( $\text{mg}/\text{m}^3$ ) | AQI      | AQI<br>Category                              |
|---|--------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|----------------------------------|----------|--|
| 1 | 0.0-75.0                             | 0.0-15.0                              | 0.0-60.0                            | 0.0-40.0                            | 0.0-65                             | 0.0-2.5                          | 0-50     | Good (Green)                                 |
| 2 | 75.1-150.0                           | 15.1-35.0                             | 60.1-120.0                          | 40.1-80.0                           | 65.1-130.0                         | 2.6-5.0                          | 51-100   | Satisfactory<br>(Green)                      |
| 3 | 150.1-250.0                          | 35.1-70.0                             | 120.1-220.0                         | 80.1-130.0                          | 130.1-195.0                        | 5.1-7.5                          | 101-150  | Moderate<br>(Yellow)                         |
| 4 | 250.1-350.0                          | 70.1-140.0                            | 220.1-320.0                         | 130.1-180.0                         | 195.1-260.0                        | 7.6-10.0                         | 151-200  | Unhealthy for<br>sensitive group<br>(Orange) |
| 5 | 350.1-450.0                          | 140.1-250.0                           | 320.1-800.0                         | 180.1-380.0                         | 260.1-450.0                        | 10.1-25.0                        | 201-300  | Unhealthy (Red)                              |
| 6 | 450.1-550.0                          | 250.1-350.0                           | 800.1-1600.0                        | 380.1-580.0                         | 450.1-550.0                        | 25.1-40.0                        | 301-400  | Very unhealthy<br>(Purple)                   |
| 7 | 550.1+                               | 350.1+                                | 1600.1+                             | 580.1+                              | 550.1+                             | 40.1+                            | 401-500+ | Hazardous<br>(Maroon)                        |

### c. Description of Ambient Air Quality

In Town Hall, the ambient Air quality monitoring system was functional for only Carbon Monoxide for 342 days. The average, minimum and maximum value of AQI (based on CO) was 122.72, 75 and 245 respectively. The maximum value was observed during the month of February while the minimum value was observed during the month of July. In Township, the ambient Air quality monitoring system was functional for only NOx for 353 days. The average, minimum and maximum value of AQI (based on NOx) was 81.37, 3 and 228, respectively. The maximum value was observed during the month of January while the minimum value was observed during the month of June. At EPA HQs, the readings of AQI (based on PM2.5) is available for 178 days for the year 2022 (ranging from Jan to July). Whereas the average, minimum and maximum value of AQI (based on PM2.5) was 152.09, 25 and 276, respectively. The maximum and minimum value was observed during January and July, respectively (Table 8). The graphical representation of minimum, average and maximum AQI is given at .

The count of AQI (based on PM2.5) of Mobile AQMS was obtained on 309 days for the year 2022. The average, minimum and maximum of AQI (based on PM2.5) was 174.20, 11 and 455, respectively. The minimum and maximum value was observed during July and December, respectively. C2 sector, Block 1, Township, Lahore (for 55 days), Canal View Society (for 6 days), China Scheme Kerol ghatti (for 64 days), Daroghawala industrial area (for 18 days), Davis Road (for 8 days), Ferozpure Road near Muslim Town (for 2 days), Gajumata Ferozpure Road (for 12 days), Government College university (for 7 days), Green Fort Canal Bank Road (for 7 days), Kot lakhpat industrial area (for 16 days), LUMS (for 10 days), Mehmood Booti (for 21 days), Met Department Jail Road (for 66 days), Punjab Civil Secretariat (for 14 days), Punjab Institute of Cardiology, Jail, Road (3 days), Punjab



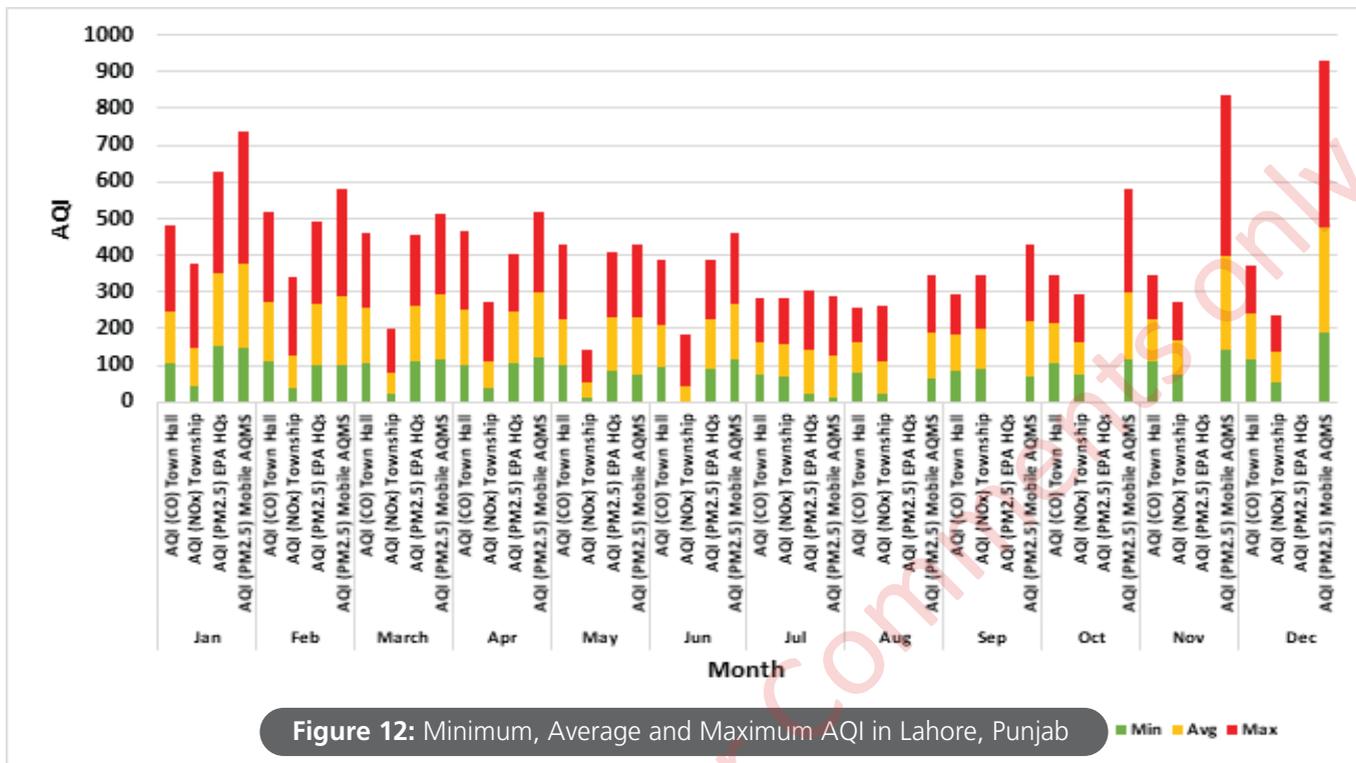
University (for 13 days), Raiwind Road (for 3 days), Sunder industrial Estate (for 8 days), Township (for 4 days), University of Home Economics Gulberg (for 5 days), University of Lahore (for 22 days), Thokar Niaz Baig (for 1 days).

The mean wind speed for the month of January was 0.0 (at 0300) and 0.5 (at 1200) and for February it was 0.0 (at 0300) and 2.0 (at 1200). Suggesting that strong correlation exists between high AQI value vis-à-vis the meteorological parameters.

**Table 8:** AQI Levels from various stations at Lahore

| Month            | AQI (CO) Town Hall |               |            | AQI (NOx) Township |              |            | AQI (PM2.5) EPA HQs |               |            | AQI (PM2.5) Mobile AQMS |               |            |
|------------------|--------------------|---------------|------------|--------------------|--------------|------------|---------------------|---------------|------------|-------------------------|---------------|------------|
|                  | Min                | Average       | Max        | Min                | Average      | Max        | Min                 | Average       | Max        | Min                     | Average       | Max        |
| Jan              | 104                | 145.38        | 230        | 41                 | 106.71       | 228        | 154                 | 198.48        | 276        | 147                     | 232.68        | 360        |
| Feb              | 110                | 163.71        | 245        | 38                 | 90.96        | 213        | 103                 | 166.18        | 223        | 102                     | 185.68        | 293        |
| Mar              | 108                | 150.63        | 200        | 20                 | 62.40        | 118        | 109                 | 152.65        | 192        | 119                     | 175.40        | 218        |
| Apr              | 100                | 152.03        | 215        | 37                 | 74.07        | 161        | 106                 | 138.60        | 159        | 124                     | 173.57        | 220        |
| May              | 100                | 125.08        | 207        | 14                 | 39.29        | 88         | 87                  | 145.74        | 174        | 77                      | 152.23        | 198        |
| Jun              | 98                 | 114.21        | 173        | 3                  | 38.63        | 142        | 92                  | 131.63        | 165        | 115                     | 155.03        | 192        |
| Jul              | 75                 | 87.77         | 122        | 71                 | 88.26        | 126        | 25                  | 118.88        | 158        | 11                      | 117.84        | 162        |
| Aug              | 81                 | 84.45         | 90         | 23                 | 86.74        | 155        | N/A*                | N/A*          | N/A*       | 66                      | 120.94        | 159        |
| Sep              | 83                 | 100.16        | 111        | 89                 | 109.73       | 149        | N/A*                | N/A*          | N/A*       | 69                      | 152.17        | 209        |
| Oct              | 106                | 111.97        | 127        | 73                 | 92.19        | 128        | N/A*                | N/A*          | N/A*       | 118                     | 183.50        | 277        |
| Nov              | 111                | 114.90        | 118        | 76                 | 91.60        | 105        | N/A*                | N/A*          | N/A*       | 140                     | 256.95        | 439        |
| Dec              | 115                | 124.97        | 134        | 54                 | 84.48        | 96         | N/A*                | N/A*          | N/A*       | 187                     | 288.75        | 455        |
| <b>Year 2022</b> | <b>75</b>          | <b>122.72</b> | <b>245</b> | <b>3</b>           | <b>81.37</b> | <b>228</b> | <b>25</b>           | <b>152.09</b> | <b>276</b> | <b>11</b>               | <b>174.20</b> | <b>455</b> |

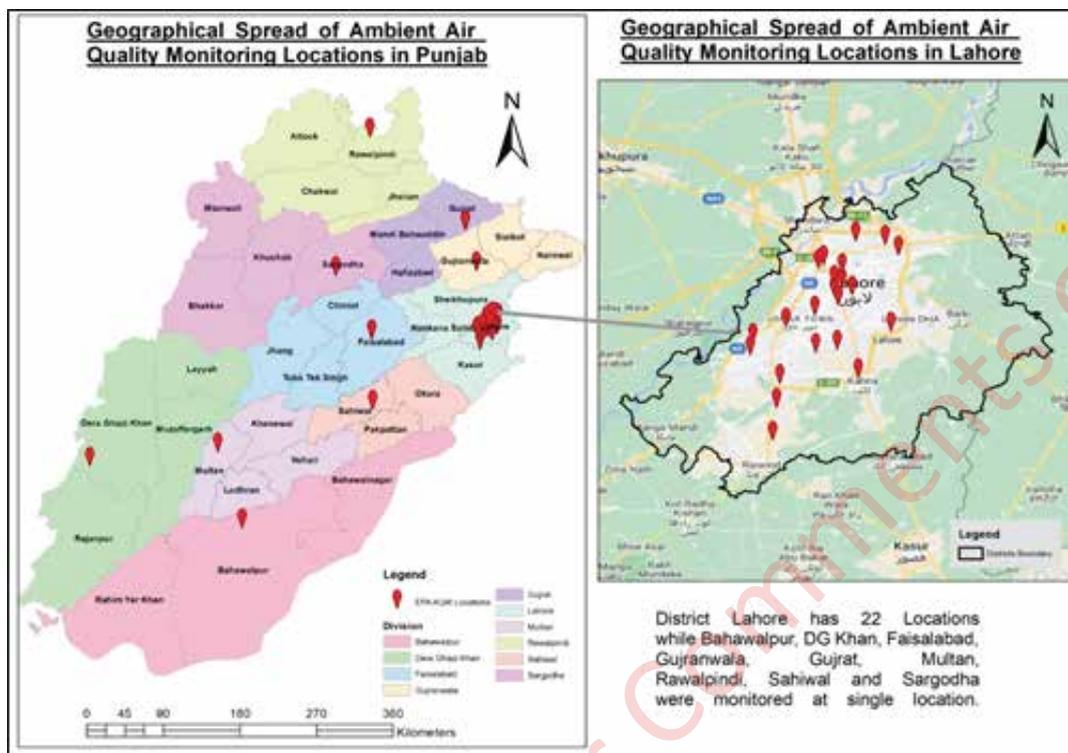
\* N/A means data is not available



The ambient air quality monitoring stations carried out the monitoring of nine divisional headquarters including Sahiwal (30-Nov-2022), Bahawalpur (1-Dec-2022) Multan (3-Dec-2022) DG Khan (4-Dec-2022) Faisalabad (6-Dec-2022) Sargodha (8-Dec-2022) Rawalpindi (9-Dec-2022) Gujrat (11-Dec-2022), Gujranwala (13-Dec-2022). Though the monitoring was carried out on only one day basis it is just a representative/ reflection of ambient air quality monitoring on a single day and it does not reflect the annual trend or prevailing values. Among these divisional headquarters, highest value of AQI (based on PM 2.5) has been found in Bahawalpur and the lowest value is found in Gujrat. The reason of highest value may be attributed to highest wind speed of being adjacent to the desert area. The value of PM 2.5 is not available for DG Khan, Rawalpindi and Sahiwal. The value of nitrogen oxide for Rawalpindi is higher as compare to other divisional headquarters. The value of Sulphur dioxide is comparatively higher for Faisalabad amongst other divisional HQs. The geographical spread of ambient air quality monitoring station in Punjab is given at Figure 13.

#### d. Strengthening of Capacity to Measure Ambient Air Quality

By order dated 19th December 2017 (the "Order") in Walid Iqbal vs. Federation of Pakistan, Writ Petition No. 34789/2016, Justice Syed Mansoor Ali Shah, the then Chief Justice of the Lahore High Court, Lahore, constituted "Smog Commission" under Order 26 of the Code of Civil Procedure, 1908, to combat smog and to formulate a Smog Policy for Punjab to identify its root causes and prescribe a plan to protect and safeguard the life and health of the people of Punjab. Dr. Parvez Hassan was appointed Chair of the Commission. The report of the Smog Commission states that according to NASA, smog/air pollution levels remain high throughout the year; lowering mercury, high humidity, and lowering of the inversion layer, only aggravate and make it visible in winter. The Commission recommended the installation of 30 Ambient AQMS in the province (Table 9).



**Figure 13:** Geographical Spread of Ambient Air Quality Monitoring Locations in Punjab

**Table 9:** Districts wise distribution of AQMS to be installed

| Sr. No. | Name of District | No. of Air AQMS to be installed |
|---------|------------------|---------------------------------|
| 1.      | Lahore           | 8                               |
| 2.      | Sheikhpura       | 1                               |
| 3.      | Faisalabad       | 3                               |
| 4.      | Rawalpindi       | 3                               |
| 5.      | Multan           | 2                               |
| 6.      | Gujranwala       | 2                               |
| 7.      | Sialkot          | 1                               |
| 8.      | Bahawalpur       | 2                               |
| 9.      | DG Khan          | 1                               |
| 10.     | Sargodha         | 2                               |
|         | Mobile AQMS*     | 5                               |
|         | <b>Total</b>     | <b>30</b>                       |

\*Five will be mobile AQMS professionally installed on vans/trucks containing all requisite accessories.

## 2.4 Pollution Sources affecting Air quality

### a. Industrial Analysis

The data available with the three government departments/agencies have been reviewed to gauge the number of pollution sources in Punjab. Three datasets have been perused i.e. one with EPA Punjab<sup>18</sup> second with Industry Department<sup>19</sup> and Map Book of the Punjab<sup>20</sup>. Description of three available data sets is as follows: During 2013-14, EPA Punjab carried out a huge exercise of geo-tagging of industrial units. This exercise resulted in identification of 18,271 establishments comprising on 67 different types of establishments. This data needs to be cleaned and updated accordingly on regular basis to understand the quantum of increase/decrease in load of establishments. But this hasn't been done so far. The data available (2016-17) with the industries department reveals that there are 18,540 industrial establishments comprising on 194 different types of establishments. The data presented in the Map Book of the Punjab, 2020 (spatial encyclopedia) reveals that there are a total 46,357 industrial establishments comprising on 24 sectors. This data relates to the Census of Manufacturing Industries, 2015-16 (Figure 14). The division comparison of these data sets is as follows (Figure 15). This data indicates the unavailability of proper data set for industrial establishments. Every organization has its own data set, which is not updated on regular basis. The unavailability of updated datasets possesses major bottleneck in understanding the quantum of problem as well as finding solution with respect thereof.

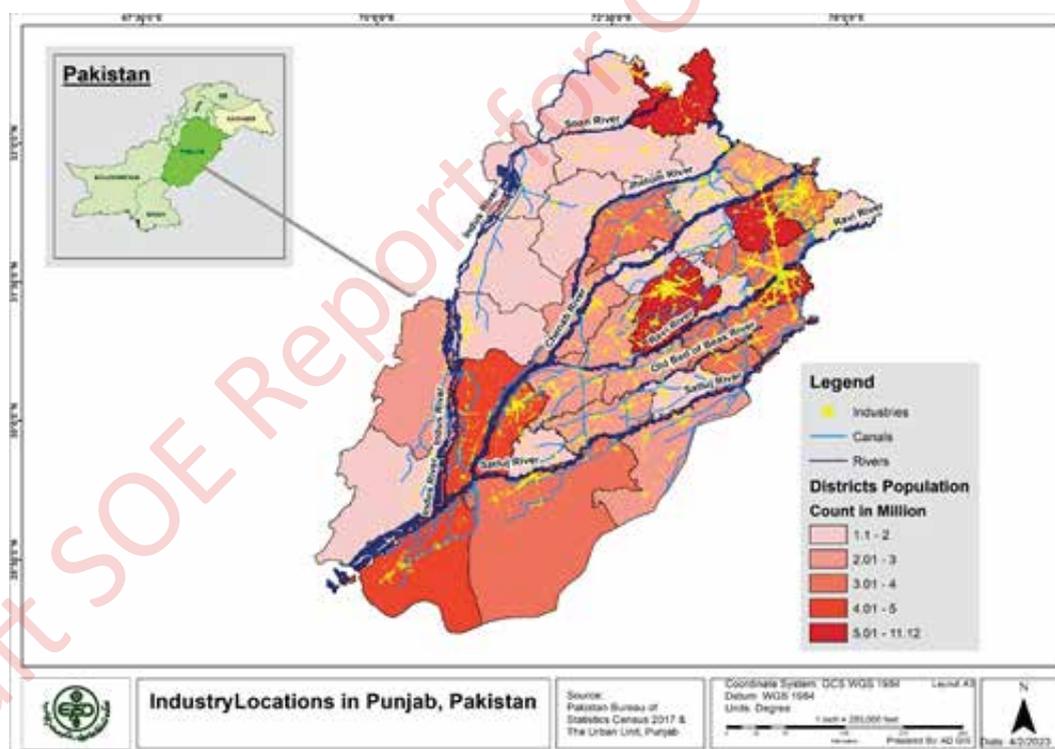


Figure 14: Industry Locations in Punjab, Pakistan

There are 8 Environmental laboratories of EPA Punjab situated in Faisalabad, Gujranwala, Lahore, Multan, Rawalpindi, Rahim Yar Khan, Sialkot and Sheikhupura. These eight laboratories are entrusted with the monitoring against each district. Only, Laboratory at Lahore has a special power to monitor the industrial establishments across the Punjab, as and when required (Table 10).

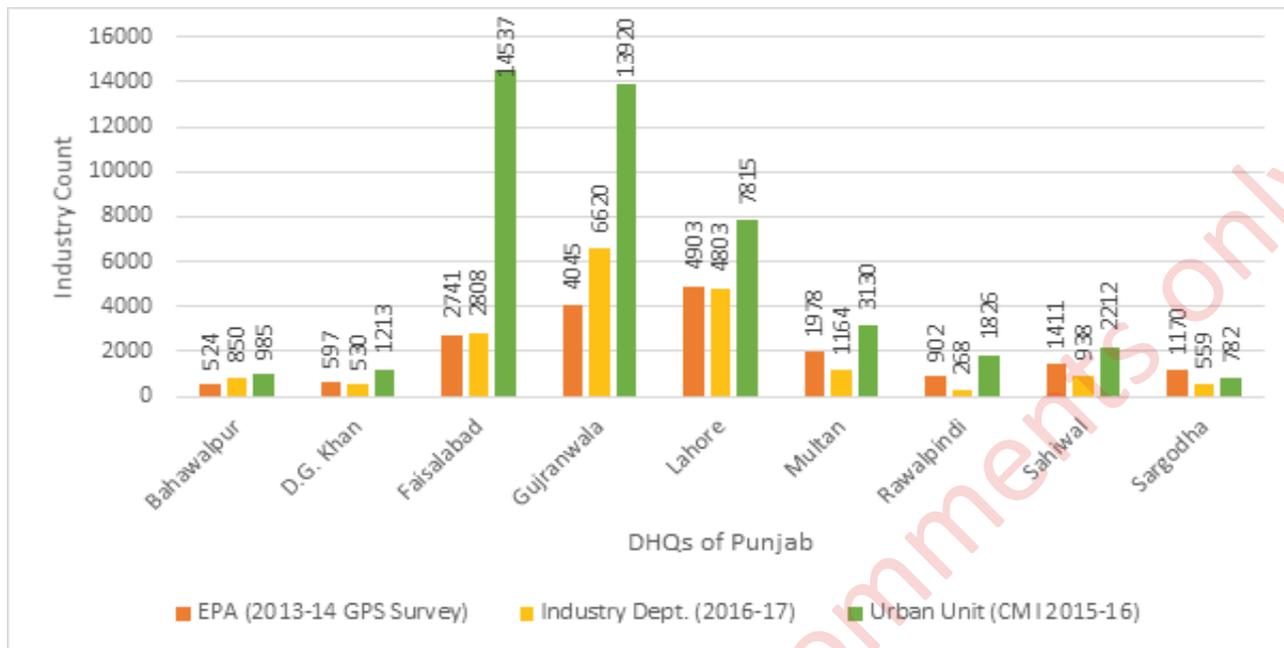
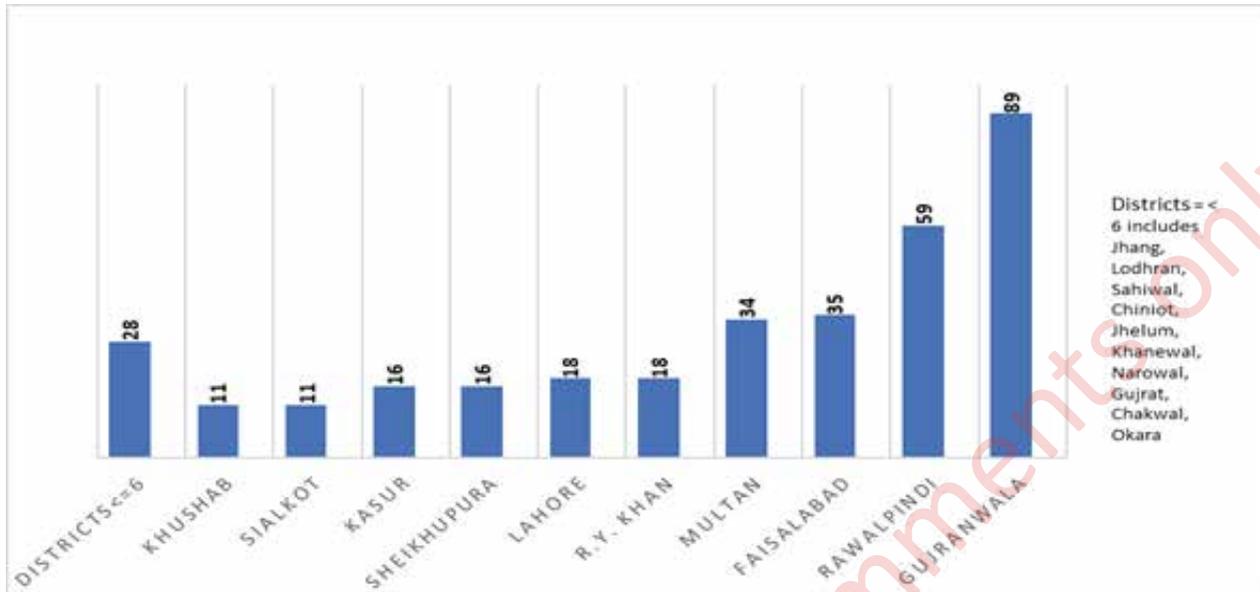


Figure 15: Division Wise Industry Count

Table 10: EPA Laboratories with their Area of Jurisdiction<sup>21</sup>

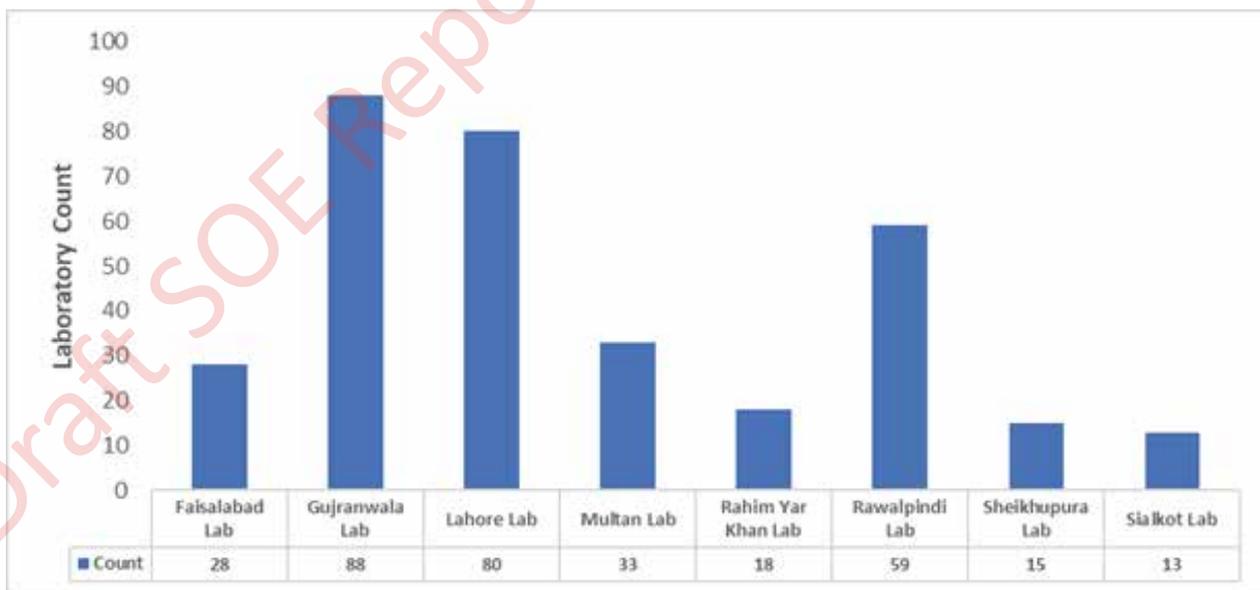
| Sr. No. | Name                           | Area of jurisdiction   |
|---------|--------------------------------|--|
| 1.      | EPA Laboratory, Faisalabad     | Faisalabad Division (Faisalabad, Toba Tak Singh & Jhang)<br>District Chiniot, Sargodha, Bhakkar & Khushab  |
| 2.      | EPA Laboratory, Gujranwala     | District Gujranwala, Gujrat and Mandi Bahu Din   |
| 3.      | EPA Laboratory, Lahore         | District Lahore, Kasur and Okara<br>& All districts of Punjab for special Monitoring   |
| 4.      | EPA Laboratory, Multan         | Multan Division (Multan, Vehari & Khanewal) Lodhran D.G Khan<br>Division (Dera Ghazi Khan, Muzaffargarh, Rajanpur & Layyah) &<br>Sahiwal Division (Sahiwal, Pakpattan and Okara District except Okara) |
| 5.      | EPA Laboratory, Rawalpindi     | Rawalpindi Division (Rawalpindi, Attock, Jhelum, Chakwal) & Mianwali   |
| 6.      | EPA Laboratory, Rahim Yar Khan | Bahawalpur Division (Bahawalpur, Bahawalnagar & Rahim Yar Khan)  |
| 7.      | EPA Laboratory, Sialkot        | District Sialkot and Narowal   |
| 8.      | EPA Laboratory, Sheikhpura     | District Sheikhpura, Nankana Shaib & Hafizabad   |

During 2022, the total 335 inspections of stack emissions were carried out (Figure 17). Smoke, Carbon Monoxide (CO), Carbon Dioxide (CO<sub>2</sub>), Sulphur Dioxide (SO<sub>2</sub>), Oxides Of Nitrogen (NO<sub>x</sub>) and Particular Matter (PM) were measured. EPA Laboratory Gujranwala & Lahore carried out comparatively higher monitoring of industrial establishments (> 75 inspections). Whereas, remaining laboratories i.e., Rahim Yar Khan, Sheikhpura, Multan & Faisalabad carried out lesser inspections ranging from 10 to 30 inspections. With regards to District, highest inspection where carried out in Gujranwala district followed by Faisalabad, Multan, Lahore, Kasur & Sheikhpura (Figure 16).



**Figure 16:** District Wise Count of EPA Labs Inspections

The maximum inspections were carried out for the Brick kiln (108 Nos) followed by furnaces including (steel, Iron, copper etc.) (62 Nos) Textile (34 Nos), Paper and Paperboard, Paper pulping (16 Nos), Chemical project (13 Nos), and Cement plants (12 Nos). Pharmaceutical, Textile, Paper, Furnace, Ceramic unit and rice mills have 80 or more than 80 value of Ringlemann scale. Sulphur dioxides are found higher in the monitoring of fertilizer plant where as higher value of Nitrogen Oxides are observed in the Power Plant. Whereas, the concentration of Particulate Matter is found higher in the cement plants.



**Figure 17:** Laboratory Wise Count of EPA Labs Inspection



## b. Vehicular Data Analysis - Excise Department

In 2020, Food and Agriculture Organization (FAO) of the United Nations published an assessment apportioning the share of contributing factors of air pollution across the Punjab. Investigations suggest that 43% air pollutants are emitted from transport sector, 25% from industrial, and 20% from agriculture sectors<sup>22</sup>. Global Change Impact Study Center (GCISC) made initial estimates with Greenhouse Gas – Air Pollution Interactions and Synergies (GAINS) model that, approximately, 17% particulate matter (PM2.5) was contributed by dust and municipal waste, 29% from industry and power plants, 36% from agriculture (crop residue burning, livestock, fertilizer) and residential sources, and 18% from mobile sources<sup>23</sup>. It is therefore pertinent that this factor is monitored and taken into consideration with regards to checks on air pollution. The monthly data of vehicle registrations throughout Punjab<sup>24</sup> for the period Jan-Oct 2022 is summarized in Table 11.

It can be seen that the number of vehicles registered is predominantly concentrated within the major cities of the province. Registrations in the provincial capital comprise over a quarter (26.28%) of the total registered throughout the province, followed by Faisalabad (7.66%), Multan (6.57%), Gujranwala (5.16%) and Sialkot (4.49%). Vehicular registrations within these aforementioned 5 districts collectively constitute more than half of the registrations within the entire province.

**Table 11:** District-wise Vehicle Registration Summary [Jan-Oct 2022]

| District        | Total            | Provincial Share (%) | Average           | Monthly Variability | Trend |
|-----------------|------------------|----------------------|-------------------|---------------------|-------|
| Lahore          | 285,231          | 26.28%               | 28,523.10         | 6,189.45            |       |
| Faisalabad      | 83,103           | 7.66%                | 8,310.30          | 1,836.35            |       |
| Multan          | 71,269           | 6.57%                | 7,126.90          | 1,329.82            |       |
| Gujranwala      | 56,000           | 5.16%                | 5,600.00          | 1,458.20            |       |
| Sialkot         | 48,767           | 4.49%                | 4,876.70          | 1,511.75            |       |
| Rahim Yar Khan  | 38,381           | 3.54%                | 3,838.10          | 1,448.55            |       |
| Rawalpindi      | 35,737           | 3.29%                | 3,573.70          | 1,093.15            |       |
| D G Khan        | 34,800           | 3.21%                | 3,480.00          | 1,983.97            |       |
| Guirat          | 33,121           | 3.05%                | 3,312.10          | 1,343.08            |       |
| Bahawalpur      | 29,793           | 2.75%                | 2,979.30          | 857.27              |       |
| Bahawalnagar    | 27,659           | 2.55%                | 2,765.90          | 931.21              |       |
| Sahiwal         | 24,717           | 2.28%                | 2,471.70          | 527.92              |       |
| Sargodha        | 24,013           | 2.21%                | 2,401.30          | 1,536.27            |       |
| Vehari          | 22,219           | 2.05%                | 2,221.90          | 491.23              |       |
| Muzaffargarh    | 19,752           | 1.82%                | 1,975.20          | 549.97              |       |
| Khanewal        | 18,868           | 1.74%                | 1,886.80          | 878.66              |       |
| Jhang           | 18,422           | 1.70%                | 1,842.20          | 623.50              |       |
| Khushab         | 17,324           | 1.60%                | 1,732.40          | 1,323.23            |       |
| Jhelum          | 17,047           | 1.57%                | 1,704.70          | 520.79              |       |
| Okara           | 16,563           | 1.53%                | 1,640.33          | 602.25              |       |
| Rajapur         | 14,328           | 1.32%                | 1,432.80          | 1,468.82            |       |
| Chniot          | 13,703           | 1.26%                | 1,370.30          | 874.23              |       |
| Toba Tek Singh  | 13,537           | 1.25%                | 1,353.70          | 698.43              |       |
| Layyah          | 13,165           | 1.21%                | 1,316.50          | 592.74              |       |
| Pakpattan       | 12,411           | 1.14%                | 1,241.10          | 399.18              |       |
| Mianwali        | 11,468           | 1.06%                | 1,146.80          | 1,267.01            |       |
| Lodhran         | 10,976           | 1.01%                | 1,097.60          | 541.04              |       |
| Hafizabad       | 10,896           | 1.00%                | 1,089.60          | 585.04              |       |
| Narowal         | 9,870            | 0.91%                | 987.00            | 331.02              |       |
| Mandi Bahauddin | 9,791            | 0.90%                | 979.10            | 387.31              |       |
| Sheikhupura     | 8,242            | 0.76%                | 824.20            | 307.33              |       |
| Bhakhar         | 7,896            | 0.73%                | 877.33            | 395.92              |       |
| Chakwal         | 7,400            | 0.68%                | 740.00            | 323.42              |       |
| Attock          | 6,572            | 0.61%                | 657.20            | 222.32              |       |
| Kasur           | 6,343            | 0.58%                | 634.30            | 359.23              |       |
| Nankana Sahib   | 5,966            | 0.55%                | 596.60            | 206.68              |       |
| <b>Overall</b>  | <b>1,085,350</b> | <b>100.00%</b>       | <b>108,535.00</b> | <b>25,287.30</b>    |       |

<sup>22</sup> <https://www.fao.org/documents/card/en/c/ca6989en/>

<sup>23</sup> An Unpublished study titled as "Application of the GAINS IGP-HF AQM Policy Planning Tool"

<sup>24</sup> Vehicle Registration Data as obtained from The Excise, Taxation & Narcotics Control Department, Government of the Punjab.

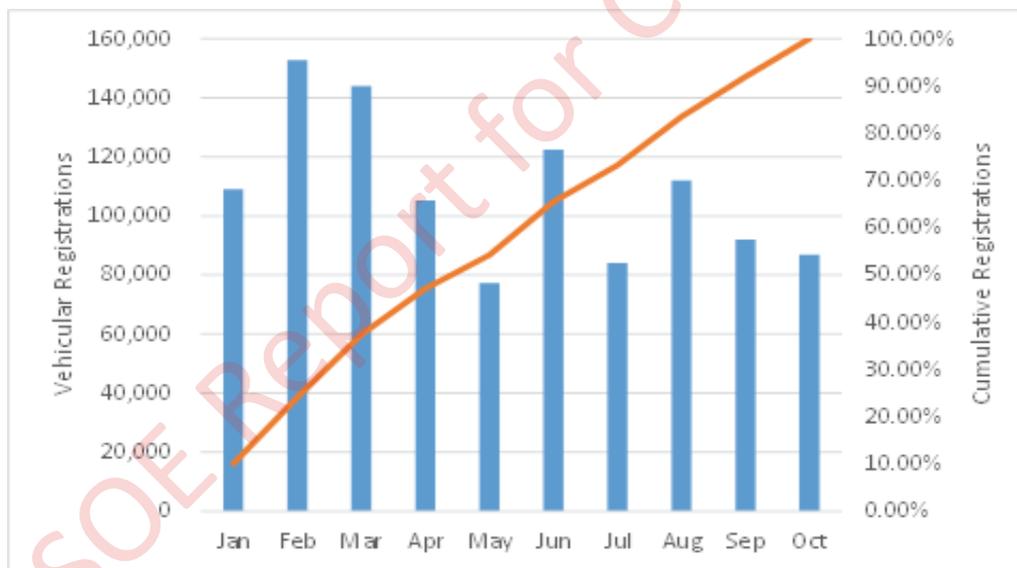


In terms of body type, motor cycles constitute an overwhelming ( $\approx 89\%$ ) proportion of the vehicles registered during the given period, followed by motor cars ( $\approx 9\%$ ). The following Table 12 summarizes data for the general body types.

**Table 12:** Vehicular Registrations by Body Type [Jan-Oct 2022]

| Body Type       | Total            | Provincial Share (%) | Monthly           |                  |   |
|-----------------|------------------|----------------------|-------------------|------------------|---|
|                 |                  |                      | Average           | Variability      | Trend   |
| Ambulance       | 113              | 0.01%                | 11.30             | 4.32             |  |
| Bus             | 1,010            | 0.09%                | 101.00            | 35.11            |  |
| Delivery Van    | 6,303            | 0.58%                | 630.30            | 237.61           |  |
| Double Cabin    | 669              | 0.06%                | 66.90             | 27.21            |  |
| Earth Machinery | 192              | 0.02%                | 19.20             | 8.07             |  |
| Motor Car       | 97,206           | 8.96%                | 9,720.60          | 1,809.76         |  |
| Motor Cycle     | 962,979          | 88.73%               | 96,297.90         | 24,816.08        |  |
| Rickshaw        | 1,351            | 0.12%                | 135.10            | 128.15           |  |
| Taxi Cab        | 186              | 0.02%                | 18.60             | 16.19            |  |
| Tractor         | 14,650           | 1.35%                | 1,465.00          | 391.87           |  |
| Truck           | 691              | 0.06%                | 69.10             | 24.85            |  |
| <b>Overall</b>  | <b>1,085,350</b> | <b>100.00%</b>       | <b>108,535.00</b> | <b>25,287.30</b> |  |

It is further noted that vehicular registrations are largely concentrated earlier in the year () , with the first 4 months constituting around half of the year-to-date registrations (Figure 18).



**Figure 18:** Monthly Vehicular Registrations throughout Punjab [Jan-Oct 2022]

It is imperative to point out that this data pertains to the vehicular registrations done during the current calendar year. It does not include data from previous years. Moreover, there is also the consideration that inter-district and inter-provincial movement and presence of vehicles in a given district that were registered out of that district, which cannot be accounted for in this (or, in fact, in any given data set). Finally, it cannot be ascertained if all these are operational, are modified in some form, have any issues regarding environmental pollution, etc. Thereby, it is not a true depiction of vehicular presence in any given district. Thus, it cannot be a realistic factor input of environmental air pollution pertaining to the transport sector within the province. However, having said that, we can still take the increase in vehicular registrations as a proxy measure to corroborate with the increase in air pollution from last year.



In Punjab, the vehicular pollution has gained serious attention in the context of the air pollution, owing to the multiple reasons. One, their number has been increased and increasing at an unprecedented rate. Secondly, the euro II vehicular emissions standards need to be upgraded. Thirdly, the fuel type is also a serious concern. The Punjab faces Federal limitations regarding Petro standards as well as vehicular standards as the both subjects fall under the ambit of Federal Government.

### 2.5 Air Quality Management Practices

The following is a glimpse of various management practices being carried out for the betterment of air quality in the province. These practices are mainly selected from the Annual Development Program 2022-23 related to the respective Government Departments. The brief description is as follows:

**a. Environment Protection Department** is undertaking multiple initiative regarding air quality management practices which have been discussed in detail in chapter 6 of this report titled as “Measures taken to Control Pollution and Improve Environmental Quality”

**b. Forest Wildlife & Fisheries Department** is undertaking the followings initiatives for air quality management practices i.e. Tree planting along ROW Ghazi Barotha Hydro Project; Establishment of Kundian Forest Park; Development of Pabbi National Park; Construction of Forest Complex at Ravi Road; Lahore, Establishment of Dargai Gill Forest Park; Afforestation along Vehari Burewala D.M. Road to Railway Crossing VChowk Vehari; Eco Conservation / Preservation of Lal Sohanra National Park Bahawalpur; Ten Billion Tree Tsunami Programme (Phase-I) Up-Scaling of Green Pakistan Programme (Revised); Upgradation / Rehabilitation of Chichawatni Forest and Wildlife Park District Sahiwal; Restoration of Forest Landscape Ecosystem Through Community Participation (PPP Mode); Endowment Fund for Development of National Parks; and Wetlands, Ecotourism sites and Safari Parks.

**c. Industries Commerce & Investment Department** is undertaking the followings initiatives for air quality management practices i.e., Establishment of a New Small Industrial Estate in Gujrat, Cluster Development Initiative; Pilot/Demonstration Resource Efficiency & Cleaner Production Investments in key Industrial Sectors (PGDP, DLI 7); Establishment of SIE DG Khan; Infrastructure Development (Civil Woks) of Quidad-e-Azam Business Park; and Development of Bahawalpur Industrial Estate – PIEDMC. Punjab Small Industries Department Under the scheme titled as “Pilot Demonstration Resource Efficiency & cleaner Production Investments in key Industrial Sectors (PGDP / DLI-7), funds amounting to Rs. 1795.978 have been allocated for RECP technology purpose, out of which Program Delivery Unit (PDU), PSIC is going to recommend funds amounting to Rs. 400.00 million each of Steel re-rolling, Steel Furnaces and Rice husking industry. It is also proposed that under the proposed scheme, loan amounting to Rs. 100.00 million will be offered to industrial units on conducive terms for adoption of RECP technology/machinery/equipment.

**d. Transport Department** is undertaking the followings initiatives for air quality management practices i.e., Procurement of 200 Eco Friendly Urban Buses for Major Cities of Punjab (DLI-6 Punjab Green Development Program); Consultancy Studies for Induction of Eco-Friendly Buses in Cities of Punjab; and Expansion of Inspection and Certification System for Motor Vehicles (DLI-6 Punjab Green Development Program).

**e. Excise Taxation, and Narcotics Control Department** has started registration of electrical vehicles in Punjab.

**f. Agriculture Department** introduced mechanized management of rice crop residue. This process will be



meant to provide 10,000 Pak Seeders, 10,000 Rice straw Choppers and 500 Rice Combine Harvesters (Head Feed) to Farmers /Service Providers on subsidized rate (60:40). The Project period would be spread over five years i.e., 2022-23 to 2026-27. The total financial implication of the instant proposed project would be around Rs. 19,783 million out of which Rs. 11,870 million would be the Government share, while Rs. 7,913 would be provided by farmers /Service Providers.

**g. PHA Lahore** estimate for development of 223.8 Canals area of Miyawaki Urban Forests in the different areas of Lahore City has been proposed along with tree plantation campaign and tree washing activities through water lorries.

**h. Lahore Electric Supply Company** is already expanding the Smart Grid System through induction of (Solar) Electric Energy into the system by providing Net Metering connections to consumer on regular basis within shortest possible time.

**i. Lahore Waste Management Company (LWMC)** is actively and effectively doing the activity of vacuum cleaning and along with these roads daily from 1100 pm onward till the completion of activity. The specifics of vacuum cleaning along these roads are presented below:

- Canal Road
- Jail Road (Main Boulevard to Jinnah Hospital (Approx 08 km on each side)
- Ferozpur Road (Muslim Town Morh to Qainchi Morh)

In addition of these aforementioned areas LWMC teams also set the daily target of vacuum cleaning of approximately 800 km distance. This activity is being performed almost on all main roads from 1100 pm till completing its daily target of 800 km.

Further, LWMC team is also carrying out the activities of lifting and disposal of garbage along these aforementioned roads. During waste lifting LWMC sanitary workers efficiently do the manual sweeping and clean the spreading of waste along these roads. The activities of waste lifting & disposal are being performed daily in three shifts. Additionally, LWMC team does the special activity of waste cleaning in the funnel area of Lahore airport to diminish the incidents of bird hazard. Moreover, LWMC had already established anti-smog squad. The foremost responsibility of anti-smog squad is washing of the main roads with mechanical washers. Mechanical washing is performed around the clock alongside the main roads. These actions will also be useful in mitigating the issue of Air Pollution.

**j. Energy Department** is undertaking the following initiative as air quality management practices i.e. Installation of Biogas Plant for Gujjar Colony, Provision of Biogas Digesters in Villages, Converting three Cities of Punjab into Solar Smart Cities, Energy Efficiency & Conservation Programme (PGDP, DLI-5), Installation of 2.5 MW Solar Photovoltaic Power Plant at Islamia University Bahawalpur (ACEIP, DLI-2), Raising & Strengthening of Gunda Bund near Maddokana Guide Wall Spur, Distribution of 1-Kw solar systems to poor population of Punjab based on BISP data, Feasibility Study for Solar Projects on Canal Top and Urban Nullahs, Energy Solution Using Indigenous Resources In villages, Renewable Energy Development Sector Investment Programme (REDSIP), Khadim-e-Punjab Ujala Program (South Punjab)(ACEIP, DLI-1,2,3,4), Feasibility Study for Solarization of Courts and District Session Courts of Punjab, Development of Renewable Energy Initiatives, Setting up Solar Tube wells in Water Logged Areas of Punjab, Improvement of Energy Efficiency in WASA Systems, Establishment of Waste



to Energy Fund to meet Financial Viability Gap for Waste to Energy Projects in Punjab, and Development of Lift Irrigation Systems using Solar Energy.

Furthermore, Energy Department is in the process of Solarisation of Institutes of Cardiology, 100 Higher Secondary Schools in Punjab, 35 Tehsil Headquarter Hospitals and 100 Rural health Care centres & installation of B.E.S.S, schools for differently abled children, Commissioners Complexes, Public Institutes (Phase-II), Tubewells in Punjab, Punjab Institute of Mental Health (PIMH) (All Branches), Basic Health Units (Phase-I) (ACEIP, DLI-2,3), Basic Health Units (Phase-II) (ACEIP, DLI-2,3), and Public Sector Buildings.

### 2.6 Conclusions

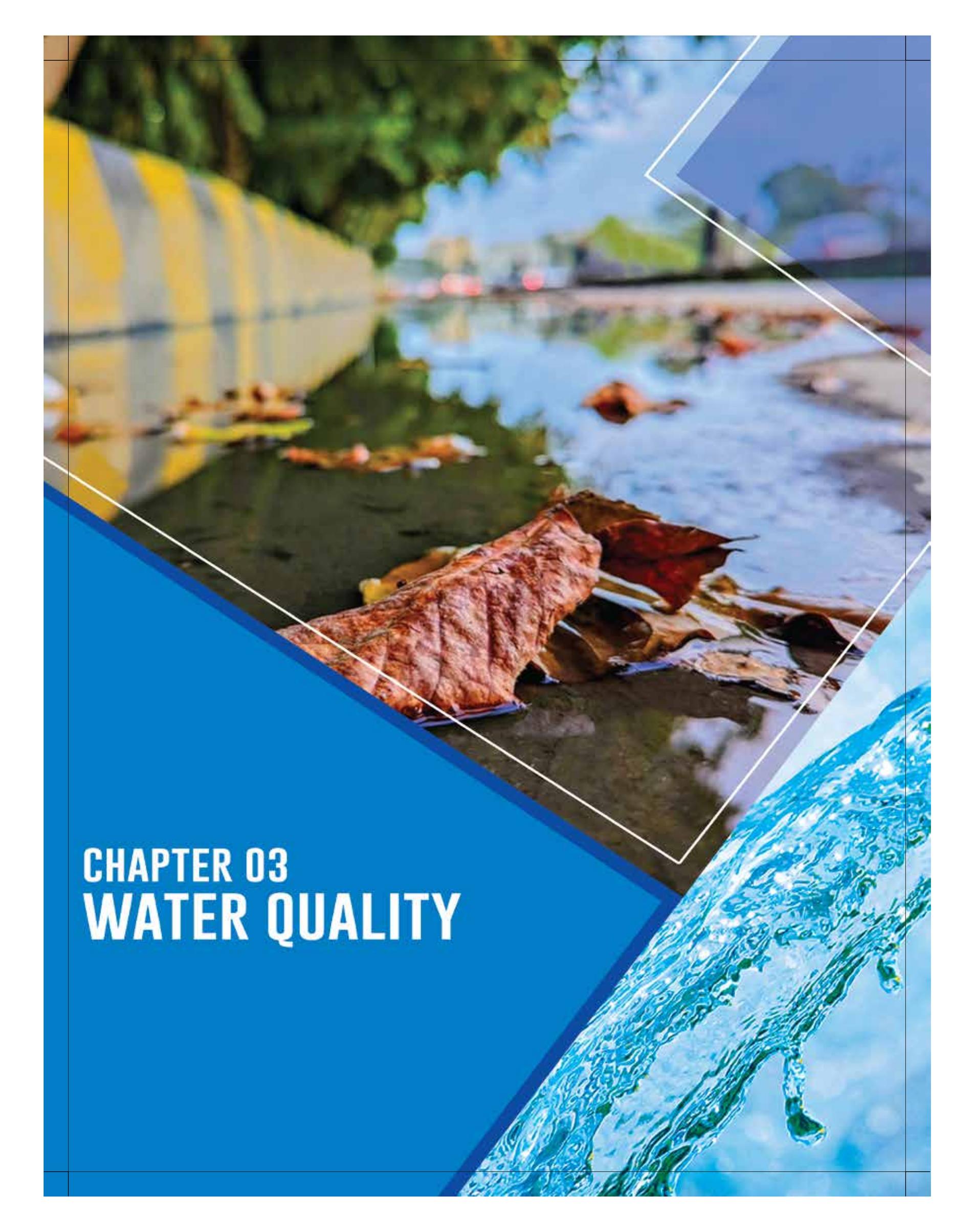
Though the Act ibid provides regulatory framework for the Air, but it does not suffice owing to the voluminous increase in industrial establishments and vehicles. Multiple legal instrument and policy documents are required to curb down the air pollution in holistic manner. Due to complex environmental issues, latest developments in industrialization and more profound air quality deterioration requires enactment of a new regulatory framework preferably a statutory framework for fighting with the menace of air pollution. Furthermore, the air quality monitoring systems presently installed in the Punjab are not as per the requirement of USEPA air quality networks for identifying the prevailing air quality. Furthermore, there is a limited operational capacity for measurement of criteria pollutants in the installed AQMS. All the criteria pollutants are not been analyzed resulting in, an incomplete picture of air quality monitoring in Punjab. There is a dire need to augment both installation of more air quality monitoring stations as well as carrying out an apportionment study for right identification of problem and for taking an informed decision regarding it. Now, the monitoring stations are pre dominantly installed and operated in the vicinity of Lahore. The value of ambient air quality remains higher in Punjab than the prescribed limits in the Punjab Environmental Quality Standards.

The quantum of industrial establishments and their pollution load is not known. There is a need, primarily, to quantify the total number of establishments in the Punjab contributing towards the air pollution. Furthermore, the pollution load of every establishment has to be identified. Now it is the time to move ahead regarding installation of continuous emissions monitoring systems linked with the EPA Punjab for regulatory compliance. The increase in vehicular pollution requires a certain action both requiring the increase in public transportation as well as strengthening of vehicular inspection certification system. It also requires the adoption of latest Euro Standards for emission and vehicle manufacturing. Noise pollution is the most neglected area in the environmental governance in the Punjab. This aspect has to be strengthened in order to meet with the emerging scenarios of noise pollution. It has to be measured in the urban centers and then findings ways to mitigate it.

The environmental governance, for betterment of air quality, lacks the Climate Change Policy, Clean Air Act, Policy & Action Plan, Anti-Smog Rules and pollutant release and transfer register. In the same analogy, the Energy Department may go for notification of certification and labeling system for green/energy saving products, energy conservation standards for newly built urban building and industrial establishment and energy saving renovation/retrofitting in existing building for improve energy efficiency.

Interventions needs to be carried out with regards to the industrial establishment in the Punjab starting from Geo tagging of industries to the implementation of resource efficiency and cleaner production technologies to the introduction of carbon neutrality regime and financial assistance to green micro-enterprises. Furthermore, fugitive dust is a major source to be addressed for the betterment of air quality.

Government departments are taking some measures to improve the air quality. Due to higher value of air pollution further more actions are required on the part of the Government departments for betterment of the air quality.

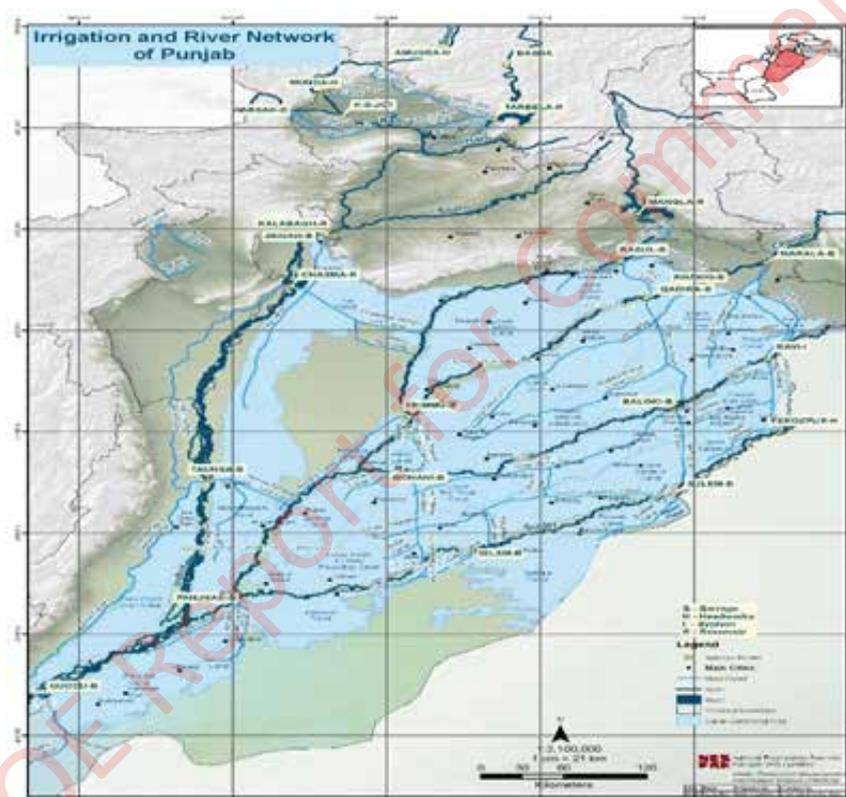
The image is a composite graphic. The top portion shows a stream with brown leaves floating in the water, reflecting a yellow and white striped barrier on the left. A blue geometric shape, consisting of a large triangle and a smaller trapezoid, is overlaid on the right side. The bottom-left corner of this blue shape contains the text 'CHAPTER 03 WATER QUALITY'. The bottom-right corner of the image shows a close-up of clear blue water splashing upwards.

**CHAPTER 03**  
**WATER QUALITY**

### 3. CHAPTER THREE

#### 3.1 Water Quality

Surface water-resources of Pakistan are mainly based on the flows of the Indus River and its tributaries. The Indus River has a total length of 2900 kilometres (Km) and the drainage-area is about 966,000 sq. Km. Five major tributaries joining its eastern side are Jhelum, Chenab, Ravi, Beas and Sutlej; besides, three minor tributaries are the Soan, Harow, and Siran, which drain in mountainous areas. Several small tributaries also join the Indus towards its western side. The biggest of such tributaries is River Kabul (Figure 19).



**Figure 19:** Irrigation and River Network of Punjab

Pakistan is limited to the three western rivers, namely Indus, Jhelum and Chenab, while India is entitled to divert flows of Ravi, Beas and Sutlej. This treaty also provided for the construction of several link canals, barrages and dams on the Indus and its two tributaries, Jhelum and Chenab, transferring at least 20 MAF of water for the irrigation of areas that were cut off from irrigation-systems of rivers Ravi, Sutlej and Beas after the Indus Basin Treaty.

Data shown (Figure 20) indicate that canal withdrawals in 1000 Cusec gradually increasing from 1st of April to May 30 in Jhelum-Chenab(J-C) and Indus zone for kharif period of 2022. In the month of June at start, water flow rates are dipped but from mid of June to end of June value of water flow rate got their range as per that



was end of May and then in July and August it gradually increases except the end of July and start of August. At the end of August for J-C it has the peak water flow rate while for Indus the peak water flow rate can be shown during July 11-20 period. The J-C zone water flow rate is shown in blue color line in chart which can be shown as smooth increment to getting it peak at end of August. While Indus zone distribution is shown in red line in chart which has its dipped in July 21-31.

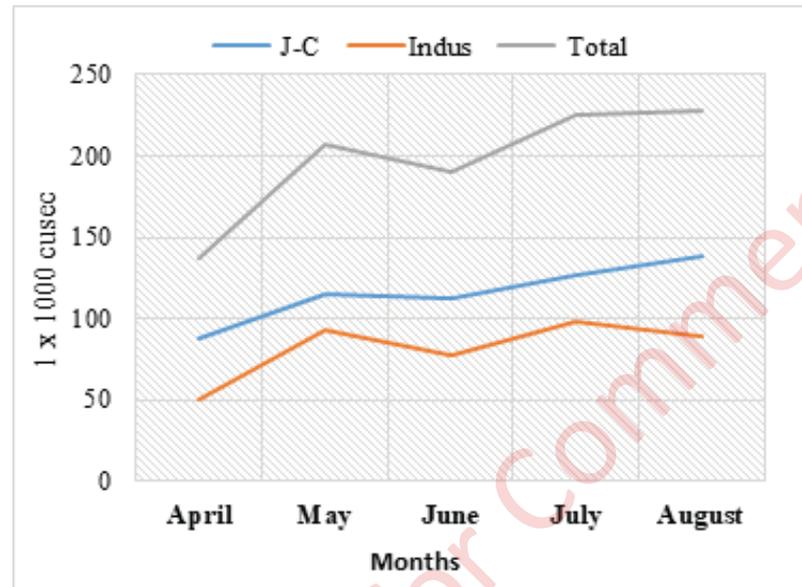


Figure 20: Canal Withdrawals (Apr, 22 to Aug, 22)

The graph for River Flows at Rim Stations for the year 2022 (in MAF) (Figure 21) shows the flows at these locations. The maximum value of River Flows was observed for River Indus in the month of August which is 14.75 whereas the lowest value was observed as 0.3 for the Kabul River in the month of February. The average value of river flows for the Indus River, Kabul River, Jhelum River, and Chenab River was found to be 4.69, 1.58, 1.35, and 1.78 respectively.

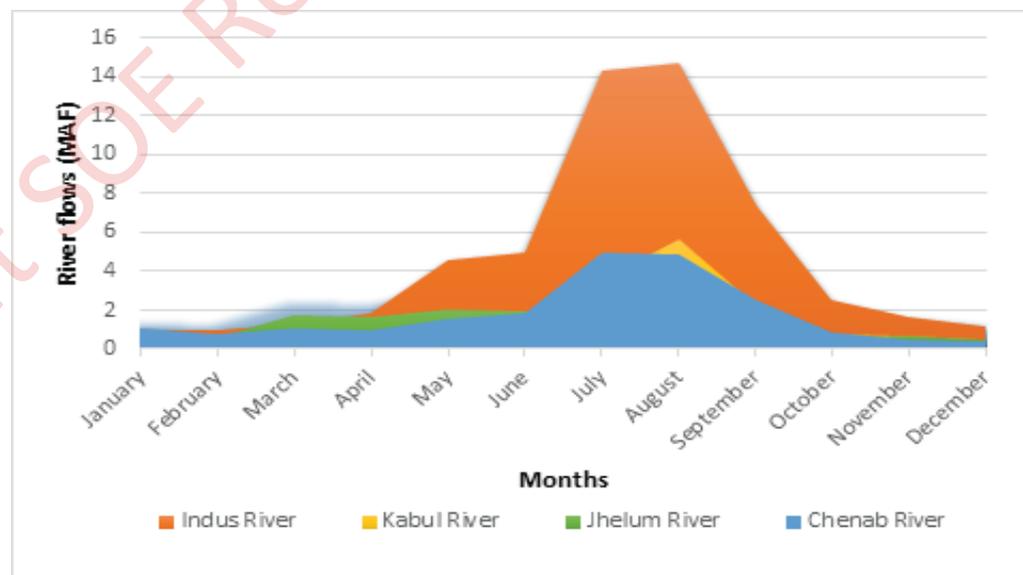


Figure 21: River Flows (MAF)



## 3.2 Regulatory Framework

The Punjab Environmental Protection Act, 1997 (XXXIV of 1997) is an Act to provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. The environment is defined § 2(x) of the Act *ibid* and means (a) air, water and land;(b) all layers of the atmosphere;(c) all organic and inorganic matter and living organisms;(d) the ecosystem and ecological relationships;(e) buildings, structures, roads, facilities and works;(f) all social and economic conditions affecting community life; and(g) the inter-relationships between any of the factors in sub-clauses (a) to (f). The Act *ibid* defined pollution § 2(xxxiii) which means the contamination of air, land or water by the discharge or emission of effluents or wastes or air pollutants or noise or other matter which either directly or indirectly or in combination with other discharges or substances alters unfavorably the chemical, physical, biological, radiational, thermal or radiological or aesthetic properties of the air, land or water or which may, or is likely to make the air, land or water unclean, noxious or impure or injurious, disagreeable or detrimental to the health, safety, welfare or property of persons or harmful to biodiversity;

The Act *ibid* further emphasized the effluent § 2 (viii) which means any material in solid, liquid or gaseous form or combination thereof being discharged from individual activity or any other source and includes a slurry, suspension or vapour. In addition to gauge the pollution levels the Agency must notify emission standards as defined § 2(ix) of the Act *ibid*. Furthermore, standards have also been defined § 2(xli) of the Act *ibid* which means qualitative and quantitative standards for discharge of effluents and wastes and for emission of air pollutants and noise either for general applicability or for a particular area, or from a particular production process, or for a particular product, and includes the Punjab Environmental Quality Standards, emission standards and other standards established under this Act and the rules and regulations made there under.

Function of the Agency § 6(1) of the Act *ibid* is to establish standards for the quality of the ambient air, water and land, by notification in the official Gazette and § 6 (h) is to take samples of any materials, products, articles or substances or of the effluents, wastes or air pollutants being discharged or emitted or of air, water or land in the vicinity of the discharge or emission. Furthermore, the Act *ibid* § (11) impose prohibition of certain discharges or emission of any effluent or waste in an amount, concentration or level which is in excess of the Punjab Environmental Quality Standards or, where applicable, the standards established under clause (g) of sub-section (1) of section 6.

The Act *ibid* provides a mechanism against the violators of the Act *ibid* through issuance of Environmental Protection Order § (16). Whoever contravenes or fails to comply with the provisions of sections 16 or any order issued thereunder shall be punishable with fine which may extend to five million rupees, and in the case of a continuing contravention or failure, with an additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues and where such contravention or failure continues.

The Punjab Environmental Quality standards were approved by the Punjab Environmental Protection Council in exercise of the powers conferred under clause (C) of sub-section (1) of section 4 of the Act *ibid*. Environment protection department notified the standards pertaining to Municipal and liquid Industrial effluent, Drinking water and Treatment of Liquid and Disposal of Bio-medical Waste by Incineration, Autoclaving, Microwaving, and Deep Burial.



### 3.3 Assessment of Water Quality

With no water quality monitoring stations installed by the EPA Punjab, the assessment of water quality may not be made in a direct manner. The EPA has so far not been able to collect a sufficient amount of pollution data to give meaningful estimates on the evolution of surface water quality in Punjab. Therefore, monitoring data from the other departments was requested to abridge this gap. In the following paragraphs data from PCRWR and WASAs have been added.

#### a. Assessment of Rivers, Drains and Ground Water:

The Pakistan Council of Research in Water Resources (PCRWR) gathers data on water channels throughout the province of Punjab, through their periodic monitoring of various biochemical indicators. Data collected through their monitoring network for the year 2022 – January to November – is analysed below. This monitoring data comprised of one sample reading taken per month on-site for the duration of the monitoring period. The water channels are classified into 2 main categories, namely surface water – comprised of rivers and drains – and groundwater – including both shallow and deep samplings thereof. The water channels are originated from the India and a transboundary effect of pollution in liquid effluent has been noted. Collated summary of the overall bio-physico-chemical scenario in the aforementioned types of water sources is provided in Table 13 below:

**Table 13:** Summary of Biochemical Indicators<sup>26</sup>

| S#  | Site- ID               | Alk.  | HCO      | Ca     | Cl     | EC       | Hrd.     | Mg     | pH   | K    | SO <sub>4</sub> | Na     | TDS      | Tur.  | N     | As    | COD    | BOD    | T.C.  | F.C.  | E.Coli | R   |
|-----|------------------------|-------|----------|--------|--------|----------|----------|--------|------|------|-----------------|--------|----------|-------|-------|-------|--------|--------|-------|-------|--------|-----|
| S-R | Surface-water: Rivers  | 3.85  | 192.27   | 39.32  | 48.62  | 615.52   | 175.86   | 18.85  | 7.42 | 1.66 | 63.55           | 71.91  | 372.97   | 13.90 | 2.94  | 6.41  | 126.48 | 69.41  |       |       |        | A   |
|     |                        | 1.66  | 83.08    | 13.69  | 35.21  | 278.96   | 61.04    | 7.40   | 0.29 | 0.60 | 26.76           | 40.73  | 169.82   | 7.89  | 1.06  | 0.88  | 35.84  | 18.71  |       |       |        | D   |
|     |                        | 17.20 | 860.00   | 140.00 | 304.00 | 2,560.00 | 645.00   | 79.58  | 8.50 | 6.00 | 310.00          | 410.00 | 1,731.36 | 36.00 | 14.40 | 11.25 | 366.00 | 238.00 |       |       |        | X   |
|     |                        | 1.20  | 60.00    | 17.00  | 8.00   | 190.00   | 75.00    | 4.86   | 6.63 | 0.80 | 12.00           | 19.00  | 124.87   | 5.10  | 0.49  | 0.00  | 26.00  | 8.00   |       |       |        | N   |
| S-D | Surface-water: Drains  | 11.91 | 595.63   | 90.90  | 176.07 | 2,049.68 | 444.30   | 52.74  | 7.47 | 3.75 | 187.76          | 274.42 | 1,204.36 | 18.15 | 13.71 | 9.50  | 504.93 | 280.05 |       |       |        | A   |
|     |                        | 3.32  | 165.79   | 19.01  | 38.78  | 434.56   | 107.69   | 24.55  | 0.20 | 2.83 | 44.79           | 64.04  | 246.00   | 11.93 | 1.61  | 2.15  | 89.33  | 45.46  |       |       |        | D   |
|     |                        | 42.20 | 2,110.00 | 262.00 | 622.00 | 5,660.00 | 1,280.00 | 198.65 | 8.10 | 8.00 | 590.00          | 866.00 | 3,417.22 | 47.20 | 43.31 | 25.00 | 997.00 | 482.00 |       |       |        | X   |
|     |                        | 1.40  | 70.00    | 20.00  | 8.00   | 275.00   | 80.00    | 2.43   | 6.59 | 0.60 | 18.00           | 23.00  | 162.02   | 2.50  | 1.15  | 2.20  | 88.00  | 47.00  |       |       |        | N   |
| S   | Surface-water: Overall | 9.22  | 461.17   | 73.70  | 133.59 | 1,571.63 | 354.82   | 41.45  | 7.45 | 3.06 | 146.36          | 206.92 | 927.23   | 16.73 | 10.12 | 8.47  | 378.78 | 209.83 |       |       |        | A   |
|     |                        | 2.64  | 132.07   | 14.51  | 31.70  | 351.11   | 87.64    | 18.37  | 0.22 | 0.56 | 31.95           | 52.50  | 208.38   | 10.29 | 1.16  | 1.22  | 69.21  | 35.84  |       |       |        | D   |
|     |                        | 42.20 | 2,110.00 | 262.00 | 622.00 | 5,660.00 | 1,280.00 | 198.65 | 8.50 | 8.00 | 590.00          | 866.00 | 3,417.22 | 47.20 | 43.31 | 25.00 | 997.00 | 482.00 |       |       |        | X   |
|     |                        | 1.20  | 60.00    | 17.00  | 8.00   | 190.00   | 75.00    | 2.43   | 6.59 | 0.60 | 12.00           | 19.00  | 124.87   | 2.50  | 0.49  | 0.00  | 26.00  | 8.00   |       |       |        | N   |
| G-S | Groundwater: Shallow   | 5.80  | 289.89   | 54.92  | 68.58  | 940.99   | 240.02   | 24.96  | 7.63 | 2.23 | 101.47          | 113.78 | 544.14   | 6.26  | 0.82  | 16.98 |        |        | 6.01  | 2.44  | -ve    | A   |
|     |                        | 0.66  | 32.89    | 10.61  | 15.88  | 147.98   | 28.52    | 8.40   | 0.23 | 0.49 | 22.31           | 26.07  | 78.28    | 4.41  | 0.17  | 4.36  |        |        | 2.26  | 1.39  | -ve    | D   |
|     |                        | 12.20 | 610.00   | 147.00 | 273.00 | 2,590.00 | 560.00   | 70.47  | 8.50 | 6.00 | 356.00          | 398.00 | 1,427.90 | 28.50 | 5.30  | 48.56 |        | 0.00   | 31.00 | 15.00 | -ve    | X   |
|     |                        | 1.00  | 50.00    | 17.00  | 6.00   | 284.00   | 90.00    | 1.22   | 6.53 | 0.00 | 10.00           | 24.00  | 174.99   | 0.30  | 0.00  | 5.00  |        | 0.00   | 0.00  | 0.00  | 0.00   | +ve |
| G-D | Groundwater: Deep      | 5.85  | 292.61   | 49.43  | 45.26  | 821.73   | 229.15   | 25.65  | 7.58 | 2.00 | 89.63           | 97.94  | 489.72   | 5.16  | 0.97  | 15.88 |        |        | 0.95  | 0.25  | -ve    | A   |
|     |                        | 1.08  | 53.94    | 11.14  | 14.22  | 169.84   | 39.50    | 7.57   | 0.23 | 0.56 | 31.04           | 26.47  | 98.44    | 3.67  | 0.17  | 1.23  |        |        | 1.35  | 0.62  | -ve    | D   |
|     |                        | 17.20 | 860.00   | 124.00 | 260.00 | 3,040.00 | 710.00   | 117.86 | 8.55 | 7.00 | 330.00          | 440.00 | 1,749.45 | 25.30 | 4.54  | 43.25 |        | 0.00   | 34.00 | 16.00 | -ve    | X   |
|     |                        | 1.40  | 70.00    | 15.00  | 4.00   | 220.00   | 80.00    | 2.43   | 6.60 | 0.20 | 15.00           | 20.00  | 147.80   | 0.30  | 0.04  | 2.05  |        | 0.00   | 0.00  | 0.00  | 0.00   | +ve |
| G   | Groundwater: Overall   | 5.83  | 291.25   | 52.18  | 56.92  | 881.36   | 234.59   | 25.31  | 7.60 | 2.12 | 95.55           | 105.86 | 516.93   | 5.71  | 0.90  | 16.43 |        |        | 3.48  | 1.34  | -ve    | A   |
|     |                        | 0.56  | 28.10    | 9.14   | 13.26  | 102.62   | 26.83    | 7.61   | 0.22 | 0.46 | 17.10           | 15.97  | 55.50    | 3.88  | 0.08  | 2.78  |        |        | 1.45  | 0.84  | -ve    | D   |
|     |                        | 17.20 | 860.00   | 147.00 | 273.00 | 3,040.00 | 710.00   | 117.86 | 8.55 | 7.00 | 356.00          | 440.00 | 1,749.45 | 28.50 | 5.30  | 48.56 |        | 0.00   | 34.00 | 16.00 | -ve    | X   |
|     |                        | 1.00  | 50.00    | 15.00  | 4.00   | 220.00   | 80.00    | 1.22   | 6.53 | 0.00 | 10.00           | 20.00  | 147.80   | 0.30  | 0.00  | 2.05  |        | 0.00   | 0.00  | 0.00  | 0.00   | +ve |
| O   | Overall                | 7.28  | 364.07   | 61.40  | 89.78  | 1,177.19 | 286.11   | 32.22  | 7.54 | 2.52 | 117.32          | 149.17 | 692.77   | 10.43 | 4.85  | 13.02 | 378.78 | 209.83 | 3.48  | 1.34  | -ve    | A   |
|     |                        | 1.33  | 66.46    | 11.02  | 20.47  | 192.91   | 50.14    | 11.58  | 0.22 | 0.48 | 19.89           | 28.47  | 112.59   | 5.17  | 0.47  | 1.11  | 69.21  | 35.84  | 1.45  | 0.92  | -ve    | D   |
|     |                        | 42.20 | 2,110.00 | 262.00 | 622.00 | 5,660.00 | 1,280.00 | 198.65 | 8.55 | 8.00 | 590.00          | 866.00 | 3,417.22 | 47.20 | 43.31 | 48.56 | 997.00 | 482.00 | 34.00 | 16.00 | -ve    | X   |
|     |                        | 1.00  | 50.00    | 15.00  | 4.00   | 190.00   | 75.00    | 1.22   | 6.53 | 0.00 | 10.00           | 19.00  | 124.87   | 0.30  | 0.00  | 0.00  | 26.00  | 8.00   | 0.00  | 0.00  | 0.00   | +ve |

<sup>26</sup>The following abbreviations are employed herein:

Alk. (Alkalinity), HCO<sub>3</sub> (Bicarbonates), Ca (Calcium), Cl (Chlorides), EC (Electrical Conductivity), Hrd. (Hardness), Mg (Magnesium), pH (Potential Hydrogen Scale), K (Potassium), SO<sub>4</sub> (Sulphates), Na (Sodium), TDS (Total Dissolved Solids), Tur. (Turbidity), N (Nitrates), As (Arsenic), COD (Chemical Oxygen Demand), BOD (Biochemical Oxygen Demand), T.C. (Total Coliform), F.C. (Fecal Coliform), E.Coli (E. Coli Presence), R (Results), A (Average), D (Dispersion), X (Maximum), N (Minimum), T (Trend)



### i). Surface-water – Rivers

PCRWR collects data pertaining to 2 rivers, Ravi and Sutlej. A summary of the biochemical characteristics of the water channels at the designated source points is depicted in the table below. We can also see where water quality at these points exceeds permissible limits as gauged against USEPA guidelines, wherein apart from pH, chlorides (mostly), TDS (mostly) and nitrates, the rest do not comply with the permissible limits.

Data for River Ravi is collected at 3 points during its flow, namely at Siphon (Lahore), Manga Mandi and Checha Watni. It can be seen that most of the indicators portray a deteriorating trend as the year progresses on, thereafter exhibiting a gradual increasing trend. Bicarbonates, chlorides, magnesium and total dissolved solids remain mostly stable near the end of the year. Moreover, as the river progresses along its trajectory, almost all indicators depict an increasing trend from River Ravi @ Siphon River Ravi @ Manga Mandi followed by a decreasing trend as the River Ravi flows onwards as monitored at Checha Watni. This is presumably due to the fact that a number of drains fall into the river around the point thereby polluting it to high levels. As the river proceeds onwards during its flow, it starts getting “cleaner” as “moving water dilutes and decomposes pollutants more rapidly than standing water”<sup>27</sup> over a wide length. Thus, at River Ravi @ Checha Watni, the river is considerably less polluted despite the fact that a few drains have spilled wastewater into it owing to the aforementioned phenomenon and the length involve therein.

In addition to these intra-river aspects, there are also significant differences between the two rivers, Ravi (averaged on the 3 collection points) and Sutlej, with the former faring higher on all measured fronts apart from pH levels. A correlation vector between the two rivers highlights that apart from Mg, K, N and As (which is strongly negatively related), the other parameters are moderately to strongly associated between the two water bodies. This may indicate that the river characteristics vary similarly Table 14.

**Table 14: Biochemical Indicator Summary of Punjab's Rivers - Ravi and Sutlej**

| Site- ID ↓                                  | Alk. | HCO <sub>3</sub> | Ca    | Cl     | EC       | Hrd.   | Mg    | pH   | K    | SO <sub>4</sub> | Na     | TDS    | Tur.  | N    | As     | COD    | BOD    |
|---|------|------------------|-------|--------|----------|--------|-------|------|------|-----------------|--------|--------|-------|------|--------|--------|--------|
| Monitoring Guidelines (USEPA)               | 20   |                  |       | 45     |          |        |       | 6.5  |      |                 |        | <500   |       | <10  |        | <100   | <10    |
| (Min → Max) →                               | 200  |                  |       | 155    |          |        |       | 9.0  |      |                 |        | <500   |       | <10  |        | <100   | <10    |
| <b>River Ravi - Sample Collection Point</b> |      |                  |       |        |          |        |       |      |      |                 |        |        |       |      |        |        |        |
| Ravi Siphon (Lahore)                        | 3.55 | 177.73           | 39.36 | 46.62  | 550.73   | 162.73 | 15.63 | 7.30 | 1.65 | 40.00           | 54.45  | 315.31 | 15.15 | 2.28 | 3.52   | 119.64 | 59.24  |
| Manga Mandi Lahore (Ravi River)             | 6.49 | 324.55           | 71.00 | 122.65 | 1,307.09 | 319.82 | 34.58 | 7.32 | 2.71 | 170.18          | 175.91 | 808.73 | 14.09 | 7.99 | 7.15   | 239.09 | 140.27 |
| Ravi River (Checha Watni)                   | 2.39 | 119.55           | 23.55 | 11.47  | 274.00   | 100.91 | 10.22 | 7.45 | 1.02 | 20.91           | 26.64  | 169.18 | 12.49 | 0.83 | 5.74   | 63.00  | 32.62  |
| River - Overall                             | 4.15 | 207.27           | 44.64 | 60.25  | 710.61   | 194.48 | 20.14 | 7.36 | 1.79 | 77.03           | 85.67  | 431.07 | 13.91 | 3.70 | 5.47   | 140.58 | 77.38  |
| River - Dispersion                          | 2.11 | 105.65           | 24.16 | 56.83  | 534.78   | 112.86 | 12.79 | 0.08 | 0.85 | 81.23           | 79.38  | 335.12 | 1.34  | 3.78 | 1.83   | 89.89  | 56.07  |
| River - Trend                               |      |                  |       |        |          |        |       |      |      |                 |        |        |       |      |        |        |        |
| <b>Sutlej River (Kasur)</b>                 |      |                  |       |        |          |        |       |      |      |                 |        |        |       |      |        |        |        |
| Sutlej River (Kasur)                        | 2.95 | 147.27           | 23.36 | 13.75  | 330.27   | 120.00 | 14.97 | 7.63 | 1.25 | 23.09           | 30.64  | 198.67 | 13.85 | 0.67 | 9.25   | 84.18  | 45.50  |
| OVERALL - Average                           | 3.55 | 177.27           | 34.00 | 37.00  | 520.44   | 157.24 | 17.55 | 7.49 | 1.52 | 50.06           | 58.15  | 314.87 | 13.88 | 2.19 | 7.36   | 112.38 | 61.44  |
| OVERALL - Dispersion                        | 0.85 | 42.43            | 15.04 | 32.88  | 268.94   | 52.67  | 3.66  | 0.19 | 0.38 | 38.14           | 38.91  | 164.33 | 0.04  | 2.14 | 2.67   | 39.88  | 22.54  |
| Correlation                                 | 0.46 | 0.46             | 0.37  | 0.68   | 0.71     | 0.42   | 0.20  | 0.53 | 0.12 | 0.36            | 0.63   | 0.61   | 0.88  | 0.26 | (0.79) | 0.64   | 0.63   |

### ii). Surface-water – Rivers

As expected, drains fare far worse than their fresh water counterparts – rivers – (and groundwater as well) on almost all biochemical indicators (except pH, which remains relatively constant). Madvana Drain (Toba Tek Singh) fared worst in most parameters except for Cl (Rangy Wala), EC (Sukhrawa), pH (Rangy Wala), Sodium (Rangy Wala), TDS (Sukhrawa), Turbidity (Rangy Wala), Nitrates (Sukhrawa), Arsenic (Shahdra) and COD/BOD levels (both Shahdra). Upper Chenab Drain (Sharqpur) reported the least values for all indicators, in general. Summary and detailed analyses are provided in Tables 1 and 3 respectively.



### iii). Groundwater Samplings

Generally, the data depicted that shallow groundwater samples fared similar to deep ones on most indicators. There were considerable observed differences in a few indicators; however, employing F-Test for statistical differences, it was found that only arsenic and total coliform levels differed significantly for the two sample sources. In general, water quality of shallow groundwater samplings presented more exceeding values than their deep counterparts. The latter provided higher ratings in alkalinity, HCO<sub>3</sub>, Mg, N, COD and BOD; for all other parameters, shallow groundwater samplings had a higher rated outcome. In terms of the largest parameter values, Khudpur Drain G/W (Deep) [Alk., HCO<sub>3</sub>], Sukhrawa Drain (Sahiwal) G/W (Shallow) [Ca], Madvana Drain (Toba Tek Singh) G/W (Shallow) [Cl, SO<sub>4</sub>, N], Sukhrawa Drain (Sahiwal) G/W (Deep) [EC, Hrd., Mg, Na, TDS], Rangy Wala Drain (Kasur) G/W (Deep) [pH], Madvana Drain (Toba Tek Singh) G/W (Deep) [K, TC, FC], Babu Sabu Drain (Lahore) G/W (Shallow) [Tur.] and Shahdra Drain (Lahore) G/W (Shallow) [As] reported the highest parameter readings for the respective parameters. In terms of E. Coli presence, Shahdra Drain (Lahore) G/W (Shallow), Sukhrawa Drain (Sahiwal) G/W (Shallow) and Upper Chenab Drain (Sharqpur) G/W (Shallow) reported presence thereof in 6 of the 11 months monitored for by PCRWR, followed by Babu Sabu Drain (Lahore) G/W (Shallow) [3 times]. On the other front, Rangy Wala Drain (Kasur) G/W (Shallow) [Alk., HCO<sub>3</sub>], Sukhrawa Drain (Sahiwal) G/W (Shallow) [Ca, pH], Babu Sabu Drain (Lahore) G/W (Deep) [Cl, Hrd., Tur.], Madvana Drain (Toba Tek Singh) G/W (Deep) [EC, Na, TDS, As], Upper Chenab Drain (Sharqpur) G/W (Shallow) [Mg], Shahdra Drain (Lahore) G/W (Shallow) [K], Haydara Drain Laloo G/W (Shallow) [SO<sub>4</sub>, N] and Rangy Wala Drain (Kasur) G/W (Deep) (and several others) [TC, FC] reported the least values for the respective parameters.

### iv). Inter-linkages

At the outset, it is important to recognize that this dataset is a point/snapshot measurement of the water quality indicators, as measured on a monthly basis by PCRWR for their own purposes. Pollution load and transportation impact analysis necessitates that discharge flow measurement is also undertaken, since it is a joint function of both concentration levels and flow. As depicted in Table 15, most of the indicators depicted mild / moderate associations (both positive and negative, as can be seen) between **drains and shallow groundwater samplings**, hinting at some causal linkage therein originating from the drain sources and seeping into shallow groundwater levels.

**Table 15:** Inter-associations between Key Drains and Adjacent Groundwater Sources

| Matrix of Correlations |       |                  |       |       |       |       |       |      |       |                 |       |       |       |       |       |      |      |      |      |        |
|------------------------|-------|------------------|-------|-------|-------|-------|-------|------|-------|-----------------|-------|-------|-------|-------|-------|------|------|------|------|--------|
| Water Source           | Alk.  | HCO <sub>3</sub> | Ca    | Cl    | EC    | Hrd.  | Mg    | pH   | K     | SO <sub>4</sub> | Na    | TDS   | Tur.  | N     | As    | COD  | BOD  | T.C. | F.C. | E.Coli |
| Drain & Shallow G/W    | -0.43 | -0.43            | -0.23 | -0.31 | -0.40 | -0.36 | -0.14 | 0.33 | -0.22 | -0.16           | -0.36 | -0.40 | 0.04  | -0.38 | 0.21  |      |      | 0.30 | 0.27 | -0.11  |
| Drain & Deep G/W       | 0.07  | 0.07             | 0.00  | 0.07  | 0.08  | 0.12  | 0.21  | 0.27 | -0.03 | 0.06            | 0.09  | 0.06  | -0.15 | -0.21 | 0.12  |      |      |      |      | -0.20  |
| Shallow G/W & Deep G/W | -0.30 | -0.30            | -0.33 | -0.31 | -0.35 | -0.32 | -0.11 | 0.49 | -0.15 | -0.32           | -0.34 | -0.36 | -0.06 | -0.26 | 0.60  |      |      | 0.11 | 0.13 | -0.30  |
| River (Ravi) & Drain   | 0.74  | 0.74             | 0.24  | 0.49  | 0.68  | 0.76  | 0.76  | 0.87 | 0.44  | 0.29            | 0.74  | 0.79  | 0.90  | 0.07  | -0.60 | 0.85 | 0.65 |      |      |        |

In terms of linkages between **drains and deep groundwater samplings**, all indicators depicted a weak association therein. This may indicate that there is no impact, at least directly, on deep groundwater pollution concentration arising from drain sources.

Furthermore, as depicted above, there is generally weak to mild association between **shallow and deep groundwater samplings** for most of the indicators, implying that their concentration at the shallow level does not greatly impact the deep level (i.e., no significant seepage/layering effects can be reliably inferred from this snapshot). For pH and As indicators, there was mildly strong association therein, implying some 'relation' for these 2 factors. However, since they themselves may dwell upon other indicators, the impact from them alone is mostly inconclusive. They also reported the highest correlation for E. Coli presence, which may hint at a causal linkage therein.

Finally, in the case of assessing relationship between **rivers and drains**, most of the indicators depicted a very strong association therein. This may imply that the drains may have a significant impact on water quality in rivers. However, this may also be attributable to the fact that the most of the samplings from rivers may be downstream/near drain outpouring points.

A structural model was also evaluated given available monthly concentration levels, confirming the same findings **(Error! Reference source not found.)**.

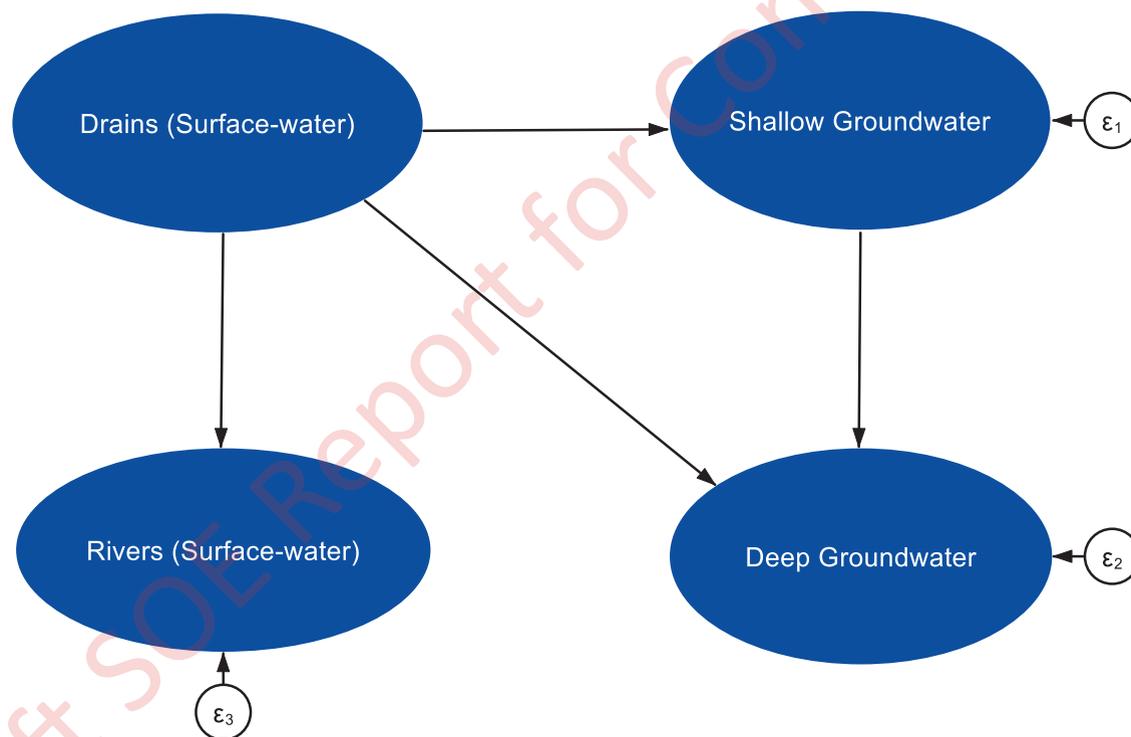


Figure 22: Structural Model for Water Sources

### v). Overall Scenario

A source wise water quality index was formulated, based on the aforementioned indicators as collected by PCRWR. The indicators were grouped under physical, biological and chemical parameter classes, as delineated below in Table 16:



**Table 16:** Physical, Biological & Chemical Parameters

| Physical Parameters  | Biological Parameters  | Chemical Parameters  |
|--|--|--|
| <ul style="list-style-type: none"> <li>• EC (Electrical Conductivity)</li> <li>• TDS (Total Dissolved Solids)</li> <li>• Tur. (Turbidity)</li> </ul> | <ul style="list-style-type: none"> <li>• T.C. (Total Coliform)</li> <li>• F.C. (Fecal Coliform)</li> <li>• E. Coli (E. Coli Presence)</li> </ul> | <ul style="list-style-type: none"> <li>• Alk. (Alkalinity)</li> <li>• HCO<sub>3</sub> (Bicarbonates)</li> <li>• Ca (Calcium)</li> <li>• Cl (Chlorides)</li> <li>• Hrd. (Hardness)</li> <li>• Mg (Magnesium)</li> <li>• pH (Potential Hydrogen Scale)</li> <li>• K (Potassium)</li> <li>• SO<sub>4</sub> (Sulphates)</li> <li>• Na (Sodium)</li> <li>• N (Nitrates)</li> <li>• As (Arsenic)</li> <li>• COD (Chemical Oxygen Demand)</li> <li>• BOD (Biochemical Oxygen Demand)</li> </ul> |

Each indicator values were first standardized so as to assure that absolute magnitudes would not lead to indicator orientation biases. Thereafter, the following rule was applied to obtain a rating of each sampled site:

$$WQI = \frac{1}{3}WQI_P + \frac{1}{3}WQI_B + \frac{1}{3}WQI_C$$

$$\text{wherein } WQI_P = \sum_i^n \frac{1}{n} \cdot P^i, WQI_B = \sum_i^n \frac{1}{n} \cdot B^i \text{ and } WQI_C = \sum_i^n \frac{1}{n} \cdot C^i$$

This analysis led to derived ratings for all the sites sampled by PCRWR. The following (Table 17) depicts these ratings along with a ranking of the sites, grouped by type of water source:

**Table 17:** A Regional Water Quality Index (WQI)

| Sr. No.    | Water Sampling Source                        | WQI Rating Score | Inter-source Ranking | Absolute Ranking |
|------------|--|------------------|----------------------|------------------|
| <b>I</b>   | <b>Surface-water – Rivers</b>                | <b>0.09</b>      | <b>D</b>             | <b>-</b>         |
| 1          | Ravi River (Checha Watni)                    | 0.15             | 1                    | 14               |
| 2          | Manga Mandi Lahore (Ravi River)              | 0.08             | 2                    | 21               |
| 3          | Sutlej River (Kasur)                         | 0.07             | 3                    | 25               |
| 4          | Ravi Siphon (Lahore)                         | 0.05             | 4                    | 26               |
| <b>II</b>  | <b>Surface-water – Drains</b>                | <b>0.23</b>      | <b>A</b>             | <b>-</b>         |
| 5          | Madvana Drain (Toba Tek Singh)               | 0.37             | 1                    | 1                |
| 6          | Rangy Wala Drain (Kasur)                     | 0.37             | 2                    | 2                |
| 7          | Sukhrawa Drain (Sahiwal)                     | 0.28             | 3                    | 3                |
| 8          | Shahdra Drain (Lahore)                       | 0.21             | 4                    | 4                |
| 9          | Khudpur Drain (Lahore)                       | 0.20             | 5                    | 6                |
| 10         | Haydara Drain Laloo (Lahore)                 | 0.18             | 6                    | 9                |
| 11         | Babu Sabu Drain (Lahore)                     | 0.15             | 7                    | 15               |
| 12         | Upper Chenab Drain (Sharqpur)                | 0.07             | 8                    | 22               |
| <b>III</b> | <b>Ground-water – Shallow Sampling</b>       | <b>0.16</b>      | <b>B</b>             | <b>-</b>         |
| 13         | Shahdra Drain (Lahore) G/W (Shallow)         | 0.21             | 1                    | 5                |
| 14         | Upper Chenab Drain (Sharqpur) G/W (Shallow)  | 0.18             | 2                    | 7                |
| 15         | Sukhrawa Drain (Sahiwal) G/W (Shallow)       | 0.18             | 3                    | 8                |
| 16         | Khudpur Drain G/W (Shallow)                  | 0.17             | 4                    | 10               |
| 17         | Madvana Drain (Toba Tek Singh) G/W (Shallow) | 0.16             | 5                    | 11               |
| 18         | Rangy Wala Drain (Kasur) G/W (Shallow)       | 0.15             | 6                    | 13               |
| 19         | Babu Sabu Drain (Lahore) G/W (Shallow)       | 0.13             | 7                    | 16               |
| 20         | Haydara Drain Laloo G/W (Shallow)            | 0.09             | 8                    | 20               |
| <b>IV</b>  | <b>Ground-water – Deep Sampling</b>          | <b>0.09</b>      | <b>C</b>             | <b>-</b>         |
| 21         | Khudpur Drain G/W (Deep)                     | 0.15             | 1                    | 12               |
| 22         | Madvana Drain (Toba Tek Singh) G/W (Deep)    | 0.12             | 2                    | 17               |
| 23         | Haydara Drain Laloo G/W (Deep)               | 0.10             | 3                    | 18               |
| 24         | Sukhrawa Drain (Sahiwal) G/W (Deep)          | 0.10             | 4                    | 19               |
| 25         | Rangy Wala Drain (Kasur) G/W (Deep)          | 0.07             | 5                    | 23               |
| 26         | Upper Chenab Drain (Sharqpur) G/W (Deep)     | 0.07             | 6                    | 24               |
| 27         | Babu Sabu Drain (Lahore) G/W (Deep)          | 0.05             | 7                    | 27               |
| 28         | Shahdra Drain (Lahore) G/W (Deep)            | 0.05             | 8                    | 28               |
|            | <b>Overall</b>                               | <b>0.15</b>      |                      |                  |



We can see from the above table that – as expected – on average the drains score the highest, followed by Ground-water – Shallow Sampling, Ground-water – Deep Sampling and Rivers respectively. In terms of absolute ratings, drains lead the way with Madvana, Rangy Wala and Sukhrawa leading the way. An indicator-wise cartographic trend depiction of all water source sites is depicted in the following graphs. This also confirms the aforementioned analyses wherein the drains usually fare the highest, followed by Ground-water – Shallow Sampling, Ground-water – Deep Sampling and Rivers respectively. Detailed analyses of the collected data are depicted in the summary graph (**Annex-II**). Average alkalinity, Bicarbonates , Calcium , Chlorides, Electrical Conductivity, Hardness, Magnisum, Ph, Potasium, Sulphate,Sodium, TDS, Turbidity, Nitrates, Arsenic, COD, BOD,Total Coliform, Fecal Choliform and E. Coli is given in (**Annex-III**).

## **b. Assessment of Drinking/Ground water quality:**

### **i. District Gujranwala:**

WASA Gujranwala is providing water and sewerage services to 73 urban union councils (93 sq. Km). Water Supply system coverage is 37% whereas the coverage of Sewerage/Drainage System is 70%. Providing safe & healthy water is one of the major functions of WASA Gujranwala. 67 Tube wells and 18 Nos Overhead Reservoirs are contributing to water supply system all over the city Gujranwala. The waste water of the entire city is drained through a network of lateral, branch and trunk sewers into 35 disposal stations and then pumped out for ultimate disposal into Qadirabad Balloki link canal through Mir Shikaran Drain via Main Drain. During 2022, WASA Gujranwala carried out analysis of 1775 water samples (amongst which 605 samples were taken from tube wells and 1170 were from consumer water. All these samples were found fit with regards to physical appearance, odour, taste, color and chemical results. Only 6% of analysis results were found unfit due to positive Micro E.Coli. This complies with the Punjab Environmental Quality Standards for Drinking Water, 2016. Furthermore, the average values of pH, turbidity (NTU), total dissolved solids (ppm), conductivity is 7.42, 0.68, 244.30, 349.17, respectively. The average value of chlorine level remains at 1.27 ppm. The samples analyzed from the source (tube wells) has the higher value of chlorine levels due to dozing of chlorine.

### **ii. District Lahore:**

The main functions of WASA Lahore are planning, designing, development and maintenance of water supply sewerage and draining system in Lahore. Table 19 depicts the services provided by WASA Lahore.



**Table 18:** Services provided by WASA Lahore

|  |                                |
|--|--------------------------------|
| <b>Tube wells</b>  | <b>316</b>                     |
| <b>Pipe lines length (3"-20" dia)</b>  | 3200 km                        |
| <b>Population served 80 gallons per capita per day</b>   | 4.11 (M)                       |
| <b>water production</b>  | 329 MGD                        |
| <b>water connections with 90% population coverage (excluding cantonment, Defense Housing Authority, Model Town, Railway Colonies and GORs)</b> | 610,000Z                       |
| <b>Sewerage systems</b>  | 2456 (cusecs pumping capacity) |
| <b>Major pump stations</b>   | 11                             |
| <b>Lift stations</b>   | 61                             |
| <b>Sewer length with 80% population coverage</b>   | 3610 Km                        |
| <b>Drains length</b>   | 180 km                         |
| <b>Major drains</b>  | 8                              |
| <b>Tributary drains</b>  | 76                             |
| <b>Carrying capacity</b>   | 6476 Cusec                     |
| <b>Drainage pumping stations</b>   |                                |
| <b>No. of pumping Stations</b>   | 4                              |
| <b>Pumping capacity</b>  | 563 cusecs                     |

During CY – 2022, the WASA Testing Laboratory, Lahore has analyzed 9373 drinking water samples throughout District Lahore, out of which 9059 (96.6%) samples were found fit for drinking purposes when compared to WHO standards. The samples were tested for physical appearance, odour, taste, color, pH, turbidity, TDS, conductivity, residual chlorine and E. Coli. all the samples were colorless, odorless and tasteless. Some samples from Mozang, Krishan Nagar, Misri Shah, Mughal Pura, Samanabad, Kahna, Mustafabad, Mustafa Town, Jubilee Town, Gulberg and Allama Iqbal Town were found unfit due to the presence of E. Coli and/or the Chlorine. However, the percentage fitness of all the samples were derived t around 99.9% after due follow-up in said areas.

### iii. District Rawalpindi

WASA Rawalpindi serves to 1.5 million with population, 85% coverage, 127,019 Nos. total consumer, 111,502 Nos. total no. of domestic consumer, 13,506 Nos. total No. of commercial consumer, 40 GPCD Planned consumptions, 10 MGD Rawal Dam, 06 MGD Khanpur Dam, 40 MGD Tube Wells, 56 MGD Total Production, 4000 Nos. No. of functional tube wells, 35% sewerage network with 150 Nos. mini filtration plants. During 2022, total 957 samples were examined in terms of certain environmental parameters. The environmental and their average value is as follows Temperature (20.17), Turbidity (2.51), pH (7.40), Alkalinity (184.39), CaCO<sub>3</sub> (198.15), Electrical Conductivity (1020.56), Calcium (59.81), Total Dissolved Solids (508.90) and Chlorides (20.70)



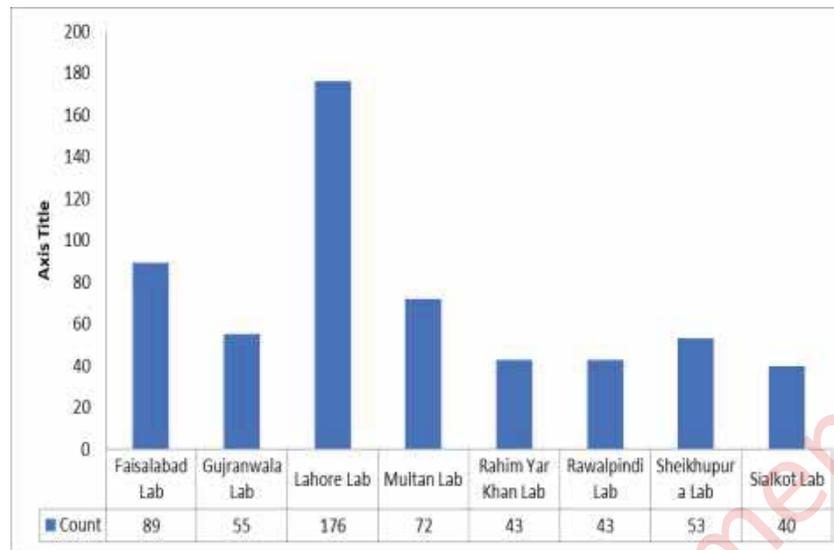
#### iv. District Faisalabad

WASA Faisalabad draws about 56 Million Gallons Per Day (MGD) water mainly from Chiniot Well-Field Area located near Chenab River through 29 tube wells. The aforesaid site is located 27KM from the terminal reservoir. Another sweet water source is positioned at a distance of nearby 13KM from terminal reservoir at Jhang Branch Canal which provides 20 MGD through 25 tube wells installed at Jhang branch Well-Field area. In addition to this, about 8 MGD water is being served to the city through 8 tube wells installed at Rakh Branch Canal which passes through the city. Moreover, around 4.5 MGD water is produced through the surface water treatment at “Jhal Khanuana Water Works” and “Millat Town Water Works”. These numerals shows that around 88.5 MGD water is produced by the WASA Faisalabad from different resources for its further provision to the citizen/consumers. WASA Faisalabad chronicles shows that about 1, 10, 000 domestic connections, 2, 348 commercials and 92 Industrial connections are registered with the WASA Faisalabad. In addition to this, 443 industrial connections are listed with the WASA Faisalabad as aquifer connections. The WASA Faisalabad annals revealed that around 72% population of city Faisalabad (2.23 million population) is served through 34 functional disposal stations located across the city. The length of sewerage network of WASA Faisalabad is around 1711KM which relates to abovementioned 34 disposal stations which are further linked with the four main channels for final disposal of waste water. The length of these main channels is 62KM. The Faisalabad city generates approximately 280 MGD sewage water. The WASA Faisalabad record shows that about 1, 27,972 domestic connections, 18808 commercials and 904 Industrial Connections are registered as sewer connections with the WASA Faisalabad.

The water quality of two sources is being monitored on the regular basis i.e., Chiniot inline Well-Field Area and Jhang Branch Canal total 207 samples were analyzed from inline source and 299 samples analyzed during 2022. Whereas no monitoring was carried out from the tube well installed at Rakh Branch Canal owing to the reasons that these tube wells have been redundant. The WASA Faisalabad has measured the following Temperature, pH, Chlorides (mg/l), Magnesium (mg/l), Total Dissolved Solids (mg/l), Electricity Conductivity ( $\mu\text{S}/\text{cm}$ ), Hardness (mg/l), Residual Chlorine (mg/l), Calcium (mg/l), Bicarbonate (mg/l) in both above mentioned areas. For inline well-field area, the average values of temperature, pH, Chlorides (mg/l), Magnesium (mg/l), Total Dissolved Solids (mg/l), Electricity Conductivity ( $\mu\text{S}/\text{cm}$ ), Hardness (mg/l), Residual Chlorine (mg/l), Calcium (mg/l), Bicarbonate (mg/l) is 29.31oC, 7.26, 55.77 (mg/l), 37.89 (mg/l), 324.48 (mg/l), 648.96 ( $\mu\text{S}/\text{cm}$ ), 267.58 (mg/l), 0.91 (mg/l), 44.67 (mg/l), 244.33 (mg/l), respectively. The average value of Jhang Branch Canal is 30.51oC, 7.38, 25.05 (mg/l), 12.22 (mg/l), 154.91 (mg/l), 309.79 ( $\mu\text{S}/\text{cm}$ ), 151.83 (mg/l), 0.90 (mg/l), 40.64 (mg/l), 135.79 (mg/l).

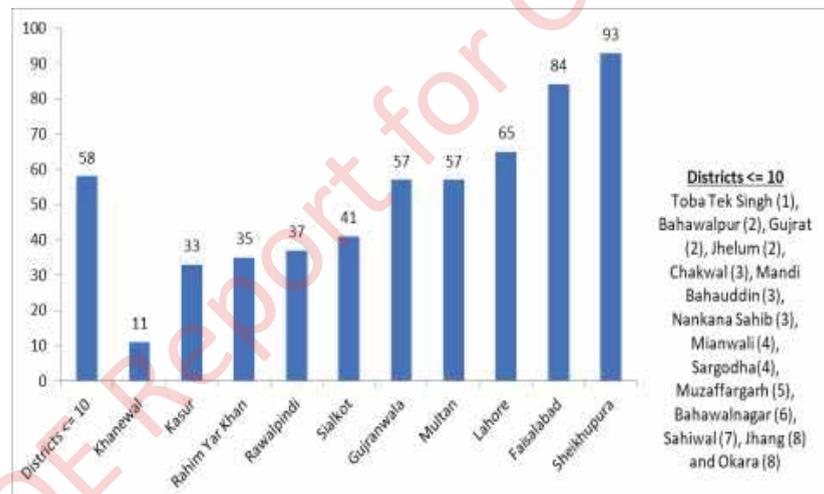
### 3.4 Pollution Sources affecting Water quality

During 2022, total 571 analysis of Waste Water were carried out by various EPA Laboratories. EPA Laboratory Lahore & Faisalabad carried out the comparatively higher monitoring (>80 inspections) as compared to other laboratories. Whereas, remaining laboratories is carried out inspections ranging from 40 to 55 numbers (Figure 23).



**Figure 23:** Laboratory Wise Industrial Inspections

With regards to district, highest inspection were carried out in Faisalabad district followed by Sheikhupura, Lahore, Gujranwala, Multan, Sialkot and Kasur (Figure 24).



**Figure 24:** District Wise Laboratory Inspections for Liquid Effluents

The maximum inspections were carried out in Textile (141 Nos.), Tanning and leather (46 Nos.), paper and paperboard paper pulping (51 Nos.), Paper and Paper Board including Paper Pulping (49 Nos.), Food (30 Nos.), Paints and Dyes (26 Nos.), Sugar Mills (19 Nos.), Manufacturing of apparel including dyeing etc. (18 Nos.), Others and Chemical Projects (16 Nos. each), Rice Mills (16 Nos.), Flour Mills (15 Nos.) and Housing Schemes and Oil and fats and vegetable ghee product and Petroleum Refineries (13 Nos. in each). The highest pH value was observed in the effluents of Chemical projects followed by the textiles etc. the highest BOD<sub>5</sub>, COD, TDS, TSS, were observed in the effluent of sugar mills. Higher value of Sulphate was observed in textile sector. The analysis of laboratory data provides a glimpse that EPA Laboratories have carried out total 905 inspections. The highest number was reported for EPA Lahore Laboratory i.e., 256 Nos. and least number was reported for EPA Laboratory Sialkot i.e., 53 Nos. Graphical representation is given in the Figure 25.

### 3.5 Water Quality Management Practices

The following is a glimpse of various management practices being carried out for the betterment of water quality in the province. These practices are selected from the Annual Development Program 2022-23. The brief description is as follows:

**a. Water Supply & Sanitation Department** is undertaking the following initiative as Water quality management practices i.e. Provision of Solarized Submersible Water Pumps in Ronghan, Sakhi Sarwar, Rakhi Gajj, Fort Munroe & Adjoining Areas, D.G.Khan, Combined PC-II of Water Quality Survey, Identification of outlived pipes, outsourcing of water Supply schemes, Rationalization of staff in WASAs, MC & PHED and pre-qualification of contractors and manufacturers.

**b. Public Buildings Department** is undertaking the following initiative as Water quality management practices i.e., Construction of Police Station Zafarwal, Narowal.

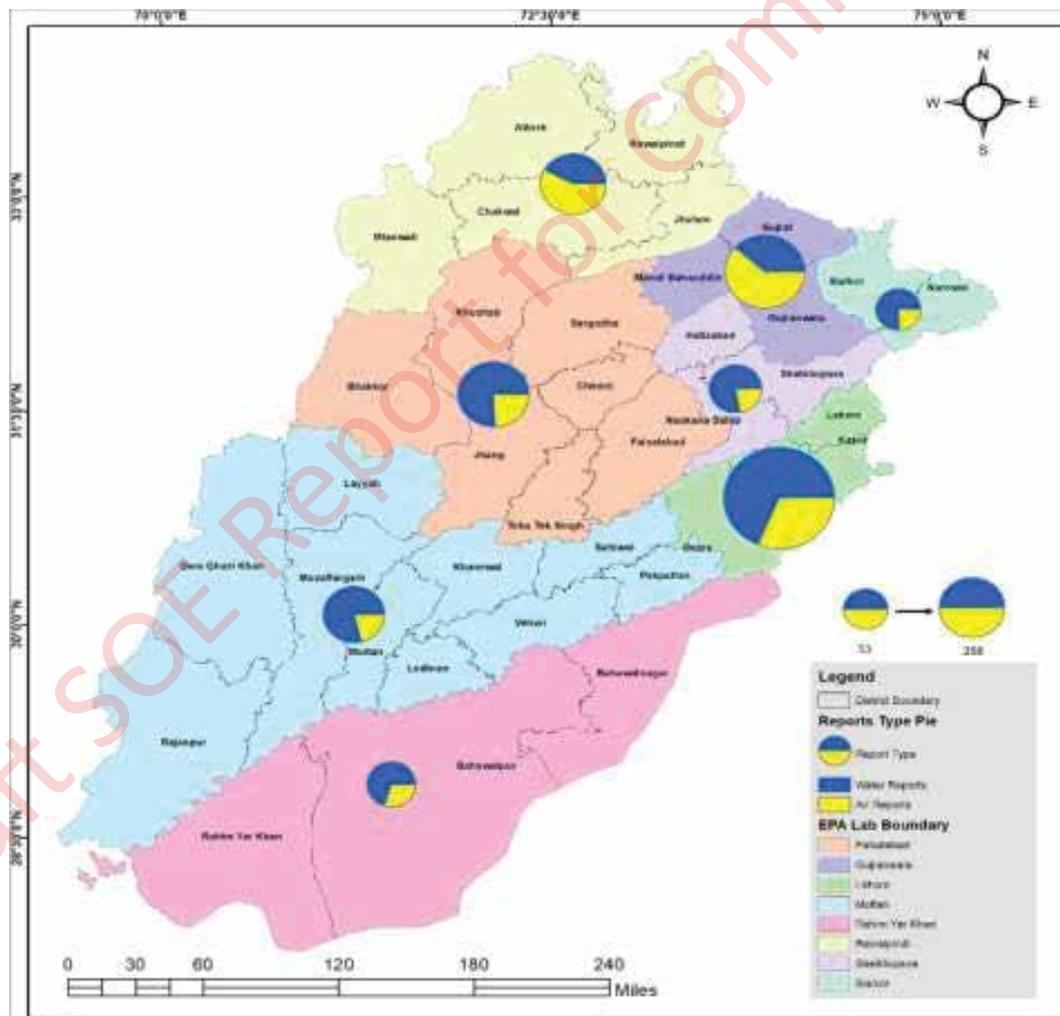


Figure 25: EPA Laboratory Wise Analysis Count in Punjab



**c. Irrigation Department** is undertaking the following initiative as Water quality management practices i.e. Drought Reduction in D.G. Khan area through Construction of Mini Reservoirs, Construction of Mohata Dam, Construction of Dadhocha Dam, Construction of Papin Dam Project, Construction of Mohra Shera Dam in District Rawalpindi, Construction of Mujahid Dam District Rawalpindi, Construction of Small Dams in District Attock Phase II Shahbazpur, Tajabara and Sadrial Dams (Revised), Raising of Shahpur Dam, Construction of Dhrabi and Minwal Dam (Revised), Construction of Small Dams in District Chakwal Phase II (Dhok Hum, Mundi Dam, Dhok Jhang and Uthwal /Lakhwal Dam (Revised), Construction of Tamman Dam, Construction of Ghabir Dam ( Land Acquisition and Command Area Development Punjab Component), Construction of Sorra Dam, Land acquisition of Sorra Dam Project, Recharge of Aquifer for Groundwater Management in Punjab.

**d. Urban Development Department** is undertaking the following initiative as Water quality management practices i.e. Construction of Eastern Wastewater Treatment Plant 45 MGD of Faisalabad City Phase-I (DANIDA Assisted), Lahore Water and Waste Water Management Project - Construction of Surface Water Treatment Plant at BRBD Canal Lahore, Rain Water Management - Drainage Arrangement for Sore Point at Sheranwala Gate, Lahore, Upgradation and Environmental Improvement of Chungi No. 09 Disposal Station Multan, storm water drainage and temporary storage system on Dijkot road Faisalabad, Management of Solid Waste at Fort Munro.

**e. Agriculture Department** is undertaking the following initiative as Water quality management practices i.e., Development of Groundwater Resources with 3d-ERM & Geo-Logging Technology (Smart DLI 11) (2021-2022 to 2022-23), National Program for Improvement of Watercourses in Pakistan Phase-II (2019-20 to 2023-24) (SMART, DLI-11).

**f. Forestry Department** is undertaking the following initiative as Water quality management practices i.e., Substitution of Solar Pumps in Depalpur Plantation, Endowment Fund for Development of National Parks, Wetlands, Ecotourism sites and Safari Parks.

**g. LG & CD Department** is undertaking the following initiative as Water quality management practices i.e., Grant in aid for Solid Waste Management System in Metropolitan Corporation Sargodha, District Sargodha, Establishment of Segregation, Treatment and Disposal plant/facility for Solid Waste Management at Sahiwal, Formulation of solid waste management strategy / framework for solid waste management in Punjab, Master Plans / Land Use & Zoning plans for Local Governments in Punjab.

### 3.6 Conclusions

Water is necessary for life. Without water there will be no life. The water crisis is looming up in Punjab. At one side of issue, the Punjab is towards the facing of acute water scarcity and on other side, the unprecedented rain and floods are complicating the entire scenario. The availability of water and quality of water is being deteriorated at an unprecedented rate. The regulatory framework available with the EPA Punjab is limited. The role of EPA Punjab for implementation of such framework is again at the minimum threshold level. Many government departments like Pakistan Council of Research in Water Resources are carrying out the monitoring of rivers and a few drains. The data reveals that the pollution load for the water coming into the Pakistan is lesser in comparison to the pollution load added in Pakistan. The ground water provided by the WASAs (Lahore,

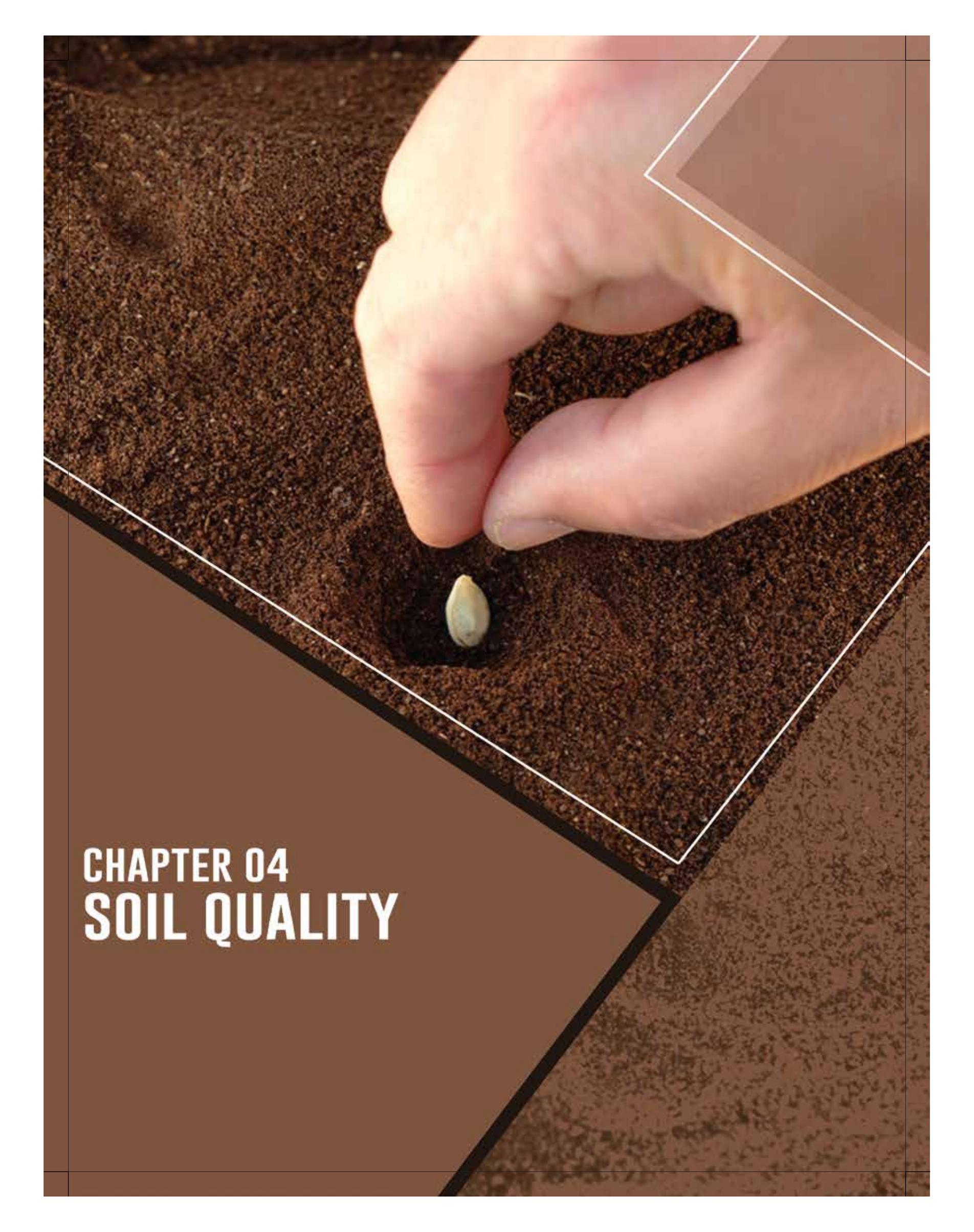


Gujranwala, Rawalpindi and Faisalabad) to its consumers is in accordance with the PEQS for drinking water. EPA Punjab is carrying out the analysis of liquid effluents in accordance with the PEQS for Industrial Effluents through eight laboratories in Punjab with its central base at EPA HQs. In, EPA laboratories there is a limitation of not analyzing the heavy metals in the liquid effluents. Albeit there is also limited functionality among these laboratories for analysis of liquid effluents. In order to strengthen the monitoring capacities there is a need for installation of at least 15 water quality monitoring stations, establishment of a reference laboratory and environmental monitoring of industrial effluents deteriorating the quality of river Ravi in Sheikhpura and Faisalabad.

Much initiatives have to be taken regarding construction of zero water discharge/water conservations schemes in the water intensive industries like textiles, sugar etc., storm water underground water recharge galleries in establishments (including public as well as private), water metering for every connection, rehabilitation of dams, rivers, drains, and canals, Conservation of natural habitats especially the Ramsar sites and installation of municipal WWTP as well as industrial WWTP.

Government department are taking some measures to improve the water quality. Due to higher value of water pollution further more actions are required on the part of the Government departments for betterment of the water quality.

Draft SOE Report for Comments Only

A close-up photograph of a hand planting a small, light-colored seed into a hole in dark brown soil. The hand is positioned at the top right, with fingers gently holding the seed. The soil is rich and textured. The image is framed by a white geometric border that forms a large triangle pointing towards the bottom right. The background is a solid brown color.

# CHAPTER 04 SOIL QUALITY



## 4. CHAPTER FOUR

### 4.1 Soil Quality

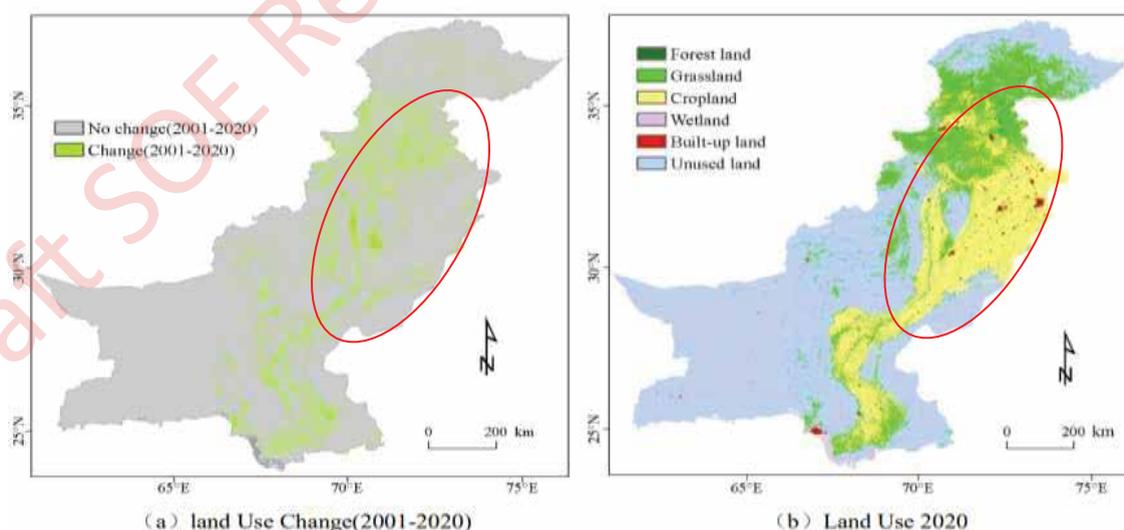
The term ‘Soil’ originates from the Latin word “Solum”, meaning ‘floor’. It is the upper strata of Earth, comprising organic and inorganic constituents, including, but not limited to the nutrients, plant growth elements, and living matter. Soil is usually formed by deposition of weathered rocks. It is a complex system with diverse physiochemical properties, potentially prone to significant changes with time, depending upon many atmospheric and geological factors.

The soil is an essential medium, required for vegetation growth. The soil acts as a nutrient and water reservoir, enabling the plant growth. Vegetation requires 12 essential nutrients for growth. These include six macro-nutrients i.e., Potassium, Calcium, Magnesium (Mg), Nitrogen (N), Sulfur and Phosphorous (P)<sup>29</sup>. The physiochemical characteristics of soil such as infiltration and water – holding capacity, temperature, pH, organic content, nutrient content and aggregation determine the subsequent soil processes including the erosion, drainage, salinity and fertility<sup>30</sup>.

### 4.2 Land cover and soils

In Punjab, 61% of total geographical area is cultivated<sup>31</sup>, which is mainly attributed to its rich, fertile alluvial soils and diverse irrigation system. Studies have shown the cultivated land in Punjab has stayed stable over past four decades (Figure 26<sup>32</sup>).

However, since most of the plowable land in the province is already cultivated, the use of fertilizers and pesticides is relatively greater, with subsequent impacts on soil quality<sup>33</sup>.



**Figure 26:** Land Use and Land Use Change, Pakistan

<sup>29</sup>Shahid et al, "Mineralogy of Soils of Major Soils of Punjab (Pakistan): International Journal of Agricultural Sciences, 2,8 (2013): 265-272

<sup>30</sup>Rogers et al, Important Agricultural Soil Properties, Irrigation Management Series

<sup>31</sup>Statistical Pocket Book of the Punjab, Bureau of Statistics, Planning & Development Board, Government of the Punjab (2022).

<sup>32</sup>Source: Xu et al, Land Degradation Assessment in Pakistan based on LU and VCF (2022)  
Climate-Smart Agriculture for Punjab, Pakistan, Food and Agriculture Organization (FAO)



### 4.3 Assessment of Soil Quality

Soil quality is defined as the capacity of a specific kind of soil to sustainably function, within an ecosystem (natural or managed), to support the productivity and habitats<sup>34</sup>. Soil quality is measured on basis of multiple parameters, including, but not limited to the soil alkalinity, porosity, water retention capacity and organic matter content. Similarly, the land or soil degradation is measured in terms of various phenomena, including presence or absence of heavy metal contamination, soil erosion, water logging, etc. The soil quality from some representative locations in the province was assessed using both the primary (a) and secondary (b-f) data.

#### a. Heavy Metals, Alkalinity and Electrical Conductivity

The sampling was carried out from urban, agricultural and industrial land of 09 districts including Bahawalpur, Rahim Yar Khan, Multan, Lahore, Faisalabad, Kasur, Khushab, Rawalpindi and Mianwali. The soil quality was tested for 15 parameters i.e., pH, Electrical Conductivity, Cadmium, Chromium, Copper, Lead, Mercury, Selenium, Nickel, Silver, Zinc, Iron, Manganese, Boron and Sodium. The results were compared with soil quality standards of India and USEPA.

Table 19-21 show the soil quality results in the agricultural, industrial and urban areas of selected districts respectively. It is pertinent to mention here that the agricultural land, from which samples were taken, was not irrigated from industrial wastewater.

**Table 19:** Soil Quality in Agricultural Areas of Punjab

|                   |                | pH   | EC     | Cd | Cr    | Cu    | Pb   | Hg | Se | Ni    | Ag   | Zn   | Fe     | Mn     | B | Na      |
|-------------------|----------------|------|--------|----|-------|-------|------|----|----|-------|------|------|--------|--------|---|---------|
| Agricultural Land | Bahawalpur     | 7.26 | 216.40 | 0  | 11.04 | 19.44 | 9.32 | 0  | 0  | 26.16 | 1.14 | 1.58 | 516.85 | 251.04 | 0 | 913.56  |
|                   | Rahim Yar Khan | 7.21 | 214.00 | 0  | 10.44 | 18.68 | 8.68 | 0  | 0  | 24.34 | 1.02 | 1.46 | 514.49 | 250.34 | 0 | 915.46  |
|                   | Multan         | 7.12 | 212.50 | 0  | 10.99 | 19.01 | 9.10 | 0  | 0  | 26.98 | 1.21 | 1.55 | 516.00 | 249.01 | 0 | 910.68  |
|                   | Lahore         | 7.65 | 173.80 | 0  | 6.02  | 12.87 | 8.55 | 0  | 0  | 14.74 | 0.39 | 2.23 | 189.28 | 114.41 | 0 | 595.11  |
|                   | Faisalabad     | 7.54 | 174.00 | 0  | 6.44  | 12.21 | 8.02 | 0  | 0  | 14.54 | 0.31 | 2.01 | 188.21 | 115.81 | 0 | 585.56  |
|                   | Kasur          | 7.02 | 170.00 | 0  | 6.23  | 11.53 | 7.55 | 0  | 0  | 14.68 | 0.41 | 2.31 | 186.66 | 121.15 | 0 | 592.81  |
|                   | Khushab        | 7.45 | 589.20 | 0  | 6.51  | 13.00 | 6.04 | 0  | 0  | 18.46 | 0.96 | 0.79 | 385.76 | 196.65 | 0 | 1419.60 |
|                   | Mianwali       | 7.12 | 585.00 | 0  | 6.59  | 12.54 | 6.12 | 0  | 0  | 18.11 | 0.90 | 0.71 | 380.69 | 192.60 | 0 | 1422.38 |
|                   | Rawalpindi     | 7.23 | 575.10 | 0  | 6.35  | 11.90 | 6.42 | 0  | 0  | 17.21 | 0.91 | 0.65 | 370.71 | 189.55 | 0 | 1415.44 |

<sup>34</sup> Natural Resources Conservation Service, U.S. Department of Agriculture (USDA)


**Table 20:** Soil Quality in Industrial Areas of Punjab

|                 |                | pH   | EC      | Cd | Cr    | Cu    | Pb   | Hg | Se | Ni    | Ag   | Zn   | Fe     | Mn     | B | Na      |
|-----------------|----------------|------|---------|----|-------|-------|------|----|----|-------|------|------|--------|--------|---|---------|
| Industrial Area | Bahawalpur     | 7.14 | 743.00  | 0  | 10.83 | 13.55 | 5.17 | 0  | 0  | 17.11 | 1.05 | 0.68 | 738.43 | 229.53 | 0 | 1992.34 |
|                 | Rahim Yar Khan | 7.10 | 750.00  | 0  | 10.53 | 12.90 | 5.02 | 0  | 0  | 12.90 | 1.21 | 0.65 | 735.74 | 223.43 | 0 | 1989.45 |
|                 | Multan         | 7.12 | 744.00  | 0  | 10.01 | 14.01 | 5.09 | 0  | 0  | 17.22 | 1.12 | 0.61 | 733.43 | 225.04 | 0 | 1965.32 |
|                 | Lahore         | 7.43 | 1749.00 | 0  | 6.88  | 17.90 | 7.43 | 0  | 0  | 18.94 | 1.14 | 0.89 | 741.20 | 241.58 | 0 | 2521.93 |
|                 | Faisalabad     | 7.43 | 1700.00 | 0  | 6.80  | 15.43 | 7.10 | 0  | 0  | 17.90 | 1.09 | 0.92 | 730.66 | 240.36 | 0 | 2571.72 |
|                 | Kasur          | 7.34 | 1720.00 | 0  | 6.83  | 16.93 | 7.60 | 0  | 0  | 17.42 | 1.13 | 0.88 | 740.99 | 235.30 | 0 | 269.89  |
|                 | Khushab        | 7.24 | 546.20  | 0  | 6.25  | 18.46 | 7.55 | 0  | 0  | 22.95 | 1.20 | 0.93 | 532.07 | 224.67 | 0 | 1505.47 |
|                 | Mianwali       | 7.34 | 555.00  | 0  | 6.30  | 17.98 | 7.66 | 0  | 0  | 22.12 | 1.01 | 0.99 | 540.50 | 230.01 | 0 | 1508.53 |
|                 | Rawalpindi     | 7.11 | 520.00  | 0  | 6.20  | 18.16 | 7.32 | 0  | 0  | 21.88 | 1.81 | 0.92 | 525.68 | 221.76 | 0 | 1510.67 |

**Table 21:** Soil Quality in Urban Areas of Punjab

|                 |                | pH   | EC     | Cd | Cr   | Cu    | Pb    | Hg | Se | Ni    | Ag   | Zn   | Fe     | Mn     | B | Na      |
|-----------------|----------------|------|--------|----|------|-------|-------|----|----|-------|------|------|--------|--------|---|---------|
| Industrial Area | Bahawalpur     | 7.09 | 857.00 | 0  | 9.68 | 19.92 | 10.47 | 0  | 0  | 26.72 | 1.15 | 1.68 | 424.01 | 228.19 | 0 | 1030.46 |
|                 | Rahim Yar Khan | 7.10 | 845.80 | 0  | 9.48 | 17.85 | 11.56 | 0  | 0  | 21.57 | 1.21 | 1.43 | 410.14 | 220.20 | 0 | 903.05  |
|                 | Multan         | 7.12 | 858.00 | 0  | 9.53 | 19.54 | 10.66 | 0  | 0  | 25.12 | 1.10 | 1.08 | 454.09 | 219.00 | 0 | 1188.32 |
|                 | Lahore         | 7.25 | 150.50 | 0  | 5.68 | 5.12  | 2.14  | 0  | 0  | 8.10  | 1.91 | 0.29 | 709.32 | 100.54 | 0 | 491.76  |
|                 | Faisalabad     | 7.23 | 150.00 | 0  | 5.58 | 5.79  | 2.12  | 0  | 0  | 8.55  | 1.88 | 0.25 | 706.30 | 102.73 | 0 | 489.53  |
|                 | Kasur          | 7.14 | 152.00 | 0  | 5.62 | 5.41  | 3.00  | 0  | 0  | 8.26  | 1.92 | 0.27 | 708.54 | 100.89 | 0 | 430.39  |
|                 | Khushab        | 7.15 | 569.00 | 0  | 7.15 | 15.67 | 8.52  | 0  | 0  | 22.64 | 1.06 | 1.25 | 496.99 | 209.43 | 0 | 1464.51 |
|                 | Mianwali       | 7.12 | 600.00 | 0  | 7.92 | 15.50 | 8.46  | 0  | 0  | 21.09 | 1.00 | 1.30 | 450.89 | 207.33 | 0 | 1450.55 |
|                 | Rawalpindi     | 7.21 | 540.00 | 0  | 7.06 | 14.99 | 8.03  | 0  | 0  | 22.42 | 1.44 | 1.38 | 480.86 | 210.54 | 0 | 1401.64 |

All the samples exhibited high values of sodium ranging from 430mg / kg to 2521 mg / kg, except for the Industrial area of District Kasur, where the reading of sodium was found to be 269 mg/kg. Hence, the soils of all areas under study were found alkaline in nature. However, as no standards of soil's sodium level have been set by India and US EPA, the values were not comparable.

Most of the tested samples had EC in the range of 740 – 1700  $\mu\text{S}/\text{cm}$ . The higher values of EC were predominantly found in the urban and industrial areas of the selected districts. As soil moisture is usually not much high in urban and industrial settings, and the sampling was done from surface, rather than deeper strata of soil, the higher EC in industrial and urban areas indicates higher concentration of ions and salts in the samples.



The concentrations of heavy metals in all areas were found within permissible limits set by both India and USEPA, indicating that the soils were not contaminated with heavy metals. Similarly, the pH was optimal in all the tested samples.

### b. Total Organic Matter

The organic matter in the soil, comprising the animal and plant tissues at different stages of decomposition, plays a significant role in soil fertility and agricultural properties. The organic matter is not only a source of growth nutrients, but is a crucial factor contributing in the improvement of soil porosity, water retention capacities, flourishing the soil organisms and retention and recycling of the fertilizers. Hence the soil rich in organic matter provides enhanced crop yields, when cultivated.

However, as indicated by secondary data based on different research works, it is reported that the soils of Punjab Pakistan are not sufficiently enriched with the organic matter, mainly due to extreme summer temperatures, use of inorganic fertilizers, and intensive tillage. A study conducted in District Muzaffargarh indicates deficiency of organic matter in 95% of the tested soils<sup>35</sup>.

### c. Physical and Hydraulic Properties

The physical and hydraulic properties of soil play a vital role in determining its quality and fertility. The soil texture, organic matter, chemical properties, infiltration rate, moisture-retention was estimated in Potohar region of Punjab. representative sites from Potohar plateau and Doabs<sup>36</sup> were selected for soil sampling and analyses. The major districts lying in Potohar Plateau and Doabs include Rawalpindi, Attock, Jhelum, Chakwal, Mianwali, Khushab, Bhakkar, Layyah, Muzaffargarh, Gujrat, Mandi-bahauddin, Sargodha, Faisalabad, Gujranwala, Narowal, Sialkot, Nankana Sahib, Sheikhpura, Toba Tek Singh, Khanewal, Multan, Sahiwal, Okara, Kasur and Lahore. The results are summarized as follows<sup>37</sup>:

### d. Infiltration Rates

The dominantly reported infiltration rates in the soils of ‘Doabs’ were up to 30 mm/hr (Figure 27). it was found that the infiltration rates of soil in Doabs were lower than those in Potohar region, due to the fact that the Doab regions are flat and intensely plowed. This causes the formation of a clay-based layer of compressed soil below the plowed zone. Here the erosion is minimal, with least washing action, due to blocked surface pores. On the other hand, the dominant infiltration rates in Potohar region were ranging from 15 to 45 mm/hr (Figure 28) . it has been reported that the higher infiltration rates in the area is attributed to the dominant erosion phenomenon pertaining to the sloppy lands.

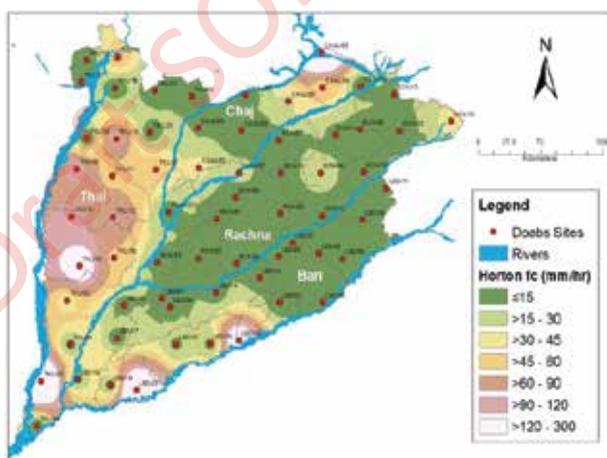


Figure 28: Infiltration rates in surface soils Doabs, Punjab

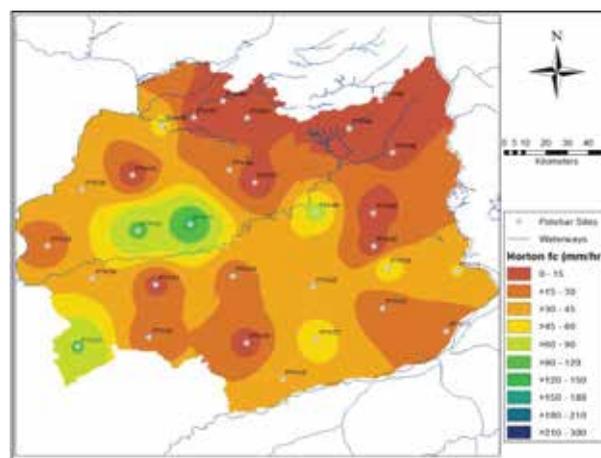


Figure 27: Infiltration Rates in surface soils of Potohar Region

<sup>35</sup> Akram et al, (2014), Soil Fertility and Salinity Status of Muzaffargarh District, Punjab Pakistan, Universal Journal of Agricultural Research 2(7): 242-249, 2014

<sup>36</sup> Thal Doab, Chaj Doab, Rachna Doab and Bari Doab

<sup>37</sup> Pakistan Council of Research in Water Resources (2019)



### e. Moisture Retention

Nine soils types in Doab, and ten soil types in Potohar region were studied it was found that the soil moisture characteristics were highly variable from site to site in Potohar region, whereas, it was quite uniform in Doabs region (Figure 29). The reason was reported as the high erosion and subsequent in Potohar region, as compared to the Doabs, where erosion was least evident.

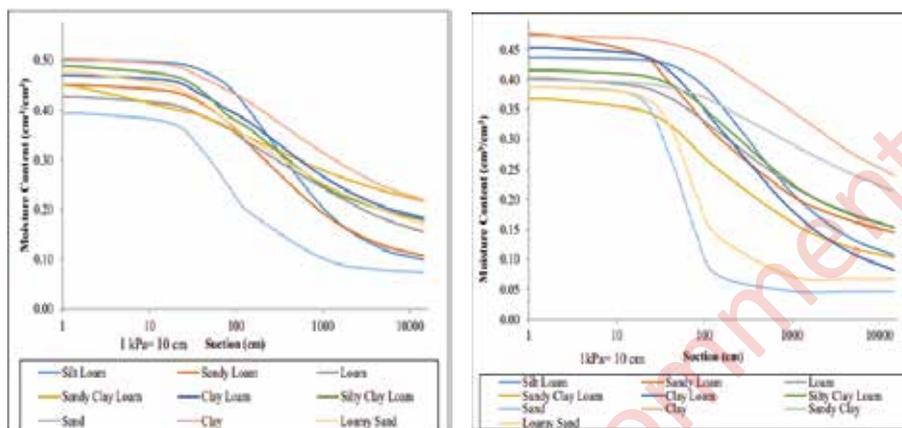


Figure 29: Soil Moisture variations in Doabs & Potohar

### f. Soil Structure

The study indicates that loam, silt loam and sandy loam are the main soil textures found in the Potohar region. The sandy texture decreased with increasing depth. The reason is again the major erosion and rainfall activity in the region. The soil textures were found as almost same in Doab region (Figure 30). However, texture varied with depth due to the fact that the washing down of top layers was evident in Potohar and minimal in Doabs as the plains in Doabs are plowed and least exposed to the surface erosion.

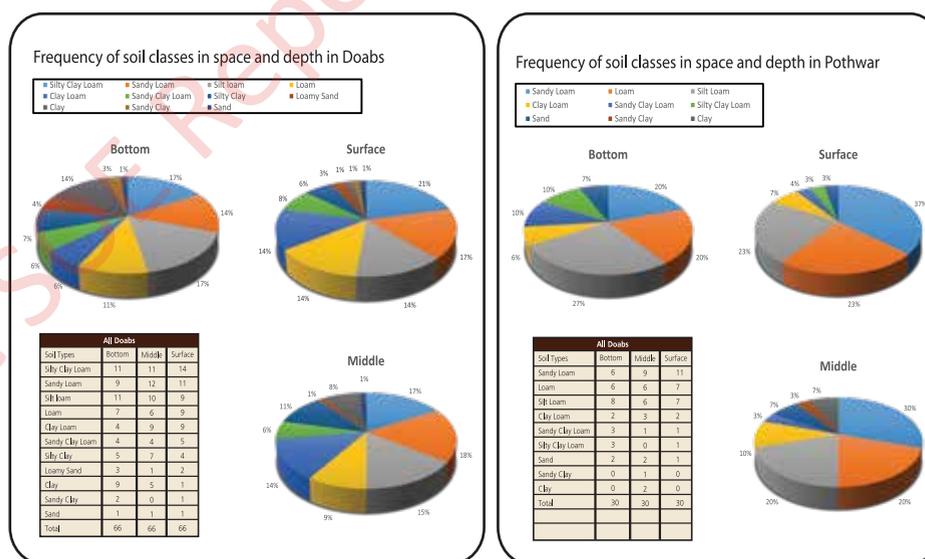


Figure 30: Soil texture in Doabs

It was further revealed that soil strata were more diverse in Potohar region as compared to the Doabs. The organic matter contents in the Pothwar ranged from 0.2 to 2.5%.



## 4.4 Pollution sources affecting Soil quality

Generally, the soil pollution results from the agricultural chemicals, industrial effluents discharged without treatment and urban municipal waste dumped at landfills, causing leachate in the soils. Irrigation from industrial wastewater significantly contributes to heavy metal contamination in the soil. The heavy metals are further diffused in the growing crops and vegetables, entering in the food chain. In a study conducted in District Faisalabad, 96% of ornamental plants sampled in the areas irrigated with industrial wastewater were found contaminated with cadmium, 56% were contaminated with lead and Nickel was found in 41% of the samples<sup>38</sup>. The electrical conductivity was reported beyond permissible limits in the industrial lands of Districts Khushab, Multan, Bahawalpur, Rahim Yar Khan, Lahore and Faisalabad also indicate the possibility of higher soil contamination due to industrial sources.

## 4.5 Soil Management practices

Soil quality in Punjab, the bread-basket of Pakistan, needs to be managed through integrate management practices in order to safeguard its quality, fertility and productivity. The organic content is a vital element for high soil fertility. The farmers use multiple methods to increase the organic matter content of the soil such as using the farmyard and poultry manure, crop residues, slaughter house waste, green manure and other solid and liquid materials present in sewage, sludge, fishponds, etc. In terms of industrial sources, EPA Punjab regulates the discharge of effluents and wastes in the environment, under the provisions of Section 11 of PEPA 1997. The agency EPD also participates in the tree plantation activities (detailed in Chapter 06).

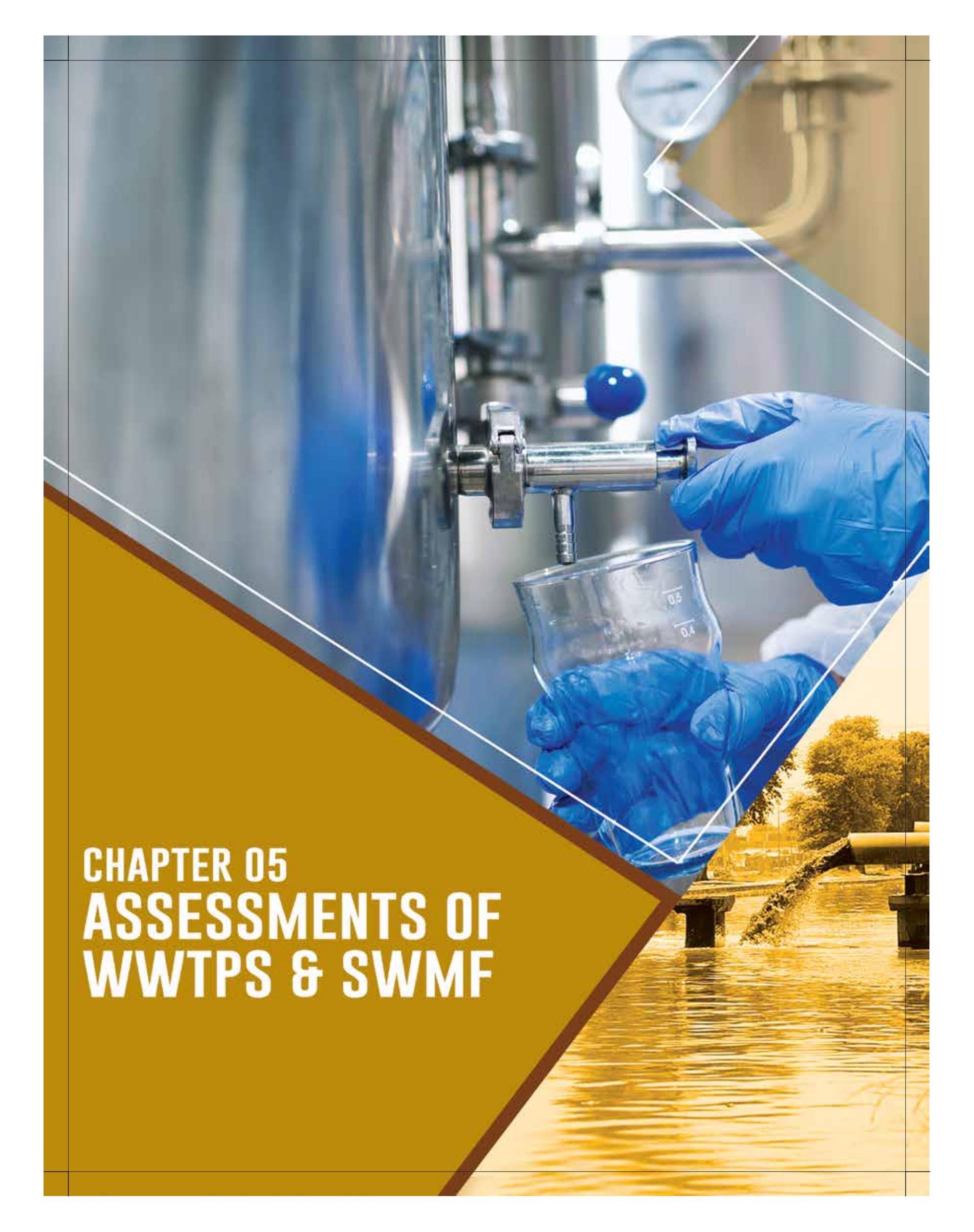
In agriculture sector, sensible use of fertilizers, shift towards organic farming, zero tillage, careful use of pesticides are key to better soil quality and fertility. Agriculture department, through its extension wing, educates and sensitize farmers about best soil and crop management practices. The department is conducting research and studies on soil's features and quality at different locations in the province. It is executing a scheme on mapping of soil series in selected areas of Sargodha district under citrus orchards. Soil survey of Punjab is strengthening its GIS Labs to evaluate the impact of human interventions on different soil series of Punjab. The department is also working on mitigation of pesticide residues in vegetables and rice through capacity building of farmers and extension agents. Work on rehabilitation of eroded, gullied land through soil conservation measures in hill torrents/barani areas of southern Punjab has also been carried out by agriculture department.

Tree plantation strengthen the soil structure and improves its organic and nutrient contents. Forest department is actively engaged in plantation projects, which also co-benefit the soils of the selected areas. The department is executing a project of tree plantation along Right of Way (ROW) of Ghazi Barotha Hydro project and also along Vehari Burewala D.M. Road to Railway Crossing, Vehari, in addition to the province wide Ten Billion Tree Tsunami Program. Furthermore, the department is also executing multiple schemes on rehabilitation, upgradation and maintenance of reserved forests and national parks, subsequently improving the soil stability and quality in the province. Regular afforestation campaigns all over the province is also a remarkable initiative by Punjab Forest Department, benefitting both the biotic and abiotic components of the ecosystems.

## 4.6 Conclusions

Soil is a lifeline for survival of all ecosystems, being the major source of food and water to the flora and fauna. For a place like Punjab, where agriculture is the main sector of the economy, soil quality needs to be regulated and maintained proficiently. Currently, no government department is maintaining the regular and updated data on soil quality. Only the baseline data on soil problems can lead to better governance and management of soils. Hence, there is need to mobilize the concerned public and private organizations to conduct studies on soil quality in the province. In addition, the environmental quality standards for soil are also the need of the hour.

<sup>38</sup> Annual Abridged Report 2021-2022, Institute of Soil Chemistry and Environmental Sciences, Ayub Agricultural Research Institute, Faisalabad.



**CHAPTER 05**  
**ASSESSMENTS OF**  
**WWTPS & SWMF**

## 5. CHAPTER FIVE

Assessment of Environmental Performance of Waste Water treatment and solid waste management facilities have been carried out and details are given as under.

### 5.1 Wastewater treatment facilities

As per the survey carried out by the field offices of EPA for the preparation of state of environment report 2022, there are a total 392 Waste Water Treatment Plants (WWTPs) in Punjab (Figure 31). Among these, there are 206 primary, 180 secondary and 06 tertiary plants. These Plants are installed in 23 various industries, out of which the highest numbers are in the textile sector (148 Nos.). Followed by sugar mills (39 Nos.) Tanning and Leather and Chemical

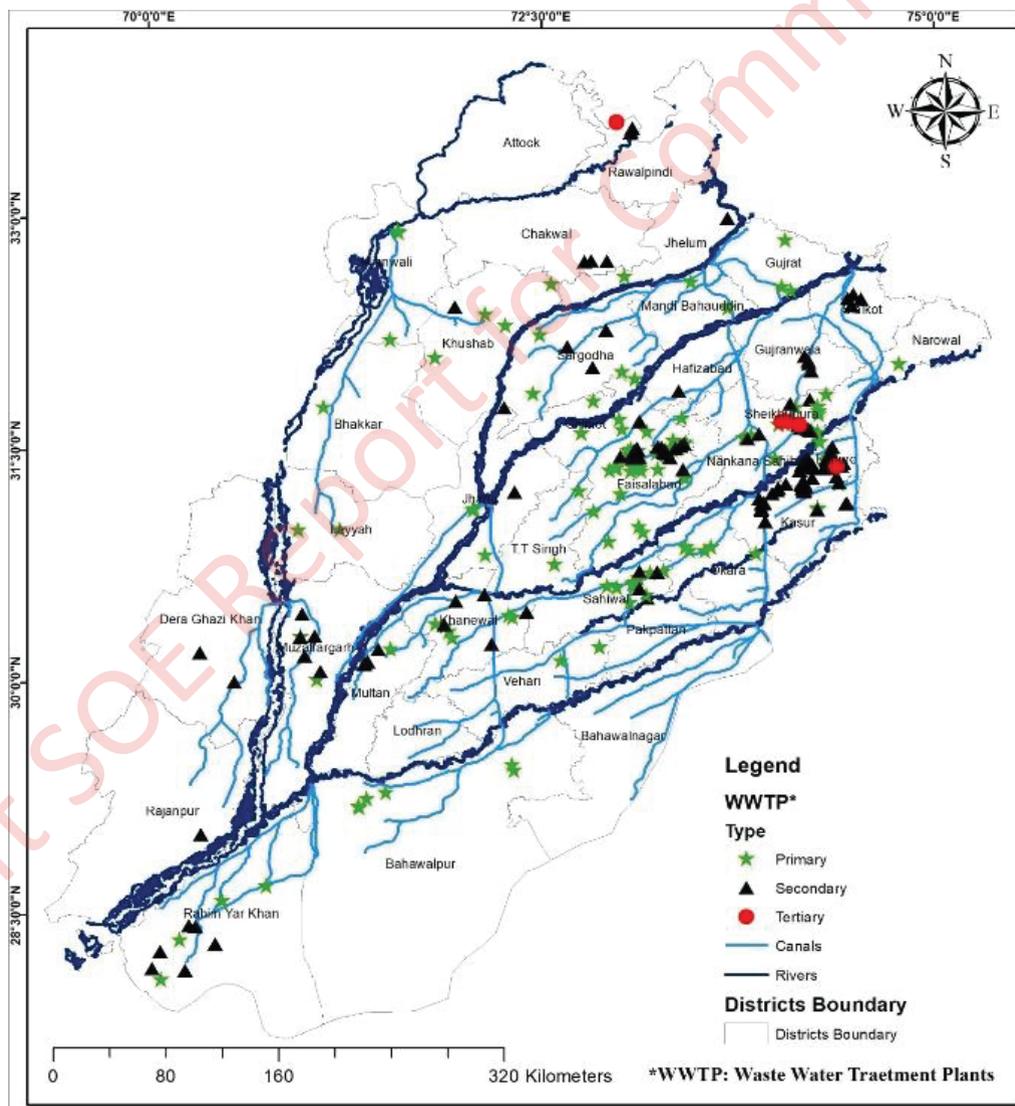


Figure 31: Waste Water Treatment Plants in Punjab, Pakistan

(25 Nos. each). Paper and Paper Board, Pharmaceuticals, Oil and Ghee, Power Plants, Beverages, Cement Plants, and Fertilizers have 21,13,13,13,11,7 and 5 respectively. The industry wise presence of WWTP is given in (Figure 33).

There is only one Municipal WWTP in Faisalabad.

As per the survey, there are only 8 districts having double digit of WWTPs, whereas only Faisalabad has WWTPs in 3 digits. Furthermore, the highest number of WWTPs in Faisalabad (120 Nos.), then Lahore (88 Nos.), then Sheikhupura (33 Nos.), then Kasur (25 Nos.) Sahiwal (13 Nos.) then Khanewal (11 Nos.) then Muzaffargarh and Rahim Yar Khan (10 Nos. each) (Figure 32).

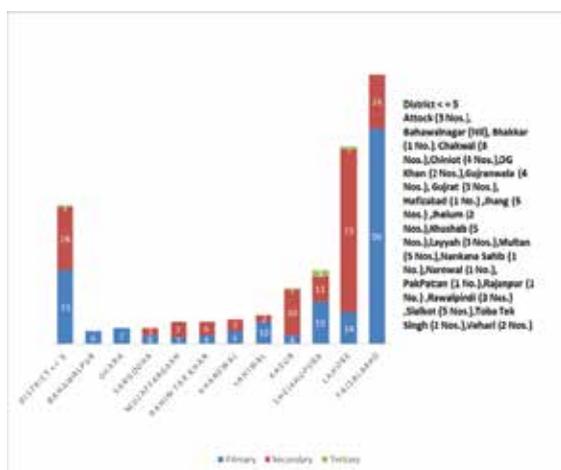


Figure 32: District Wise Distribution of WWTP

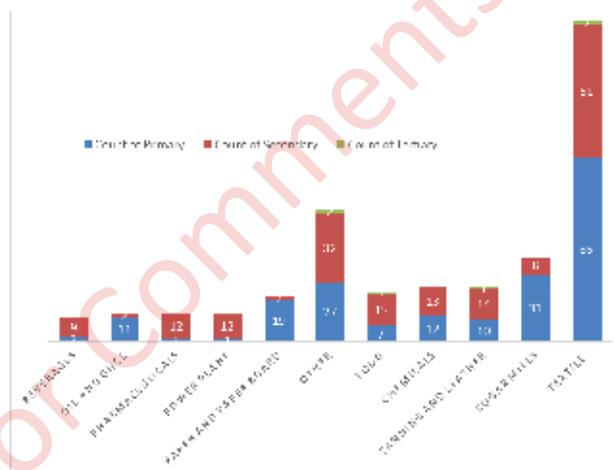


Figure 33: Industry Wise Distribution of WWTP

Among these 392 WWTPs installed in the industries, only waste water of 35 WWTPs have been analyzed for both in terms of prior treatment and after the treatment. This analysis was carried out to gauge the environmental performance of the WWTPs. The EPA Laboratories of Lahore, Faisalabad and Multan carried out analysis of 1,10, and 21 WWTPs, respectively. With reference to the type of plants only 27 primary, 12 secondary and 1 tertiary treatment plants were analyzed. The average value of parameter analyzed before and after the treatment of liquid effluent is summarized in Table 22. The analysis of WWTP installed at various industrial units are as follows:

- For WWTPs installed in the animal feed industry, the average value of pH, chlorides and sulfates remain within the limits of PEQS. Whereas the average value of COD, TSS and Sulphide remains higher after the treatment of liquid effluent.
- For WWTPs installed in the beverages industry, the value of pH, COD, TDS, TSS, chloride and sulfate remains within the PEQS limits before as well as after the treatment. However, the treatment has decreased the pollution load while reducing the average values of COD, TDS, TSS, chloride and sulfates. Whereas, Sulphide remains higher after the treatment of liquid effluent.
- For WWTPs installed in the fertilizer's plants, the value of TSS remains within PEQS limits prior to treatment. However, the value of COD, TDS, Chloride and sulfate were reduced from non-compliance values to the compliance values as per PEQS. Whereas, Sulphide remains higher after the treatment of liquid effluent.



- For WWTPs installed in the food industry, the average value of pH, sulfate and chloride remains within the PEQS limits. However, the value TSS is reduced from the compliance limits of PEQS after the treatment. Whereas, the values of Sulphide, BOD, COD and TDS remained higher than the compliance limits of PEQS.
- For WWTPs installed in the Man-made fiber, the value of pH, Sulphate and TDS remains within the limits of PEQS. However, the value of COD is reduced within the compliance limit of PEQS. Whereas, Sulphide remains higher after the treatment of liquid effluent.
- For WWTPs installed in the Oil and fats and vegetable ghee projects, the value of pH, TDS, Chloride and sulfate remains within the limits of PEQS. However, the value of TSS is reduced within the compliance limit of PEQS. Whereas, the value of COD and Sulphide are way higher than the compliance limit of PEQS.
- For WWTPs installed in the Paper and paperboard, paper pulping, the values of pH, chloride and sulfate remain within the limits of PEQS. However, the values of Sulphide , BOD, COD and TDS remain higher than the compliance limit of PEQS.
- For WWTPs installed in the Power Looms, the value of pH, TDS, Chloride and sulfate remains within the limit of PEQS. However, the value of TSS is reduced from the compliance limit of PEQS. Whereas the values of Sulphide, BOD and COD remain higher than the compliance limits of PEQS.
- For WWTPs installed in the Sugar Mills, the average values of pH, Chlorides and sulfate remain within the limits of PEQS. However, the value of TDS is reduced from the compliance limit of PEQS. Whereas, the value of Sulphide, COD and BOD are way higher than the compliance limits of PEQS.
- For WWTPs installed in the Tanning and leather finishing projects, the average value of pH remains within the limits of PEQS. However, the values of Chloride, sulfate and TDS are reduced from the compliance limit of PEQS. Whereas, the value of Sulphide and COD are way higher than the compliance limits of PEQS.
- For WWTPs installed in the Textiles the average values of pH and sulfate remain within the limits of PEQS. However, the values of Chloride, TDS and TSS are reduced from the compliance limit of PEQS. Whereas, the values of Sulphide, COD and BOD are way higher than the compliance limits of PEQS.

**Table 22:** Average Values of Parameters before and after treatment of Liquid Effluents

| Type of Industry  | Average of Sulfide (S <sub>2</sub> -) |             | Average of Temperature |              | Average of pH |                 | Average of BOD <sub>5</sub> |               | Average of COD  |               | Average of TDs           |                 | Average of TSS |               | Average of Chloride |               | Average of Sulfate |               |
|---|---------------------------------------|-------------|------------------------|--------------|---------------|-----------------|-----------------------------|---------------|-----------------|---------------|--------------------------|-----------------|----------------|---------------|---------------------|---------------|--------------------|---------------|
|   | B*                                    | A*          | B*                     | A*           | B*            | A*              | B*                          | A*            | B*              | A*            | B*                       | A*              | B*             | A*            | B*                  | A*            | B*                 | A*            |
| Animal feed   | 20.00                                 | 16.00       | 19.20                  | 17.90        | 7.20          | 7.50            | N/A                         | N/A           | 416.00          | 336.00        | 3,742.00                 | 3,356.00        | 302.00         | 256.00        | 946.00              | 852.00        | 418.00             | 392.00        |
| Beverages   | 9.00                                  | 5.00        | -                      | -            | 7.50          | 7.25            | 24.00                       | N/A           | 192.00          | 108.00        | 1,916.00                 | 1,437.00        | 82.00          | 47.00         | 177.00              | 88.50         | 316.00             | 125.00        |
| Fertilizer Plants   | 20.00                                 | 8.00        | 27.00                  | 26.20        | 8.90          | 8.60            | N/A                         | N/A           | 1,040.00        | 164.00        | 5,674.00                 | 2,218.00        | 150.00         | 27.00         | 1,166.00            | 506.00        | 672.00             | 344.00        |
| Foods   | 12.00                                 | 5.40        | 24.26                  | 23.98        | 8.32          | 7.46            | 6,060.00                    | 3,050.00      | 1,766.00        | 1,146.00      | 3,370.83                 | 2,343.33        | 295.00         | 170.50        | 654.00              | 355.17        | 357.50             | 268.00        |
| Man-made fibers and resin projects with total cost of less than Rs. 100 million | 8.00                                  | N/A         | 24.00                  | 21.00        | 8.30          | 7.20            | N/A                         | N/A           | 164.00          | 102.00        | 3,224.00                 | 2,134.00        | N/A            | N/A           | 318.00              | 212.00        | 302.00             | 218.00        |
| Oils and fats and vegetable ghee projects                                       | 8.00                                  | 4.00        | 24.00                  | 22.10        | 8.20          | 7.60            | N/A                         | N/A           | 256.00          | 166.00        | 2,254.00                 | 1,842.00        | 218.00         | 196.00        | 816.00              | 798.00        | 412.00             | 386.00        |
| Paper and Paperboard, Paper Pulping   | 52.07                                 | 29.40       | 22.43                  | 24.40        | 8.41          | 8.00            | 1,288.00                    | 820.00        | 970.67          | 374.67        | 3,852.00                 | 3,428.67        | 402.33         | 243.33        | 989.67              | 617.33        | 405.67             | 334.00        |
| Power Looms   | 10.00                                 | 6.00        | 21.60                  | 20.70        | 7.30          | 6.70            | N/A                         | N/A           | 196.00          | 160.00        | 2,205.00                 | 1,643.00        | 242.00         | 191.00        | 528.00              | 364.00        | 335.00             | 283.00        |
| Sugar Mills   | 6.74                                  | 4.52        | 24.50                  | 20.30        | 6.46          | 6.18            | 2,727.00                    | 1,762.50      | 3,785.60        | 2,476.00      | 3,895.20                 | 2,776.80        | 359.60         | 211.20        | 917.00              | 594.20        | 477.60             | 279.60        |
| Tanning and leather finishing projects  | 12.00                                 | 4.00        | 26.30                  | 26.10        | 8.90          | 7.60            | N/A                         | N/A           | 920.00          | 182.00        | 6,326.00                 | 3,230.00        | 846.00         | 218.00        | 1,096.00            | 810.00        | 716.00             | 292.00        |
| Textiles  | 10.92                                 | 6.40        | 23.80                  | 20.25        | 8.50          | 8.37            | 821.71                      | 273.13        | 1,211.20        | 521.91        | 5,364.50                 | 3,139.82        | 319.70         | 189.36        | 1,454.00            | 859.18        | 361.90             | 290.73        |
| <b>Grand Total</b>  | <b>14.24</b>                          | <b>7.78</b> | <b>23.74</b>           | <b>21.73</b> | <b>7.99</b>   | <b>7.59</b>     | <b>1,716.57</b>             | <b>936.07</b> | <b>1,420.12</b> | <b>811.97</b> | <b>4,046.71</b>          | <b>2,696.35</b> | <b>318.20</b>  | <b>184.65</b> | <b>943.79</b>       | <b>599.06</b> | <b>396.85</b>      | <b>283.94</b> |
| B*  | Before Treatment                      |             |                        |              | A*            | After Treatment |                             |               |                 | N/A           | Means Data not Available |                 |                |               |                     |               |                    |               |

## 5.2 Solid Waste Management Facilities

Solid waste management has become a critical issue throughout the Punjab province due to rapid urbanization, uncontrolled population, institutional weaknesses, and lack of resources and awareness of solid waste disposal.



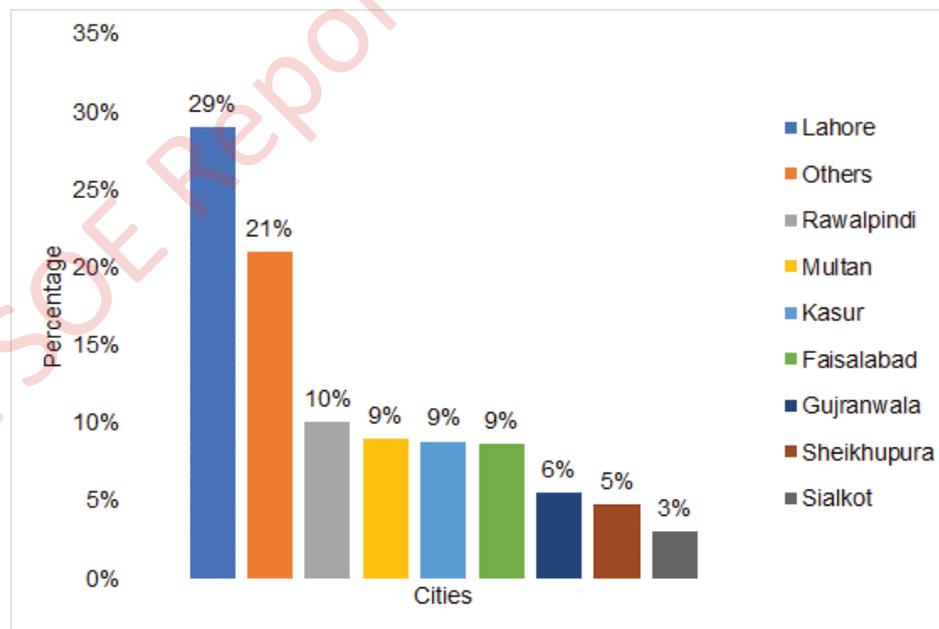
Punjab's average solid waste collection efficiency is around 50%, causing multiple diseases like diarrhea and dengue fever<sup>39</sup>.

The waste collected is normally dumped in open areas along the roadside, canal banks, and low-lying areas. Uncollected waste is illegally piled on sidewalks, in open spaces, sewer lines, or even in canals, and blockage of wastewater flow in the sewers is seen, causing an additional problem for the government.

There are no formal recycling systems in any of the municipalities in Punjab. Instead, most recycling activities are informal and occur at various stages of the waste management process, from collection to disposal. Typically, individuals retain recyclable materials such as paper, plastic, glass, and metal and then sell them to street vendors or waste dealers for recycling. Illegal dumping sites are prevalent throughout open spaces, and even authorized disposal sites are environmentally inadequate. The waste is deposited on the ground without any protective base to prevent leachate infiltration into the groundwater. The sites lack proper leachate collection and treatment systems and gas collection and control systems, which are essential for responsible waste management. Additionally, waste pickers at these sites impede efficient operations and pose a significant risk to public health. To reduce the volume of waste, dumpsites are often set on fire, adding to the air pollution caused by the left uncovered waste. Due to the absence of regulations and standards for landfill operations, compliance and monitoring are currently challenging. Furthermore, there is dire need to have a Plastic Management Strategy and Regulations on the production and consumption of single-use plastic.

### a. Municipal Waste

In Punjab, the municipal waste generation in Punjab is 15841.5 tons/day<sup>40</sup>. Lahore contributes highest in total waste generation in the province, followed by Rawalpindi, Multan, Kasur, Faisalabad, Gujranwala, Sheikhupura, and Sialkot. While the remaining 28 districts,



**Figure 34:** Comparison of percentage of MSW generation contributed by 36 districts in Punjab

categorized as 'others' collectively contribute 21% of total waste generation in Punjab (Figure 34)

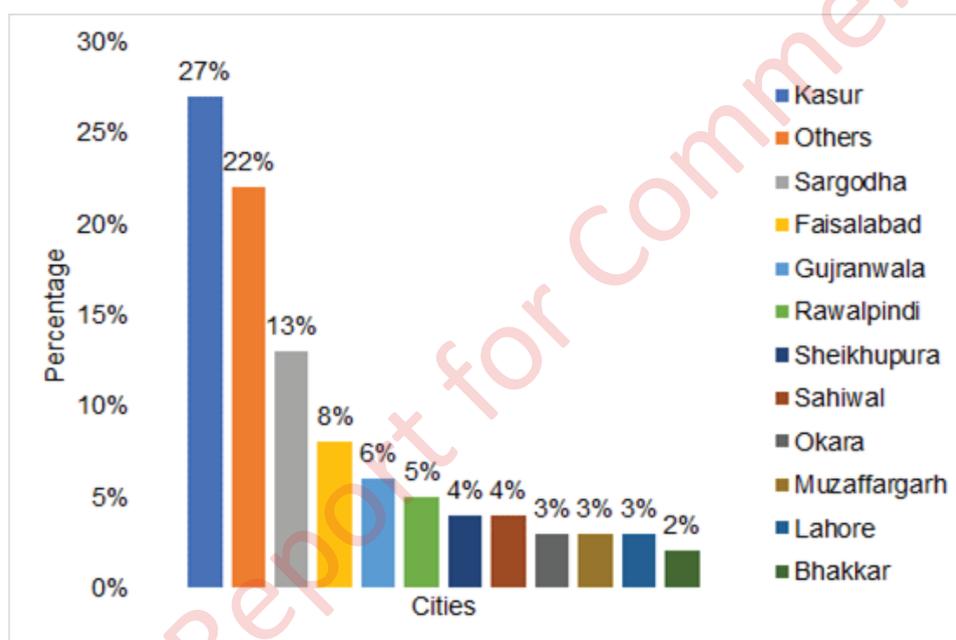
<sup>40</sup> EPA Punjab



### b. Hospital Waste

With more than 5000 major hospitals (more than 20 beds), safe disposal of hospital waste is a big challenge in the province. Only the major hospitals, all over Punjab, generate approximately 28355.85 kg of infectious waste per day, excluding the waste generation from numerous clinics, pathological laboratories, maternity homes, veterinary hospitals, clinics and research institutes and other facilities engaged in healthcare services<sup>41</sup>.

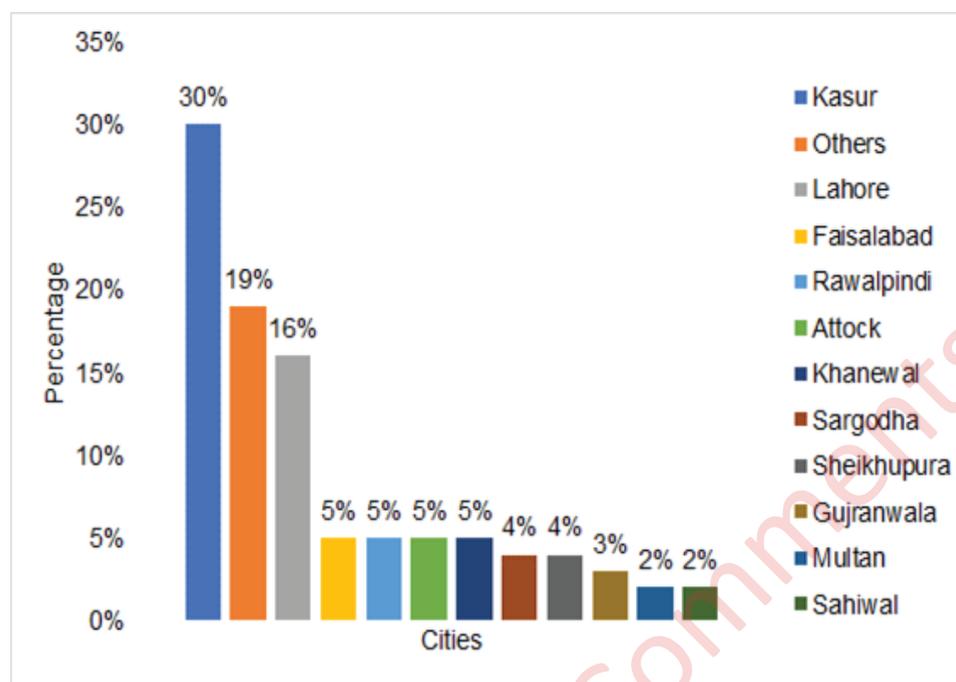
As far as the hospital waste collection is concerned, the survey conducted by EPA field offices reveal that the collection rate in Kasur is highest, followed by Sargodha Faisalabad, Gujranwala, Rawalpindi, Sheikhupura, Sahiwal, Okara, Muzaffargarh, Lahore and Bhakkar. The remaining districts, represented as 'others' showed a collection percentage of 22.1% (Figure 35)



**Figure 35:** District wise comparison of incineration capacity in Punjab (%)

Kasur has highest incineration capacity, 30.2%, followed by Lahore, Faisalabad, Khanewal, Attock, Rawalpindi, Sargodha, Sheikhupura, Gujranwala, Multan, and Sahiwal. The incineration capacity of other districts is 19.2% as a whole (Figure 36).

<sup>41</sup> Hospital Inventory (2021), EPA Punjab



**Figure 36:** District wise comparison of hospital waste collection in Punjab (%)

### c. Environmental Performance of Solid Waste Management Facilities

For purposes of this report, the assessment of environmental performance of landfill/open dumping sites and incineration facilities located in four districts, Lahore, Faisalabad, Rawalpindi, and Multan was carried out. Table 23 show the basic information relevant to the solid waste management in the selected district.

**Table 23:** Features of Study Area

|                       | Lahore <sup>42</sup>                                 | Multan <sup>43</sup>                             | Faisalabad <sup>44</sup>                        | Rawalpindi <sup>45</sup>                         |
|-----------------------|--|--|---|--|
| <b>Area</b>           | 1772 km <sup>2</sup>                                 | 3721 km <sup>2</sup>                             | 1330 km <sup>2</sup>                            | 479 km <sup>2</sup>                              |
| <b>Population</b>     | 11.1 million people                                  | 2.0 million                                      | Above 3.5 million                               | 2.1 million                                      |
| <b>MSW Generation</b> | 6000-6500 tons/day at the rate of 0.54 kg/capita/day | 1,000 tons/day at the rate of 0.48/kg/capita/day | 1600 tons/day at the rate of 0.45 kg/capita/day | 1280 tons/day, at the rate of 0.61 kg/capita/day |

Environmental performance of these facilities was assessed on the basis of their contribution in air, water and soil pollution. For this, leachate, ambient air and soil quality was tested from the selected municipal waste dumping sites, whereas, stack emissions and fly ash were tested from selected incineration facilities located in the study area. Brief Description of results of environmental analyses conducted is as follows:

<sup>42</sup> LWMC, "Municipal waste characterization study," Lahore Waste Management Company, Lahore, 2022.

<sup>43</sup>Arshad, R et al 2021. Solid Waste Management - An Integrated Approach towards Sustainability in Multan. European Journal of Applied Science and Technology-Novus (EJAST), pp. 44-70

<sup>44</sup>Aslam, B et al, 2022. Identifying and Ranking Landfill Sites for Municipal Solid Waste Management: An Integrated Remote Sensing and GIS Approach. Buildings, 12(5), 605.

<https://doi.org/10.3390/buildings12050605>.

Ilmas et al. 2021. Characterization and energy potential evaluation of urban municipal solid waste of Pakistan. Carbon Management, 12(6), 581-591. <https://doi.org/10.1080/17583004.2021.1976675>.

**Leachate** - The leachate from landfill/open MSW dumping sites was tested for pH, COD, BOD, TSS, Cadmium, Arsenic, Ammonia, Cadmium and Zinc. The results indicate that except pH, all the tested parameters were beyond PEQS limits ( Figure 37).

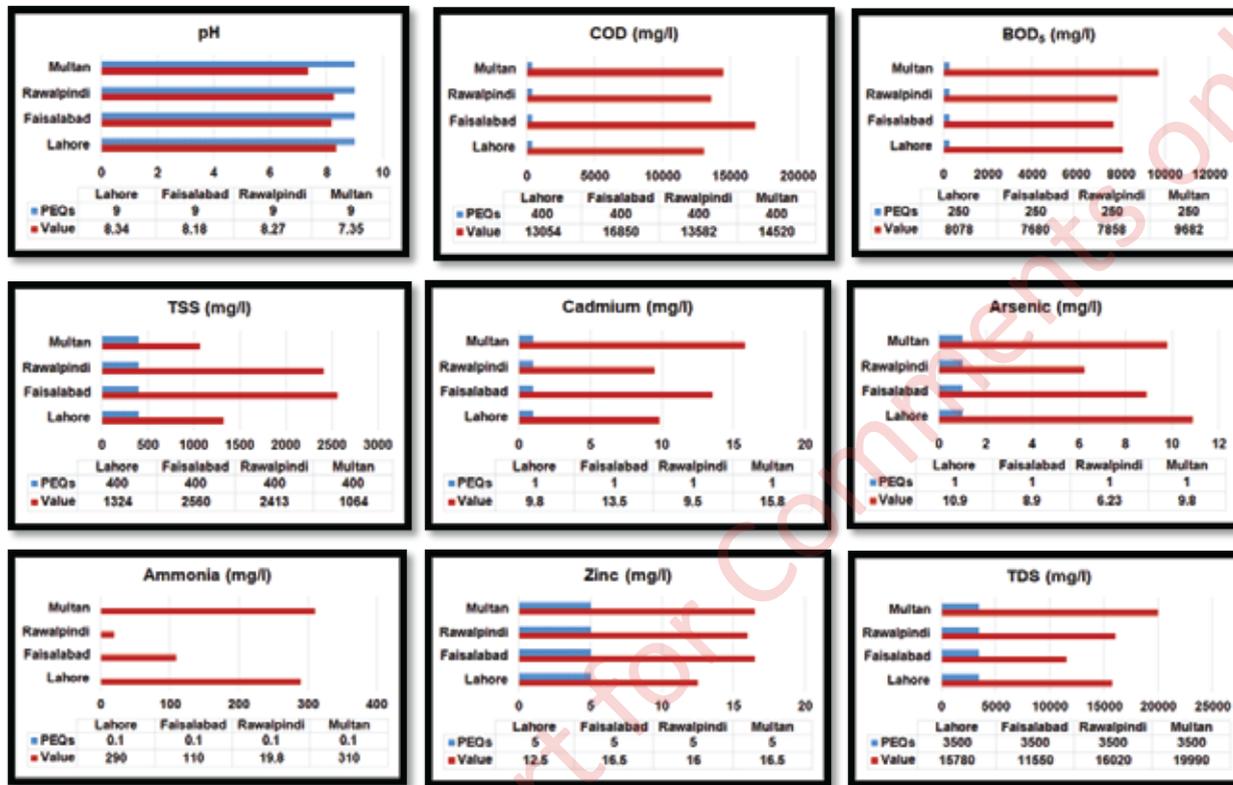


Figure 37: Results of Leachate Analyses in study area

**Soil:** - The soil from landfill/open MSW dumping sites was tested for pH, Cadmium, Arsenic. The results indicate that pH and arsenic were beyond US EPA limits (Figure 38)

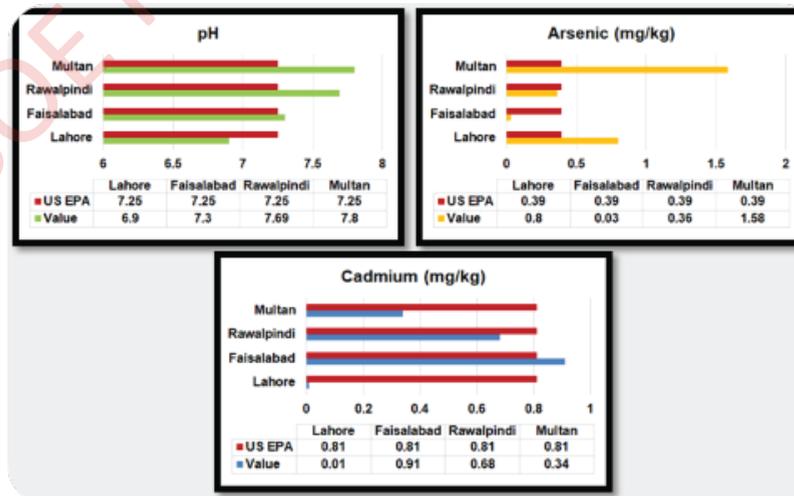
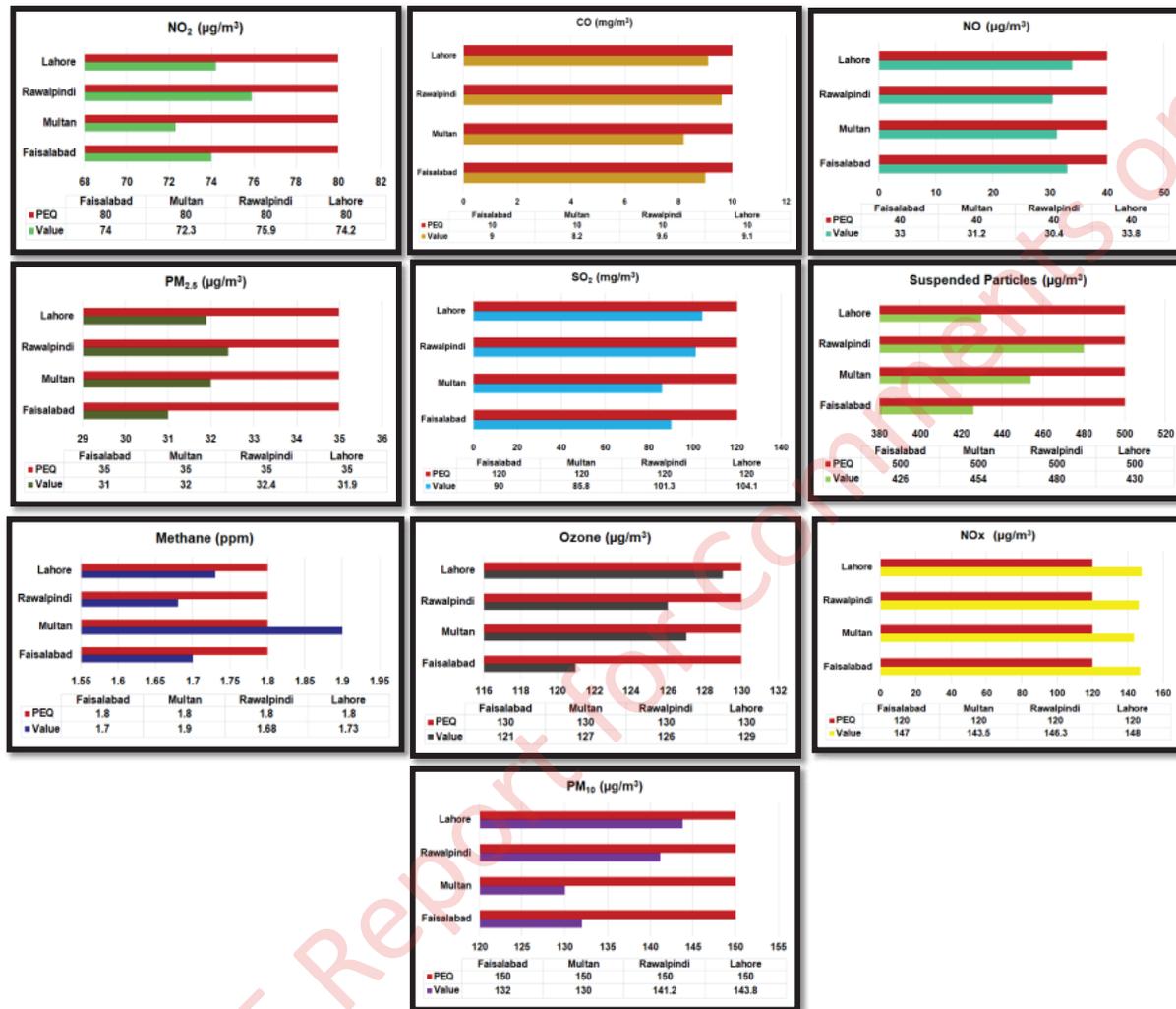


Figure 38: Results of Soil Analyses in study area (values compared with USEPA Standards for soil quality)

**Ambient Air** The landfill/open dumping sites were also assessed for their ambient air quality (**Error! Reference source not found.**). The results indicate that the NO<sub>x</sub> were beyond



**Figure 39:** Results of Ambient Air Quality Analyses at landfill sites located in study area

PEQs in the sites located in all the four districts, whereas, in Multan, the level of methane at the landfill/open dumping site was beyond the permissible limits.

**Stack Emissions and Ash Analysis** The percentage of moisture content (MC) and unburnt carbon (UC) was determined in the bottom ash produced from selected public and private incinerators of Lahore, Faisalabad, Rawalpindi and Multan. Unburnt carbon was found in all the samples of bottom ash. As far as the stack emissions are concerned, all the parameters tested were found within permissible limits as per PEQS from all the incineration facilities located in the study area.



### d. Solid Waste Management Index

#### (i) Methodology

The Solid Waste Management Index for the four districts, Lahore, Faisalabad, Rawalpindi and Multan was calculated using following equations.

$$K - X = Y \dots\dots\dots(i)$$

$$Y \times 100 / K = Z \dots\dots\dots(ii)$$

K= PEQ value of parameter

X= Observed value of parameter

Y= +/- variation from PEQ

Z= +/- %

Then all the Z values were added and divided by common denominator to Normalize the value as Single score between 0 to 100.

#### (ii) Color coding

Color coding was categorized by different scales (0-14 as dark red, 15-28 as light red, 29-42 as yellow, 43-56 as light blue, 57-70 as dark blue, 71-84 as light green, and 85-100 as dark green). Single score was calculated after normalization between 0 to 100. 0 is the worst score and 100 best score. There are some figures that denote color coding of all five parameters.

#### (iii) Leachate

All the cities showed negative score, but Multan has shown the most negative score for leachate (Figure 40). Leachate from Rawalpindi landfill site is at top from all four sites. Some parameters have shown very high negative results like Ammonia, TDS (Total Dissolved Solids), COD, and BOD5.

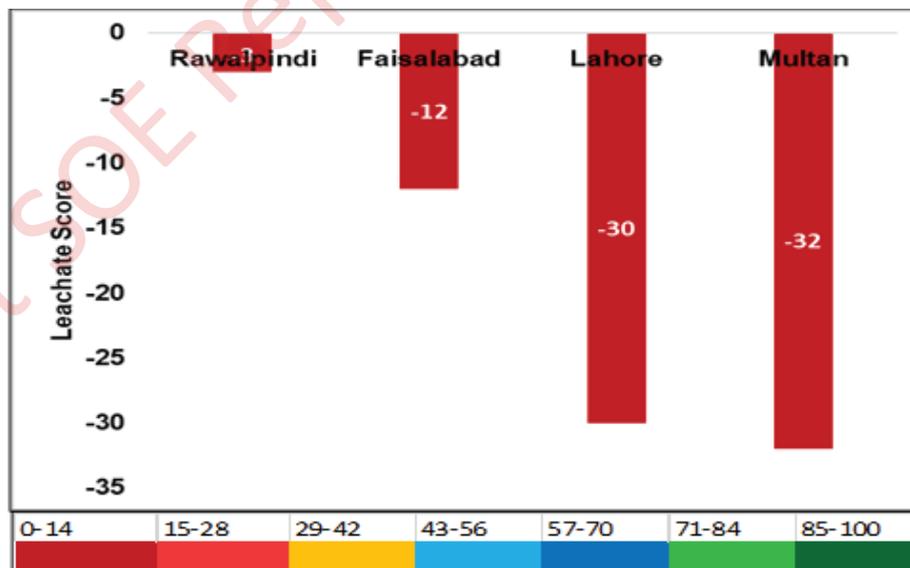


Figure 40: Leachate score of four cities



### (iv) Stack Emissions

Stack emissions results of all the cities have shown positive results (Figure 41). There is no negative value in the whole normalized chart.

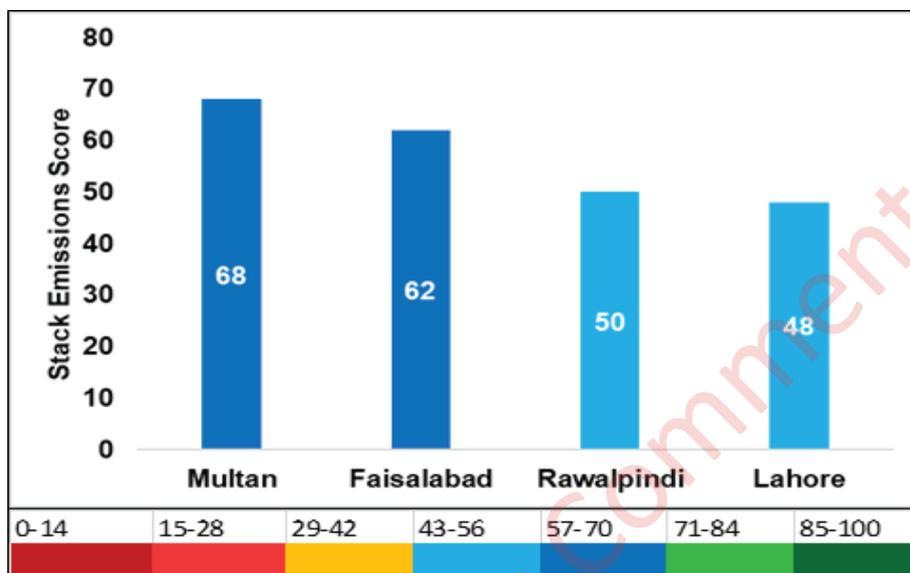


Figure 41: Stack emissions score of four cities

### (v) Ambient Air Quality

All the parameters tested for ambient air quality were within PEQS, except NOx. Faisalabad and Lahore have shown same score in terms of ambient air quality at landfill/open dumping sites. (Figure 42),

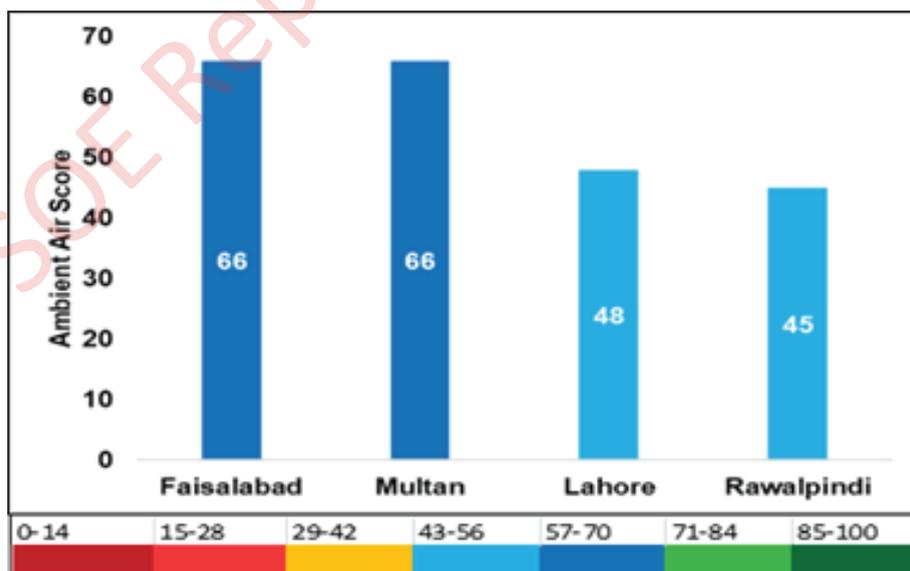


Figure 42: Ambient Air score of four cities



### (vi) Soil analysis

Soil analysis showed higher levels of Arsenic in the soil tested from landill/open dumping site located in District Multan, leading to its lower score among other districts (Figure 43).

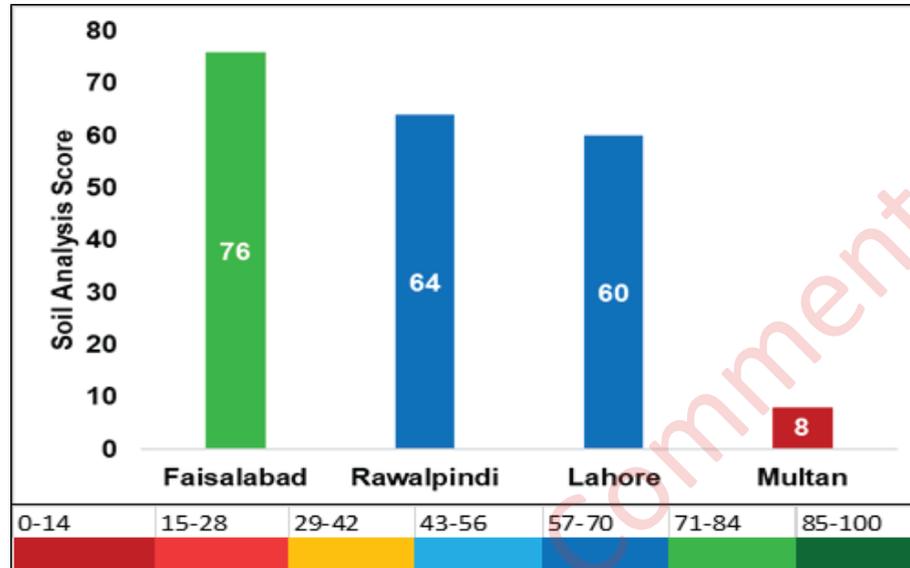


Figure 43: Soil Analysis score of four cities

### (vii) Ash Analysis

Overall score of Ash analysis is positive (Figure 44). There is no PEQ standard for incinerator ash, so average value was taken as standard to compare the values of four cities. Multan showed the best score among all the cities.

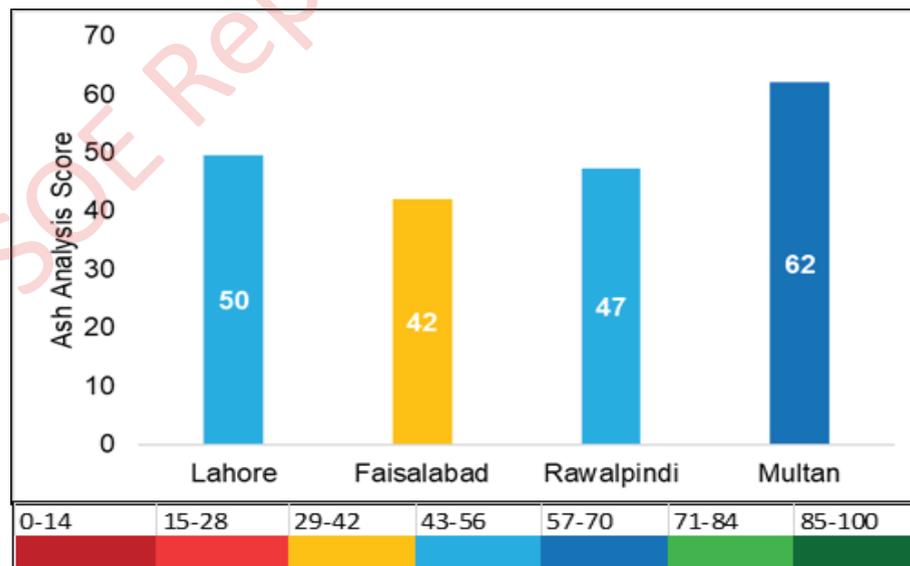


Figure 44: : Ash Analysis score of four cities



### (viii) Overall Solid Waste Management Index

Overall single score of four cities were calculated after the addition of all the parameters single scores and normalization of data between 0-100 (Figure 45). In the study area, District Faisalabad was ranked first in terms of environmental performance of SWMFs followed by Lahore, Rawalpindi and Multan.

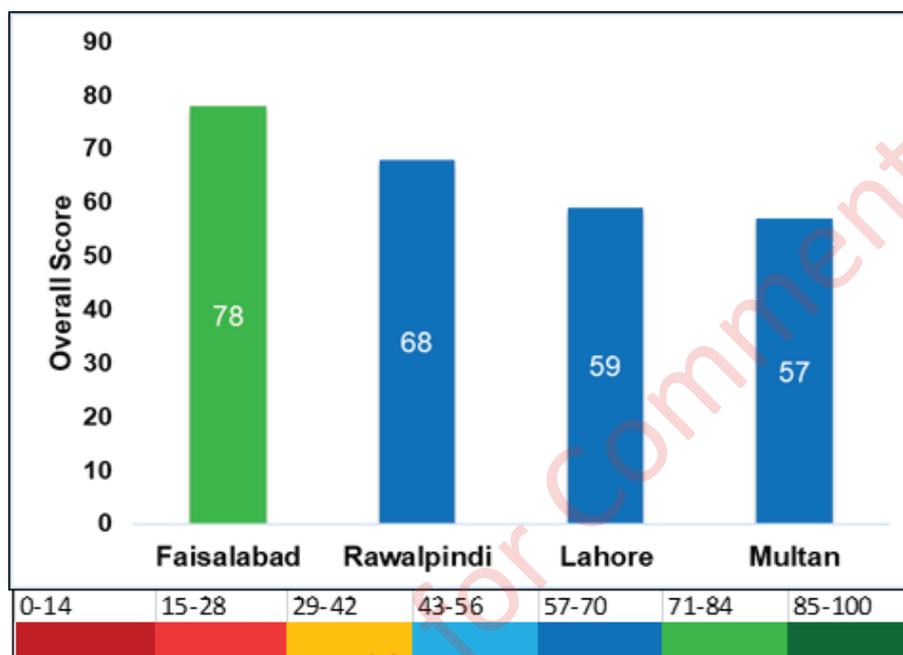
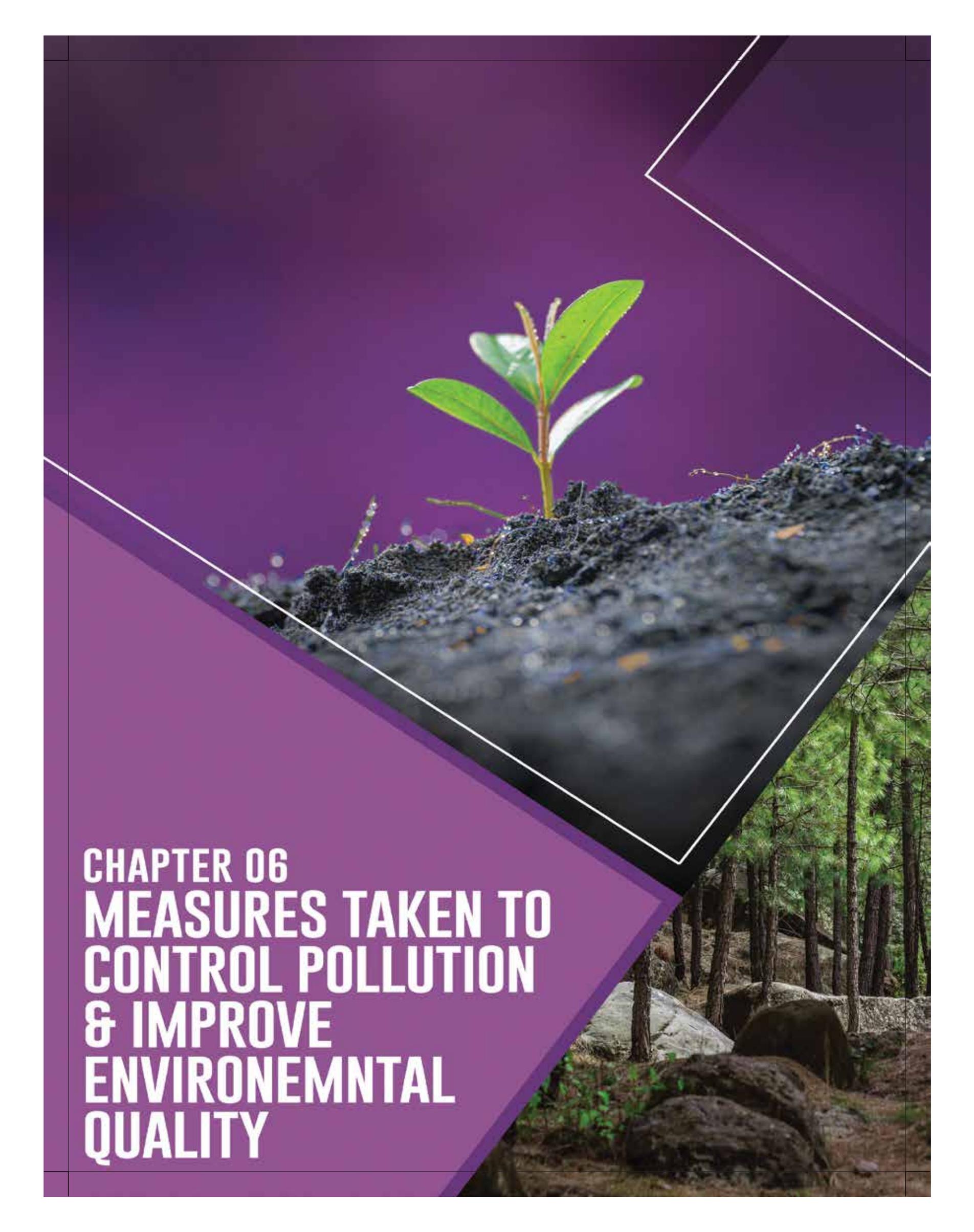


Figure 45: : Total Score of four cities

### 5.3 Conclusions:

A Solid waste management index was developed to assess the environmental performance of solid waste management facilities in four districts of Punjab. The index may be used to extend the assessments in all districts of Punjab. overall findings of the study reflects that although most of the indicators selected to score the selected districts showed positive trends in terms of compliance with environmental quality standards, but the solid waste management system in the province still needs to be improved in terms of scientific landfills well-equipped with the impermeable lining and methane collection system, implementation of recycling practices to minimize the volume of waste and streamlining and simplification of responsibilities at different tiers of governance.

The environmental governance lacks the E-waste management rules, hazardous substance/ waste management policy and rules etc. Further actions are required regarding establishment of integrated solid waste management facilities in each urban as well as rural areas, cleanup of the heaps of garbage spread around the vicinity and rehabilitation of land, waste minimization (reduce, recycle, and reuses of MSW) to improve waste collection efficiency, installation of waste to energy projects in urban center, provision of hospital waste management facilities by large private hospitals (having more than 30 beds) and provision of industrial waste management facilities in industrial or cluster levels.

The image features a young green plant with several leaves growing out of a mound of dark, rich soil. The background is a blurred forest of tall, thin trees, likely pines, with large rocks in the foreground. The entire scene is framed by a dark purple background with white geometric lines forming a large triangle that points towards the bottom right.

**CHAPTER 06  
MEASURES TAKEN TO  
CONTROL POLLUTION  
& IMPROVE  
ENVIRONMENTAL  
QUALITY**



## 6. CHAPTER SIX

### 6.1 Measures Taken to Control Pollution

Environment Protection Agency (EPA) Punjab, established under the Punjab Environmental Protection Act (PEPA), 1997, strives for protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. The key endeavors by EPA Punjab to control pollution during the CY 2022 are as follows:

#### a. Environmental Approvals

§ 12 of the Act *ibid*, read with the “Punjab Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations, 2022”, requires proponent of a project to obtain Environmental Approval from EPA Punjab before the commencement of any project<sup>46</sup>. For acquiring the Environmental Approvals, the project proponents have to submit either an Initial Environmental Examination (IEE) or an Environmental Impact Assessment (EIA) (Schedule – I and Schedule – II of the Regulations, respectively). The project proponents also have to seek approval from EPA Punjab before operationalizing their projects, after submitting the compliance status reports of the conditions imposed in the Environmental Approval for construction phase. The environmental approvals are issued to the project proponents with certain conditions, including but not limited to the regular monitoring of their stack emissions and installation of pollution control devices, in order to ensure compliance with PEQS. In this way, EPA Punjab regularizes the development projects from environmental perspective and hence, promotes the sustainable development.

#### b. Anti-smog Campaign – 2022:

EPA Punjab initiated Anti-smog measures well before the onset of winter season in CY 2022 and launched an Anti-smog campaign as a pre-emptive measure to control the seasonal high air pollution levels.

#### c. Anti-smog squads

Anti – smog squads were notified in major districts including Lahore, Gujranwala, Faisalabad, Multan and Sheikhpura, besides the regular monitoring teams of EPA Punjab. The squads comprised the representatives from field offices and laboratories of EPA Punjab, Punjab Police, office of Assistant Commissioner (AC) concerned and Municipal Corporation (MC)/Town Committees (TCs) and were assigned with the duty to proceed against the polluting units/industries and submit their daily anti-smog progress to the departmental representative through District and Divisional anti-smog committees. In wake of major contributions of agriculture slash & burn activities, municipal waste burning and vehicular emissions in smog formation, the Department requested administrative secretaries of Agriculture, Local Government & Community Development, Transport and Industries Department to establish Smog Cells in their departments, to carry out and coordinate the anti-smog activities through their field formation. Special squads were also notified for checking of vehicular pollution, comprising motor vehicle examiners, representatives from Vehicular Inspection and Certification System (VICS), representatives from traffic police and EPA Punjab.



#### d. Android Application and Complaint Line

In collaboration with Punjab Information Technology Board (PITB), EPD Punjab has developed an android application, equipped with a dashboard. The application is used by the anti-smog squads for uploading the geo-tagged monitoring data, of the industrial units inspected, to the dashboard. The control room monitors and tracks the movement of squads. To facilitate public, a WhatsApp complaint number has also been launched for receiving complaints on the pollution sources from all over the province, in addition to already installed telephone line. All the squads were directed to take the action on citizen complaints within 24 hours.

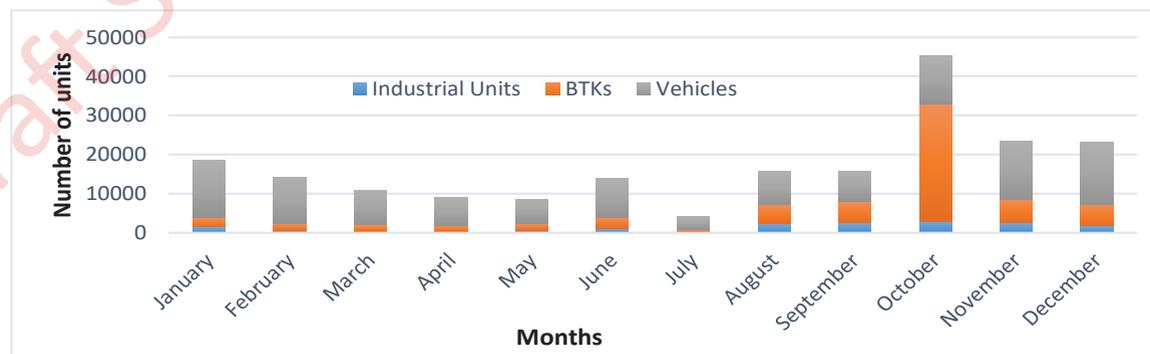
#### e. Control Room

A Control Room was established in Environment Protection Department, Punjab in August 2022, for continuous smog monitoring and collecting information regarding anti-smog activities from all departments. In the Control Room, eight LEDs have been displayed to monitor the overall air quality conditions and tracking the movement of Squads all over the Punjab. Two different shifts of dedicated staff have been deputed in the Control Room for monitoring and continuous operations. The control room captures NASA's real time, geo-tagged imagery for thermal anomalies arising from crop/open burning in the region. SUPARCO also shares with EPD Control Room the real-time thermal anomalies data in the province. The information is then disseminated to the concerned Deputy Commissioner and Agriculture department for prompt action against the violators.

In order to track the possible variations in the smog intensity, the wind direction and weather forecast issued by Pakistan Meteorological Department (PMD) is also displayed in the control room. Moreover, the real time Air Quality Index (AQI) data, originating from the air quality monitoring devices (low – cost sensors) installed in most polluted areas of District Lahore, including Karol Ghatti along the Ring Road, is also being continuously monitored in the control room, to take swift decisions regarding the directions for the movements of anti-smog squads to the pollution hotspots.

#### e. Regulatory and Enforcement Actions taken during Campaign

The anti-smog squads were assigned with the responsibilities of inspecting major smog-emitting sources, including the industrial units operating without pollution control devices, stone crushers, old technology brick kilns (BTKs), pyrolysis plants and the smoke emitting vehicles. During 2022, 16770 industrial units including the stone crushers, 63979 brick kilns, 12184 vehicles and 168 pyrolysis plants were inspected. Month wise inspections of industries Units, BTKs and vehicles are given (Figure 46) details of action taken are also given (Table 24)



**Figure 46:** Number of Inspections of Smoke emitting sources in Punjab during CY 2022



**Table 24:** Actions taken against smoke-emitting facilities during 2022

| Month        | Industrial Units including the stone crushers |             |               | Stone Crushers Operating without wet scrubbers |             |              | Non-Compliant Brick Kilns (BTK) |                  |             | Pryolysy Plants |                  |                 |                                |             |
|--------------|---|-------------|---------------|--|-------------|--------------|---------------------------------|------------------|-------------|-----------------|------------------|-----------------|--------------------------------|-------------|
|              | Units Inspected                               | FIRs Lodged | Units Sealed  | Units Inspected                                | FIRs Lodged | Units Sealed | Units Inspected                 | Fine Imposed     | FIRs Lodged | Units Sealed    | Plants Inspected | Violating Plant | Units sealed/operation stopped | FIRs lodged |
| January      | 1000  | 11          | 32            | 466  | 9           | 24           | 2348                            | 2193271          | 75          | 47              | 0                | 0               | 0                              | 0           |
| February     | 569   | 10          | 15            | 0  | 0           | 0            | 1684                            | 1915003          | 42          | 32              | 0                | 0               | 0                              | 0           |
| March        | 378   | 0           | 4             | 12   | 0           | 0            | 1629                            | 2625001          | 59          | 8               | 0                | 0               | 0                              | 0           |
| April        | 323   | 0           | 15            | 18   | 0           | 0            | 1349                            | 1400000          | 24          | 12              | 0                | 0               | 0                              | 0           |
| May          | 458   | 1           | 3             | 105  | 0           | 14           | 1609                            | 2015014          | 120         | 25              | 0                | 0               | 0                              | 0           |
| June         | 898   | 39          | 29            | 128  | 9           | 9            | 2896                            | 6857019          | 233         | 76              | 0                | 0               | 0                              | 0           |
| July         | 247   | 0           | 5             | 40   | 0           | 0            | 473                             | 510004           | 33          | 12              | 0                | 0               | 0                              | 0           |
| August       | 2039  | 57          | 128           | 351  | 43          | 5            | 4877                            | 5910001          | 248         | 336             | 69               | 17              | 7                              | 10          |
| September    | 2216  | 45          | 78            | 303  | 4           | 40           | 5491                            | 9825011          | 170         | 511             | 58               | 17              | 7                              | 7           |
| October      | 2187  | 124         | 135           | 643  | 32          | 105          | 30260                           | 74258027         | 1580        | 204             | 21               | 8               | 5                              | 4           |
| November     | 1863  | 67          | 100012        | 682  | 30          | 47           | 6042                            | 22255010         | 405         | 267             | 13               | 8               | 15                             | 1           |
| December     | 1603  | 45          | 53            | 241  | 5           | 18           | 5321                            | 7868000          | 234         | 80              | 7                | 2               | 2                              | 0           |
| <b>Total</b> | <b>13781</b>                                  | <b>399</b>  | <b>100509</b> | <b>2989</b>                                    | <b>132</b>  | <b>262</b>   | <b>63979</b>                    | <b>137631361</b> | <b>3223</b> | <b>1610</b>     | <b>168</b>       | <b>52</b>       | <b>36</b>                      | <b>22</b>   |

An active regulatory and enforcement drive was initiated against smoke emitting vehicles with assistance from the Traffic Police. (Table 25)

**Table 25:** Actions taken by EPD Punjab against Smoke Emitting Vehicles during 2022

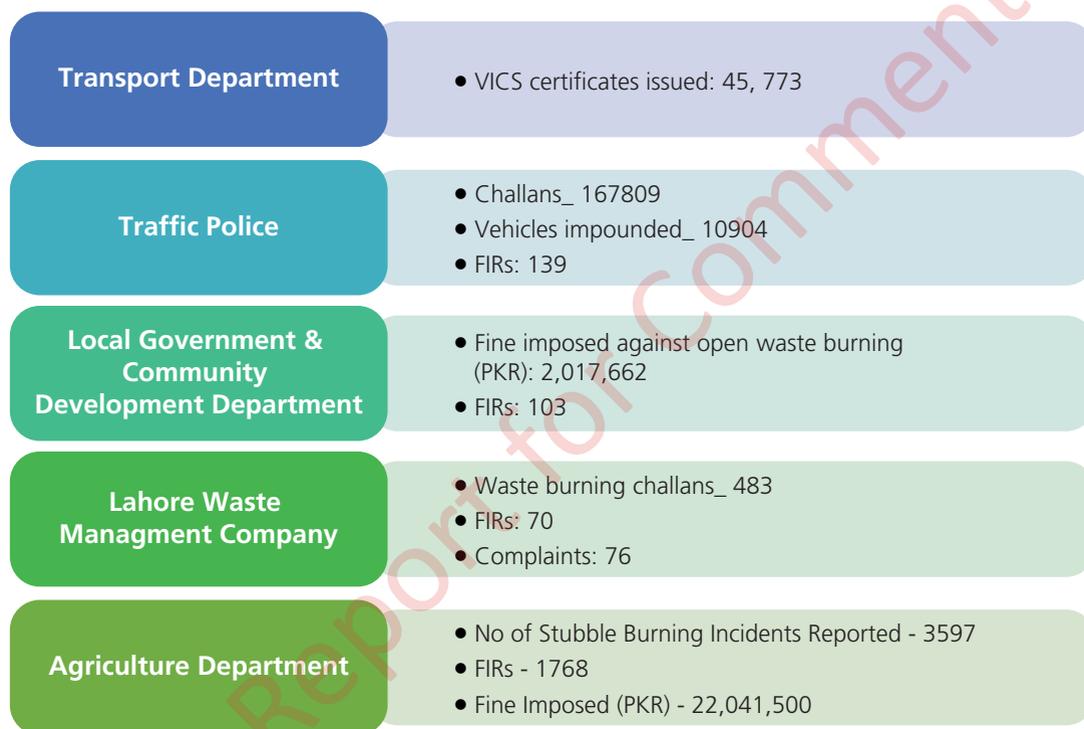
| Month        | Vehicles Checked | Vehicles Challaned | Fine Imposed      | Vehicles Impounded | FIRs Lodged  |
|--------------|------------------|--------------------|-------------------|--------------------|--------------|
| January      | 14,654           | 4,860              | 3,178,750         | 503                | 11           |
| February     | 12,008           | 8,830              | 2,078,655         | 2,709              | -            |
| March        | 8,747            | 2,290              | 1,137,950         | 57                 | -            |
| April        | 7,268            | 1,902              | 774,055           | 12,937             | 7,550        |
| May          | 6,484            | 1,653              | 762,700           | 54                 | 1            |
| June         | 10,070           | 2,999              | 1,220,351         | 787                | -            |
| July         | 3,486            | 762                | 908,500           | 102                | -            |
| August       | 8,486            | 1,551              | 1,126,800         | 219                | -            |
| September    | 7,742            | 1,972              | 2,043,500         | 300                | -            |
| October      | 12,138           | 2,750              | 4,497,900         | 681                | -            |
| November     | 14,749           | 3,527              | 5,134,600         | 687                | -            |
| December     | 15,982           | 3,604              | 5,089,400         | 662                | -            |
| <b>Total</b> | <b>121,814</b>   | <b>36,700</b>      | <b>27,953,161</b> | <b>19,698</b>      | <b>7,562</b> |



Furthermore, Government of the Punjab imposed a complete restriction on the manufacturing, transportation and use of Pyro-carbon powder, along with usage of thrift clothes/apparel in the burning process by industrial units, under § 144 of CrPC, vide Order dated 25-10-2022, in an effort to curtail smog – emitting sources.

### g. Action taken by other Departments:

During anti-smog campaign, EPD Punjab, adopting an integrated approach, coordinated with concerned stakeholder departments with the request to contribute for curtailing smog in the province. Different departments took anti-smog initiatives and reported EPD’s Control Room accordingly, through their focal persons. Some key steps taken by multi-stakeholder in coordination with EPD Punjab are as follows: (Figure 47).



**Figure 47:** Actions taken by other departments

### h. Smog Policy & Action Plan

EPD Punjab successfully updated the “Policy on Controlling Smog” (2017) as “Punjab Clean Air Policy”. A Clean Air Action Plan was also developed under the umbrella of this policy.

### i. Punjab Green Development Program

EPD Punjab is executing a World Bank funded Punjab Green Development Program (PGDP) with the main objectives of strengthening environmental governance and promoting green investments in Punjab. Along with EPD, Transport Department, Energy Department, Industry Department and Finance Department are the implementing Agencies for this Program. It is a 273 million USD program, with a duration from 2018-2025. The program comprises eight disbursement linked indicators, listed below (Figure 48):



|              |  |
|--------------|--|
| <b>DLI 1</b> | Improving EPD'S Capacity                                       |
| <b>DLI 2</b> | Air and Water Quality Monitoring                               |
| <b>DLI 3</b> | Disclosure of Environmental Information and Citizen Engagement |
| <b>DLI 4</b> | Sound Management of Plastics                                   |
| <b>DLI 5</b> | Energy Efficiency Investments in Public Institutions           |
| <b>DLI 6</b> | Vehicle Compliance with Emission Standards                     |
| <b>DLI 7</b> | Green Investments by Polluting Industries                      |
| <b>DLI 8</b> | Mobilization of Sustainable Green Financing                    |

**Figure 48:** Punjab Green Development Program (PGDP)

First four DLIs are related to environmental governance whereas, DLI 8 is directly related to the green investments. EPD Punjab has an active role in these DLIs, whereas DLI 5-7 are being implemented by Energy, Transport and Industries Department respectively. Under DLI-2, EPD Punjab has launched a Scheme titled "Enhancing the air quality monitoring system in Punjab" and is making advancements in this project at a rapid pace. The scheme envisions the installation of 30 Air Quality Monitoring Stations (AQMS) in 10 districts of Punjab i.e. Lahore, Gujranwala, Sheikhpura, Multan, Rawalpindi, Bahawalpur, Sialkot, DG Khan, Faisalabad and Sargodha. The AQMS will monitor six criteria air pollutants as well as some meteorological parameters significant in context of ambient air pollution. Sites for these installations were identified and pre-qualification of contractors for installation and operationalization of AQMSs was commenced during 2022. Furthermore, the work on repair and upgradation of existing nine AQMS was also initiated. Similarly, in scheme titled "Enhanced Water Quality Monitoring System in Punjab" at least 15 water quality monitoring stations will be installed along surface water bodies located in different districts of Punjab. A typical water quality monitoring station will comprise a combination of different analyzers/probes for pollutant measurements, a real – time flow information and data logger. The stations will be linked with an integrated data acquisition system, housed in Environmental Monitoring Center (EMC), EPD Punjab. For establishment of EMC, another scheme is in pipeline.

## j. ADP Schemes

### (i) Revision of Existing Punjab Environmental Quality Standards and Development of Industry-specific Environmental Quality Standards

A scheme titled "establishment of missing environmental quality standards and revision of existing standards" was initiated, which aimed, not only to rationalize the existing PEQS for their effective enforcement but also to develop industry-specific standards. The project proposal got approved during 2022 and execution of project was commenced. In first phase, sixteen (16) major polluting industries i.e. Paper and Pulp industry, Ceramic industry, Paint industry, Pesticide industry, Tanneries and Leather industry, Brick Kiln sector, Cement Plants, Stone Crushing units, Thermal power plants, Ethanol and distilleries, All integrated textile units of cotton, woolen, polyester, units having printing, dyeing bleaching process or manufacturing and garment units, Foundries and smelting industries, Pharmaceutical industries, Sugar industries, Polymer and Plastics and Chemical industry (Acid Manufacturing) were selected for which the development of environmental quality standards has been commenced.



### (ii) Pilot Project for low-cost wastewater treatment plants

EPD Punjab envisages the identification, design, and piloting low-cost and decentralized technologies, such as constructed wetland, to treat domestic wastewater for small towns, villages, housing colonies, and the like. In this context, a pilot project on low-cost waste water treatment plant, has been proposed. The project proposal is in process of approval.

### (iii) Apportionment of Pollution Sources

EPD Punjab has also initiated a study titled as **“Investigating Sources of Particulate Matter for Informed Decision Making in Punjab”** in six major districts, in collaboration with Space & Upper Atmospheric Research Commission (SUPARCO). The study includes All-Seasons in-situ Particulate Matter Monitoring and Speciation, Satellite based Monitoring of Atmosphere, Emission Sources data and GIS and Model based Assessment of Air Quality.

## 6.2 Measures Taken to Improve Environmental Quality

Act *ibid* provides EPA Punjab with different powers and functions under § 6, leading to the improvement in environmental quality. These include taking measures to promote research and the development of science and technology, identifying the needs for, and initiate legislation in various sectors of the environment, rendering advice and assistance in environmental matter, providing assistance to the local councils, local authorities, Government Agencies and other persons to implement schemes for the proper disposal of wastes, providing information and guidance to the public environmental matters, recommending environmental courses, topics, literature and books for incorporation in the curricula and syllabi of educational institutions, promoting public education and awareness of environmental issues through mass media and other means, including seminars and workshops and taking all necessary measure for the protection, conservation, rehabilitation and improvement of the environment.

2022 was the year wherein the country experienced unprecedented heatwaves and devastating floods, causing massive loss and damages. This year, the subjects of “changing environment” and climate’ became the ‘talk of the town’. EPA Punjab has initiated multiple endeavors to contribute for the sake of environment and climate change this year. Some endeavors for improvement of environmental quality are as follows:

### a. Hospital Waste Management

In light of the Punjab Hospital Waste Management Rules (2014) notified under § 31 of the Act, EPA Punjab regulates the infectious hospital waste generated at both public and private healthcare facilities from generation to final disposal through surveillance/inspection/surveys at provincial level. The Rules require the managements of all hospitals to ensure safe disposal of infectious hospital waste during its collection, transportation, storage, treatment, and disposal.

District In-charge Officers/District Officers (Environment) conduct random inspections of the public and private hospitals located in their area of jurisdiction to ensure implementation of the Rules. All such inspections are reported to EPA HQs regularly. Contravention(s) of any provision of the Rules are dealt under § 16 of the Act *ibid* (Rule 23). In case of continuous violation and non-compliance of the Orders passed by the Agency §16 of the Act, the Departmental Complaints are regularly instituted before the Punjab Environmental Tribunal § 21 of the Act *ibid*.



EPA Punjab has devised a format for Monthly Reporting on implementation of the Rules from EPA Field formation, wherein the District In-charge officers apprise EPA HQs regarding total number of hospitals inspected in a month and legal action taken against the violators. During 2022, around 2169 public and private hospitals were inspected by EPA Punjab to check the implementation of these Rules. Subsequent to these inspections, around 832 hearing notices and 123 Environmental Protection Orders were issued to the non-complaint hospitals.

### **b. Tree Plantation**

EPA Punjab acknowledges that such tree species must be planted which may contribute in environmental improvement such as carbon-capturing and sequestration, soil stability, water retention, aquifer recharge, provision of habitat, releasing ample amount of oxygen, absorbing CO<sub>2</sub> and PM holding capacity.

EPA HQs issued directions to EPA Field formation to prohibit the plantation of Conocarpus (Buttonwood) in their respective districts and substitute the already planted Conocarpus wherever possible. Conocarpus (Buttonwood) species is not preferred for plantation and has been banned in many countries due to allergic pollens, extensive root system, undermines the growth of other trees planted near it, uses the large quantity of underground water and it bears no fruits or flowers.

The mainstays for tree plantation being executed by EPA Punjab are as follow:

#### **(i) Clean Green Pakistan (CGP)**

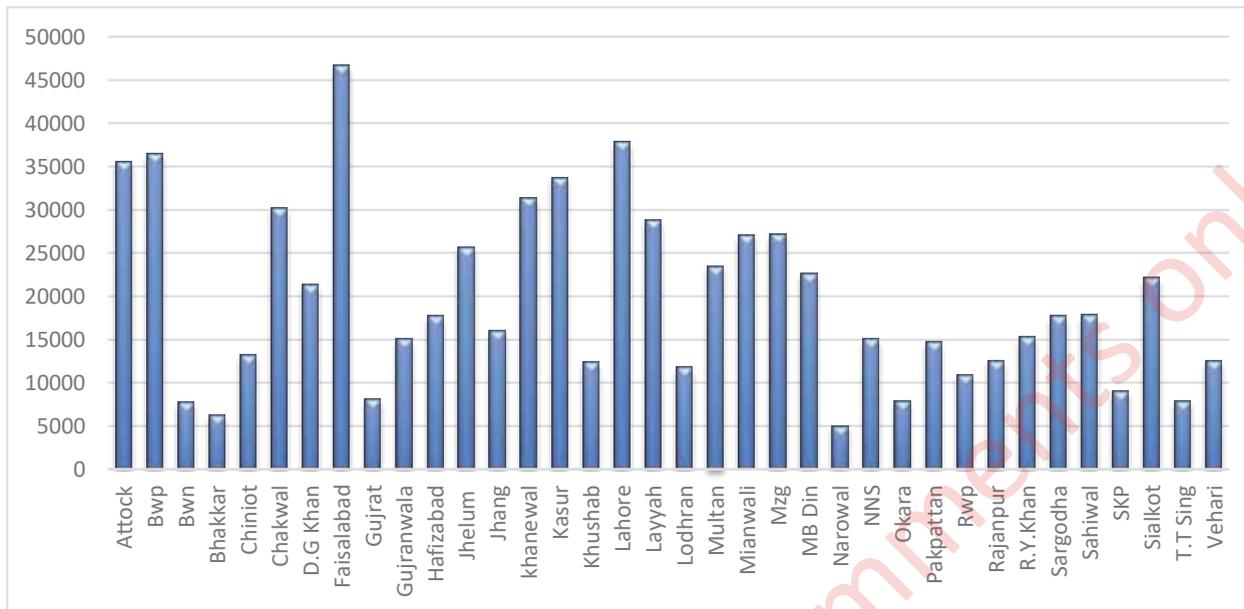
In order to execute the "Tree Plantation" component of Government's 'Clean & Green Pakistan Initiative' in the Province, EPA Punjab in collaboration with other stakeholders is executing Tree Plantation Campaign from last 04 years.

#### **(ii) Plantation under Environmental Approvals (EAs)**

EPA Punjab accords environmental approvals to industrial projects under § 12 of the Act, which, among other conditions, entrust the project proponents with the responsibility for plantation of specific number of trees in project area under the supervision of concerned District in-charge officer of EPA Punjab.

### **c. Tree Plantation during the Year 2022**

A total of **705,650** Trees were planted under the supervision of EPA Field officers throughout Punjab in collaboration with multiple stakeholders (Figure 49).



**Figure 49: Tree Plantation Progress**

In addition to regular tree plantation activities, EPA Punjab contributed in following special tree plantation drives:

### (i) Spring Tree Plantation Campaign, 2022

Punjab Forest Department commenced tree plantation campaign for Spring Season during 3rd week of February, 2022. The strategy/action plan for this campaign was shared with all provincial departments, including the EPA Punjab, enlisting the sector-wise tree plantation targets, festivals/plantation days to be celebrated during campaign and reporting Mechanism.

EPA Punjab participated actively in this noble cause, through vigorous tree plantation and co-activities, including:

- i. Tree Plantation Targets \_ Plantation targets of 10000 to 15000 trees per district were set. A total of 362,181 trees were planted during Spring Tree Plantation Campaign under the supervision of EPA Field Formation. The number of trees planted in Districts Bahawalpur, Chakwal, DG Khan, Faisalabad, Gujrat, Rajanpur and Sargodha, during the campaign were beyond the set targets.
- ii. Plant for Pakistan Day\_ celebrated in each district
- iii. Media Campaign\_ A massive media campaign launched with following targets: (Table 26)

**Table 26: Activities of Tree Plantation**

|    |   |                           |
|----|---|---------------------------|
| a. | Inauguration Ceremonies: graced by Deputy Commissioner/ Assistant Commissioner as Chief Guest | 1 per district            |
| b. | Shajarkari Walks  | 1 per district            |
| c. | Display of Banners/Streamers/other awareness material   | at-least 100 per district |
| d. | News Clipping/Media coverage/social media awareness activities                                | at least 20 per district  |

## (ii) Green Week

A ‘Green Week’ was also celebrated during 2022 from 14-08-2022 to 20-08-2022 throughout Punjab. During this week, 99570 trees were planted under the supervision of the officers of EPA Punjab (Figure 50)

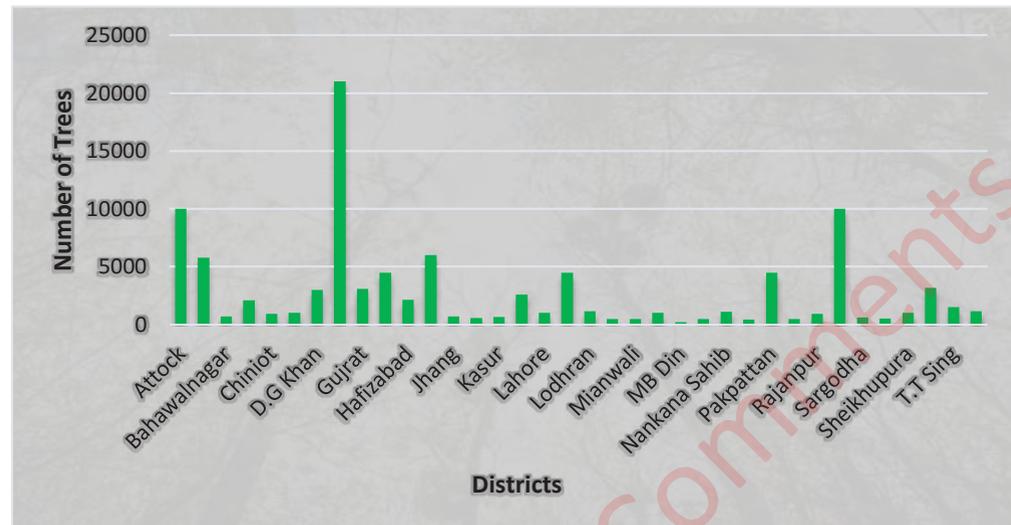


Figure 50: Trees Planted during Green Week

## 6.3 Regulatory & Institutional Reforms

### a. Restructuring of Environment Protection Department

Restructuring plan of EPD Punjab has been approved and notified in the official Gazette. The plan incorporates the provisions for the establishment of Environmental Monitoring Center (EMC), Environmental Technology Center (ETC) and Environmental Policy Center (EPC) under EPD Punjab.

### b. Environmental Monitoring Center (EMC)

EMC is mandated to keep a regular check over quality of major constituents of ambient environment i.e., air, water, and land, maintain a network of data acquisition tools across the province and its dissemination to the public and establish a state-of-the-art Provincial Environmental Reference Laboratory (PERL).

### c. Environmental Technology Center (ETC)

ETC is mandated for the enrollment of qualified indigenous and internationally best available technologies for the monitoring of environmental quality, treatment of wastes, resource efficient businesses, and solutions good at reducing carbon and water foot prints, promoting the research through academic and professional research organizations for adoption of climate resilient technologies and make technology transfer through viable means including, but not limited to, subsidies, exhibition of prototype models, province-wide outreach of technologies, organizing local and international trainings for the relevant officers/technicians of EP&CCD, EPA, EMC, EPC and any other from public sector and civil society through an organized manner and compiling and regularly updating data about academic courses and programs being offered in the province and country and suggest/recommend emerging technologies and topics of core relevance.



#### d. Environmental Policy Center (EPC)

Environmental Policy Center is mandated for formulating environmental policies including policy briefs and documents on climate change, green financing, and pollution reduction, advising the provincial government on regulation of major natural resources and industrial sectors, preparing and presenting annual state of environment reports to Punjab Environmental Protection Council for decision making about protection of natural environment, downscaling the climate change projection for enhancing the climate resilience and promote climate adaptation with the aim to mitigate adverse effects, bringing policies to attract green investments, environmental awareness, citizen engagement and carrying out activities contributing in the achievement of sustainable development goals.

#### e. Health Advisory System for Critical Air Pollution Events

Under DLI 3 i.e., Disclosure of Environmental Information and Citizen Engagement of Punjab Green Development Program, EPD Punjab has established a Health Advisory System for Critical Air Pollution Events (HAS CAPEs), targeting vulnerable population groups.

Following are the salient features/components of the HAS-CAPEs:

- i. Setting up institutional arrangements through formation of a Steering Committee (an Apex Body), Provincial CAPEs Committee (for monitoring and assessment of CAPEs) and District Critical Air Pollution Events Committees (DCC) in district for effective implementation of HAS-CAPEs.
- ii. Formulation of Action Plan i.e. actions to be taken by concerned Departments and District Critical Air Pollution Events Committees (DCC) to manage Critical Air Pollution Events.
- iii. Issuance of Health Advisory Notes, for general public and vulnerable groups

#### f. IEE and EIA Review Regulations, 2022

During CY 2022, EPA Punjab has notified the Punjab Review of IEE and EIA Regulations, read under § 12 of the Punjab Environment Protection Act, 1997. Previously, PAK-EPA's IEE and EIA Regulations, 1997 were being followed for issuance of Environmental Approvals. It was a remarkable endeavor by EPA Punjab to have provincial regulations on Environmental Impact Assessments. The timelines for issuance of environmental and the list of projects included in Schedules I and II have been upgraded.

#### g. Hazardous Substances Rules:

Section 14 of the Act *ibid* deals with "Handling of Hazardous Substances", which states that no person shall generate, collect, consign, transport, treat, dispose of, store, handle or import any hazardous substance except under a licence issued by the Agency and in such manner as may be prescribed; or in accordance with the provisions of any other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement or other instrument to which Pakistan is a party.

In order to implement the provision of § 14 (a) of the Act *ibid*, EPA Punjab has drafted the Hazardous Substances Rules, after examining various national and international Hazardous Substances Rules and comments received from different stakeholders.

The draft Hazardous Substances Rules was submitted to Law and Parliamentary Department, Punjab in the second half of the CY 2022.



## h. Plastic Waste Management Strategy and Regulations on Single-use Plastics:

Punjab has one of the highest demands for single-use plastic and other plastic-based products (estimated to be 1.3 million tons/annum) for daily life in the form of LDPE bags and PET bottles. Most of this plastic ends up in dumpsites or litters the streets except PET bottles. A total of 15.348 million tons of solid waste is generated per year in Punjab, out of which 1.22 million tons is plastic waste.

During 2022, SPIU, EPD Punjab, under DLI 4 of the Punjab Green Development Program (PGDP), hired the services of a consultancy firm for preparation of Plastic Management Strategy and Regulations on the production and consumption of single-use plastics. The strategy is being devised through review of regional and international best practices and case studies regarding plastic management, conducting field visits for collection of data regarding the plastic uses and users, carrying out key informant interviews and series of broader stakeholders' consultative sessions. The stakeholders included representatives from academia, relevant government departments, international non-governmental organization like WWF-Pakistan, plastic manufacturing association, chamber of commerce and industries, plastic retailers/recyclers/ informal sector and those dealing with ecofriendly alternatives of Plastics. Three consultative sessions were held during 2022, wherein in detailed discussions of various aspects of the plastics management strategy carried out. The strategy has been submitted and under the process of the Approval. Further, the Regulations on production and consumption of single-use plastics are under the process of preparation.

## 6.4 ADP Schemes

### a. Environment Endowment Fund (EEF)

The Act *ibid* requires creation of a Provincial Sustainable Development Fund (PSDF) to finance the environmental projects. § 9 of the Act states that PSDF shall be derived from grants made or loans advanced by the government, aid and assistance, grants, advances, donations and other non-obligatory funds received from foreign governments, national or international agencies, and non-governmental organizations and contributions from private organizations, and other persons. EPD Punjab has notified PSDF Board in 2013 to manage the PSD Fund. However, the PSD Fund could not be operationalized as per its prescribed mandate.

Under DLI -8 of the Punjab Green Development Program, EPD Punjab has executed a scheme titled "Establishment of Environment Endowment Fund" for which US \$30 Million were earmarked for capitalization and generating investment returns to finance eligible environmental projects/activities. Under DLR 8-2 of the PGDP i.e. Sustainable Green Financing, Government of the Punjab, it is required to capitalize EEF with USD 50.00 million to qualify disbursement of USD 30.00 million. The World Bank has already disbursed USD 25.00 million on achievement of capitalization of USD 42.00 million and will further disburse USD 5.00 million on the confirmation of additional capitalization of USD 8.00 million in bank account of PSDF Board.

During CFY, PSDF Board in its 8th meeting approved further capitalization of Rs.1852 million in bank account of PSDF Board. Finance Department authorized the State Bank of Pakistan to transfer Rs. 1,852 million to PSDF Board bank account. The funds have been transferred by the SBP to the aforementioned bank account. Independent Verification by KPMG has been completed for credit of Rs. 1,852 million (Approx. USD 8.00 million) in the PSDF Board bank. Submission of verification report by KPMG to the World Bank is in process.

After letter of confirmation from the World Bank, withdrawal request of US \$ 5 Million linked with compliance of DLI/DLR 8-2 will be submitted to the WB.



### b. Automation Regime

In order to strengthen the EPA/EPD for improved service delivery through digitization of existing manual systems and promote E-Governance, a scheme titled "Automation Regime of Environment Protection Department has been reflected in ADP 2022-2023. Main objectives of the project are the design and development of new web and mobile based applications, integration and information synchronization of existing applications, building IT hardware and software infrastructure for implementation of systems (linking to the dashboard) in EPD and upgradation of current EPD website.

### c. Import/Export of Waste materials/Scrap

Section 13 of the Act *ibid* prohibits the import of hazardous waste in Punjab. The Act further provides a Schedule of Multilateral Environmental Agreements to which Pakistan is a signatory, with the provision that government of the Punjab may make any rules for implementation of the MEAs listed in this schedule. The Convention on Trans-boundary Movement of Hazardous Waste (Basel Convention) has also been included in the Schedule to the Act. The Convention provides lists of both the hazardous and non-hazardous wastes and provides obligations its parties for import and export of such wastes.

The Ministry of Climate Change, Islamabad is the focal point of Pakistan for Basel Convention. It issues license/permission to importers and exporters of non-hazardous materials defined under List B of the Convention, such as metal and plastic scrap, subject to certain conditions in light of Pakistan Environmental Protection Act, 1997 and Basel Convention. Provincial EPAs act as recommendatory bodies to the Ministry for issuance of licenses to such import and export cases pertaining to respective provinces. The Ministry has developed Standard Operating Procedures (SOPs) to deal with such cases.

EPA Punjab reviews the cases wherein import from or to the Punjab Province is involved and submits recommendations regarding issuance or otherwise of the permission for import/export of certain materials to the Ministry after carrying out the site inspections of the import/export facilities through its field formation. During 2022, only 8 import cases were received and processed in EPA Punjab.

### d. Climate Change

EPA Punjab is contributing in the climate action at provincial level in following manners:

- Regulating the industrial sector through Environmental Approvals to prevent or at-least minimize the pollution arising from industrial development.
- Regularizing, as well as striving for technological interventions, to control the vehicular emissions
- Developing industry – specific environmental quality standards, including the standards for GHGs (CO<sub>2</sub>, CH<sub>4</sub>, etc.)
- Promoting and supervising Tree plantation to generate carbon sinks
- Promoting the water conservation and rain harvesting practices through environmental approvals

Furthermore, EPD, in pursuance to the urgent need for building the province's resilience to the current and projected repercussions of climate change, as well as affirmation to the national and international mitigation and adaptation commitments, has taken lead for the formulation of an all-inclusive "Punjab Climate Change Policy". The policy aims to build the adaptive capacity and resilience of Punjab against the impacts of climate change and mainstream it in provincial planning, especially in socially and economically vulnerable sectors of the economy, contributing in national commitments pertaining to climate change mitigation and adaptation.

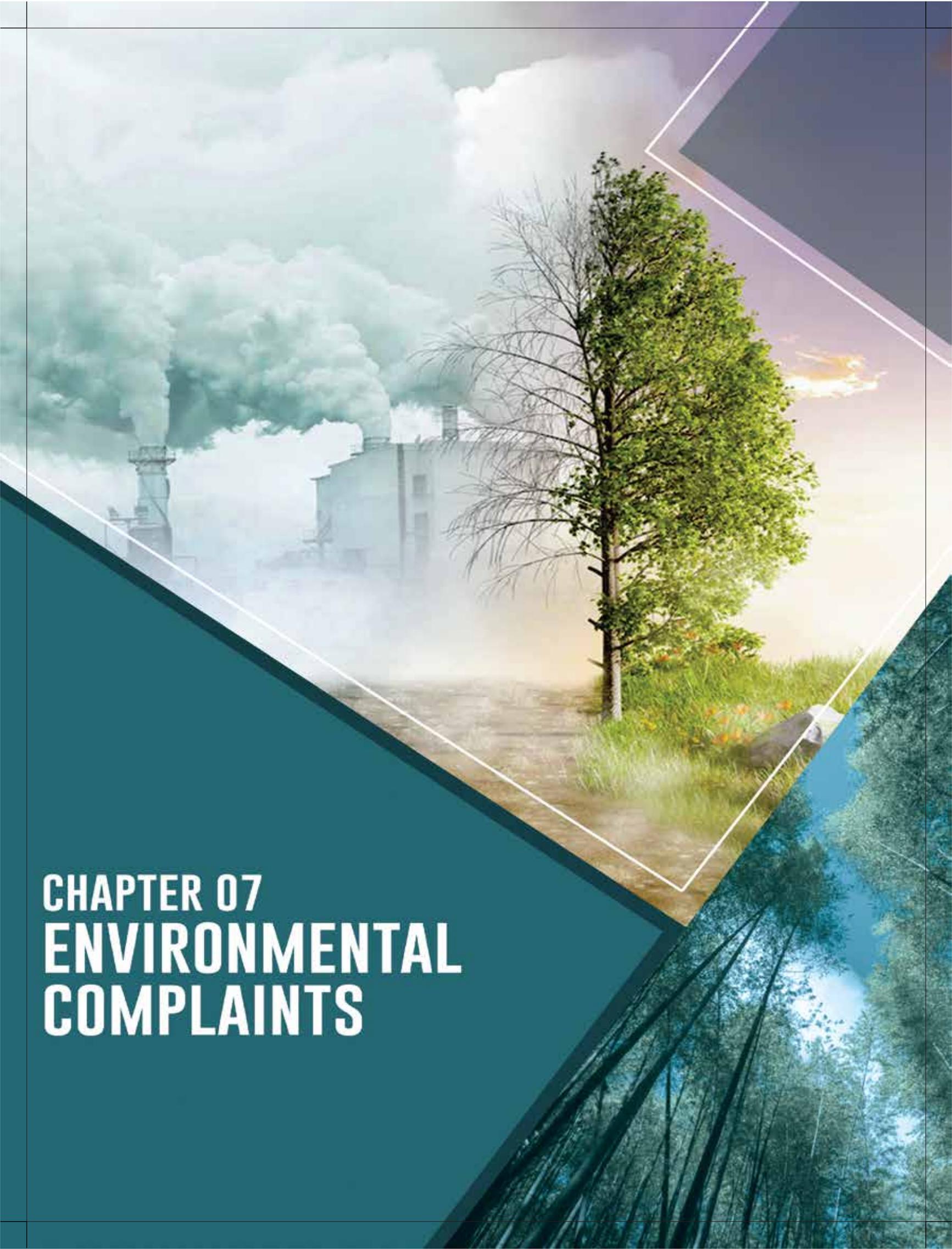


## 6.5 Conclusions

EPA Punjab is striving for environmental protection, conservation, rehabilitation, pollution control and sustainable development under the provisions of the Punjab Environmental Protection Act, 1997. The administrative department i.e. EPD Punjab is in process of building its technical and regulatory capacity, which would lead to enhanced environmental monitoring and governance in the province, further improving its environment and ecosystems.

Furthermore, the environmental governance has to be strengthened through augmentation of the citizen engagement activities through establishment of hotline, interactive data portal for getting public input on environmental management and air & water web-based data portal. Furthermore, Public communication campaigns on negative environmental and health impacts of single use plastic, disclosure of environmental information through electronic means and public communication campaigns on water conservation, rain water harvesting, environment conservation etc. has to be carried out throughout the province. Implementation of health advisory in the wake of critical air pollution events may also be carried out.

Draft SOE Report for Comments Only



**CHAPTER 07**  
**ENVIRONMENTAL**  
**COMPLAINTS**



## 7. CHAPTER SEVEN

### 7.1 Environmental Complaints

The Punjab Environment Protection Act, 1997 provides a unique set of arrangements for the redressal of environmental complaints proactively across Punjab through a formalized established Grievance Redressal mechanism. In addition to that, under Section 6 sub-section 2 (a) of the Act *ibid*, the Agency may undertake inquires or investigation into environmental issues, either of its own accord or upon complaint from any person or organization.

A wide number of avenues for filing complaints or grievance are available for those who may have serious concerns with regards to environmental pollution. The duration of grievance procedure and the associated resolution may vary based on the nature of complaint. Following are the major options available for a complainant to file a complaint i.e.

- a) Manually in the Office of the Chief Minister, Chief Secretary, Secretary Environment, Director General, EPA, Commissioner, Deputy Commissioner and Environment officer of the relevant districts
- b) Electronically through Prime Minister Delivery Unit, Chief Secretary complaint cell or by sending an email to the quarters concerned
- c) By mail/post, through posting a hard copy of complaint to the concerned office

No matter how complaints received, they are properly assessed and processed for solution seeking resolutions accordingly.

### 7.2 Grievance Redressal Mechanism

The institutional arrangement proffered by the EPD and EPA is aimed at providing an avenue for general public, organizations and communities seeking satisfactory resolution through lodging their complaints related to environmental issues. It also serves as an effective tool for the early identification, assessment and timely resolution of environmental issues under the provisions convened in the Act *ibid*.

An environment complaint, if not filed with the district In-charge, transmits to the concerned district in-charge. If the complaint is relevant to the environmental issue, then it will be processed in the office, and if otherwise, it will be forwarded to the concerned office. Afterwards, the district In-charge or its staff visit the complainant and location of the unit to ascertain the contents of the complaint. For establishing the violation under Section 11 of the Act *ibid*, the district In-charge may request the environmental laboratory to take samples and issue reports accordingly. Section 11 of the Act *ibid*, no person or entity is allowed to "discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the PEQS or, where applicable, the standards established under clause (g) of Sub-section (1) of section 6 of the Act *ibid*".



After the visit, a site inspection report is prepared and based on the violation of the unit, these reports are either dealt in the district offices or sent to the Directorate of Planning & Coordination in the EPA Punjab for further necessary action. The cases to be dealt at the district level has to be in accordance with the “Delegation of Powers for Environmental Complaints, 2016”. In both cases, a hearing notice is issued to the owner of the unit to give their responses. If no reply is received or reply found deficient, then an Environmental Protection Order is being issued under section 16 of the Act *ibid*. Section 16(1) clearly delineates that “the Provincial Agency may, after giving the person responsible for such acts an opportunity of being heard, by order, direct such person to take such measures as the Provincial Agency may consider necessary within such period as may be specified in the order for any violation”. On non-compliance of the order, a complaint is filed with the Environmental Tribunal or Environmental Magistrate, whatever is the case may be. Furthermore,

- a) Powers of Environmental Tribunals is provided in Sections 20-23 and relating punishments of all contraventions is under Section 17, Sub-section (1) of the Act *ibid*.
- b) Powers of Environmental Magistrates as provided in Sections 24-25 of the Act *ibid*, relating to punishments of all contraventions is under Section 17, Sub-section (2) of PEPA.

In addition to the above mechanism, the Lahore High Court, Lahore has empowered through certain orders to impose fines against the violators.

These legal frameworks define the contours of an appropriate and accessible grievance redressal mechanism for affected entities to lodge their complaints related to environmental issues.

### 7.3 Nature of complaints

In 2022, most common types of environmental complaints lodged relating to following environmental issues i.e.:

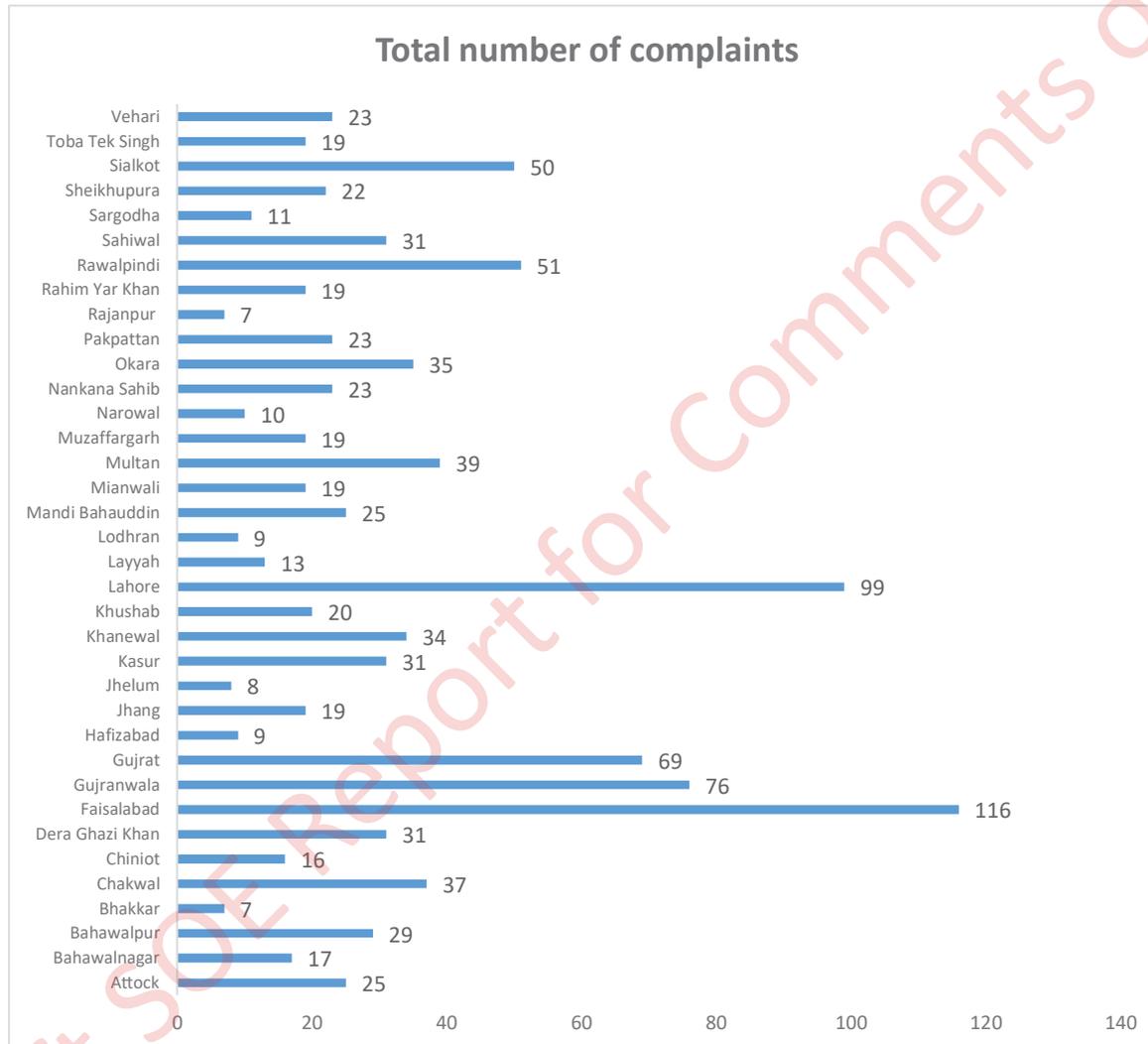
- Air Pollution (means contamination of environment by any substance that causes pollution of air)
- Waste water pollution/Untreated Wastewater
- Noise Pollution (means the intensity, duration and character of sounds from all sources, and includes vibration)
- Hazardous/Hospitals/Municipal Solid Waste (means waste which is or which contains a hazardous substance or which may be prescribed as hazardous substance or which may be prescribed as hazardous waste, and includes hospital waste and nuclear waste)
- Sub-standard Fuel(s) used for Combustion
- Cancellation of Environmental Approval/Operation without Environmental Approval
- Soil Pollution/Land Degradation (means the presence of toxic chemicals (pollutants or contaminants) in the soil, in very high concentrations to pose a risk to human health and the ecosystem); and
- Others (Traffic Management, Polythene bags, odor, dust, Spray Polish, Stubble Burning etc.)

During preparation of this report, a performa was circulated in the Field Offices of EPA Punjab, of all districts of Punjab to get information regarding sources of complaints, types of environment issues and actions taken accordingly.



## 7.4 Nature of complaints

A total of 1091 complaints were reported from 36 districts across Punjab during year 2022, out of which 512 complaints were related to air pollution and the remaining comprised pollution issues related to noise, untreated waste water, sub-standard fuel use and municipal solid waste. Following (Figure 51) shows the number of complaints received in each district:



**Figure 51:** Complaints received during 2022 (Jan-Dec, 2022)

Amongst these districts, Faisalabad district received highest number of complaints which are 116 complaints. After Faisalabad, highest number of the complaints were received in Lahore, Gujranwala and Gujrat as 99, 76 & 69 respectively. Out of 1091 total complaints, maximum complaints received at Lahore related to air pollution are 75. Following is graphically presentation of the complaints categorization. However, it is pertinent to mention that few of districts receive multiple recurrent complaints related to air, noise, hazardous, cancellation of environmental approvals and that has been accounted in "other" category.

Faisalabad district is at top receiving maximum complaints of this category which are 78 (Figure 53). The geospatial distribution of complaints received, source and their categorization is given in the Figure 52.

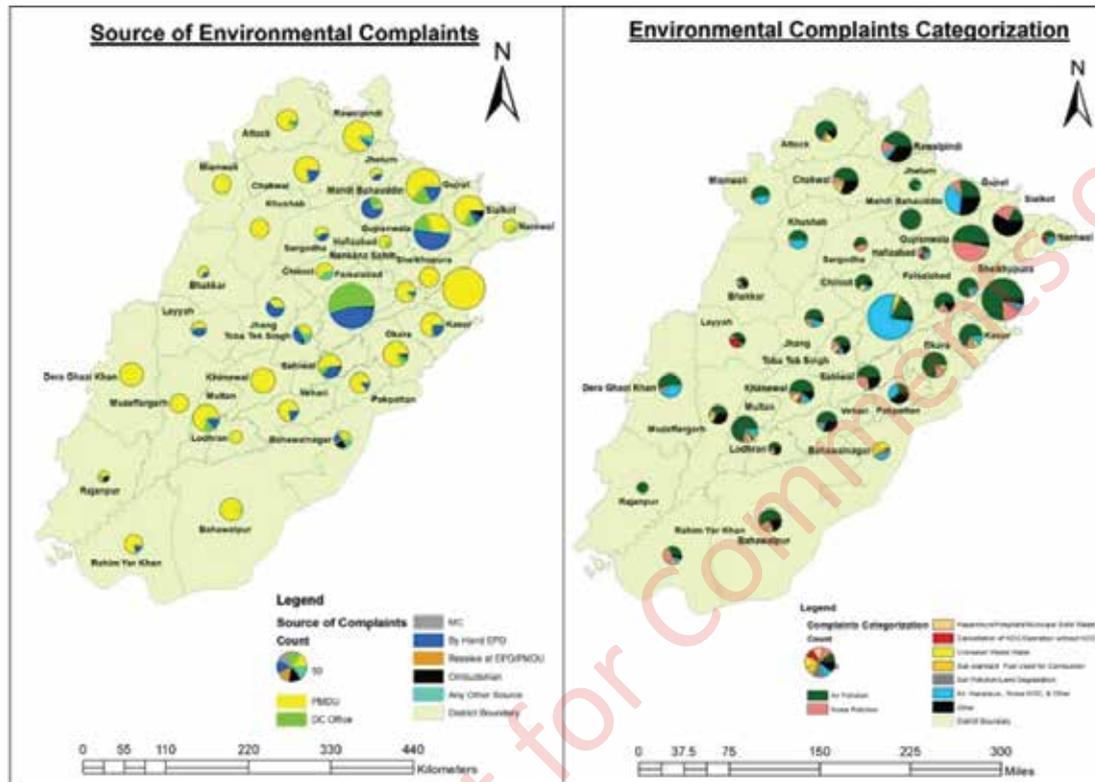


Figure 52: District Wise Environmental Complaints (Sources & Categorization)

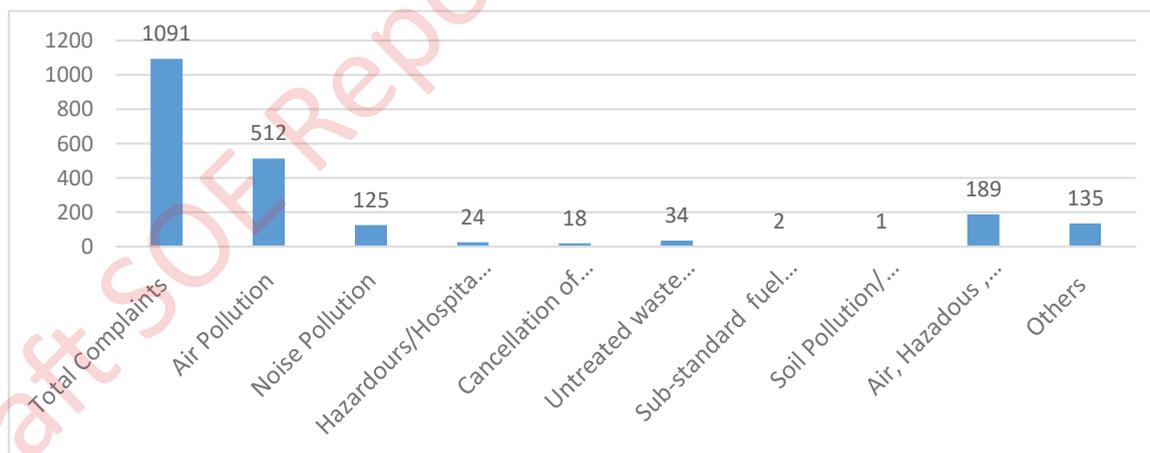


Figure 53: Complaints Categorization (January-December, 2022)

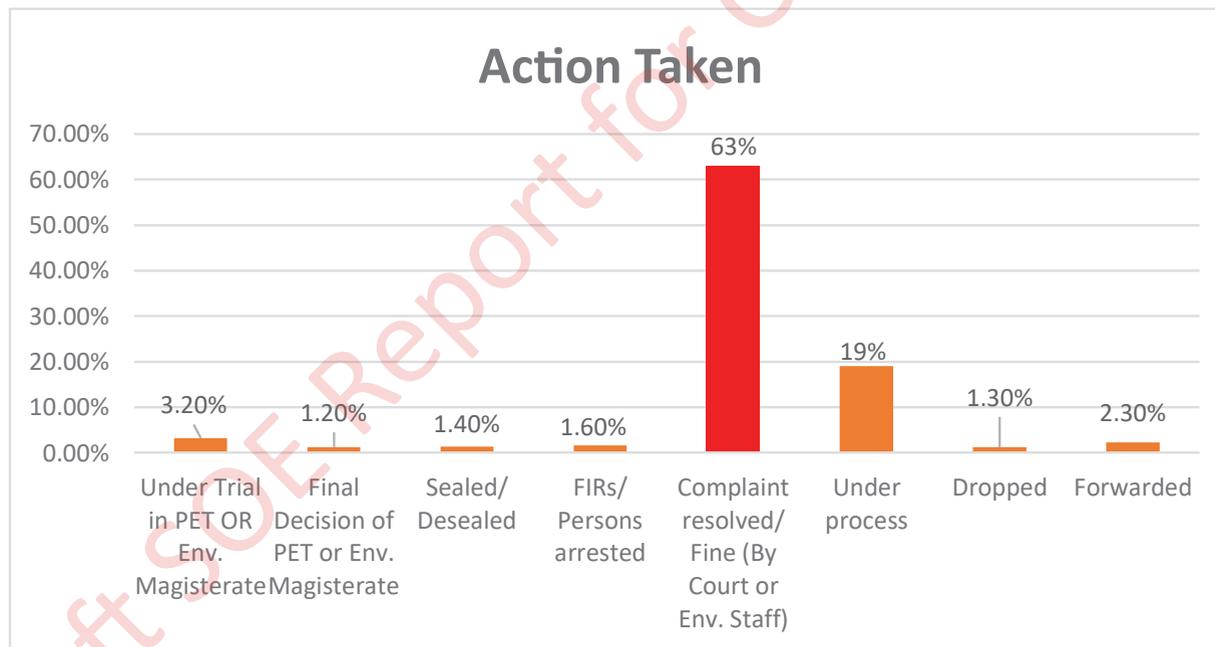
Major industries against which the complaints are received include textile industry, power looms, woolen looms, brick kiln, dyeing, ceramics, welding Plant, generator, metal works, steel mills, plastic works and foundries in Faisalabad & Gujranwala. With 31 complaints related to noise pollution in Gujranwala are mostly related to atta chaki, hammer machine, iron works, construction building, dye maker and surgical units.



After lodging and defining the type of complaint, it moved through different channels of preliminary examination by taking the proactive approach to promptly resolve it. Preliminary examination defines different steps of complaints investigations enabling the process to easily resolve it. It typically generates following primary steps to response the complaints:

- Receive and register grievance
- Preliminary examination (to ascertain whether the complaint is related to environmental issue or otherwise. If related to other department, then it will be forwarded there for further necessary action, as per their area of jurisdiction), site visit and investigating to resolve the complaint
- Direct action to resolve the complaint, or
- Forwarding the complaint to EPA HQs with the Site Inspection Report
- Issuance of hearing notice or Environmental Protection Order at the district level

Types of actions that are adopted by the Agency is to file complaint in the Punjab Environmental Tribunal (PET), Sealing of the Units, Decision of Environment Magistrate, Imposition of fine or Filing of FIRs with Police Stations. Out of 1091 complaints, 63% complaints were resolved and rest are processed through various modes of actions to address them effectively. (Figure 54)



**Figure 54:** Action Taken against complaints (January-December, 2022)

### a. Details of FIRs

Out of 1091 complaints, 68 were the total FIRs lodged against complaints. 11 FIRs were filed in Multan with maximum number. However, 08 number of total 11 complaints were resolved (Table 27).

**Table 27:** Detail of FIRs

| Total Complaints | BHW | D.G. Khan | FSD | Gujrat | Jhang | Kasur | Khanewal | Khushab | Lahore | Multan | Rajanpur | RY Khan | Sargodha | SKP | T.T. Sing |
|------------------|-----|-----------|-----|--------|-------|-------|----------|---------|--------|--------|----------|---------|----------|-----|-----------|
| 1091             | 29  | 31        | 116 | 69     | 19    | 31    | 34       | 20      | 99     | 39     | 7        | 19      | 11       | 22  | 19        |
| Total FIRs       | 2   | 3         | 9   | 3      | 1     | 4     | 2        | 1       | 1      | 11     | 2        | 3       | 1        | 15  | 3         |
| 68               |     |           |     |        |       |       |          |         |        |        |          |         |          |     |           |

**b. Details of Units Sealed/ De-sealed**

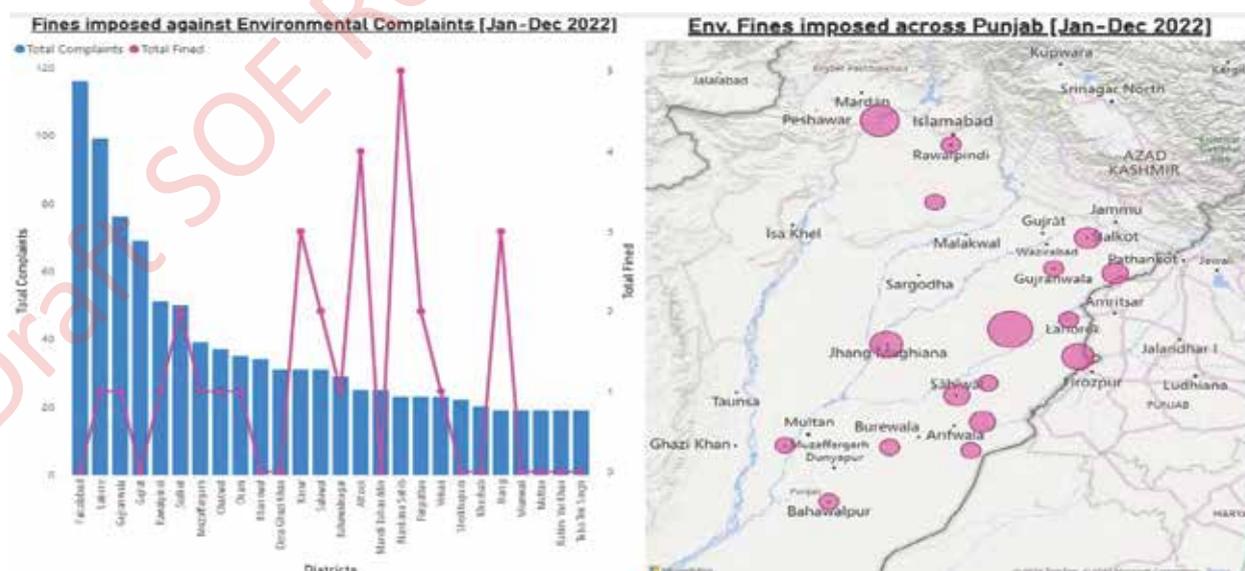
Total 93 units were sealed. Lahore with 26 sealed units against 99 total complaints and Gujrat with 25 against 69 total complaints wherein most of the units were sealed belonging to foundry, brick kiln, pottery kiln, soap manufacturing unit, brick kiln, Atta chaki & foundries related. However, it is pertinent to mention that these complaints were later on resolved. (Table 28)

**Table 28:** Detail of Units sealed/de-sealed

| Total Complaints | BHN | CKL | CT | FSD | GJW | GRT | Kasur | KHB | LHR | MLN | N. Sahib | OK | PPN | RWP | SDG | T.T. Sing | VR |
|------------------|-----|-----|----|-----|-----|-----|-------|-----|-----|-----|----------|----|-----|-----|-----|-----------|----|
| 1091             | 17  | 37  | 16 | 116 | 76  | 69  | 31    | 20  | 99  | 39  | 23       | 35 | 23  | 51  | 11  | 19        | 23 |
| Total Sealed     | 1   | 11  | 1  | 1   | 6   | 25  | 1     | 3   | 26  | 2   | 3        | 6  | 2   | 1   | 1   | 2         | 1  |
| 93               |     |     |    |     |     |     |       |     |     |     |          |    |     |     |     |           |    |

**c. Details of Fine Imposed**

Out of 36 districts, 16 districts reported that fines were imposed subject to different amount starting from Rs/-5,000 and maximum fine that was imposed in District Nanakana Sahib remained at top where total amount of 450,000/- was imposed during year 2022. (Figure 55)



**Figure 55:** Fine imposed against complaints (January-December, 2022)



### c. Inadmissible complaints

Complaints need to describe the actual or potential adverse impact that the complainants believe results from any kind of activity being executed in his surroundings. However, some issues that could cause adverse impacts are not within functions of EPD/EPA. Few of the following complaints were observed:

- Anonymous complaints other than EPA mandate
- Against disposal of municipal waste
- Price over charging
- Against Dairy farm

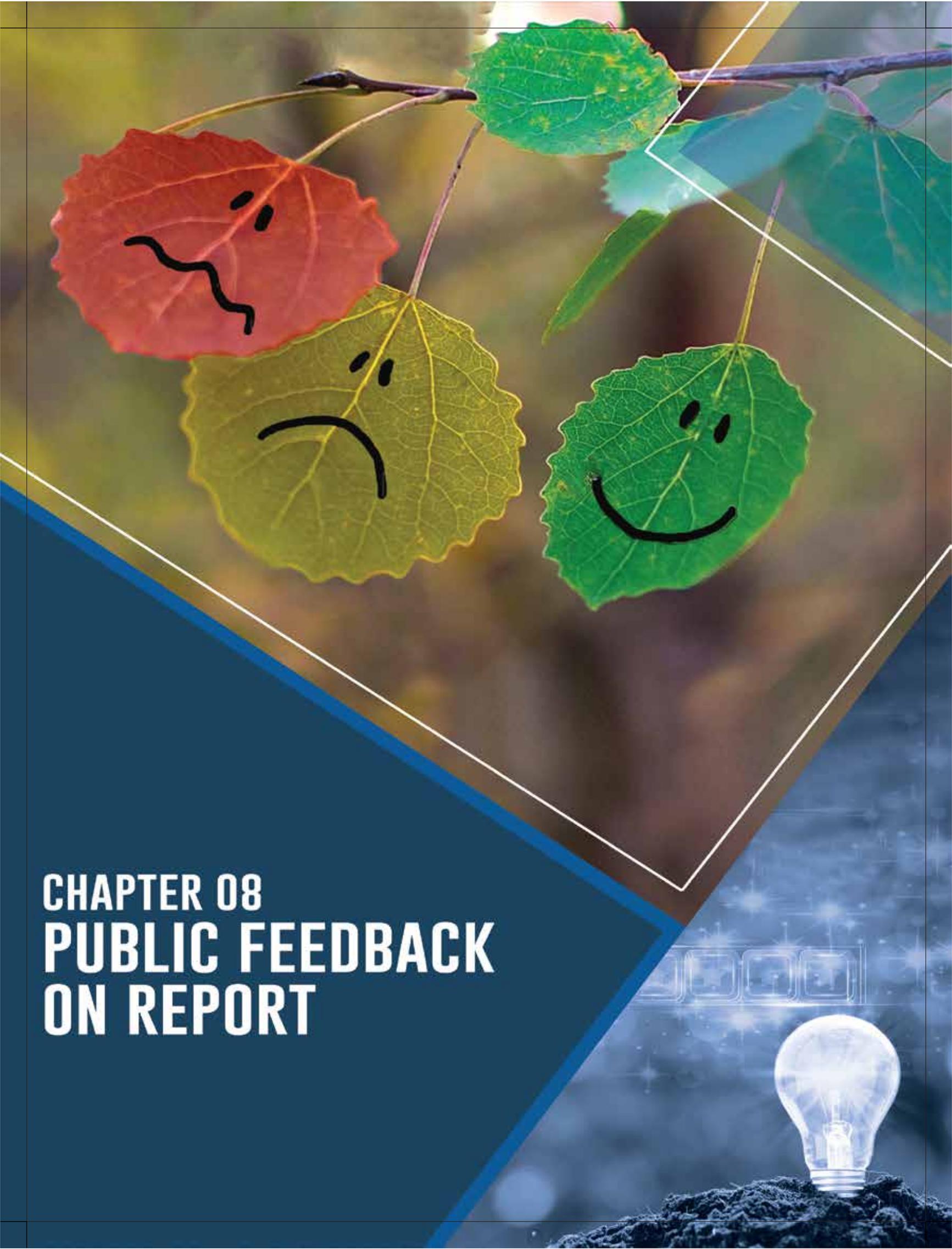
## 7.5 Conclusion

1,091 complaints were reported throughout the year 2022 [January to December] across Punjab. 63% complaints were resolved and rest were processed through various modes of actions to address them effectively and timely. A performa was circulated in Field Offices, of all districts of Punjab to get information regarding sources of complaints, types of environment issues and actions taken accordingly.

Faisalabad district remained at top receiving highest number of complaints as 116 while Lahore at 2nd number with 99 complaints. Mostly complaints were related to air pollution causing units which was 47% of total complaints and rest were related to noise, hazardous/Hospitals/Municipal Solid waste, Cancellation of Environmental Approval/Operation without Environmental Approval, Untreated waste Water, Sub-standard fuel used for combustion and Soil Pollution/Land Degradation. Sialkot and Gujrat received maximum number of multiple recurrent complaints related to air, noise, hazardous, cancellation of Environmental Approval and that fall in "other" category.

It is difficult to maintain records for complaints manually. Due to unavailability of on line system for keeping complaints records results in difficulty to track and monitor them effectively. Pertaining to the existing mechanism, there is dire need to introduce automated system in EPA Punjab for not only instant complaints lodging by the community but also to track the complaints progress and their timely closure. This automated system will be secured and will also be free from any sort of data loss and also help in efficient record keeping. Regular monitoring and follow-up of complaints is also necessary to check the status of the resolution of complaints via on line system.

Potential complainants must know where to go and who to talk to if they have a complaint, and understand the process that will be followed for timely redressal. However, the complaint mechanism should ensure transparency on the nature and number of complaints, and their eventual resolution, by addressing all inhibitory issues and expeditious service delivery failures therein. Effective monitoring of this resolution mechanism for its efficacy could enable citizens' concerns in directly enforcement of the process and decisions thereof, and will resultantly increase the trust of public regarding addressing of their complaints.



**CHAPTER 08  
PUBLIC FEEDBACK  
ON REPORT**

## 8. CHAPTER EIGHT

### 8.1 First Round – On Proposed Contents

The public feedback on report was obtained on two rounds. One on the proposed Contents and second on the proposed report.

The first round was initiated with the advertisement in the newspaper dated 05th October, 2022 (Figure 56). Public hearing was carried out on 07th November, 2022. Apart from the advertisement, individual letters were written to following stakeholder for provision of feedback on the proposed contents. Glimpses of the event are available at

<https://drive.google.com/drive/folders/1cqp76csydH37r569wat-f9G23kLc8vrD> (Figure 57 to 60) .



Figure 56: Notice for Public Hearing

During this round, feedback has been received on two ways i.e. one written through letters/emails etc. and second during the public hearing proceedings. Public feedback and EPD's response is as follows: During this round, feedback has been received on two ways i.e. one written through letters/emails etc. and second during the public hearing proceedings. Public feedback and EPD's response is as follows:

- i. **Irrigation Department dated 03.11.2022** commented for inclusion of climate change; overview water resources in Punjab and its quantity and quality status; mapping of pollution sources with trend analysis; limitations, constraints and challenges in water quality; implementation mechanism for best management practices and is separate heading for water quality monitoring should be added.
- ii. **Sialkot Chamber of Industry dated 04.11.2022** commented for inclusion of solid waste, its collection, re-utilization for recycling, training and reduction of plastic waste, hostel waste and as well as industrial waste. Further awareness seminars be arranged along with a small documentary on environment friendly practices should be developed by the Departments.
- iii. **Agriculture Department dated 04.11.2022** commented for inclusion map for air water and soil quality, Geo locations of Hazard sites, Reclamation plan of polluted sites and legal framework for banning crop cultivation over polluted sites.
- iv. **Punjab Healthcare Commission dated 18.11.2022** commented for inclusion summary of various environmental factors and pollutants impacting the health status on the people of Punjab. The summary should include an account of any baseline study, basic data on prevalence of such factors, impact of measures taken so far on the overall health status of populations exposed to such risks, and projected magnitude of the risk associated in case nothing is done to control such pollutants.
- v. **The Urban Unit dated 14.11.2022** commented for inclusion data analytics to find hotspots: portray historic, current and future trends: foresee future states (predictions/forecasting) and draw concrete conclusions (specifically policy and regulatory reforms) about the information they contain. In addition to this, the components of biodiversity, forestry/green cover, solid waste, urban sprawl and environmental health are not part of the SOE reporting, considering the fact that this data is readily available with the concerned Government Departments. Likewise, GIS/RS mapping and environmental modelling and the correlation between multiple drivers, pressures and states is also recommended.

### Public Hearing on 07.11.2022:



Figure 57: Public Hearing on 07.11.2022

- i. **Ms. Maleeha Sajjad, Representative of UNICEF** commented for inclusion of United Nation declaration for environment as a fundamental right, proper sanitation practices and ground water depletion verses water recharge rates.
- ii. **Mr. Naeem Bajwa, Member Lahore Conservation Society** commented on importance of environmental awareness for children, trans boundary effects of air pollution as well as water pollution, strengthening feedback loop and introduced effective citizen engagement.
- iii. **Mr. Syed Mubeen Abid, Assistant Manager from Small and Medium Enterprise Development Authority (SMEDA)** commented on importance of mechanism for greening the brown patches of land, building sense of ownership through community engagement at UC level.
- iv. **Ahsan Razzaq, representative Chamber of Commerce, Faisalabad** commented for making water as a top priority because we are facing with water scarcity, development of zero carbon emission city, key plantation drive mandatory public transport mechanism and electricity generation from municipal solid waste.



Figure 58: Public Hearing on 07.11.2022

- v. **Ms. Tehmina Saeed Chaudhary, representative Chamber of Commerce, Lahore** commented that the process of data collection has to be mentioned in the report so that the same may be augmented accordingly.
- vi. **Muhammad Tanveer, Managing Director, Water and Sanitation Agency, Rawalpindi** commented that community ownership shall be developed for stoppage of water wastage in our daily life, water metering, water recharge galleries and installation of waste water treatment plant.
- vii. **Mian Ahmad saeed, representative Chamber of Commerce, Sahiwal** commented that during issuance of environmental permits for the operational phase environmental concern should be addressed, sanitary products be introduced for the water conservations as well as piloting of products, no product has to be certified except compliant with the environmental standards. Poultry industry has to adopt the sustainable mechanism.
- viii. **Anesa Agha, Lawyer** commented children are facing immense air pollution levels due to smog and got sick during winter season. Transport policy as well as fuel policy are the federal subjects which accounts for 80% of sectorial emissions which require working by the federal government. Resultantly the people of Punjab are getting affected due to these policies. Shutting down of school is not a solution. it is just the passing the buck of federal government to school.

- ix. **Dr. Ghulam Hussain, Assistant Professor, Institute of Environmental Engineering and Research, University of Engineering and Technology, Lahore** commented for inclusion of in chapter three of the proposed contents water conservation as well as water consumption pattern has to be reported. Prior to proceeding to chapter no. 8 of the proposed contents the gaps has to identify in each above chapter before proposing action plan so that the same may be addressed accordingly.



Figure 59: Public Hearing on 07.11.2022

- x. **Roohan Javaid, Director WASA, Faisalabad** commented study of under ground water aquifer has to be carried out, water conservation strategies has to be added into the no objection, installation of primary WWTP in each industry, and technology of WWTP for each city be provided.
- xi. **Baqi Raza, Director Pakistan Council of Research in Water Resources (PCRWR) Lahore** commented that nature base solution may be find out for soil, water and air; Soil desertification control has to be mentioned.
- xii. **Haseeb Sarwar, Manager SMEDA** commented that industry is not formalized therefore the data is not available and institutes to be involved for making a strategy.
- xiii. **Ms. Shehar Zad, a citizen** commented that awareness campaign has to be carried out and schools are being shutdown which may be avoided.
- xiv. **Miss Hina Ishaque, representative from Industries Department** commented that in the report hospital waste has to be catered along with municipal solid waste, and the linkages of burden of disease with water/ air quality has to be developed. Further she also told that under PGDP, five sectors are proposed where RECP technologies will be installed.
- xv. **Dr. Obaidullah Nadeem, Professor of City and Regional Planning from University of Engineering and Technology, Lahore** commented that State of Environment Report is long waited. It shall contain green cover analysis as well as biodiversity. In regulatory framework the issues in its implementation as well as constraints/gaps and responsibilities of lined departments have to be added. Capacity building activities has to be added in the report. Urban sprawl, rural migration, development patterns are a base for the environmental action plan. Further, master planning for the Punjab has to be carried out. Environmental awareness shall not only provided for the school but for general public too.



Figure 60: Public Hearing on 07.11.2022

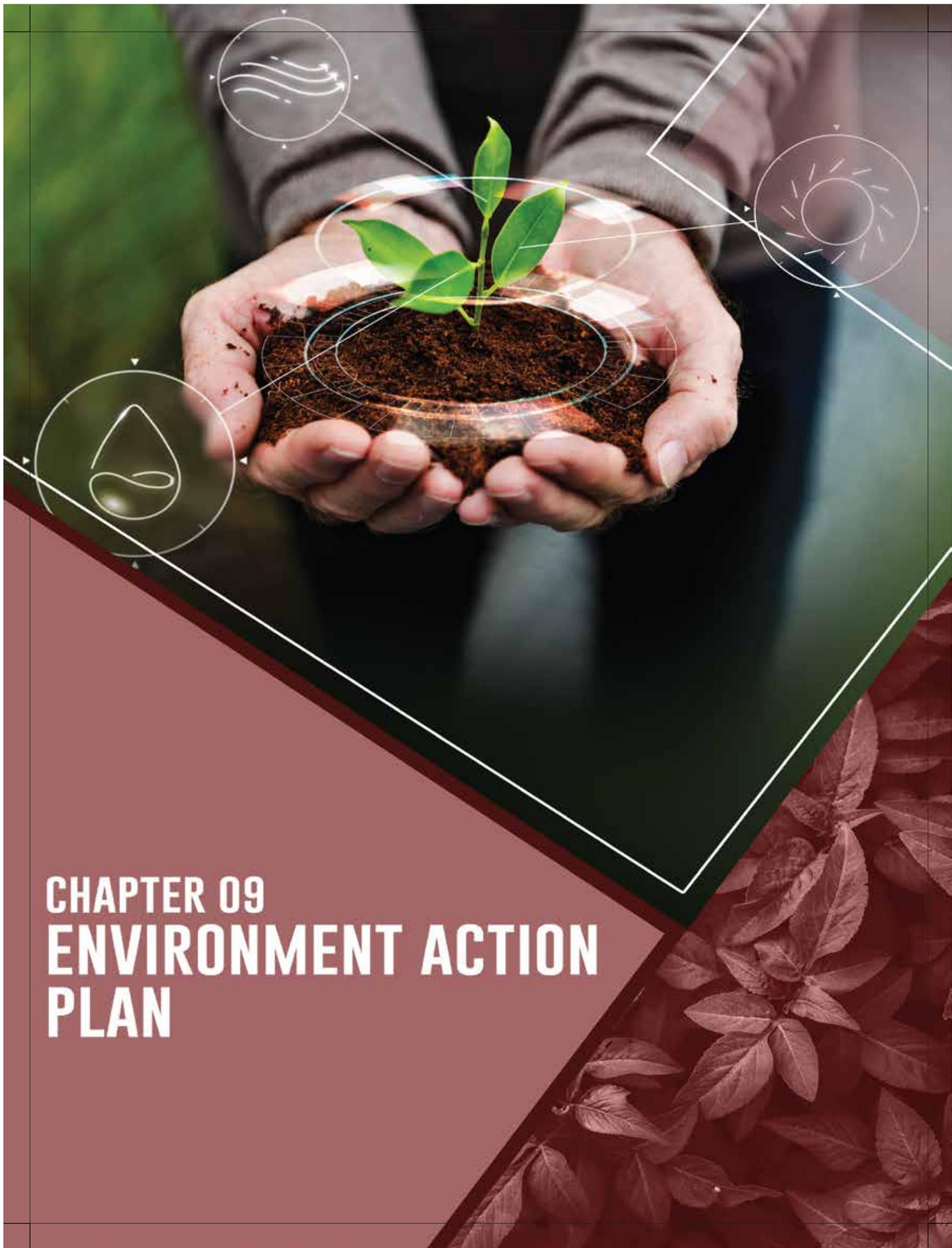
- xvi. **Dr. Ghulam Hassan Abbasi from Islamia University of Bahawalpur** commented that the installation of air quality monitoring station is not suffice and it require the root cause identification of the sources for the air pollution and soil health the issue of salinity has to be highlighted and the environment subject has to be compulsory in the curriculum.
- xvii. **Arshad Javeed Keyani, representative from Pakistan Ethanol Manufacturers Association** commented that during 2017 a research Laboratory was proposed for the ethanol sector but the said initiative was not implemented yet and Our association is ready to implement the recommendations of the government.
- xviii. **Hafiz Muhammad Moin u Din, Senior Research Officer, WASA Faisalabad** commented that for research grants an action may be taken to provide the funding through academia and chamber linkages and industrial sectors have to be robust to ask for academia for their potential problems.

## Response of Environment Protection Department

Environment Protection Department acknowledges each and every comment and feedback given by the honorable stakeholders. Every effort will be made to prepare the report in accordance with these comments. However, if there is any limitation the same have been incorporated in the action plan appropriately.

## 8.2 Second Round – On Proposed Report

Details will be incorporated after the second public hearing on the proposed draft of the State of Environment Report, 2022.



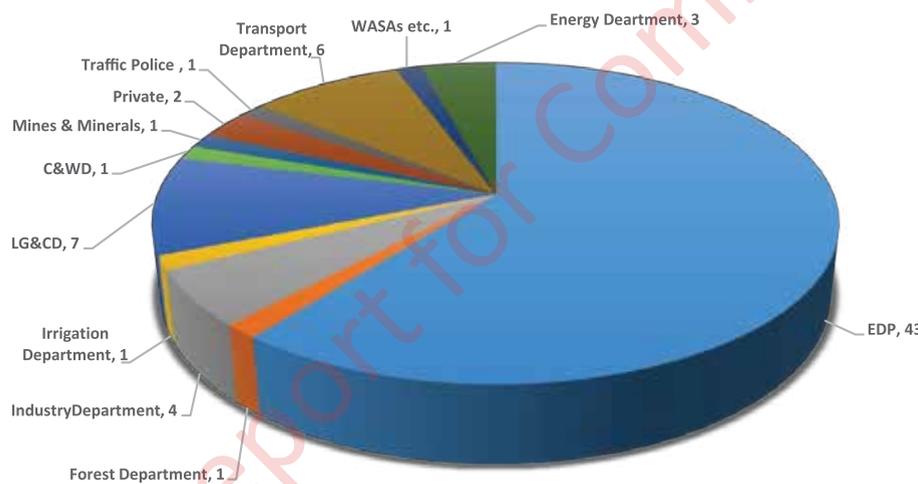
**CHAPTER 09**  
**ENVIRONMENT ACTION**  
**PLAN**

## 9. CHAPTER NINE

### 9.1 Environmental Action Plan

Environment Protection Department and Environmental Protection Agency has come to this stage of administration of the laws. Rules & Regulations etc., after a long and striving commitment. Much has been done. But more is needed to pace with the rapid industrialization, urbanization and complexity of environmental issues.

The environmental governance needs to be strengthened for achieving the desired objectives of sustainable development. The environmental action plan is systematically divided into the 11 main area of interventions i.e. Legislative, Citizen Engagement, Industries, Vehicular, Monitoring, Water & Waste Water, Solid Waste & Hospital/Industrial waste, Mobilization of Punjab Sustainable Development Fund/Environment Endowment Fund, Fugitive dust control, Remodeling environmental governance and others.



**Figure 61:** Role of organizations/ departments in Environmental Action Plan

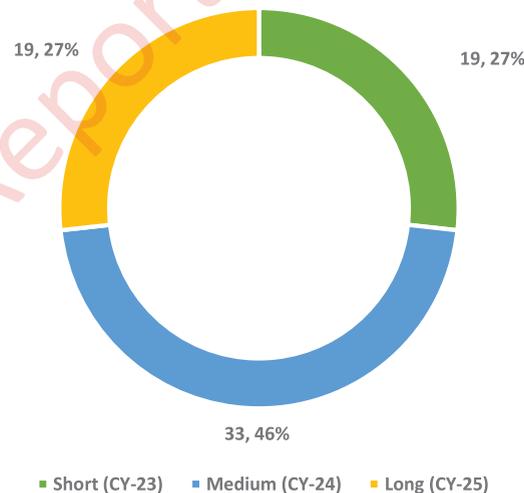
These areas of interventions are subsequently divided into sub area of interventions. "Legislative" contains 10 sub interventions which includes notification of rules & regulations, Enactment of air, publication of plastic, regulation and production SUP, Development of environmental quality, Certification and labeling, Energy conservation standards, Energy saving renovations, E-waste management and establishment of pollution "Citizen Engagement" contains 08 sub interventions which includes establishment of hotline, interactive data portal, establishment of air water, public communication campaigns, environmental information, action to bring change, public communication campaigns on water and issuance of health advisory "Industries" contains 07 sub interventions which includes geo tagging of industries, implementation of resource efficiency, implementation of zero water, implementation of carbon, support to green, evaluation of impacts, comprehensive control of enterprises "Vehicular" contains 07 sub interventions which includes devising mechanism, enhancing the area of jurisdiction, mandatory vehicle inspection, promote mass transport, mechanism high air pollution, green transportation and removing traffic congestion "Monitoring" contains 07 sub interventions which includes installation of 30 ambient, installation of 15 water quality, establishment of reference laboratory, establishment



of GIS, establishment of noise monitoring, environmental monitoring, investigation of source “Water & Waste Water” contains 07 sub interventions which includes construction of storm water, water metering, rehabilitation of dams, conservation of natural habitats, installation of municipal of waste, installation of industrial waste water, mandatory provision, “Solid Waste & Hospital/Industrial waste” contains 06 sub interventions which includes establishment of scientifically solid waste, cleanup of the heaps, waste minimization, installation of waste energy project, provision of hospital waste “Mobilization of Punjab Sustainable Development Fund/Environment Endowment Fund” contains 02 sub interventions which includes operationalization of environment, devising operational guidelines, “Fugitive dust control” contains 03 sub interventions which includes area pollution and dust control, controlling fugitive, implementation of zero sand “Remodeling environmental governance” contains 05 sub interventions which includes automation regime, establishment of environmental policy center, establishment of environmental technology center, compliant industry, collaboration and “others” contains 05 sub interventions which includes construction of green building, research and development, establishment of woodlands, establishment of noise and land use classification.

These areas of interventions and their sub-intervention is systematically distributed within the following departments/agencies i.e., Energy Department, Industry Department, Transport Department, Traffic Police, LG&CD, C&W Department, WASAs and municipal authorities, Irrigation Department, Mines & Minerals and Forest Department. Furthermore, “private” organizations have already been mandated for certain tasks (Figure 61).

In the action plan, there are 61 sub-interventions under the 11 interventions. These interventions are further put on the time scale i.e., Short Term (CY-23), Medium Term (CY-24) and Long Term (CY-25). Amongst 71 sub-interventions, there are 19 short term, 33 Medium Term and 19 Long Term (Figure 62). The responsibilities and timelines are given as follows:



**Figure 62:** Short, medium and long term distribution Environmental Action Plan

## 9.2 Responsibilities and timelines

Environmental Action Plan with the responsibilities and timelines is as follows (Table 29). It is pertinent to mention here that implementation of action plan is contingent upon the availability/confirmation of resources.



**Table 29:** Environmental Action Plan

| Sr. No. | Area of Interventions | #   | Sub-interventions   | Responsibility    | Terms         |                |              |
|---------|-----------------------|-----|---|-------------------|---------------|----------------|--------------|
|         |                       |     |   |                   | Short (CY-23) | Medium (CY-24) | Long (CY-25) |
| 1       | Legislative           | 1.  | Notification of rules & regulations under the Punjab Environmental Protection Act, 1997 like Hazardous Substance Rules and implementation of MEAs given in the Schedule | EPD               |               | ☑              |              |
|         |                       | 2.  | The Punjab Climate Change Policy  | EPD               | ☑             |                |              |
|         |                       | 3.  | The Punjab Clean Air Act  | EPD               |               | ☑              |              |
|         |                       | 4.  | The Punjab Clean Air Policy & Action Plan   | EPD               | ☑             |                |              |
|         |                       | 5.  | The Punjab Environmental Protection (Anti-SMOG) Rules   | EPD               | ☑             |                |              |
|         |                       | 6.  | Plastic management strategy   | EPD               | ☑             |                |              |
|         |                       | 7.  | Regulations on production and consumption of single use plastic   | EPD               | ☑             |                |              |
|         |                       | 8.  | Missing environmental quality standards and revision of existing standards  | Energy Department | ☑             |                |              |
|         |                       | 9.  | Certification & labeling system for green, energy-saving products   | Energy Department |               | ☑              |              |
|         |                       | 10. | Energy conservation standards for newly built urban buildings and industrial establishments.  | Energy Department |               | ☑              |              |
|         |                       | 11. | Energy saving renovations/ retrofitting in existing buildings and improved energy efficiency guidelines/ regulations/rules  | EPD               |               | ☑              |              |
|         |                       | 12. | E-Waste management rules  | EPD               |               | ☑              |              |
|         |                       | 13. | Hazardous Substance/ waste management policy and rules,   |                   | ☑             |                |              |
|         |                       | 14. | Green Financing Strategy  | FD                | ☑             |                |              |
|         |                       | 15. | Establishment of pollution release and transfer register  | EPD               | ☑             |                |              |
| 2       | Citizen Engagement    | 16  | Establishment of hotline  | EPD               | ☑             |                |              |
|         |                       | 17  | Establishment of interactive data portal for getting public input on environmental management   | EPD               | ☑             |                |              |



**Table 29:** Environmental Action Plan

| Sr. No. | Area of Interventions | #   | Sub-interventions   | Responsibility          | Terms         |                |              |
|---------|-----------------------|-----|---|-------------------------|---------------|----------------|--------------|
|         |                       |     |   |                         | Short (CY-23) | Medium (CY-24) | Long (CY-25) |
|         |                       | 18. | Establishment of air & water web-based data portal  | EPD                     |               | ☑              |              |
|         |                       | 19. | Public communication campaigns on negative environmental and health impacts of single use plastic focusing on the children.                       | EPD                     |               | ☑              |              |
|         |                       | 20. | Disclosure of environmental information through electronic means  | EPD                     | ☑             |                |              |
|         |                       | 21. | Public communication campaigns on water conservation, rain water harvesting, environment conservation etc. focusing on the children.              | EPD                     |               |                | ☑            |
|         |                       | 22. | Implementation of health advisory in the wake of critical air pollution events  | EPD                     |               | ☑              |              |
| 3       | Industries<br><br>EPD | 23. | Geo tagging of industries (as well as others establishments having environmental concerns)  | EPD                     | ☑             |                |              |
|         |                       | 24. | Implementation of resource efficiency and cleaner production technologies   | Industry Department     |               | ☑              |              |
|         |                       | 25. | Implementation of zero water discharge/water conservations schemes in the water intensive industries like textiles, sugar etc.                    | Industry Department/EPD |               |                | ☑            |
|         |                       | 26. | Introduction of carbon neutrality regime  | EPD                     |               | ☑              |              |
|         |                       | 27. | Financial assistance to green micro-enterprises   | Industry Department     | ☑             |                |              |
|         |                       | 28. | Evaluation of impacts of pollution sources on the soil quality.   | EPD                     |               | ☑              |              |
|         |                       | 29. | Comprehensive control of industrial establishments & reduced emission of multi pollutants, end of pipe particular matter remover, installation of | EPD                     |               |                | ☑            |



**Table 29:** Environmental Action Plan

| Sr. No. | Area of Interventions | #   | Sub-interventions   | Responsibility                             | Terms         |                |              |
|---------|-----------------------|-----|---|--|---------------|----------------|--------------|
|         |                       |     |   |  | Short (CY-23) | Medium (CY-24) | Long (CY-25) |
|         |                       |     | continuous emission monitoring systems etc.   |  |               |                |              |
| 4       | Vehicular             | 30. | Devising mechanism for retiring excessively old vehicles  | Transport Department                       | ☑             |                |              |
|         |                       | 31. | Enhancing the area of jurisdiction of vehicles inspection and certification regime to the private vehicles            | Transport Department                       |               | ☑              |              |
|         |                       | 32. | Mandatory vehicle inspection certificate prior to sale and purchase of any vehicle regarding emission compliance      | Transport Department/Excised Department    |               | ☑              |              |
|         |                       | 33. | Promote mass transport facilities in the major urban centers of the province  | Transport Department                       |               | ☑              |              |
|         |                       | 34. | Devising mechanism to increase road denials during high air pollution levels  | Transport Department/EPD                   |               | ☑              |              |
|         |                       | 35. | Green transportation, standards, action plans & solutions   | Transport Department                       |               |                | ☑            |
|         |                       | 36. | Road Engineering for removing traffic congestion in the major roads of the urban centers                              | Traffic Police/ Development Authorities/MC |               | ☑              |              |
| 5       | Monitoring            | 37. | Installation of 30 ambient air quality monitoring stations  | EPD  |               | ☑              |              |
|         |                       | 38. | Installation of 15 water quality monitoring stations  | EPD  |               | ☑              |              |
|         |                       | 39. | Establishment of a reference laboratory   | EPD  |               | ☑              |              |
|         |                       | 40. | Establishment of a GIS cell in EPD  | EPD  | ☑             |                |              |
|         |                       | 41. | Establishment of noise monitoring networks  | EPD  |               | ☑              |              |
|         |                       | 42. | Environmental monitoring of industrial effluents deteriorating the quality of river Ravi in Sheikhpura and Faisalabad | EPD  |               | ☑              |              |
|         |                       | 43. | Investigation of sources of particulate matter for informed decision making in Punjab                                 | EPD  |               | ☑              |              |



**Table 29:** Environmental Action Plan

| Sr. No. | Area of Interventions                    | #   | Sub-interventions  | Responsibility                  | Terms         |                |              |
|---------|--|-----|--|---------------------------------|---------------|----------------|--------------|
|         |  |     |  |                                 | Short (CY-23) | Medium (CY-24) | Long (CY-25) |
| 6       | Water & Waste Water                      | 44. | Construction of storm water underground water recharge galleries in establishments (including public as well as private) | LG&CD/ C&W Department           |               |                | ☑            |
|         |  | 45. | Water metering for every connection of domestic as well as the industrial establishment                                  | WASAs and municipal authorities |               | ☑              |              |
|         |  | 46. | Rehabilitation of dams, rivers, drains, and canals   | Irrigation Department           |               |                | ☑            |
|         |  | 47. | Conservation of natural habitats especially the Ramsar sites   | EPD                             |               |                | ☑            |
|         |  | 48. | Installation of municipal waste water treatment plants against each existing disposal station                            | LG&CD/ Housing Authorities      |               |                | ☑            |
|         |  | 49. | Installation of industrial waste water treatment plants  | Private/EPD                     |               |                | ☑            |
|         |  | 50. | Mandatory provision of construction of municipal waste water treatment plants in new establishment of disposal stations  | LG&CD                           |               |                | ☑            |
| 7       | Solid Waste & Hospital/ Industrial waste | 51. | Establishment of Integrated solid waste management facilities in each urban as well as rural areas                       | LG&CD                           |               |                | ☑            |
|         |  | 52. | Cleanup of the heaps of garbage spread around the vicinity and rehabilitation of land                                    | LG&CD                           |               | ☑              |              |
|         |  | 53. | Waste minimization (reduce, recycle, and reuses of MSW) to improve waste collection efficiency                           | LG&CD                           |               | ☑              |              |
|         |  | 54. | Installation of waste to energy projects in urban center   | LG&CD/Energy Department         |               |                | ☑            |
|         |  | 55. | Provision of hospital waste management facilities by large private hospitals (having more than 30 beds)                  | Private/ Health Department      |               | ☑              |              |
|         |  | 56. | Provision of industrial waste management facilities in industrial or cluster levels                                      | Industry Department             |               |                | ☑            |



**Table 29:** Environmental Action Plan

| Sr. No. | Area of Interventions               | #   | Sub-interventions   | Responsibility                                  | Terms         |                |              |
|---------|-------------------------------------|-----|---|---|---------------|----------------|--------------|
|         |                                     |     |   |   | Short (CY-23) | Medium (CY-24) | Long (CY-25) |
| 8       | Sustainable Green Financing         | 57. | Operationalization of environment endowment fund management unit  | EPD   | ☑             |                |              |
|         |                                     | 58. | Devising operational guidelines for the disbursement of the Fund  | EPD   | ☑             |                |              |
| 9       | Fugitive dust control               | 59. | Area pollution and dust control/urban dust management   | EPD/ Housing Authorities/C&W                    |               | ☑              |              |
|         |                                     | 60. | Devising standards for controlling fugitive/ construction dust from road shoulders and construction sites.                                | EPD   | ☑             |                |              |
|         |                                     | 61. | Implementation of zero sand spillage regime regarding sand moving trolleys  | Mines & Minerals/District Govt./ Traffic Police |               | ☑              |              |
| 10      | Remodeling environmental governance | 62. | Automation regime to expedite the public service delivery in Environment Protection Department  | EPD   | ☑             |                |              |
|         |                                     | 63. | Establishment of Environmental Policy Center  | EPD   | ☑             |                |              |
|         |                                     | 64. | Establishment of Environmental Technology Transfer Center   | EPD   |               | ☑              |              |
|         |                                     | 65. | Incentivization the environmentally compliant industries  | EPD/ MOCC/ FBR                                  |               | ☑              |              |
|         |                                     | 66. | Collaboration/regional dialogues on transboundary water and air pollution   | EPD/MOCC  |               |                | ☑            |
| 11      | Others                              | 67. | Construction of Green Building (in Lahore)  | EPD   |               | ☑              |              |
|         |                                     | 68. | Research and development for developing/adoption of indigenous technologies for pollution abatement preferably through industry academia. | EPD   |               |                | ☑            |
|         |                                     | 69. | Establishment of woodlands especially in urban centers of indigenous and environment-friendly species                                     | Forest Department                               |               |                | ☑            |
|         |                                     | 70. | Establishment of noise-free zones   | EPD/ Development Authorities                    |               |                | ☑            |
|         |                                     | 71. | Land use classification of each district to gauge the urban sprawl, development pattern etc.  | LG&CD/ Development Authorities                  |               |                | ☑            |



## Annex - I

### General Weather Patterns – PMD Stations in Punjab [Jan-Jun 2022]

| S # | STATION            | STATION LEVEL PRESSURE |            | RELATIVE HUMIDITY |         | TEMPERATURE |          | MONTHLY RAIN ACC. | MEAN WIND SPEED |         | RESULTS       | DOMINANT WIND DIRECTION |         |
|-----|--------------------|------------------------|------------|-------------------|---------|-------------|----------|-------------------|-----------------|---------|---------------|-------------------------|---------|
|     |                    | AT 0300                | AT 1200    | AT 0300           | AT 1200 | MEAN MAX    | MEAN MIN |                   | AT 0300         | AT 1200 |               | AT 0300                 | AT 1200 |
| 1   | MURREE             | 795.60                 | 795.13     | 49.50             | 52.67   | 18.97       | 9.20     | 95.53             | 2.50            | 2.12    | Average Trend | NE                      | SE      |
| 2   | M.O. SIALKOT       | 980.23                 | 977.98     | 63.67             | 39.83   | 30.78       | 16.30    | 52.15             | 2.93            | 5.00    | Average Trend | NE                      | SW      |
| 3   | JHANG              | 990.47                 | 988.13     | 70.67             | 38.67   | 32.85       | 17.60    | 43.30             | 0.47            | 0.67    | Average Trend | NE                      | SW      |
| 4   | SARGODHA           | 986.35                 | 983.87     | 70.67             | 44.83   | 32.57       | 18.55    | 23.85             | 1.28            | 2.25    | Average Trend | NE                      | NE      |
| 5   | MULTAN CITY        | DNA<br>DNA             | DNA<br>DNA | 68.83             | 40.33   | 32.90       | 18.73    | 20.55             | 1.52            | 2.60    | Average Trend | SW                      | SE      |
| 6   | MULTAN A/P         | 993.47                 | 990.88     | 64.67             | 32.50   | 33.12       | 19.43    | 11.60             | 3.13            | 5.58    | Average Trend | NE                      | SW      |
| 7   | BAHAWALNAGAR       | 988.98                 | 986.97     | 61.17             | 44.00   | 33.97       | 19.23    | 14.50             | 0.40            | 2.32    | Average Trend | NE                      | NW      |
| 8   | KAROR LAL ESAN     | DNA<br>DNA             | DNA<br>DNA | 67.17             | 38.00   | 32.88       | 17.07    | 22.70             | 0.20            | 0.45    | Average Trend | N                       | NW      |
| 9   | KOT ADDU           | 993.42                 | 991.67     | 67.00             | 38.33   | 33.67       | 19.02    | 17.88             | 0.75            | 1.48    | Average Trend | NW                      | NW      |
| 10  | BAHAWALPUR CITY    | 993.97                 | 991.48     | 68.67             | 37.83   | 34.05       | 18.43    | 12.08             | 2.98            | 3.02    | Average Trend | SW                      | NW      |
| 11  | BHAKKAR            | DNA<br>DNA             | DNA<br>DNA | 69.50             | 41.33   | 33.62       | 17.20    | 28.40             | 0.93            | 2.17    | Average Trend | NE                      | SE      |
| 12  | FAISALABAD AIRPORT | 987.35                 | 984.92     | 66.67             | 38.17   | 32.15       | 18.33    | 22.83             | 2.45            | 3.52    | Average Trend | NE                      | NW      |
| 13  | PBO JHELMUM        | 981.10                 | 978.42     | 69.17             | 43.33   | 32.25       | 17.02    | 51.15             | 0.93            | 2.45    | Average Trend | NW                      | NW      |
| 14  | MANGLA AIRPORT     | 977.95                 | 975.92     | 66.00             | 39.00   | 31.33       | 15.97    | 57.02             | 1.47            | 5.00    | Average Trend | NW                      | NW      |
| 15  | BAHWALPUR A/P      | 993.83                 | 991.35     | 68.33             | 42.50   | 33.82       | 23.38    | 14.37             | 4.65            | 5.98    | Average Trend | NE                      | NW      |
| 16  | KASUR              | DNA<br>DNA             | DNA<br>DNA | 71.17             | 45.17   | 28.08       | 20.10    | 30.08             | 0.50            | 1.27    | Average Trend | SW                      | SW      |
| 17  | MANDI BAHAUDDIN    | 983.03                 | 980.47     | 68.17             | 43.83   | 32.37       | 17.67    | 35.83             | 1.08            | 1.55    | Average Trend | NW                      | NW      |
| 18  | RAHIM YAR KHAN     | 998.38                 | 995.43     | 63.50             | 29.00   | 35.63       | 18.32    | 9.98              | 2.75            | 3.53    | Average Trend | SW                      | NW      |
| 19  | PBO SIALKOT        | 979.10                 | 976.68     | 71.50             | 45.17   | 28.62       | 14.70    | 61.86             | 0.55            | 2.18    | Average Trend | NE                      | NW      |
| 20  | KHANEWAL           | 990.03                 | 988.13     | 71.50             | 45.17   | 33.18       | 16.45    | 14.40             | 1.02            | 1.05    | Average Trend | NE                      | NW      |
| 21  | GUJRANWALA         | DNA<br>DNA             | DNA<br>DNA | 71.33             | 48.17   | 31.20       | 16.45    | 41.05             | 1.90            | 3.70    | Average Trend | NW                      | NW      |
| 22  | ATTOCK             | 966.12                 | 963.33     | 66.17             | 39.00   | 30.37       | 15.68    | 36.82             | 0.25            | 0.97    | Average Trend | NE                      | NE      |
| 23  | LAHORE A/P         | 980.97                 | 978.52     | 62.67             | 38.50   | 31.27       | 18.35    | 54.22             | 5.47            | 8.50    | Average Trend | NW                      | NW      |
| 24  | DG KHAN            | 989.57                 | 986.85     | 61.17             | 42.50   | 33.67       | 18.80    | 25.38             | 3.12            | 4.63    | Average Trend | NE                      | SE      |
| 25  | KHANPUR            | 997.13                 | 994.13     | 69.33             | 35.83   | 34.95       | 18.20    | 8.88              | 1.13            | 1.53    | Average Trend | NW                      | SW      |
| 26  | GUJRAT             | DNA<br>DNA             | DNA<br>DNA | 65.50             | 41.67   | 31.08       | 17.17    | 41.68             | 1.33            | 1.90    | Average Trend | NE                      | SE      |
| 27  | SAHIWAL            | 988.55                 | 986.13     | 70.17             | 42.83   | 32.15       | 18.00    | 14.33             | 1.60            | 2.60    | Average Trend | SE                      | SW      |
| 28  | PBO LAHORE         | 983.67                 | 981.38     | 62.17             | 39.67   | 31.35       | 19.18    | 41.25             | 0.77            | 2.10    | Average Trend | NW                      | SW      |
| 29  | NAROWAL            | 980.50                 | 978.62     | 75.17             | 49.83   | 30.73       | 16.12    | 49.00             | 0.97            | 2.20    | Average Trend | NE                      | NW      |
| 30  | OKARA              | 986.63                 | 984.33     | 63.50             | 39.33   | 33.93       | 19.53    | 21.92             | 1.40            | 1.20    | Average Trend | SE                      | SW      |
|     | OVERALL            | 978.60                 | 976.28     | 66.82             | 41.23   | 32.00       | 17.74    | 31.98             | 1.68            | 2.78    | Average Trend | -                       | -       |

#### N.B.

1. 'DNA' means that data was not available for that particular station.
2. Data for station level pressure is not available for 6 stations; thus, averages and trends are calculated taking the available data into account. For other parameters, data is available for all stations; thus, all available data is employed into these computations.
3. Data is not available for 6 months for temperature (both max and min) and cumulative rainfall for a number of stations. All computations are thus undertaken with consideration of this limitation.
4. Wherever monthly rain is designated as 'TR', it is taken as zero (0) mm for computation purposes.
5. The dominant wind direction is the predominant wind direction for the overall monitoring period as determined from averaged monthly wind direction data.



Annex - II

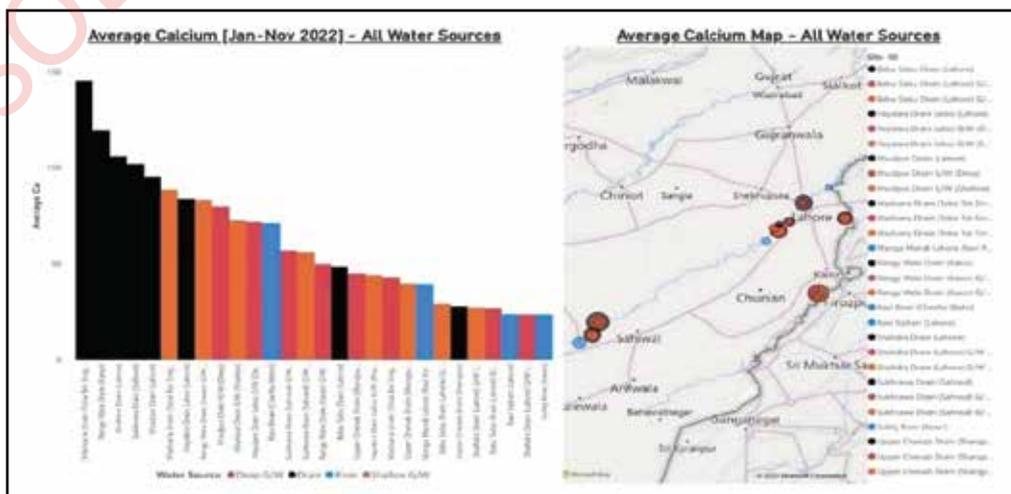
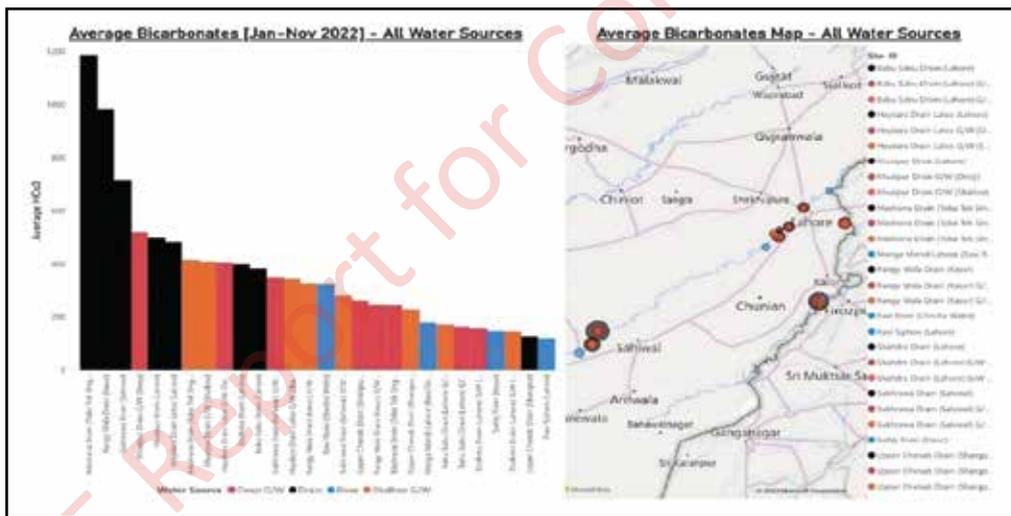
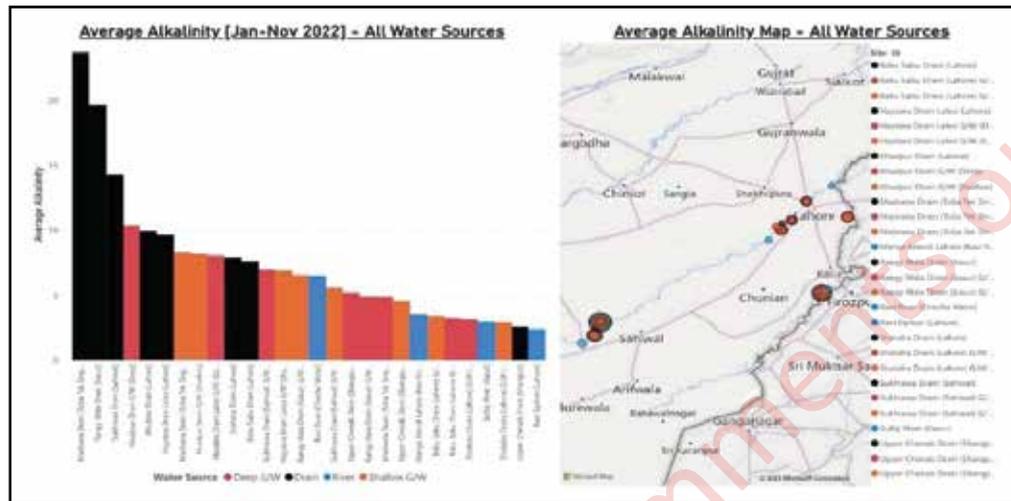
Location-wise Analysis of Biochemical Indicators

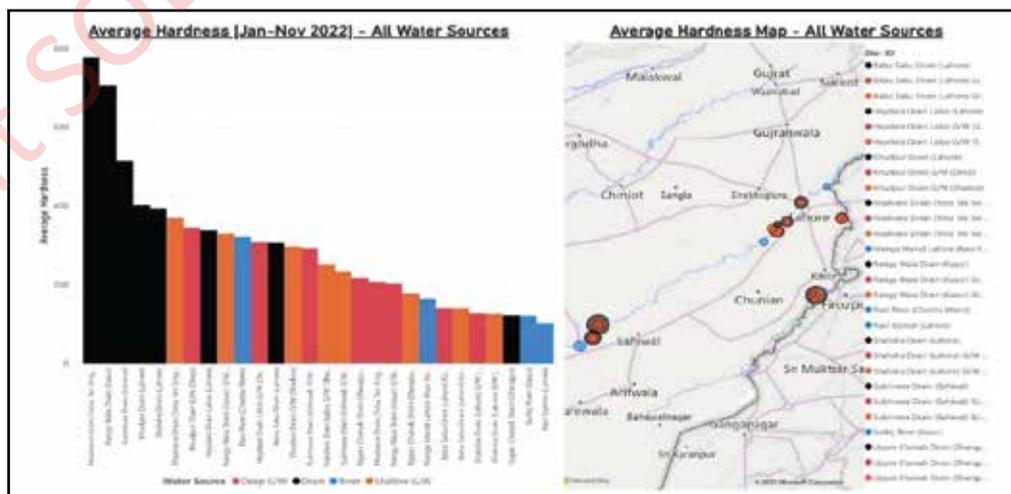
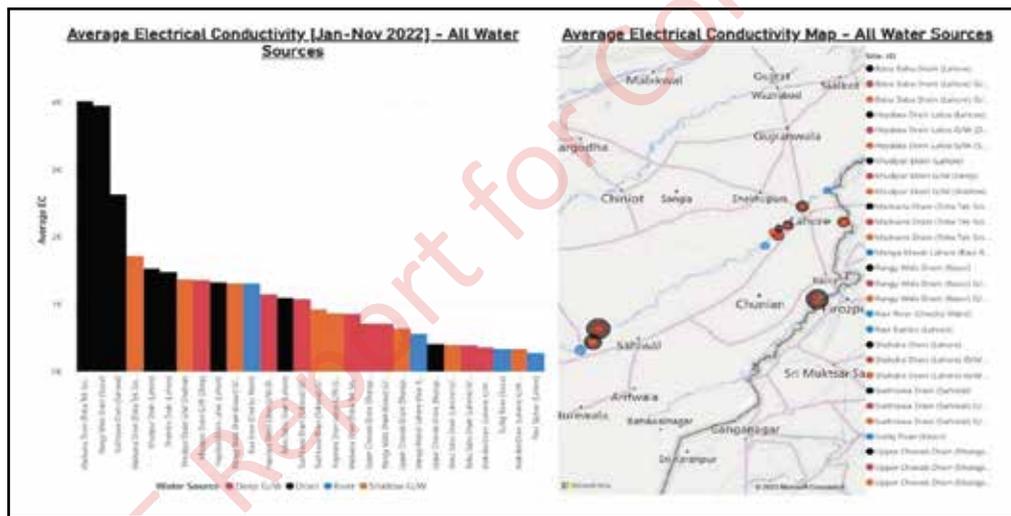
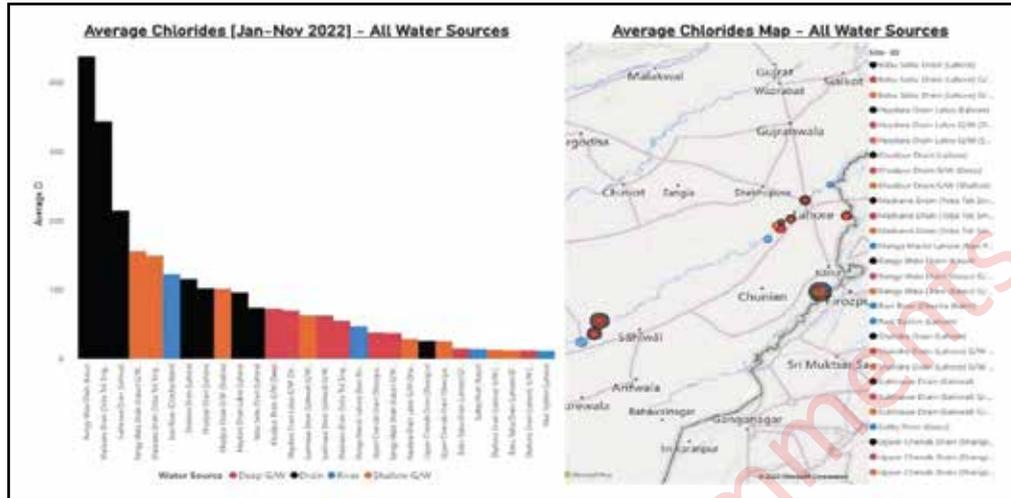
| S # | Site- ID                                     | Alk.  | HCO <sub>3</sub> | Ca     | Cl     | EC       | Hrd.   | Mg     | pH   | K    | SO <sub>4</sub> | Na     | TDS      | Tur.  | N     | As    | COD    | BOD    | T.C.  | F.C. | E.Coli | R |
|-----|--|-------|------------------|--------|--------|----------|--------|--------|------|------|-----------------|--------|----------|-------|-------|-------|--------|--------|-------|------|--------|---|
| 1   | Ravi Siphon (Lahore)                         | 2.39  | 119.55           | 23.55  | 11.47  | 274.00   | 100.91 | 10.22  | 7.45 | 1.02 | 20.91           | 26.64  | 169.18   | 12.49 | 0.83  | 5.74  | 63.00  | 32.62  | -     | -    | -      | A |
|     |  | 0.87  | 43.44            | 15.11  | 29.20  | 128.73   | 24.09  | 5.95   | 0.20 | 0.19 | 18.28           | 19.15  | 65.21    | 1.86  | 0.52  | 12.50 | -      | -      | 11.64 | 5.40 | -      | D |
| 2   | Manga Mandi Lahore (Ravi River)              | 3.55  | 177.73           | 39.36  | 46.62  | 550.73   | 162.73 | 15.63  | 7.30 | 1.65 | 40.00           | 54.45  | 315.31   | 15.15 | 2.28  | 3.52  | 119.64 | 59.24  | -     | -    | -      | A |
|     |  | 2.73  | 136.68           | 39.54  | 34.46  | 451.18   | 119.69 | 8.13   | 0.26 | 0.10 | 50.09           | 53.42  | 256.00   | 6.55  | 1.12  | 6.47  | 132.49 | 63.04  | 0.00  | 0.00 | -      | D |
| 3   | Ravi River (Checha Watni)                    | 6.49  | 324.55           | 71.00  | 122.65 | 1,307.09 | 319.82 | 34.58  | 7.32 | 2.71 | 170.18          | 175.91 | 808.73   | 14.09 | 7.99  | 7.15  | 239.09 | 140.27 | -     | -    | -      | A |
|     |  | 1.32  | 66.16            | 23.72  | 36.04  | 406.66   | 84.40  | 6.83   | 0.44 | 0.00 | 53.70           | 55.40  | 218.43   | 7.67  | 2.42  | -     | 53.20  | 35.42  | -     | -    | -      | D |
| 4   | Sutlej River (Kasur)                         | 2.95  | 147.27           | 23.36  | 13.75  | 330.27   | 120.00 | 14.97  | 7.63 | 1.25 | 23.09           | 30.64  | 198.67   | 13.85 | 0.67  | 9.25  | 84.18  | 45.50  | -     | -    | -      | A |
|     |  | 2.34  | 116.95           | 26.47  | 38.41  | 310.05   | 68.30  | 3.90   | 0.39 | 0.00 | 23.71           | 37.09  | 177.20   | 9.52  | 1.26  | 7.78  | 34.28  | 20.37  | 0.00  | 0.00 | -      | D |
| 5   | Haydara Drain Laloo (Lahore)                 | 9.62  | 480.91           | 83.73  | 96.18  | 1,324.27 | 337.73 | 31.20  | 7.37 | 3.02 | 54.00           | 159.82 | 762.91   | 18.49 | 9.99  | 5.77  | 557.09 | 298.73 | -     | -    | -      | A |
|     |  | 0.40  | 20.05            | 3.58   | 3.96   | 29.81    | 21.65  | 5.02   | 0.29 | 0.00 | 7.40            | 5.37   | 23.02    | 4.52  | 0.15  | 10.38 | -      | -      | 8.50  | 2.75 | -      | D |
| 6   | Haydara Drain Laloo G/W (Deep)               | 8.07  | 403.64           | 71.55  | 69.82  | 1,140.82 | 307.73 | 31.31  | 7.38 | 2.64 | 132.82          | 142.64 | 706.31   | 4.31  | 3.05  | 17.39 | -      | -      | 0.00  | 0.00 | -ve    | A |
|     |  | 0.85  | 42.68            | 10.24  | 7.71   | 78.70    | 54.38  | 11.20  | 0.30 | 0.00 | 4.37            | 4.98   | 48.69    | 8.90  | 0.10  | 3.02  | -      | -      | 10.57 | 3.89 | -      | D |
| 7   | Haydara Drain Laloo G/W (Shallow)            | 6.89  | 344.55           | 44.00  | 28.49  | 866.27   | 250.45 | 34.13  | 7.75 | 2.22 | 76.36           | 95.82  | 489.84   | 4.50  | 0.16  | 11.81 | -      | -      | 1.20  | 0.40 | -ve    | A |
|     |  | 0.62  | 30.78            | 7.87   | 4.56   | 49.35    | 33.70  | 7.71   | 0.36 | 0.00 | 7.24            | 8.77   | 33.38    | 7.89  | 0.10  | 1.14  | -      | -      | 10.25 | 4.99 | -      | D |
| 8   | Rangy Wala Drain (Kasur)                     | 19.64 | 981.82           | 119.36 | 437.91 | 3,946.00 | 705.45 | 98.91  | 7.85 | 6.67 | 351.82          | 581.55 | 2,273.15 | 20.75 | 20.01 | 5.44  | 375.36 | 242.18 | -     | -    | -      | A |
|     |  | 1.29  | 64.71            | 19.86  | 16.71  | 200.84   | 65.46  | 6.43   | 0.43 | 0.00 | 25.44           | 18.93  | 117.61   | 8.63  | 1.05  | 15.78 | 45.35  | 28.62  | 0.00  | 0.00 | -      | D |
| 9   | Rangy Wala Drain (Kasur) G/W (Deep)          | 4.91  | 245.45           | 49.73  | 36.91  | 705.73   | 201.36 | 18.72  | 7.62 | 2.13 | 77.55           | 79.00  | 411.96   | 5.50  | 0.11  | 5.38  | -      | -      | 0.00  | 0.00 | -ve    | A |
|     |  | 4.42  | 221.15           | 44.12  | 64.26  | 660.60   | 115.05 | 5.60   | 0.23 | 0.31 | 87.85           | 97.06  | 384.01   | 5.90  | 5.07  | 6.43  | 350.26 | 103.25 | 0.00  | 0.00 | -      | D |
| 10  | Rangy Wala Drain (Kasur) G/W (Shallow)       | 6.55  | 327.27           | 83.18  | 155.45 | 1,314.45 | 329.09 | 29.44  | 7.55 | 2.93 | 166.64          | 162.00 | 799.20   | 4.71  | 0.63  | 9.99  | -      | -      | 2.60  | 1.00 | -ve    | A |
|     |  | 1.10  | 55.00            | 10.69  | 32.13  | 152.59   | 29.33  | 3.54   | 0.36 | 0.00 | 65.34           | 18.91  | 98.83    | 8.64  | 2.80  | 2.88  | 68.26  | 47.88  | -     | -    | -      | D |
| 11  | Shahdra Drain (Lahore)                       | 7.95  | 397.27           | 105.73 | 115.18 | 1,474.64 | 392.27 | 31.09  | 7.35 | 3.31 | 186.82          | 171.00 | 929.62   | 18.95 | 17.94 | 7.91  | 748.09 | 394.55 | -     | -    | -      | A |
|     |  | 2.17  | 108.44           | 22.97  | 27.31  | 257.02   | 61.11  | 15.66  | 0.46 | 0.00 | 47.07           | 53.91  | 168.50   | 13.19 | 4.27  | 4.81  | 80.13  | 34.61  | 0.00  | 0.00 | -      | D |
| 12  | Shahdra Drain (Lahore) G/W (Deep)            | 3.15  | 157.27           | 23.36  | 12.55  | 357.64   | 127.00 | 16.67  | 7.72 | 1.04 | 33.00           | 34.27  | 215.72   | 4.94  | 0.12  | 26.52 | -      | -      | 0.00  | 0.00 | -ve    | A |
|     |  | 1.55  | 77.39            | 17.81  | 61.43  | 306.74   | 36.14  | 4.59   | 0.58 | 0.00 | 38.83           | 48.69  | 172.63   | 5.82  | 0.22  | 1.12  | -      | -      | 2.57  | 0.84 | -      | D |
| 13  | Shahdra Drain (Lahore) G/W (Shallow)         | 2.91  | 145.45           | 27.09  | 13.51  | 329.27   | 125.18 | 13.96  | 7.38 | 0.87 | 30.18           | 32.27  | 205.97   | 8.67  | 0.13  | 36.71 | -      | -      | 15.80 | 6.20 | +ve    | A |
|     |  | 2.23  | 111.48           | 27.94  | 31.65  | 308.62   | 76.33  | 19.30  | 0.35 | 0.00 | 44.53           | 44.80  | 200.81   | 9.55  | 8.93  | 6.72  | 170.31 | 68.53  | -     | -    | -      | D |
| 14  | Babu Sabu Drain (Lahore)                     | 7.63  | 381.36           | 48.45  | 73.91  | 1,091.00 | 305.45 | 44.79  | 7.35 | 1.98 | 116.64          | 128.82 | 655.81   | 15.01 | 2.87  | 13.51 | 445.45 | 263.36 | -     | -    | -      | A |
|     |  | 3.08  | 154.13           | 25.37  | 31.75  | 364.56   | 102.25 | 16.62  | 0.44 | 0.00 | 60.09           | 46.16  | 231.53   | 2.84  | 3.48  | 1.41  | 210.72 | 21.92  | 0.00  | 0.00 | -      | D |
| 15  | Babu Sabu Drain (Lahore) G/W (Deep)          | 3.24  | 161.82           | 26.64  | 14.93  | 384.55   | 139.82 | 17.79  | 7.82 | 1.02 | 36.00           | 36.36  | 230.28   | 4.42  | 0.09  | 9.51  | -      | -      | 0.80  | 0.00 | -ve    | A |
|     |  | 2.05  | 102.48           | 20.41  | 79.16  | 480.90   | 55.68  | 10.94  | 0.20 | 0.00 | 53.05           | 94.69  | 327.25   | 8.58  | 15.11 | 12.04 | 94.25  | 38.63  | 0.00  | 0.00 | -      | D |
| 16  | Babu Sabu Drain (Lahore) G/W (Shallow)       | 3.42  | 170.91           | 28.91  | 12.60  | 389.73   | 139.55 | 16.35  | 7.76 | 1.22 | 33.00           | 39.27  | 235.58   | 6.54  | 0.23  | 5.79  | -      | -      | 7.20  | 3.50 | -ve    | A |
|     |  | 1.51  | 75.64            | 23.56  | 20.21  | 191.35   | 67.50  | 15.61  | 0.60 | 0.00 | 29.23           | 22.74  | 104.73   | 3.13  | 1.06  | 3.83  | -      | -      | 4.79  | 1.63 | -      | D |
| 17  | Khudpur Drain (Lahore)                       | 9.95  | 497.27           | 95.36  | 101.82 | 1,521.64 | 402.27 | 39.82  | 7.43 | 3.20 | 127.18          | 172.00 | 893.67   | 21.30 | 11.82 | 6.10  | 673.55 | 329.73 | -     | -    | -      | A |
|     |  | 2.49  | 124.44           | 4.96   | 23.80  | 204.22   | 68.31  | 16.77  | 0.29 | 0.00 | 20.96           | 27.18  | 127.40   | 8.09  | 1.47  | 5.25  | 35.66  | 59.08  | 0.00  | 0.00 | -      | D |
| 18  | Khudpur Drain G/W (Deep)                     | 10.38 | 519.09           | 79.64  | 71.96  | 1,352.73 | 343.18 | 35.01  | 7.35 | 2.69 | 144.64          | 176.91 | 829.76   | 6.18  | 1.58  | 16.19 | -      | -      | 2.80  | 0.20 | -ve    | A |
|     |  | 1.02  | 51.01            | 10.48  | 14.84  | 77.75    | 28.84  | 5.94   | 0.23 | 0.00 | 10.93           | 10.70  | 41.22    | 5.86  | 0.10  | 10.88 | -      | -      | 8.86  | 4.00 | -      | D |
| 19  | Khudpur Drain G/W (Shallow)                  | 8.18  | 409.09           | 72.36  | 101.09 | 1,365.55 | 296.82 | 28.17  | 7.60 | 3.29 | 149.82          | 183.00 | 788.50   | 9.18  | 1.11  | 13.85 | -      | -      | 4.10  | 2.00 | -ve    | A |
|     |  | 4.64  | 231.88           | 42.80  | 147.79 | 926.60   | 164.65 | 19.95  | 0.32 | 0.42 | 100.67          | 166.47 | 584.74   | 3.59  | 10.94 | 10.01 | 216.04 | 92.38  | 0.00  | 0.00 | -      | D |
| 20  | Sukhrava Drain (Sahiwal)                     | 14.29 | 714.55           | 101.73 | 214.55 | 2,623.91 | 513.18 | 62.90  | 7.53 | 4.13 | 269.55          | 386.09 | 1,601.53 | 17.84 | 32.70 | 21.85 | 499.36 | 286.91 | -     | -    | -      | A |
|     |  | 1.83  | 91.66            | 39.20  | 65.20  | 328.77   | 102.15 | 17.61  | 0.42 | 0.00 | 62.10           | 43.81  | 201.18   | 6.78  | 3.25  | 3.54  | -      | -      | 4.60  | 1.41 | -      | D |
| 21  | Sukhrava Drain (Sahiwal) G/W (Deep)          | 6.96  | 348.18           | 56.91  | 62.29  | 1,067.91 | 290.91 | 36.12  | 7.39 | 2.07 | 119.18          | 126.73 | 614.50   | 4.93  | 0.48  | 31.85 | -      | -      | 0.00  | 0.00 | -ve    | A |
|     |  | 2.52  | 125.92           | 33.01  | 30.00  | 291.00   | 84.15  | 20.62  | 0.37 | 0.00 | 36.27           | 40.77  | 181.68   | 14.61 | 10.16 | 14.14 | 132.61 | 73.22  | 4.62  | 0.58 | -      | D |
| 22  | Sukhrava Drain (Sahiwal) G/W (Shallow)       | 5.58  | 279.09           | 55.82  | 62.62  | 916.36   | 233.18 | 22.75  | 7.66 | 1.96 | 98.00           | 105.00 | 516.65   | 6.38  | 0.39  | 11.37 | -      | -      | 6.80  | 1.70 | +ve    | A |
|     |  | 1.81  | 90.71            | 18.44  | 75.43  | 488.52   | 80.93  | 17.09  | 0.22 | 0.40 | 111.16          | 81.77  | 253.43   | 8.36  | 4.22  | 7.25  | 162.61 | 106.69 | 0.00  | 0.00 | -      | D |
| 23  | Madvana Drain (Toba Tek Singh)               | 23.69 | 1,184.55         | 145.09 | 343.36 | 4,014.91 | 777.27 | 100.73 | 7.60 | 6.40 | 357.09          | 553.09 | 2,282.79 | 18.69 | 12.36 | 9.40  | 594.09 | 314.64 | -     | -    | -      | A |
|     |  | 1.00  | 49.96            | 19.52  | 44.31  | 178.23   | 35.43  | 9.80   | 0.41 | 0.00 | 61.77           | 21.17  | 116.23   | 15.30 | 6.66  | 4.68  | 93.33  | 92.83  | 6.50  | 3.00 | -      | D |
| 24  | Madvana Drain (Toba Tek Singh) G/W (Deep)    | 4.89  | 244.55           | 42.73  | 55.05  | 855.45   | 206.36 | 24.19  | 7.83 | 2.56 | 106.00          | 110.27 | 495.32   | 6.69  | 2.06  | 4.01  | -      | -      | 4.00  | 1.80 | -ve    | A |
|     |  | 3.28  | 163.83           | 41.83  | 77.49  | 561.83   | 105.60 | 34.35  | 0.43 | 0.00 | 81.98           | 96.01  | 297.50   | 13.53 | 6.28  | 21.23 | 104.08 | 56.17  | 5.43  | 2.40 | -      | D |
| 25  | Madvana Drain (Toba Tek Singh) G/W (Shallow) | 8.29  | 414.55           | 88.36  | 149.64 | 1,712.09 | 369.09 | 36.01  | 7.78 | 3.53 | 191.82          | 224.82 | 959.53   | 4.37  | 3.56  | 16.25 | -      | -      | 1.10  | 0.60 | -ve    | A |
|     |  | 2.63  | 131.30           | 24.50  | 67.04  | 303.77   | 95.87  | 20.12  | 0.33 | 0.00 | 64.51           | 65.28  | 206.20   | 9.40  | 10.70 | 8.55  | 118.59 | 53.32  | 8.36  | 3.73 | -      | D |
| 26  | Upper Chenab Drain (Sharqpur)                | 2.55  | 127.27           | 27.73  | 25.64  | 401.09   | 120.73 | 12.49  | 7.25 | 1.33 | 39.00           | 43.00  | 235.40   | 14.19 | 2.02  | 6.04  | 146.45 | 110.27 | -     | -    | -      | A |
|     |  | 6.09  | 304.62           | 15.96  | 135.15 | 1,208.64 | 230.75 | 50.66  | 0.30 | 0.52 | 111.38          | 159.94 | 637.57   | 15.24 | 11.33 | 5.87  | 153.16 | 113.38 | 0.00  | -    | -      | D |
| 27  | Upper Chenab Drain (Sharqpur) G/W (Deep)     | 5.22  | 260.91           | 44.91  | 38.56  | 709.00   | 216.82 | 25.40  | 7.52 | 1.89 | 67.82           | 77.36  | 413.87   | 4.34  | 0.31  | 16.19 | -      | -      | 0.00  | 0.00 | -ve    | A |
|     |  | 13.33 | 666.65           | 42.58  | 185.94 | 1,709.78 | 395.78 | 72.51  | 0.33 | 0.64 | 137.21          | 241.05 | 997.43   | 10.18 | 14.29 | 9.75  | 142.72 | 72.44  | 14.76 | 6.99 | -      | D |
| 28  | Upper Chenab Drain (Sharqpur) G/W (Shallow)  | 4.56  | 228.18           | 39.64  | 25.24  | 634.18   | 176.82 | 18.89  | 7.55 | 1.85 | 65.91           | 68.09  | 357.86   | 5.70  | 0.37  | 30.05 | -      | -      | 9.30  | 4.10 | +ve    | A |
|     |  | 7.77  | 388.67           | 48.61  | 122.94 | 864.11   | 210.49 | 50.42  | 0.30 | 0.00 | 149.33          |        |          |       |       |       |        |        |       |      |        |   |

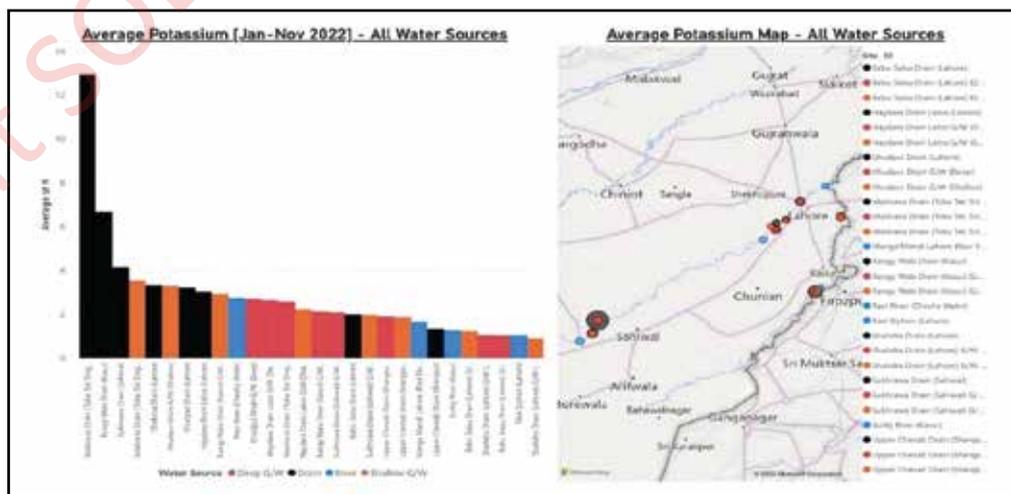
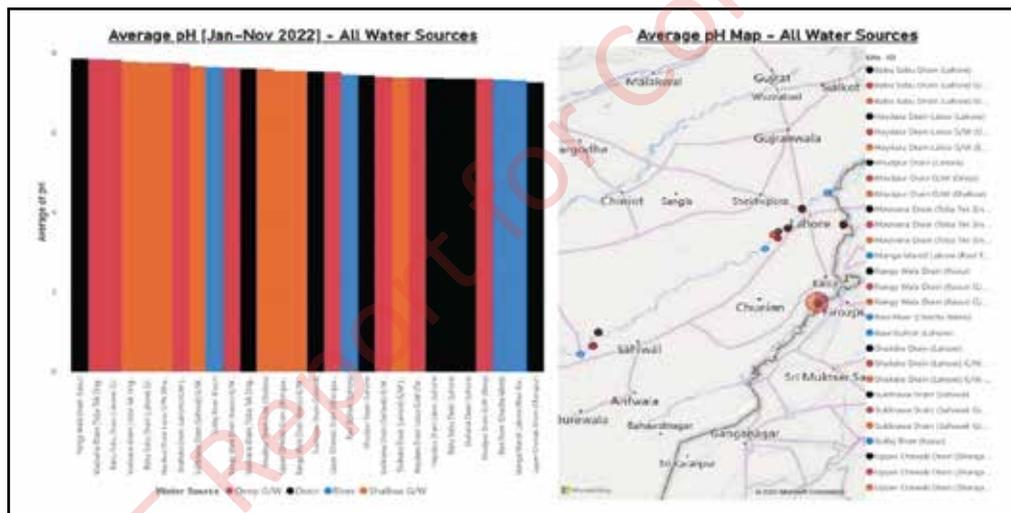
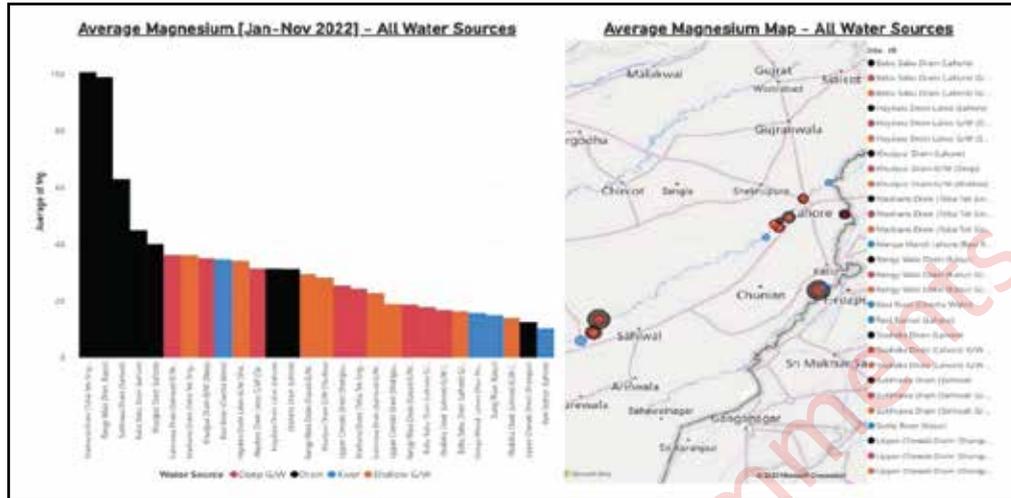


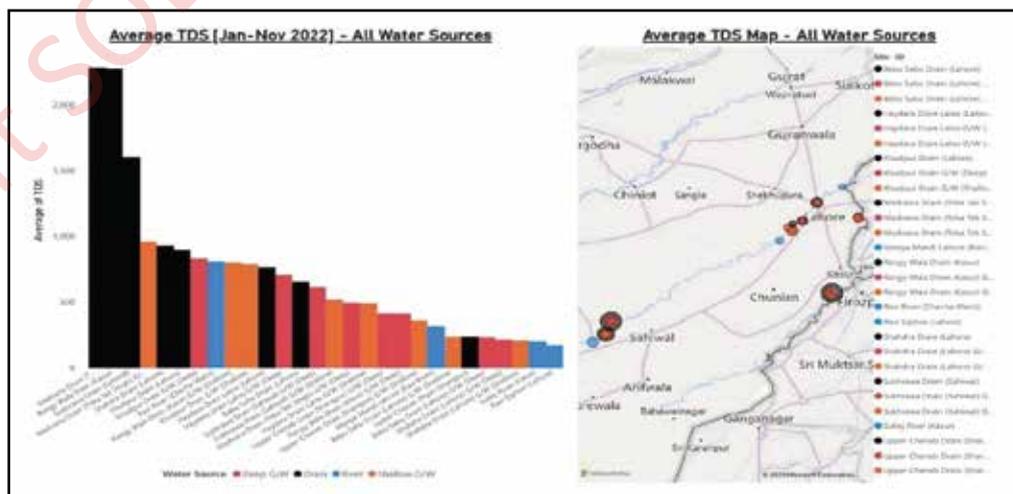
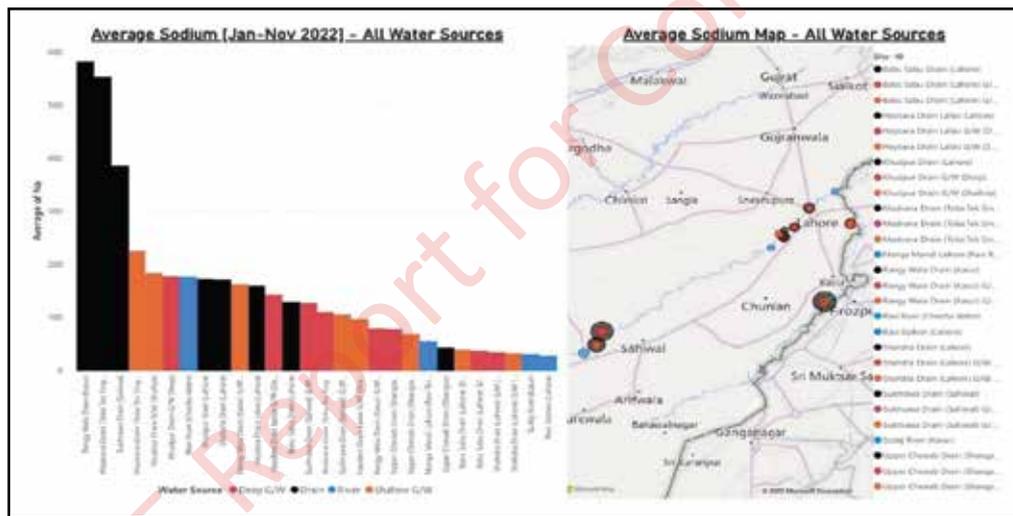
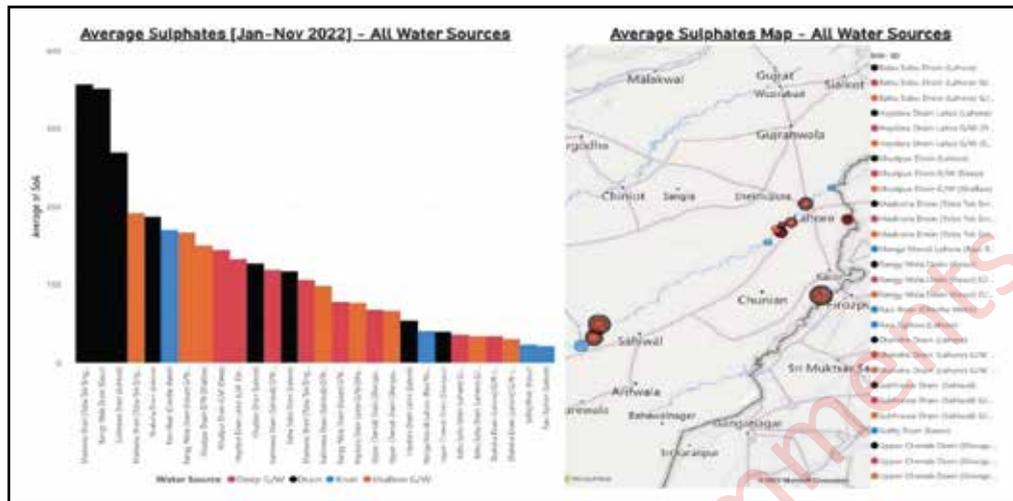
Annex - III

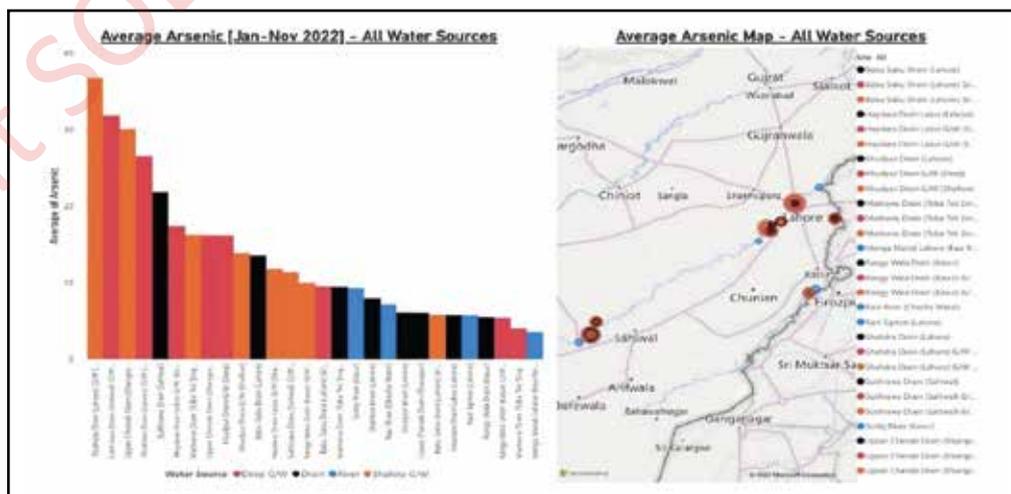
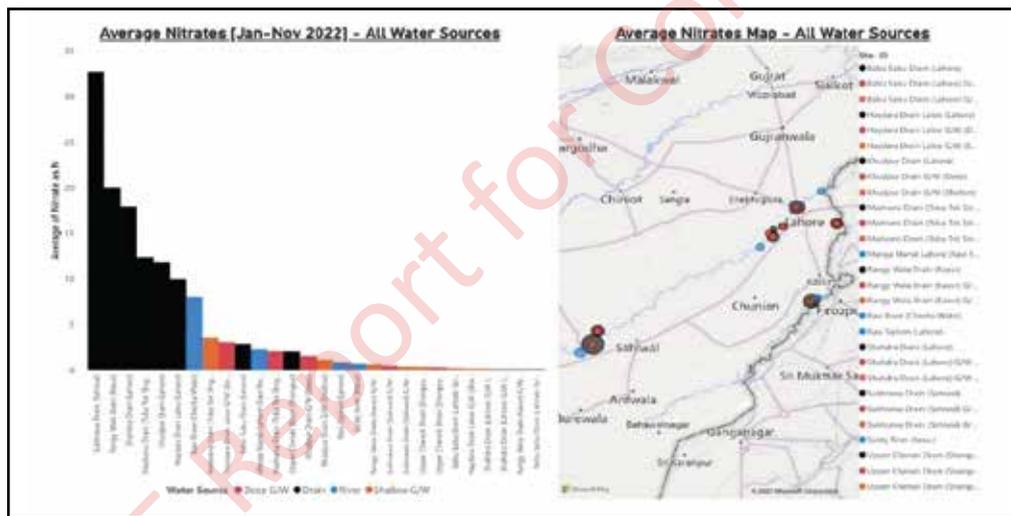
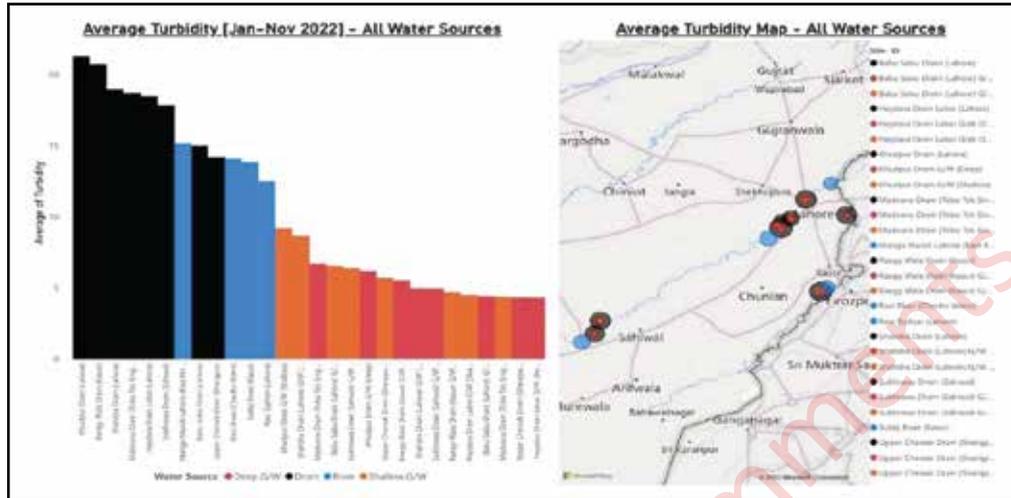
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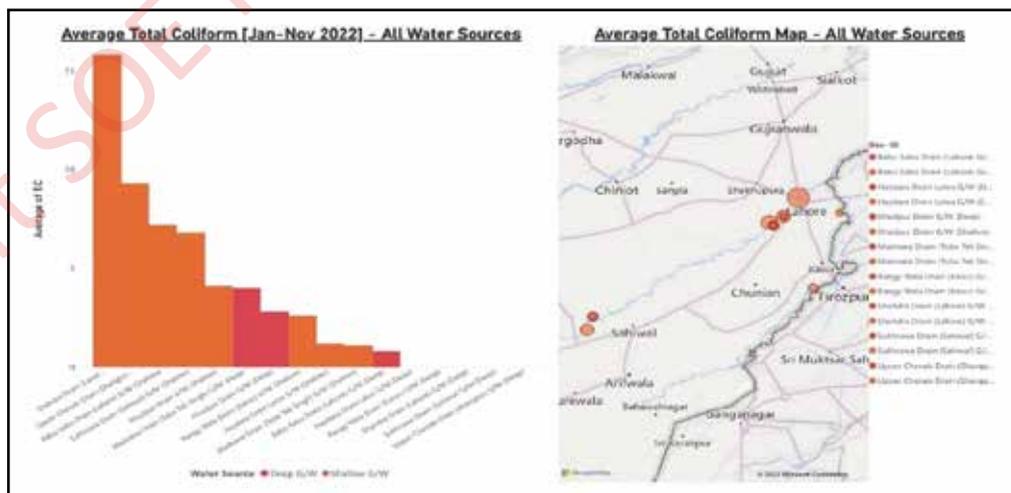
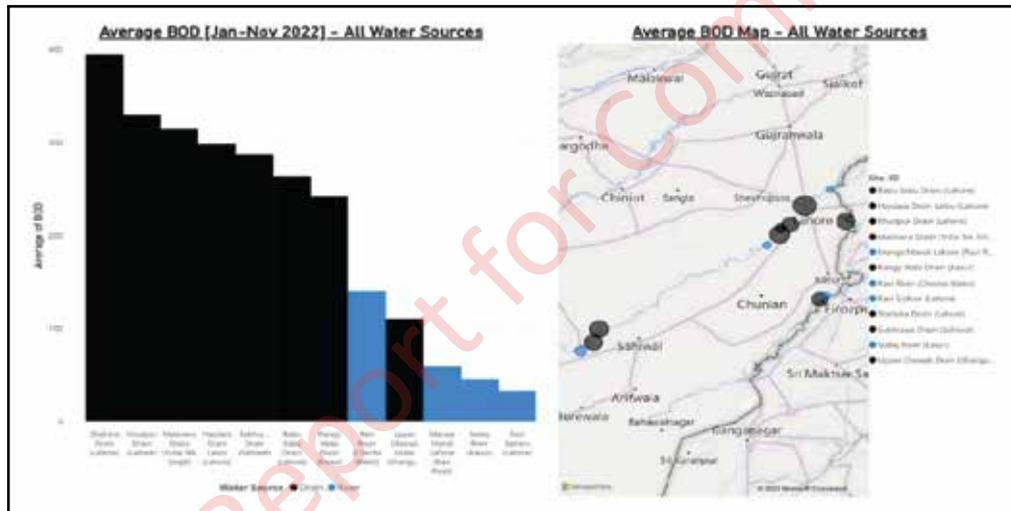
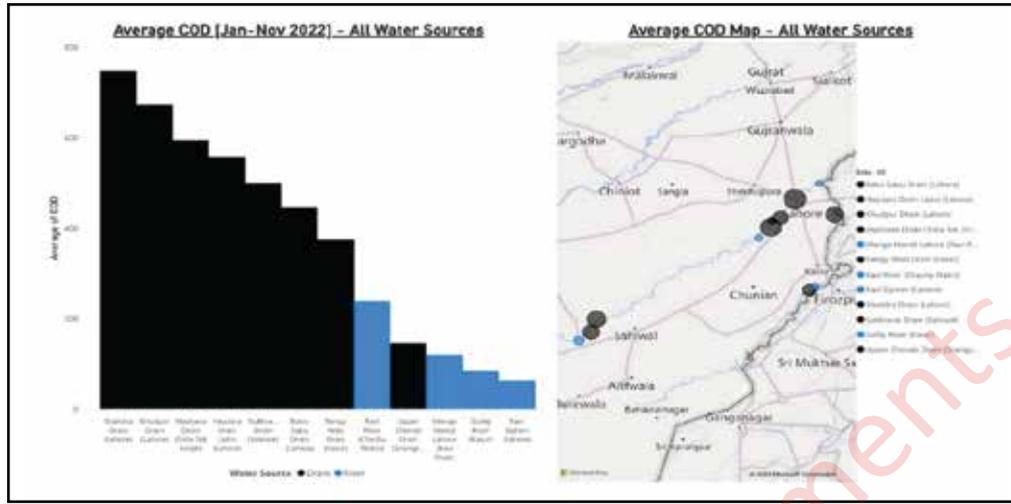


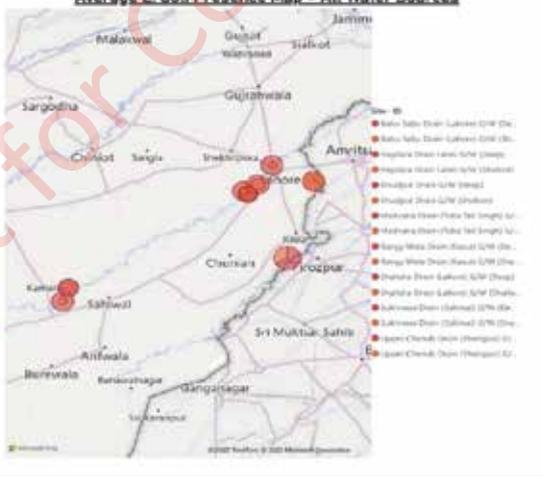
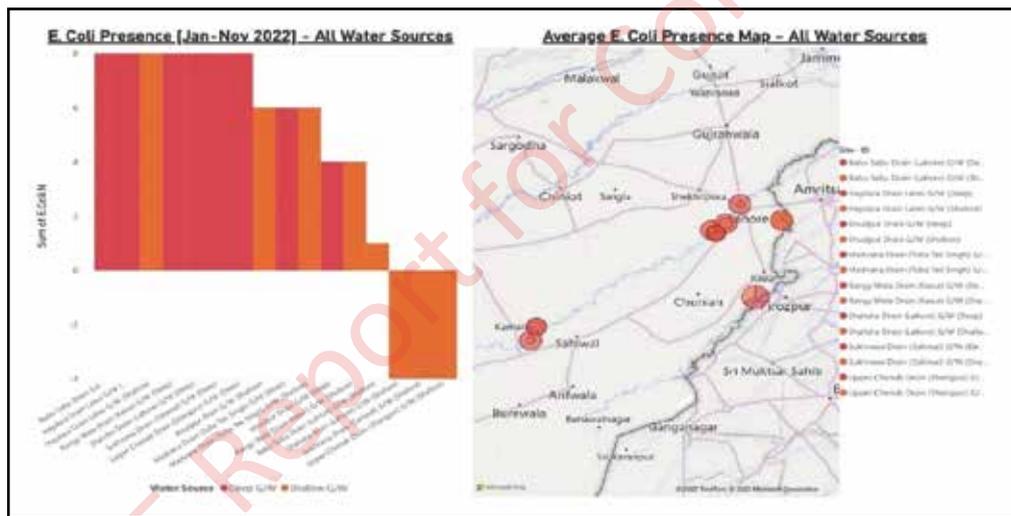
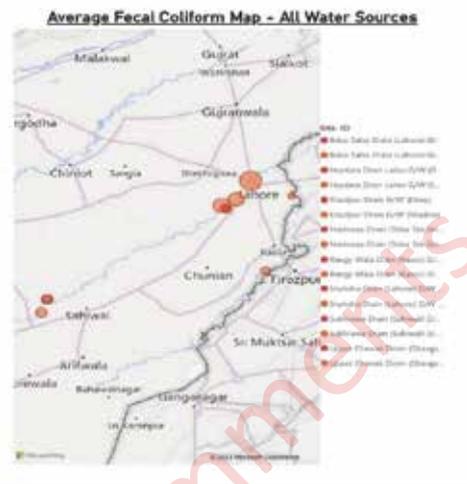
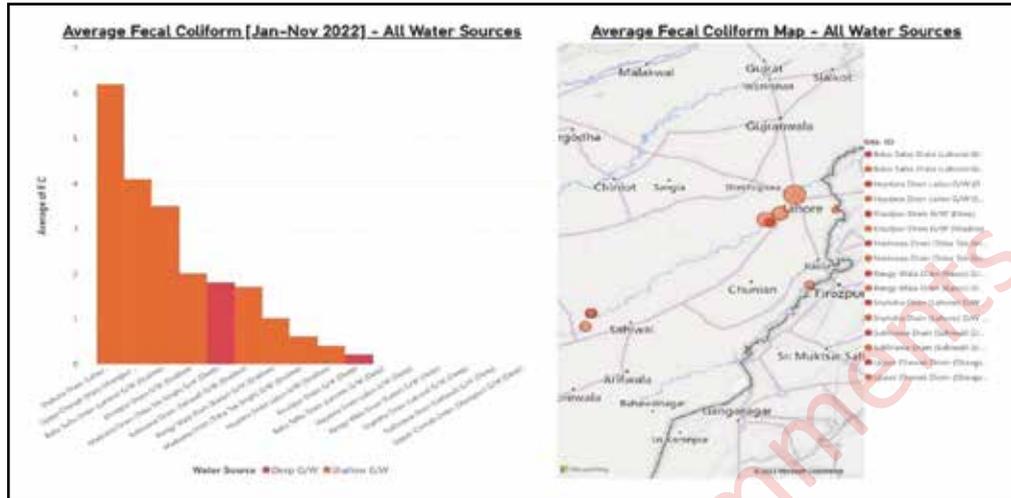












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### Annex - IV

Details of letters written to stakeholders for feedback on the proposed contents of SOE, 2022 (Table 30)

**Table 30:** Feedback on the proposed contents of SOE, 2022

| #  | Details of Stakeholder  |
|----|---|
| 1  | The Secretary GOP Mines & Minerals Department Lahore                                      |
| 2  | The Secretary GOP Primary & Secondary Healthcare Department Lahore,                       |
| 3  | The Secretary GOP Finance Department Lahore   |
| 4  | The Secretary GOP Specialized Healthcare & Medical Education Department Lahore            |
| 5  | The Secretary GOP Energy Department Lahore  |
| 6  | The Secretary GOP Industries, Commerce, Investment & Skills Development Department Lahore |
| 7  | The Chief Executive Officer Urban Unit Lahore   |
| 8  | The Secretary GOP Livestock and Dairy Development Department Lahore                       |
| 9  | The Chairman Pakistan Council of Research in Water Resources Islamabad                    |
| 10 | The Secretary GOP Irrigation Department Lahore  |
| 11 | The Secretary GOP Agriculture Department Lahore   |
| 12 | The Secretary GOP Transport Department  |
| 13 | The Secretary GOP Excise Taxation & Narcotics Control Department Lahore                   |
| 14 | The Secretary GOP Housing Urban Development & Public Health Department Lahore             |
| 15 | The Regional Director Pakistan Meteorological Department Lahore                           |
| 16 | The Managing Director Water and Sanitation Agency Multan                                  |
| 17 | The Secretary, Trade Development Authority of Pakistan TDAP Lahore                        |
| 18 | The General Manager, Pakistan Space & Upper Atmosphere Research Commission Lahore         |
| 19 | The Managing Director, Water and Sanitation Agency, Gujranwala                            |
| 20 | The Managing Director, Water and Sanitation Agency, Rawalpindi                            |
| 21 | The Managing Director, Water and Sanitation Agency, Faisalabad                            |
| 22 | The Managing Director, Water and Sanitation Agency, Lahore                                |
| 23 | The Managing Director Water and Sanitation Agency Multan                                  |
| 24 | The Chief Executive Officer, Punjab Healthcare Commission Lahore                          |
| 25 | The Managing Director, Punjab Energy and Conservation Agency Lahore                       |
| 26 | The Manager, Small and Medium Enterprise Development Authority Lahore                     |
| 27 | The Director General, Provincial Disaster Management Authority Lahore                     |
| 28 | The President, Faisalabad Chamber of Small Traders and Small Industry Faisalabad          |
| 29 | The President Chamber of Commerce Sialkot   |
| 30 | The President Chamber of Commerce Sheikhpura  |
| 31 | The President Chamber of Commerce Rawalpindi  |
| 32 | The President Chamber of Commerce Lahore  |



**Table 30:** Feedback on the proposed contents of SOE, 2022

| #  | Details of Stakeholder   |
|----|--|
| 33 | The President Chamber of Commerce Gujranwala   |
| 34 | The President Chamber of Commerce Faisalabad   |
| 35 | The President Chamber of Commerce south Punjab   |
| 36 | The President, Chamber of Commerce, Women Chamber, Lahore,   |
| 37 | The President, Chamber of Commerce, Attock,  |
| 38 | The President, Chamber of Commerce, Rawalpindi   |
| 39 | The President, Chamber of Commerce, Dera Ghazi Khan  |
| 40 | The President, Chamber of Commerce, Gujrat   |
| 41 | The President, Chamber of Commerce, Chakwal  |
| 42 | The President, Chamber of Commerce, Jhang  |
| 43 | The President, Chamber of Commerce, Jhelum   |
| 44 | The President, Chamber of Commerce, Multan   |
| 45 | The President, Chamber of Commerce, Okara  |
| 46 | The President, Chamber of Commerce, Khanewal   |
| 47 | The President, Chamber of Commerce, Rahim yar khan   |
| 48 | The President, Chamber of Commerce, Sahiwal  |
| 49 | The President, Chamber of Commerce, Sargodha   |
| 50 | Prof. Dr. Sajjad H. Sheikh, Chairman, Institute of Environment Engineering and Research University of Engineering and Technology Lahore              |
| 51 | Prof. Dr. Obaidullah Nadeem, City and Regional Planning Department University of Engineering and Technology Lahore.                                  |
| 52 | Dr. Imdad Hussian, Assistant Professor and Chairperson, Department of Governance and Global Studies, Information Technology University (ITU), Lahore |
| 53 | Dr. Ghulan Mrtaza, Director, Institute of Soil and Environmental Sciences, University of Agricultural, Faisalabad                                    |
| 54 | Dr. Sohail Yousaf, Head of Department of environmental sciences, Quaid e Azam University, Islamabad  |
| 55 | Dr. Muhmmad Fahim Khokhar, Head of Department, Department of Environmental Sciences, National University of Sciences & Technology (NUST), Islamabad  |
| 56 | Dr. Ghulam Hassan Abbasi, Head of Department, Institute of Agro-Industry and Environment, The Islamia University of Bahawalpur, Bahawalpur           |
| 57 | Dr. Saif Ur Rehman Kashif, Chairman, Department of Environmental Sciences, University of Veterinary & Animal Sciences, Lahore                        |
| 58 | Prof. Dr. Arifa Tahir, Chairperson Department of Environmental Sciences, Lahore College for Women University, Lahore                                 |



**Table 30:** Feedback on the proposed contents of SOE, 2022

| #  | Details of Stakeholder  |
|----|---|
| 59 | Muhammad Nawaz Chaudhry, Head of Department, Department of Environmental Sciences & Policy, Lahore school of Economics, Lahore        |
| 60 | Dr. Derk Machiel bakker, Chairperson, Department of Environmental Sciences, Forman Christian College (A Chartered University), Lahore |
| 61 | Prof. Dr. Faiza Sharif, Director, Sustainable Development Study Centre (SDSC), Government College University, Lahore                  |
| 62 | The President Lahore Conservation Society, Lahore   |
| 63 | The President, Greenstep Foundation, Lahore.  |
| 64 | The President, Asma Foundation, Lahore,   |
| 65 | The President, WBM Foundation, Lahore.  |
| 66 | The Resident Editor, Dawn News, Lahore  |
| 67 | The Editor, The Nation News, Lahore   |
| 68 | The Group Editor, Daily Times News, Lahore.   |
| 69 | The Director News, City42 News Lahore   |
| 70 | The Director News, Lahore News, Lahore  |
| 71 | Ms. Fouzia Bilquees Malik, Head, International Union for Conservation of Nature (IUCN), Islamabad.                                    |
| 72 | Mr. Wildboard Nagambi, Chief Field Office Punjab, United Nations International Children's Emergency Fund, Pakistan Lahore.            |
| 73 | The Director General, World Wide Fund for Nature (WWF), Lahore  |
| 74 | Ms. Sana Zia, Development Advisor, Foreign, Commonwealth and Development Office, Islamabad.   |
| 75 | The Chairman, Pakistan Cosmetics Manufacturers Association Lahore   |
| 76 | The Chairman, Polymer Waste Importers and Recyclers Association Lahore  |
| 77 | The Chairman, Pakistan Ethanol Manufacturers Association  |
| 78 | The Chairman, Pakistan Sugar Mills Association, Lahore  |
| 79 | The Chairman, Pakistan Steel Mills Association, Lahore  |
| 80 | The Chairman, Pakistan Jute Mills Association, Lahore   |
| 81 | The Chairman, Pakistan Footwear Manufacturers Association Lahore  |
| 82 | The Chairman, Pakistan Flour Mills Association Lahore   |
| 83 | The Chairman, All Pakistan PVC Pipe Manufacturers Association Lahore  |
| 84 | The Chairman, All Pakistan Particle Board Manufacturers Association Lahore  |
| 85 | The Chairman, Pakistan Hosiery Manufacturers Association PHMA Lahore  |
| 86 | The Chairman, Pakistan Cotton Fashion Apparel Association Lahore  |
| 87 | The Assistant General Secretary, The Pakistan Steel Re-rolling Mills Association Lahore   |
| 88 | The Chairman, All Pakistan Poultry Association Lahore   |
| 89 | The Chairman, Pakistan Plastic Manufacturing Association Lahore   |
| 90 | The Chairman, Pakistan Plastic Manufacturing Association Lahore   |



The Punjab's State of Environment Report, 2022 is the first state of environment report for the Punjab in over 25 years.

This report is prepared in accordance with the guiding principles as mentioned in the Program Appraisal Document of the Punjab Green Development Program.

The report has been prepared under Section 6(1)(d) of the Punjab Environment Protection Act, 1997 wherein it is the function of the EPA, Punjab to prepare and publish an annual State of Environment Report



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