TECHNICAL PAPER 10

ENVIRONMENT PROTECTION AND CONSERVATION

10 ENVIRONMENT PROTECTION AND CONSERVATION

10.1 INTRODUCTION

This chapter will provide a spatial portrait of Punjab's environmental sector analyzing the baseline conditions of environmental parameters, their key challenges followed by a roadmap presenting strategic targets and their phase wise goals along with implementation strategy that will help considering environment in the main stream decision making process along with the aims for sustainable development. The chapter is divided into the following sections:

Environmental Setting: capturing baseline of environmental parameters with an aim to achieve environmental objectives by targeting conservation and management options.

Environmental Challenges: presenting environmental issues and profiling of natural disasters

Strategic Environmental Management Tools: decision making tools to analyze development initiatives

The overall objective of this section is to have an evidence based approach supported by environmental management framework with a set of tools that will help considering environment in the main stream decision making processes.

IMPORTANCE

In Punjab, environmental protection is recognized as an integral part of the social and economic development. Our quality of life, health and well-being rely on clean land, water and air, productive soils, available minerals, water resources and fluvial systems and processes. They also depend on distinctive and inspirational landscapes, a wealth of wildlife, vibrant communities, a healthy, well managed countryside and open spaces accessible for everyone to enjoy.

The province of Punjab has a highly fragmented landscape with a lot of pressure from developmental activities and alternative land use. In such a landscape, conservation and protection opportunities must be carefully targeted, which is possible through spatial prioritization analysis. As developmental activities and anthropogenic impacts are inevitable in areas like this, offsetting and mitigation options can serve as a surrogate for conservation.

The World Bank has estimated a loss of PKR 365 Billion annually for the economy of Pakistan due to environmental degradation.[1]

PSS aims to protect, conserve and restore Punjab's environment in order to improve the quality of life of public through sustainable development. It also envisions measures to promote economic growth in the region and in improve environmental quality standards in Punjab.

The Environmental Objectives of Punjab Spatial Strategy are

Contributing to Punjab being **environmentally sustainable** federating unit through **Strategic Environmental Assessment** and mitigation of potential development impacts

Conservation of natural resources through **sustainable development**

Protection and **improvement** of **environmental conditions** and **resources**

The **Punjab Spatial Strategy** (PSS) comprehended with an environmentally sustainable spatial structure of the Punjab while specifically focusing on protecting and improving physical and biological Resources.

10.2 ENVIRONMENTAL SETTING

One of the biggest challenges globally is achieving sustainable development in urban centers and cities with a balanced approach towards social, economic and environmental aspects. This is equally true for major cities in Punjab that have experienced fast paced economic and social development but partly at the cost of environmental degradation. The major factors that contributed to environmental deterioration include uncontrolled urbanization, haphazard industrialization, rapid increase in transportation and use of pesticides in agriculture. It is therefore well recognized that the real attainment of sustainable development is through integration of environmental considerations while achieving the goals of economic growth.[2] Environment is broadly categorized into three components; physical and biological. A brief overview on quality of each component is as under;

10.2.1 Physical Environment

A physical environment is considered an area that is tangible and supports, influences, and develops life. It is a part of human environment that includes physical factors (i.e. air, water and land). Component wise detail is as under;

TEMPERATURE AND PRECIPITATION

Variations in temperature and precipitation are adversely influencing land resources such as water, farming systems, beach front areas, freshwater territories, vegetation, and topographical features[3]. Punjab, province lies on the edge of

[1] World Bank. 2016. *Pakistan Strategic Country Environmental Assessment Report*. Vol 1. South Asia Environment and Social Development Unit. South Asia

[2] Punjab Economic Research Institute (PERI). 2017. *Punjab Economic Report*. Government of Punjab

[3] Malla, G. 2009. Climate change and its impact on Nepalese agriculture. Journal of agriculture and environment. 9: 62-71

the monsoon climate (31.1704° N, 72.7097° E). The temperature is by and large sweltering, with checked varieties amongst summer and winter. In June the average temperature achieves the mid-89s F (mid-30s C), whereas in January the average temperature is in the mid-49s F (low 10s C). The temperatures are higher in southern Punjab (i.e. Bahawalpur, Lodhran, Rahim Yar Khan and Rajanpur) where yearly average temperature exceed above 28^0C. The temperature becomes cooler in northern side (i.e. Chakwal, Rawalpindi and Attock) where yearly average drops down around 14^0C. The yearly average temperature of Punjab Province is presented in **Figure 10.3.**

Similarly, northern region of Punjab receives more rainfall as compared to southern while humidity decreases from north to south. These figures clearly indicate that both Mean annual maximum temperature and rainfall have highest values in the north and lowest in the Middle and Southern region. The yearly average rainfall in Punjab Province is presented in **Figure 10.4**.

CLIMATE CHANGE

Pakistan lies in the zone that faces one of the highest risks of climate change in the 'high-extreme risk category' as illustrated in **Figure. 10.1**. South Punjab falls in the 'extreme risk' category while central and north Punjab are at 'high risk'. The negative effect of floods alone is estimated to be USD 6 billion per year.

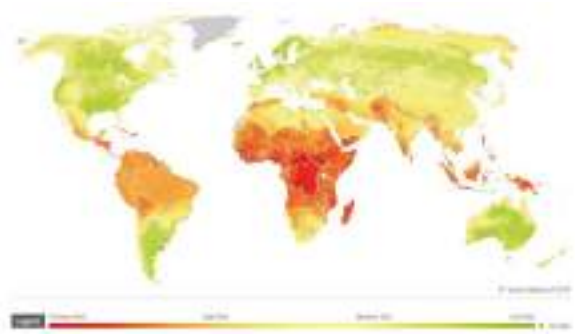
The climate of the Punjab ranges from extremely hot summers to mild foggy winters. The land is hydrated by summer monsoons and by the five rivers which run longitudinally through the province, namely, Indus, Jehlum, Chenab, Ravi, and Sutlej. Summers are hot from May to July, followed by monsoon rainfall from the Bay of Bengal from August to September which breaks the heat spell. These bring precipitation to the northern parts of the province. The Southern parts of the province receive rainfall from southwest winds from over the Arabian Sea[4].

According to Global Climate Risk Index (2017) Pakistan ranks 7th amongst the most adversely affected countries by Climate Change.[5]

Climatic data (Rainfall and Temperature) was obtained from weather stations of Pakistan Meteorological Department (PMD) across Punjab. The data included temperature (^{o}C) and rainfall (mm) for different regions in District Punjab for (a) Average data for two normal periods (1955 to 1985 and 1985 to 2015). These two parameters (Temperature and Rainfall) have the longest and largest information scope. The Climate-Risk Vulnerability Assessment (CRVA) was done that intends to primarily address climate change impact adaptation from an urban perspective for key city sectors, including energy, water demand/supply and wastewater treatment, transportation, and human health.

The annual mean temperature in Pakistan has increased by roughly 0.5 degree centigrade while some districts of Punjab like Rahim Yar Khan have even experienced a 1.3 degree increase. Precipitation patterns have changed over time as well, where maximum increment in precipitation was seen in Lahore 359.62 mm recorded over two normal periods (1951 to 1980 and 1981 to 2015). A statistical analysis shows that strongest correlations (in R^2) among key parameters are found between $PM_{2.5}$ and CO implying road traffic is a main source of fine PM in Pakistan. Pakistan's urban air pollution is among the highest in South Asia and the resulting damage already exceeds several high-profile causes of mortality and morbidity in the region. Such variability has led to considerable increase in frequency and intensity of extreme weather events, erratic monsoon rain and floods that pose a threat to water security, food security, energy security and National Security. With the focus being given to climate change action increasing globally, there is a dire need to address climate change in the planning and implementation of development projects in Punjab.

Figure 10.1: Climate Change Vulnerability Index 2017[6]



CLIMATE-RISK VULNERABILITY ASSESSMENT (CRVA)

Temperature and precipitation are the two key climate variables for CRVA. The baseline spatial data of the two variables was derived from WordClim database[7]. The baseline and climate change projection of the spatial precipitation and temperature of Punjab is presented in **Figure 10.5** and **Figure 10.6**. By 2035, precipitation is likely to increase, with the mid scenario projected a slight increase of 1.1% at the southwest to 5.7% at the northeast of the province. The uncertainty range is 0.8 to 4.3% for the southwest and 2.1 to 10.7% for the northeast (**Figure 10.5**). In comparison to precipitation, the projected temperature increase is more uniform: a likely 0.95^{o}C increase for most areas from baseline by the mid scenario, with the uncertainty range of 0.70^{o}C to 1.8^{o}C as projected by the low and high scenarios. Western and northern high altitude areas have a slightly higher increase

[4] Pakistan Journal of Metrology; Salma, S., S. Rehman, M. A. Shah; Rainfall trends in different climate zones of Pakistan, Vol. 9, Issue 17: Jul 2012

[5] Pakistan Economic Survey 2016-17. 2017. *Chapter Climate Change*. Government of Pakistan

[6] Climate Change Vulnerability Index 2017, Verisk Maplecroft

[7] http://www.worldclim.org

rate than the rest of the area (**Figure 10.6**). The key findings of this study are:

- For energy sector, climate change will likely add further energy demand for major cities of Punjab; climate change may cause reduced hydroelectricity generation due to its impact on stream-flow.
- For water resources, climate change will bring in additional challenges in water resource management. Besides normal projected demand increase, additional water will be needed due to climate change for the cities.
- Climate change will also affect the groundwater recharge through its impact on river inflows in the region, and combined effects from the climate change impact are most likely pointing to continuing groundwater resource depletion.
- Climate change will likely cause more severe urban flooding through impact on heavy rainfall events. Besides enhanced rain intensity, climate change also implies more frequent severe flood events.
- Enhanced rainfall also influences the wastewater system. During flood events, the wastewater systems become overloaded, which can potentially cause pollution and threat to water borne diseases.
- For transport, enhanced flood risk causes water damage to the road networks.
- Furthermore, the potential increase of heat wave places stress on road infrastructures, softens the asphalt causing traffic rutting, potentially resulting in pavement cracking.

Strategies to improve Punjab's growth and economy has been a regular topic of debate at various national forums in the public and private sector. Without climate smart interventions and solutions to all growth needs, especially in infrastructure, urban development, energy and power generation, agriculture and water sectors, growth of Punjab will be in peril. It is important to indulge PSS with **"Triple Win"** strategies[8] offered by the paradigm which looks at Low Carbon Development, Climate Resilient Development, and the arising Co-benefits of adaptation and mitigation efforts.

Figure 10.2: Climate Compatible Development Paradigm

In order to achieve **Sustainable Development Goals (SDGs)** by 2030, Punjab must redefine its development plan with a more inclusive approach; climate change and environment components now constitute a greater number of goals and targets than before. Out of the 17 SDGs **Goal 13: Climate Action,** is dedicated to reduce the impact of climate change. PSS and SDGs promote climate action, development in harmony with nature, sustainable ecosystem management, and economically sound environmental technologies. PSS proposes sustainability, reduction in environment degradation, and climate resilient development. [9]

Policy Statement: Align development to climate change resilience

Indicator	Target 2027	Target 2037	Target 2047
GHG emissions	18% reduction in the provincial GHG emissions	25% reduction in the provincial GHG emissions	35% reduction in the provincial GHG emissions
Urban Heat Island	Reduce Temperature difference in affected areas by 2 degree (identified as High priority areas)	Reduce Temperature difference in affected areas by 1 degree (identified as Medium priority areas)	Reduce Temperature difference in affected areas by 1 degrees (identified as low priority areas)
Urban forest	Increase urban forest cover by 6%	Increase urban forest cover by 10%	Increase urban forest cover by 15%
% Urban population with access to intra-city public transport	>82	>88	>95

Implementation Strategy

One of the core objectives of the PSS is the design and construction of climate change resilient infrastructure. The baseline climatic conditions of the region are given in the environment section of the PSS report. In order to implement

[8]https://cdkn.org/2011/06/defining-climate-compatible-development/?loclang=en_gb

[9] United Nations Sustainable Development Goals

adaption and mitigation options for managing the climatic impacts of the development following steps will be made part of the implementation strategy;

- Development of Climate Change Act and revision of Environmental Protection Act
- Restructuring of Environment Protection Department for improved environmental governance
- Development of an active GHG inventory at provincial level starting with 10 major cities
- Development of Climate Change Resilient Infrastructure Codes and Rules including institutionalization of climate change action in urban development
- Best Available Techniques (BAT) to be introduced in the environmental permits for industries
- Development of future climate change scenarios with quantification and mapping of risk to urban service delivery sectors (water storage, transport, health, solid waste, energy systems etc.)
- With the help of impact assessment models, identification of adaptation strategies that could enhance the resilience of the climate sensitive development projects' components at design and construction phases
- Afforestation to help more forests act as carbon sinks

Figure 10.3: Average Annual Temperate of Punjab Province

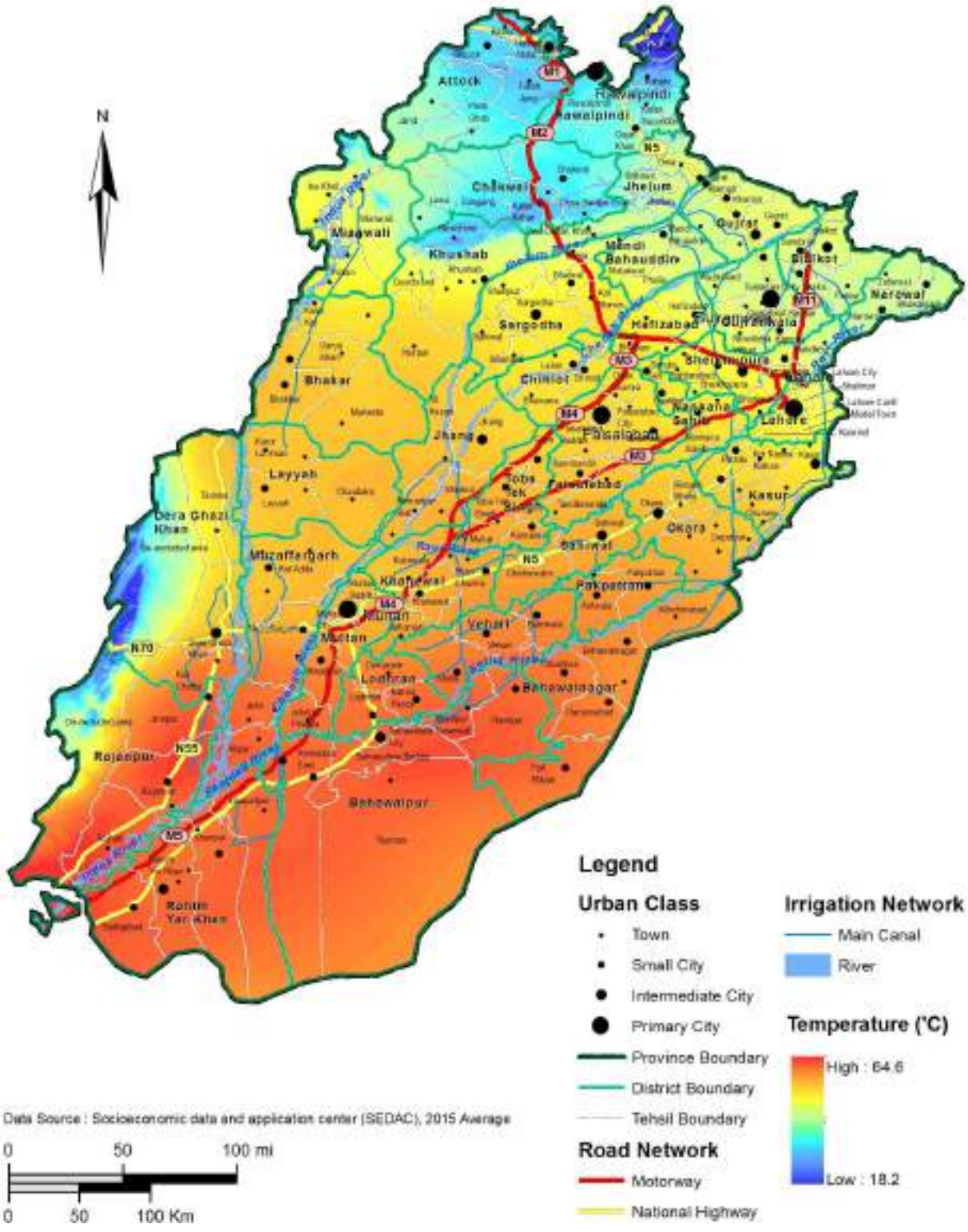


Figure 10.4: Average Annual Rainfall in Punjab province

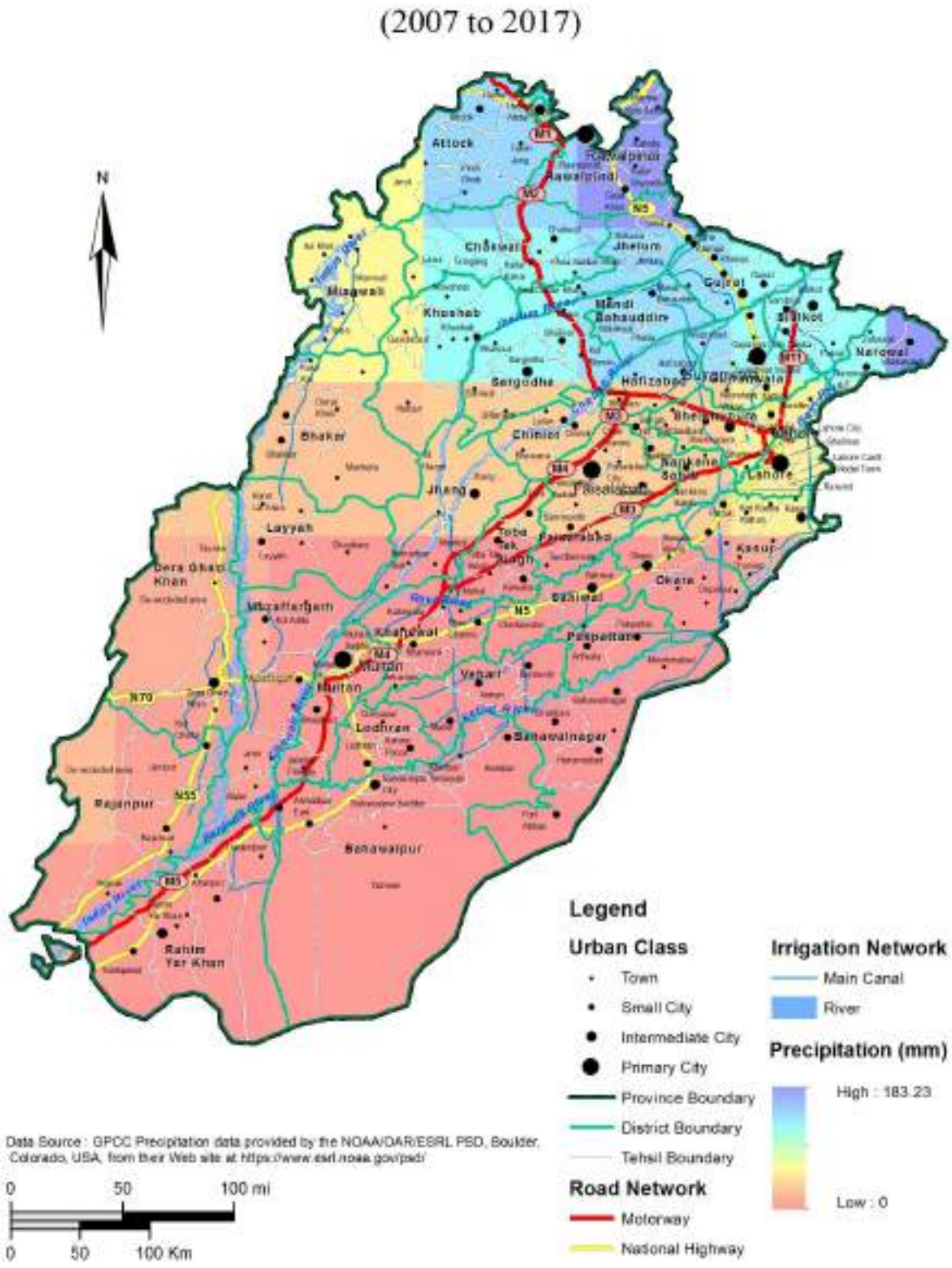
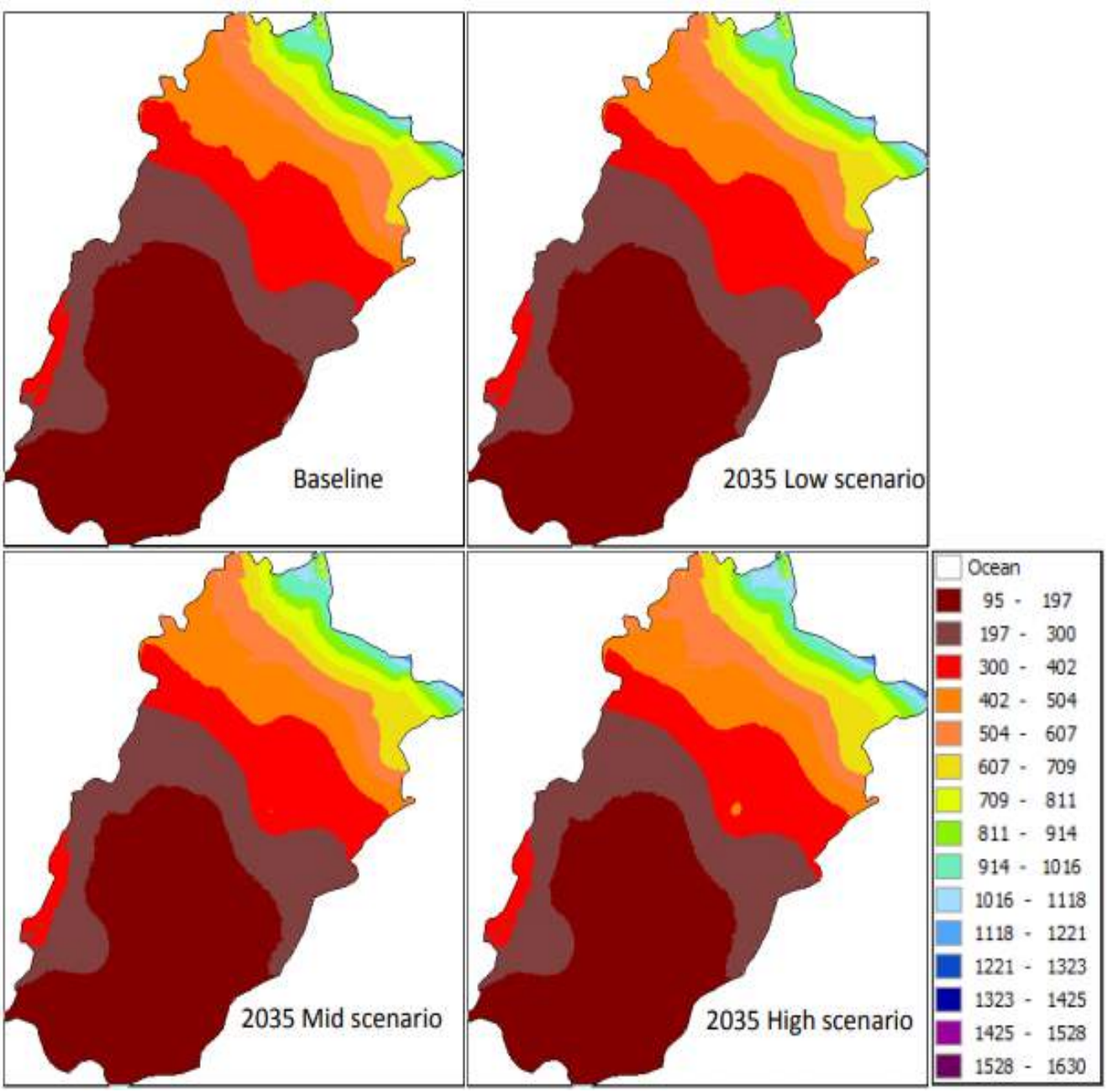
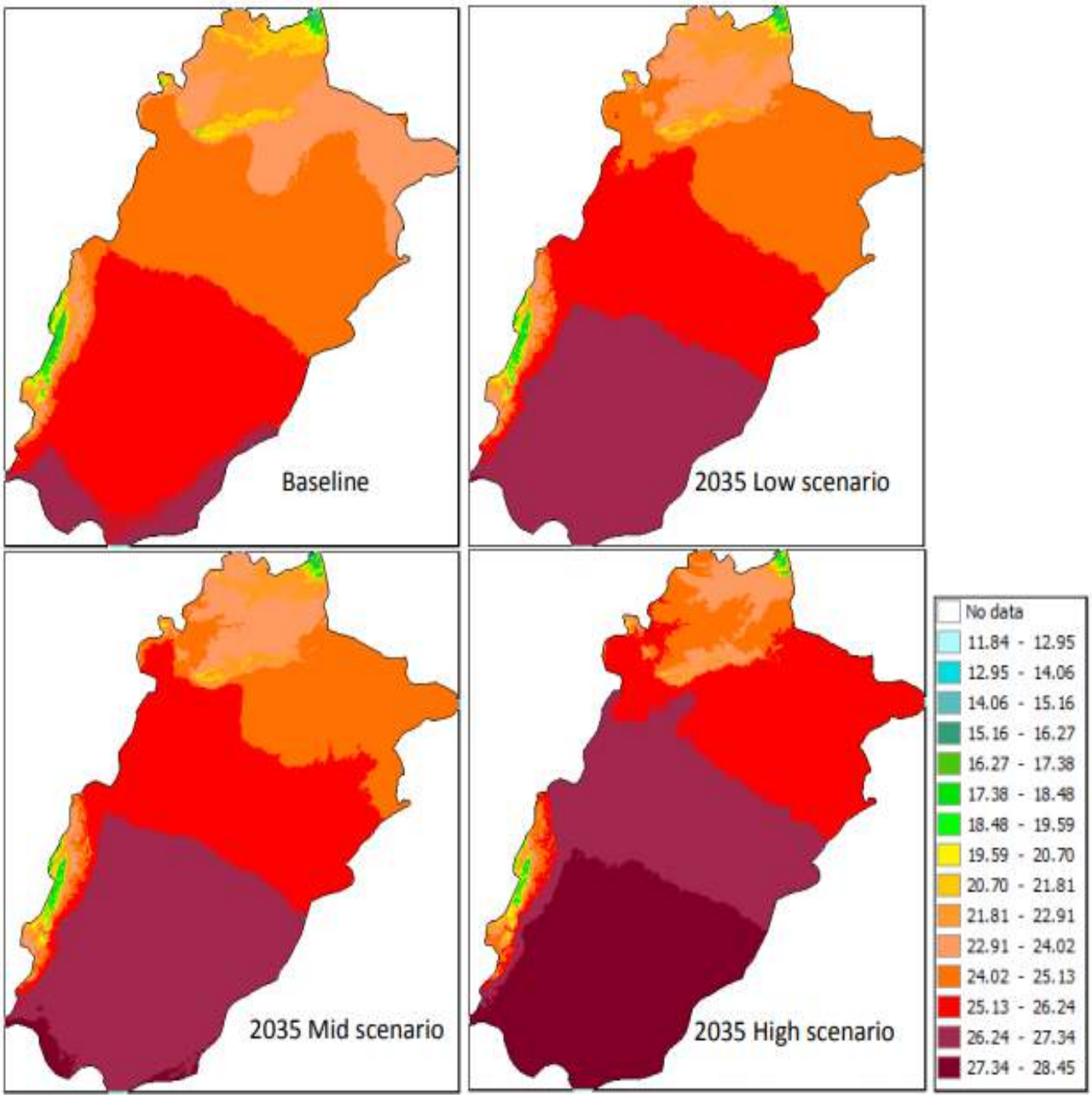


Figure 10.5: Punjab Annual Mean Precipitation (Mm): Baseline and 2035 projection[10]



[10] Climate Risk and Vulnerability Assessment, Punjab Intermediate Cities Improvement Investment Program- ADB, 2015

Figure 10.6: Punjab Annual Mean Average Temperature (^{0}c): Baseline and 2035 projection[11]



[11] Climate Risk and Vulnerability Assessment, Punjab Intermediate Cities Improvement Investment Program- ADB, 2015

AIR QUALITY

Air pollution in Punjab is amongst the most severe in the world, and it significantly damages human health and the economy. Air pollution, particularly in large urban centers, damages the populations' health and quality of life, and contributes to environmental degradation[12]. From 2007 to 2011, the reported levels of Particulate Matter (PM), Sulfur Dioxide (SO_2), and Lead (Pb) were many times higher than the World Health Organization (WHO) air quality guidelines[13]. The number of premature deaths and illnesses caused by air pollution exceeds most other high profile causes of public health problems that receive significantly more attention in Punjab, including road accidents[14].

According to a World Health Organization (WHO) estimate, in 2015, almost 60,000 Pakistanis died from the high level of fine particles in the air, one of the world's highest death tolls from air pollution.

The most important economic costs associated with air pollution correspond to impacts on human health. Cement, fertilizer, sugar units, and power plants are considered to be the most air polluting industries of Pakistan. Transportation is also main culprit for air and noise pollution. Depending on the level, quality and exposure of noise duration, noise pollution may adversely affect the human health. Currently the situation is getting alarming with increase in traffic density on city roads. Moreover, trans-boundary effects are worsening air pollution in Punjab, posing a threat to human health and environment. Concentrations of NO2 and P.M2.5 of overall Punjab province are presented **in Figure 10.7** & **Figure 10.8** respectively.

As an example, a case box for air quality index for Lahore city has been presented in **Figure 10.9**. The purpose of AQI is to understand what local air quality means to our health. An AQI value of 100 generally corresponds to the Provincial air quality standard (PEQs of Air) for the pollutant, which is the level EPA has set to protect public health. AQI values at or below 100 are generally thought of as satisfactory.This shows that if/once the data is available, such indices can be used for evidence based decision-making in the province.

Policy Statement: Greening of cities for improving livability

Indicator	Target 2027	Target 2037	Target 2047
Air Quality Index	Bring AQI to the value of 51-100 for 10 major cities	Bring AQI to the value of 0-50 for all cities	Bring AQI to the value of 0-30 for all cities
PEQS compliant urban industries	20% of the urban industries to comply to PEQS	40% of the urban industries to comply to PEQS	70% of the urban industries to comply to PEQS

Implementation Strategy

The environmental baseline section has identified sensitive areas/ high risk polluting regions related to ambient air quality by spatially analyze the ambient air parameters (e.g. P.M 2.5, NO_2) gathered through various sources (open source remote sensing data and published data sets). The environmental chapter also classify the industries on basis of pollution emissions as per the EPA Self-Assessment and Monitoring Rules 2001. The above information will be clubbed to evaluate high risk polluting regions. In order to improve the air quality of these regions the following steps will be made part of the implementation strategy;

- Restructuring of Environment Protection Department and revision of Environment Protection Act for improved environmental governance
- Install air quality monitor to re-verify air quality baseline
- Regular monitoring of Industries (especially those within cities) to comply Punjab Environmental Quality Standards (PEQS)
- Digital mapping of pollution sources e.g. industrial zones and demarcation of high-risk zones based on pollution loads and peak pollution timings of the year
- Incorporation of Best Available Techniques (BAT) and Market Based Instruments (MBIs) for industrial pollution control

[12] Sánchez-Triana, *et al*. 2014. *Cleaning Pakistan's Air: Policy Options to Address the Cost of Outdoor Air Pollution. Washington*, DC, World Bank.
[13]Gurjar, B. R. *et al*. 2008. *Evaluation of Emissions and Air Quality in Megacities*. Atmospheric Environment. 42:1593–606.
[14] http://www.who.int/violence_injury_prevention /road_safety_status/ country_profiles/pakistan.pdf.

Figure 10.7: Concentration of No_2 in Punjab

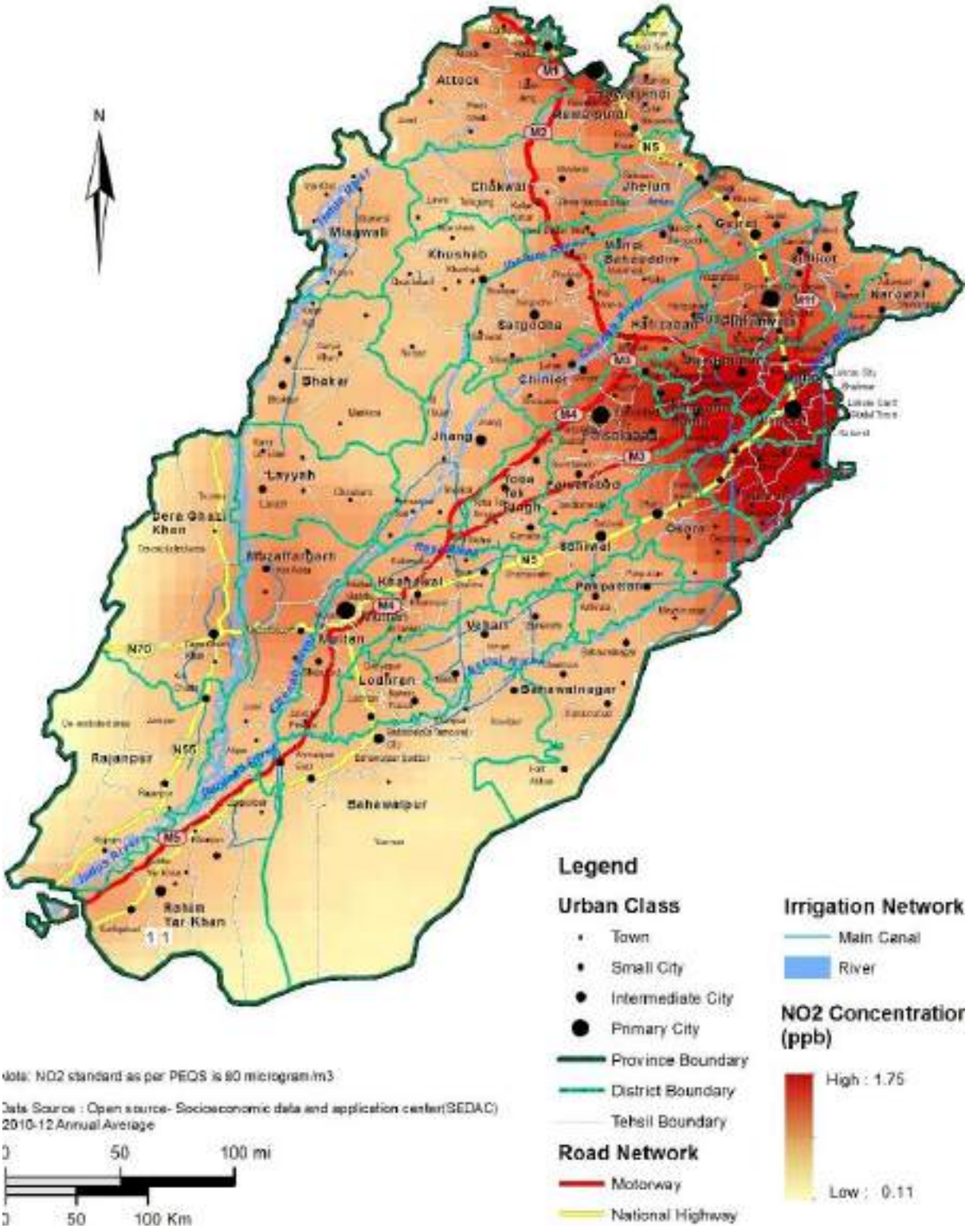


Figure 10.8: Concentration of $Pm_{2.5}$ in Punjab

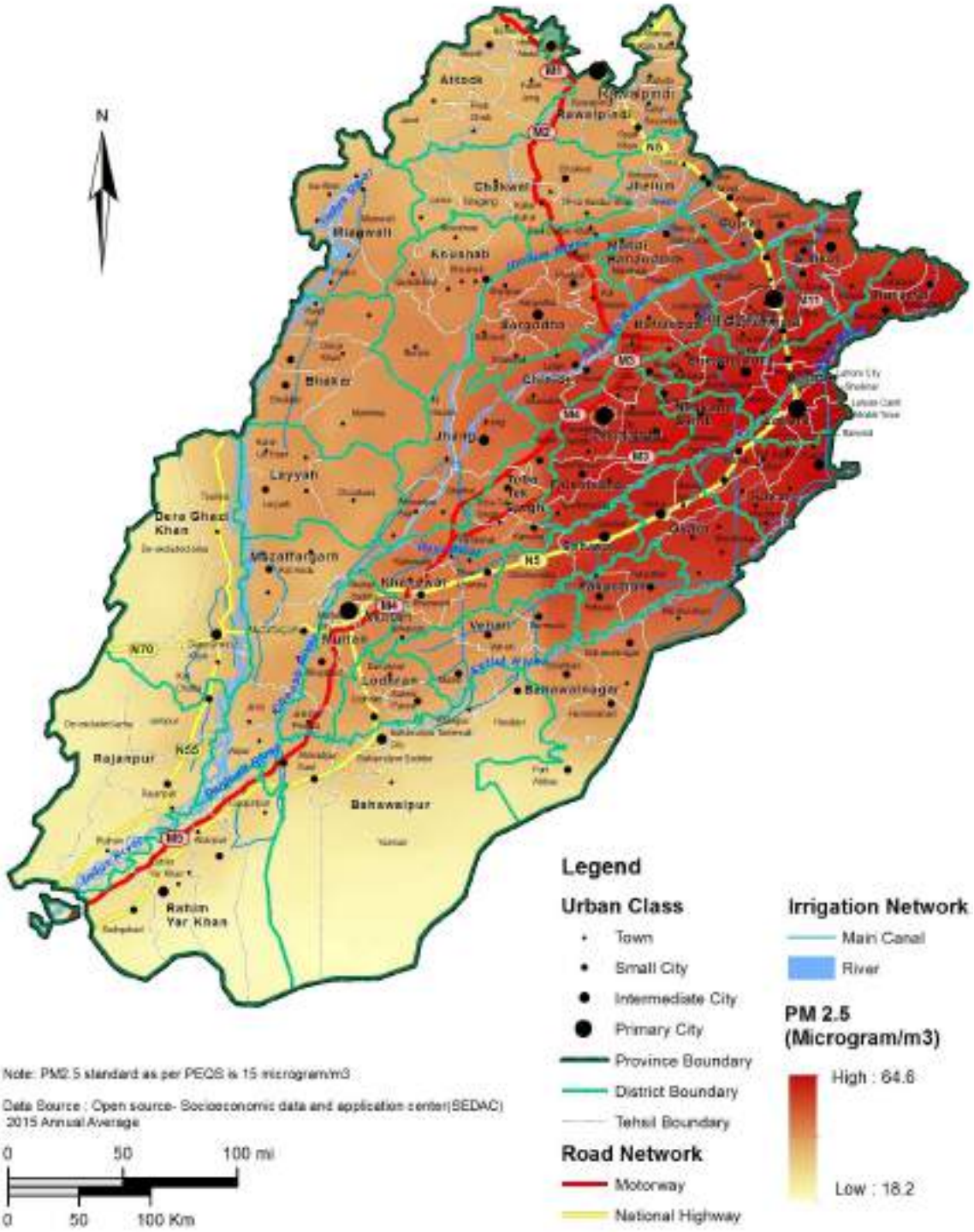
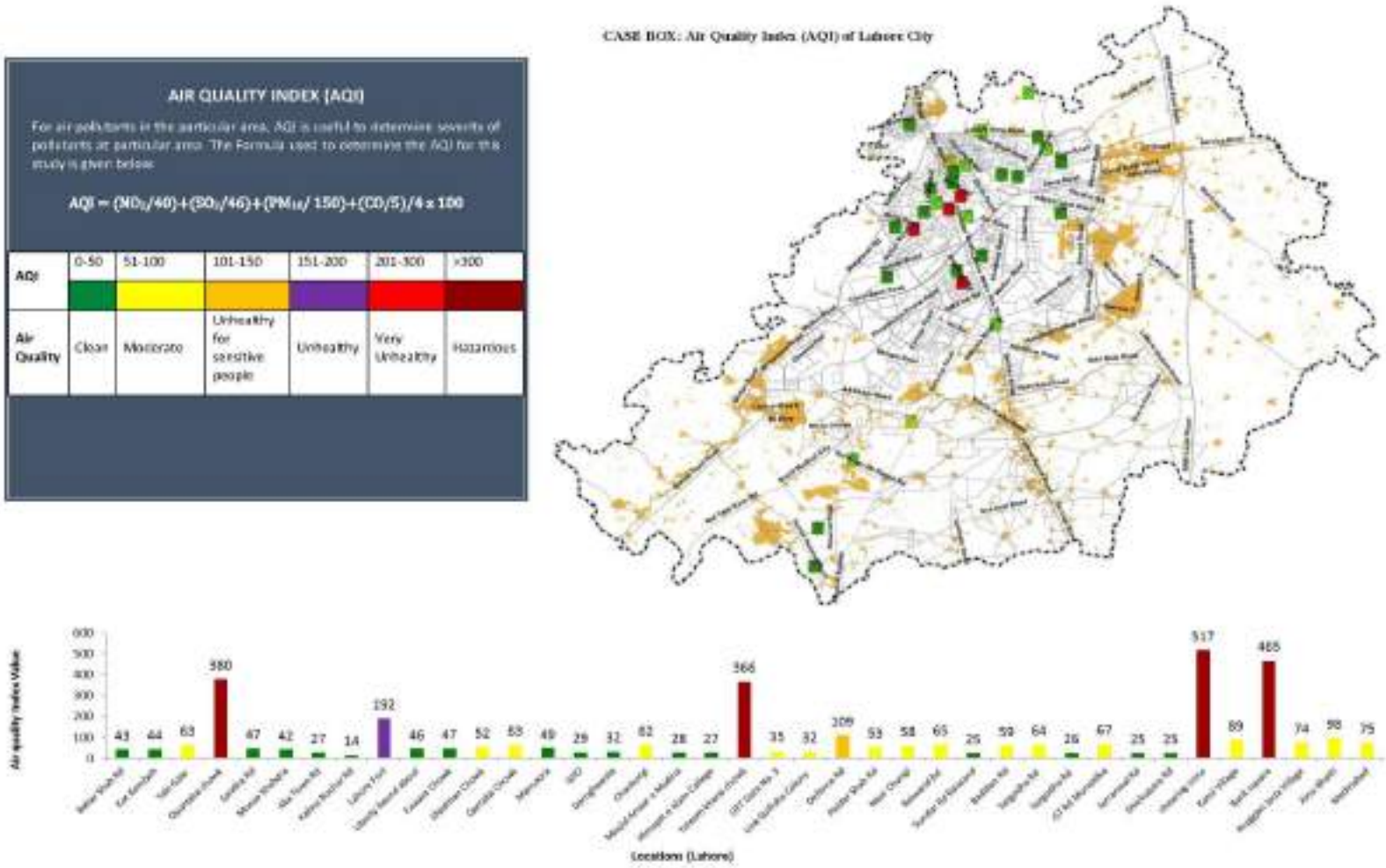


Figure 10.9: Air Quality Index of Lahore city



WATER QUALITY

Pakistan is among the world's 36 most water-stressed countries, with its agricultural, domestic, and industry sectors scoring high on the World Resource Institute's water stress index. Per capita annual water availability has dropped, fundamentally because of population growth, from 5,600 cubic meters in 1947 to the current level of 1,017 cubic meters, and is projected to decline further under the current infrastructure and institutional condition. Demand for water is on the rise, projected to reach 274 million acre-feet (MAF) by 2025, while supply is expected to remain stagnant at 191 MAF, resulting in a demand-supply gap of approximately 83 MAF[15].

Almost four-fifths (79%) of the Punjab province has access to fresh groundwater. Some 9.78 million acres are underlain with groundwater of less than 1000 mg/l TDS, 3 million acres with salinity ranging from 1000 to 3000 mg/l TDS and 3.26 million acres with salinity more than 3000 mg/l TDS. Saline waters are mostly found in the central Doab areas.

The exponential increase in groundwater usage over the past few decades in the Punjab province in Pakistan is responsible for the significant groundwater table decline in many parts of the province, leading to an urgent need for policy measures to better manage groundwater use. Average depth to ground water table in Punjab for the year 2016, is presented in **Figure 10.10**. The figure shows some serious concerns as the depth to ground water table as gone down to more than 40 feet in Lahore, Okara, Chinot, Pakpattan, Vehari, Khanewal, Lodhran, Multan, Bahawalpur and Bahawalnagar.

Approximately 11.2 million (49%) urban and only 6.2 million (9%) rural population has access to tap water supply whereas a tremendous increase on motorized pumping for drinking water supplies has been observed.[16] According to the PCRWR, the main drinking water source in Punjab is groundwater that is contaminated with many bacteriological and chemical pollutants[17]. Monitoring of surface water bodies, particularly the eastern rivers Ravi and Sutlej shows presence of all kind of contaminants such as microbial, physico-chemical, heavy metals and even Persistent Organic Pollutants (POPs)[18]. It has been estimated that around 2,000 million gallons of sewage is being discharged to surface-water bodies every day in Pakistan[19]. Drinking water quality tests carried out in twelve districts of Punjab showed that microbes and heavy metals (arsenic) were major contaminations in all districts [20]. Groundwater quantity and quality, in almost all urban centers of Punjab, has deteriorated to the extent that availability of good quality raw water has become a serious concern.

As per drinking water quality reports by EPA, UNICEF, PCRWR, PHED department in last few years arsenic (As), fluoride (F) and nitrate (NO3) levels are found to be more than the permissible limits as mentioned by WHO and national drinking water quality standards. All these contaminate are major hazardous and health risk to the peoples of Punjab. Contamination of surface and underground water aquifers due to discharge of untreated industrial, domestic and commercial effluent is taking place. In some areas of Punjab, badly sited latrines and septic tanks are a significant source of contamination, especially for shallow wells. Local industries can also give rise to contamination of water sources, particularly when chemicals are handled and disposed off without proper care. Major health risk contaminants found in water sources in different districts of Punjab are discussed below.

Total Dissolved Solids (TDS)

TDS is the widely distributed contaminant of water which makes it saline. The decrease in ground water quality is due to the over pumping of saline water and its addition to fresh water. The ground water quality in Pakistan is found saline far away from the main rivers and fresh water near main rivers. In Punjab, some 9.78 million acres are underlain with groundwater of less than 1000 mg/L TDS, 3 million acres with salinity ranging from 1000 to 3000 mg/L TDS and 3.26 million acres with salinity more than 3000 mg/L TDS. Saline waters are mostly found in the central Doab areas. The Cholistan area in southern Punjab has highly brackish water, which cannot be used for drinking purposes. See **Figure 10.11** for spatial distribution of TDS across the Punjab Districts.

Arsenic (As)

Arsenic is a major concern after high total dissolved solids (TDS) in the groundwater occurrences in the Punjab Districts. Although the results of the UNICEF study for the PHED have been widely considered, a definitive explanation for all the occurrences is yet to be accepted. The occurrence of arsenic in ground water sources is linked with human activities and doesn't represent the natural occurrence. Dr Islam-ul-Haque (2015)[21] demonstrates the use of arsenic based pesticides as the source of significant arsenic levels in groundwater. In addition, the use of high levels of phosphate fertilizer can also facilitate the mobilization of naturally occurring arsenic from the alluvial outwash sediments in the Indus Basin. Among water contaminants, Arsenic (As) is one of the hazardous chemical deteriorating the drinking water quality and impairing the public health. More than 150 million people are affected worldwide by arsenic contamination in 70 countries, out of which 50 million people in Bangladesh and 30 million people in India are at risk. However according to a recent study

[15] International Monitory Fund, 2015: issues in managing water challenges and policy instruments: regional perspectives and case studies.

[16] Pakistan Bureau of Statistics. 2016. Pakistan Social And Living Standards Measurement (PSLM) 2014-15. Government of Pakistan. Statistics Division. Islamabad

[17] Tahir, M. A. *etal.* 2011. *Technical Assessment Survey Report of Water Supply Schemes of Punjab.* Part 1. Punjab Council of Research on Water Resources (PCRWR), Islamabad.

[18] Imran, S. *etal.* 2016. *Water Quality Status of Major Cities of Pakistan 2015-16.* Punjab Council of Research on Water Resources (PCRWR), Islamabad.

[19] Ibid at 5

[20] Daud, M. K., *et al.* 2017. Drinking Water Quality Status and Contamination in Pakistan. *BioMed Research International.* pp. 6

[21] Islam-ul-Haque, 2015. Sustained Applications of Pesticides and Fertilizers in Sugarcane, Cotton and Wheat Cultivated Areas Causes Ground Water Arsenic Contamination - District Rahim Yar March 4, 2015 Khan, Pakistan. International Journal of Environmental Monitoring and Analysis

by Podgorski et al., (2017)[22] only in Lahore and Hyderabad of Pakistan some 50-60 million people are at risk due to presence of arsenic in ground water, far more than previously thought. Groundwater samples from Khushab, Mianwali, Jhelum, Gujrat and Sargodha districts have shown concentrations of arsenic that are well above the Punjab Environmental Quality Standards for drinking water, 0.05 mg/l (50ppb).

Fluoride (F^-)

Fluoride occurs naturally in soil, water, plants, animals and humans in trace quantities. It is an essential element for human health and both its deficiency and overexposure can lead to different severities like bone deformities and dental fluorosis. In Punjab, a large variation in fluoride concentration has been observed in drinking water. High concentrations of fluoride that are observed in various studies are primarily due to leaching from fluoride-bearing minerals, industrial wastes, agricultural fertilizers and combustion of coal which release fluoride into the air later reaches the soil through precipitation. According to Punjab Environmental Quality Standards (PEQs) for drinking water, the standard value for Flouride (F) is less than 1.5 mg/l. Groundwater with high fluoride content is found in the Salt Range, Lahore, Sargodha, Khushab, Mianwali, Bhakkar and also in the Bahawalpur districts. (**Figure 10.13**).

Nitrate (NO_3)

Nitrate is a problem in drinking water due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric an intestinal cancer. Many local sources of potential nitrate contamination of groundwater are sites used for disposal of human and animal sewage; fertilizers; septic tanks; industrial wastes related to food processing; and sites where handling and accidental spills of nitrogenous materials may accumulate. According to Punjab Environmental Quality Standards (PEQs) for drinking water, the standard value for Nitrate (NO_3) is 50 mg/l. The spatial analysis of water quality data showed that approximated 11.5 million population has been at risk due to higher levels of Nitrate in ground water, concentrated in three districts i.e. Chakwal, Attock and Khushab. Spatial distribution of NO_3 in Punjab has been shown in **figure 10.14**.

As an example a case box for water quality index (WQI) for Faisalabad city has been presented in **Figure 10.15**. Water quality parameters were collected from secondary sources. Observed values were then compared with the standard vales of Punjab Environmental Quality Standards (PEQs). Unit weight were calculated and quality rating were determined, on the basis of which WQIs were determined. It is important to point out that the priority parameters used to calculate WQIs were depended on the proposed activity. EPA Punjab is responsible for providing guidance on the selection of priority parameters. This shows that if/once the data is available, such indices can be used for evidence based decision-making in the province.

Policy Statement: Greening of cities for improving livability

Indicator	Target 2037	Target 2047	Target 2047
Water Quality Index	Bring WQI to the value of 26-50 for 10 major cities	Bring WQI to the value of 26-50 for all cities	Bring WQI to the value of 0-25 for all cities
PEQS compliant urban industries	20% of the urban industries to comply to PEQS	40% of the urban industries to comply to PEQS	70% of the urban industries to comply to PEQS

Implementation Strategy

The environmental baseline section has spatially identified sensitive areas/ high risk polluting regions related to ground water quality parameters (total dissolved solids, fluoride, nitrate and arsenic) collected from various sources and analyzed spatially. This section also presents information related to surface water bodies and industrial units. The above information will be clubbed to evaluate high risk polluting regions.

The Urban Unit has also developed an interactive dashboard for water quality monitoring. The data has been compiled from various sources and are also creating more liaisons to enrich and manage data all over Punjab. The dashboard also have provision to perform certain statistical analysis. In order to improve the overall quality of water of these sensitive regions the following steps will be made part of the implementation strategy;

- Restructuring of Environment Protection Department and revision of Environment Protection Act for improved environmental governance
- Increase PEQs compliance of Water Quality by greening industries present in the areas of 4 major concentrations: Faisalabad, Golden Triangle, Lahore and Multan
- Approval of new industrial estates will be subject to development of Combined Effluent Treatment Plants (CETP) and current industrial estates bound to develop in their boundaries
- Re-verify water quality baseline collected for the PSS to certain baseline

[22] Podgorski, J.E., Eqani, S.A.M.A.S, Khanam, T., Ullah, R., Shen, H., Berg, M., Extensive arsenic contamination in high-pH unconfined aquifers in the Indus Valley, Science Advances 3(8), 2017.

Figure 10.10: Depth to ground water table in Punjab

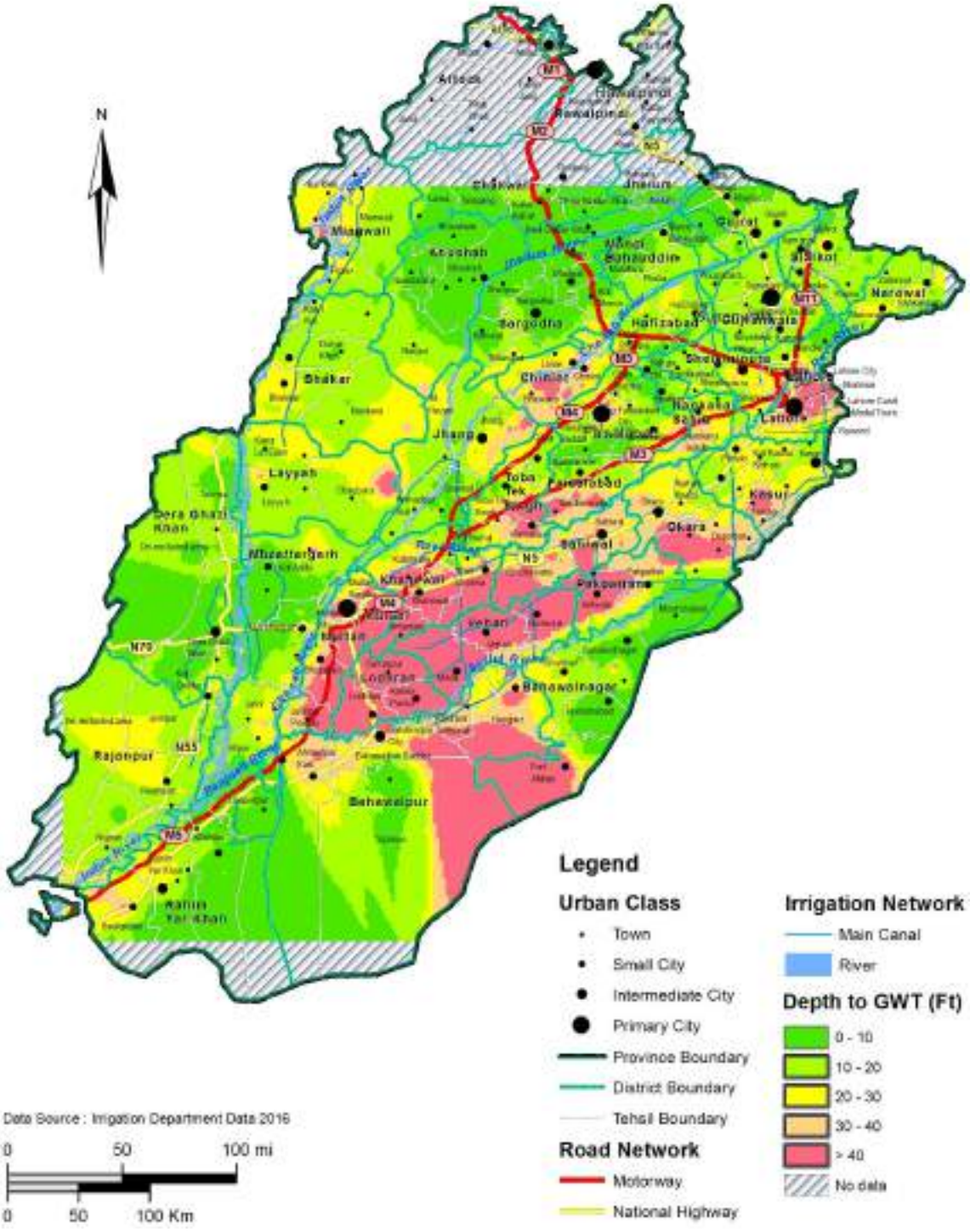
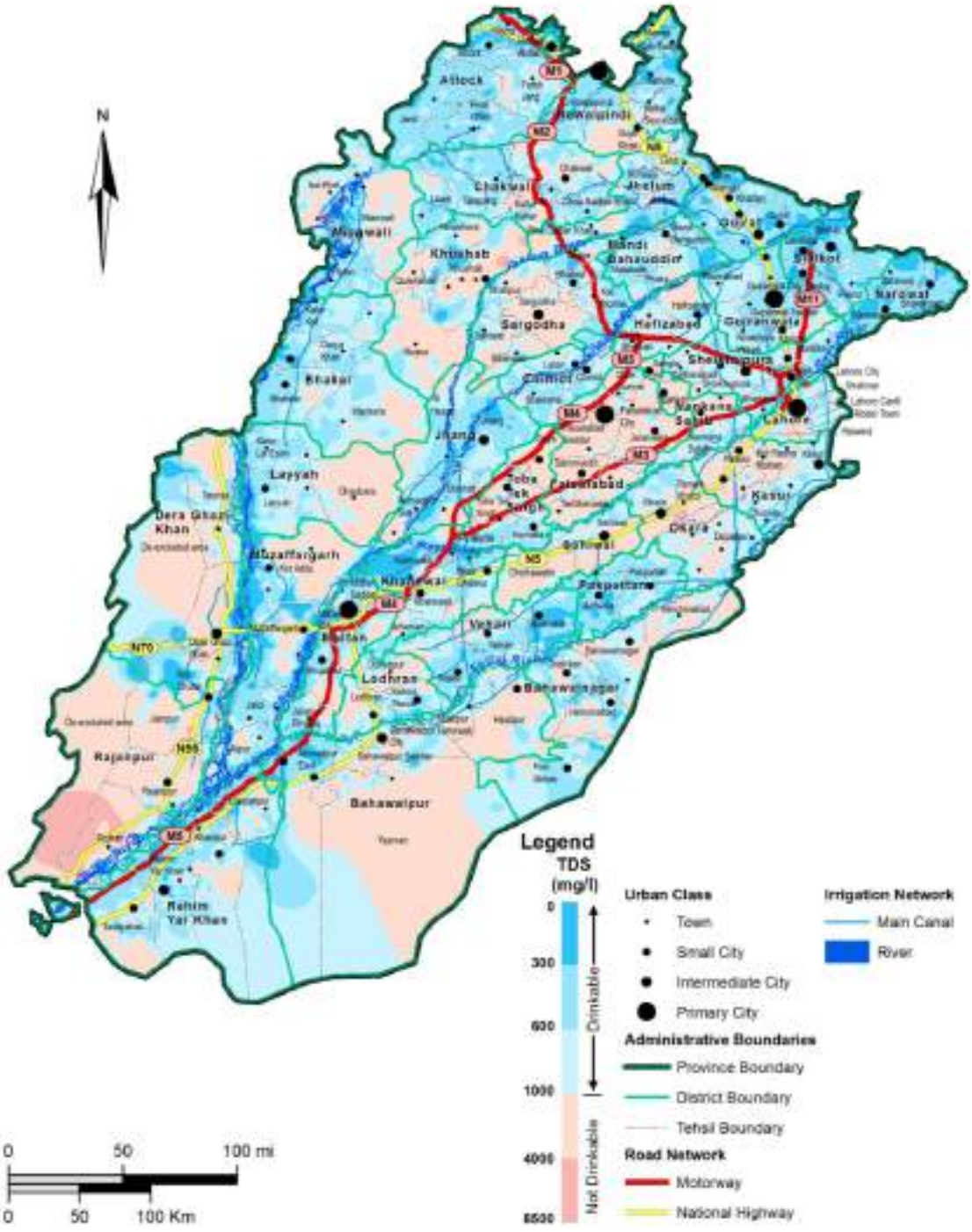
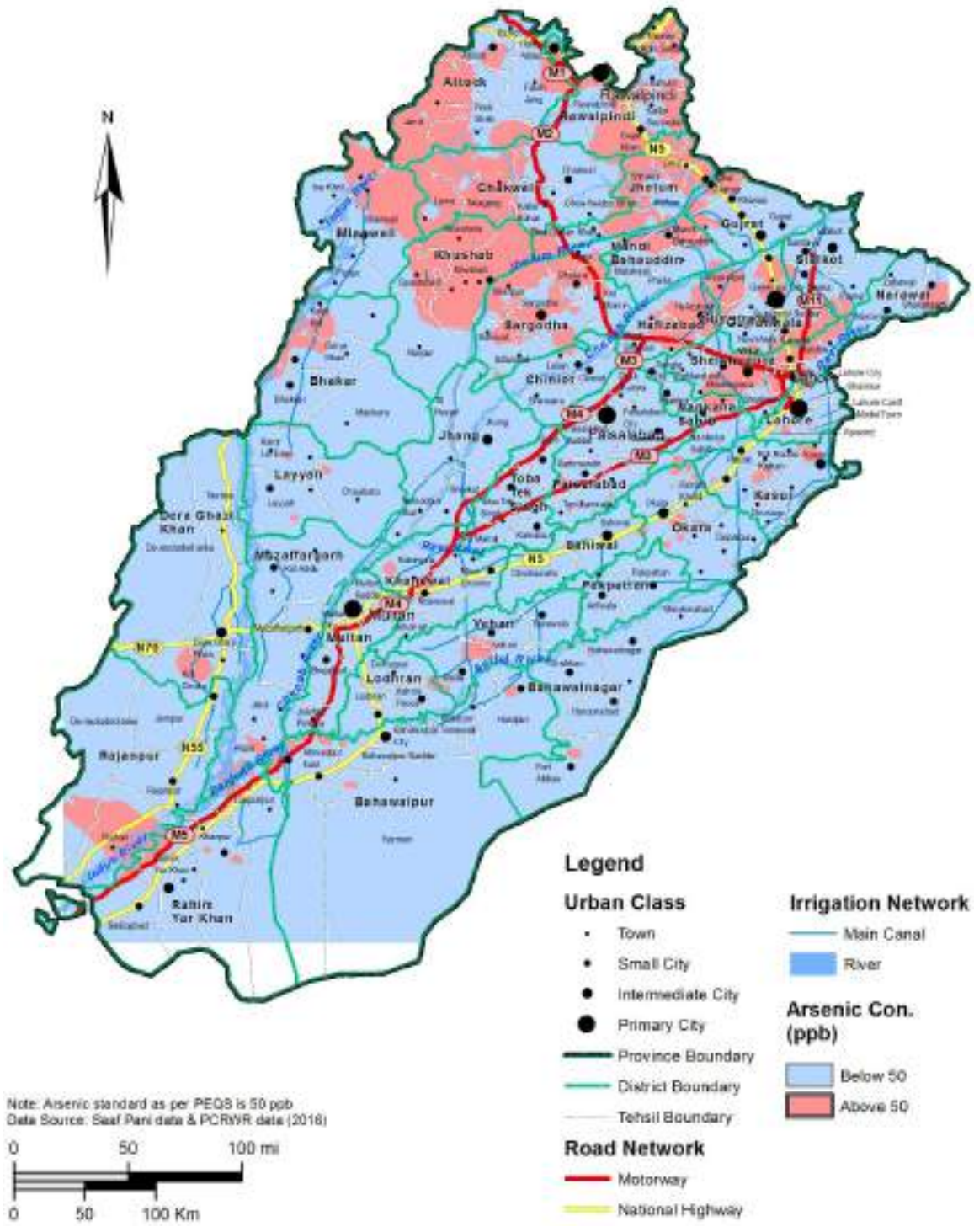


Figure 10.11: TDS distribution in ground water sources across the Punjab[23]



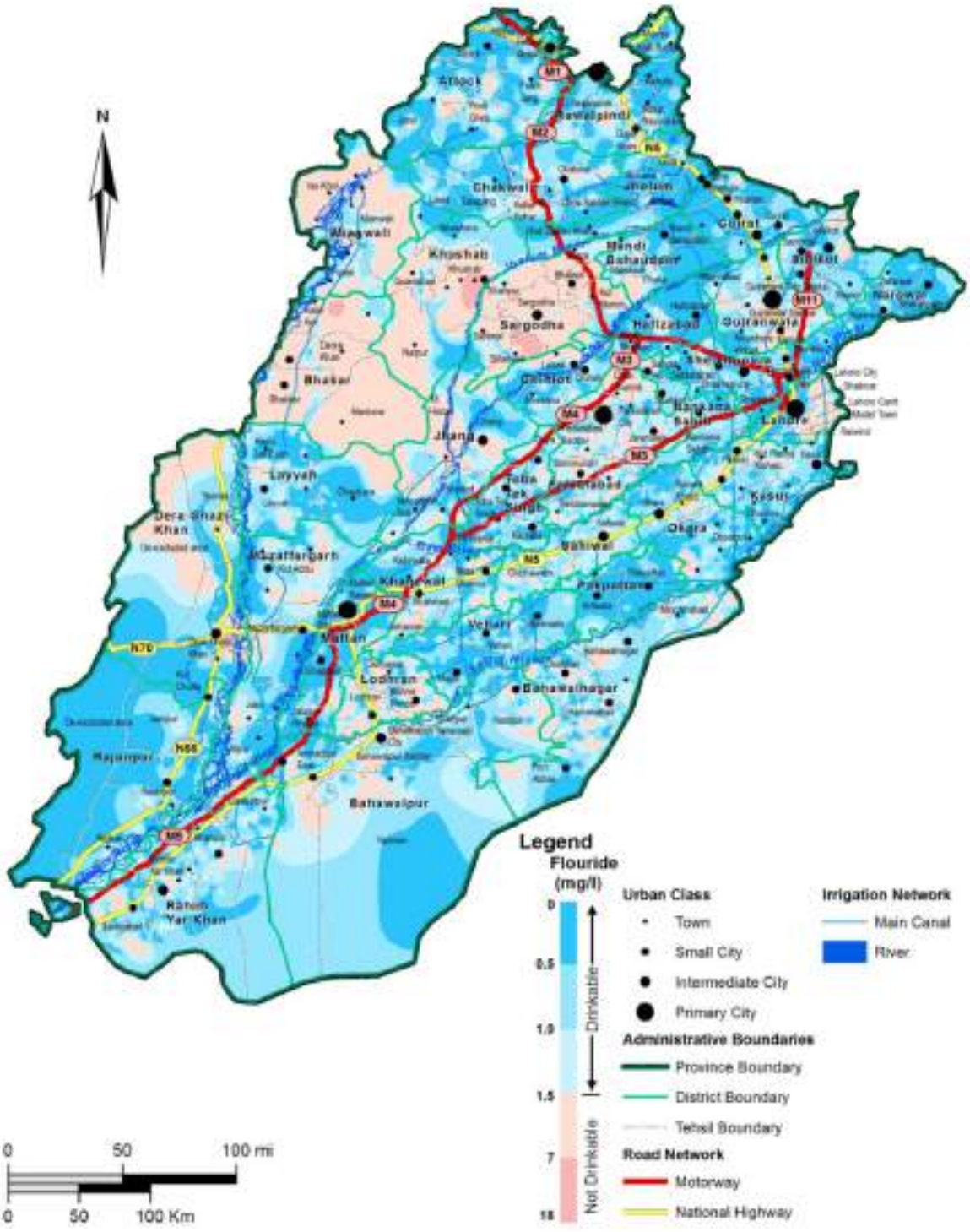
[23] UNICEF-PHED 2014

Figure 10.12: Arsenic distribution in ground water sources across the Punjab[24]



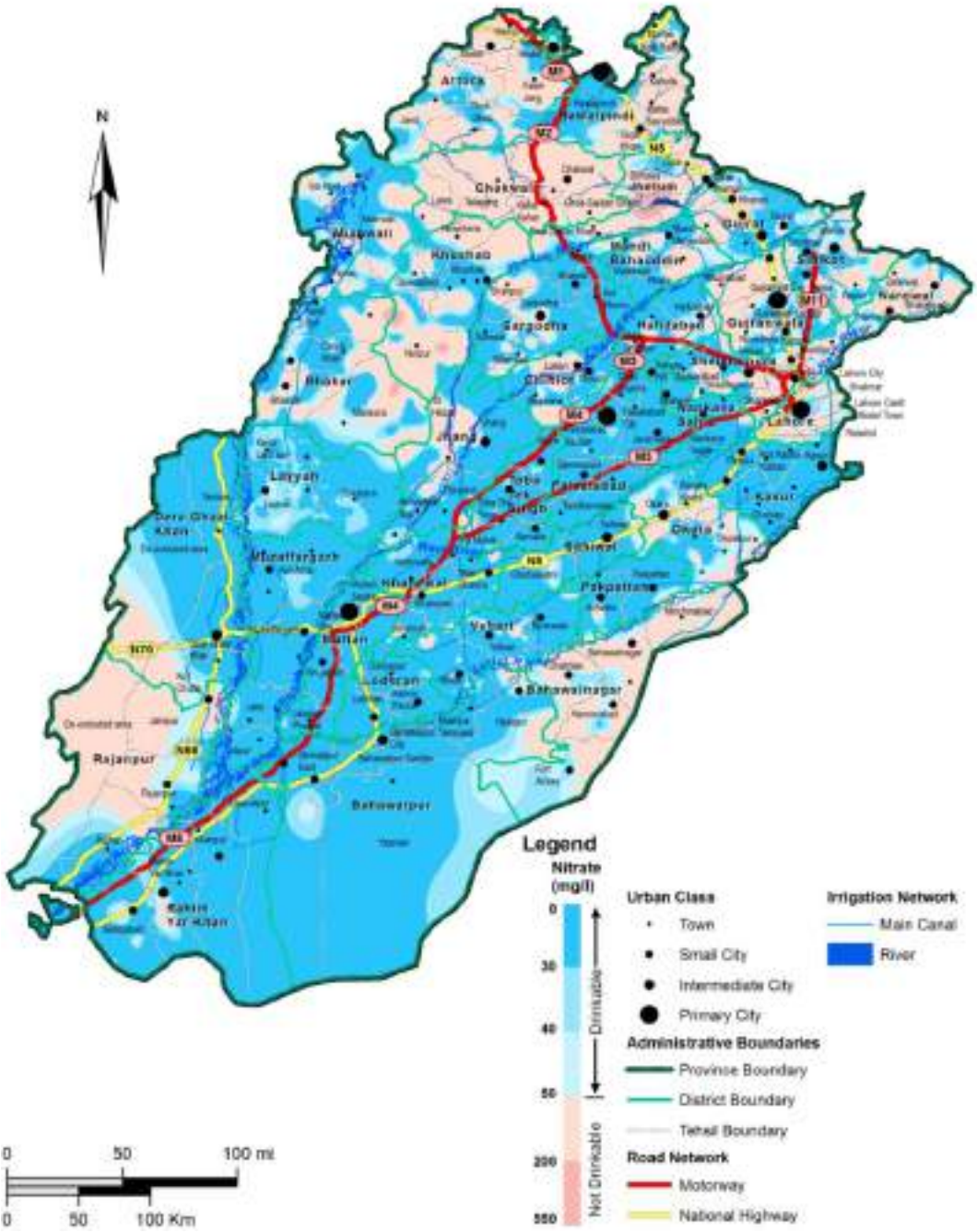
[24] UNICEF-PHED 2014

Figure 10.13: Fluoride distribution in ground water sources across the Punjab[25]



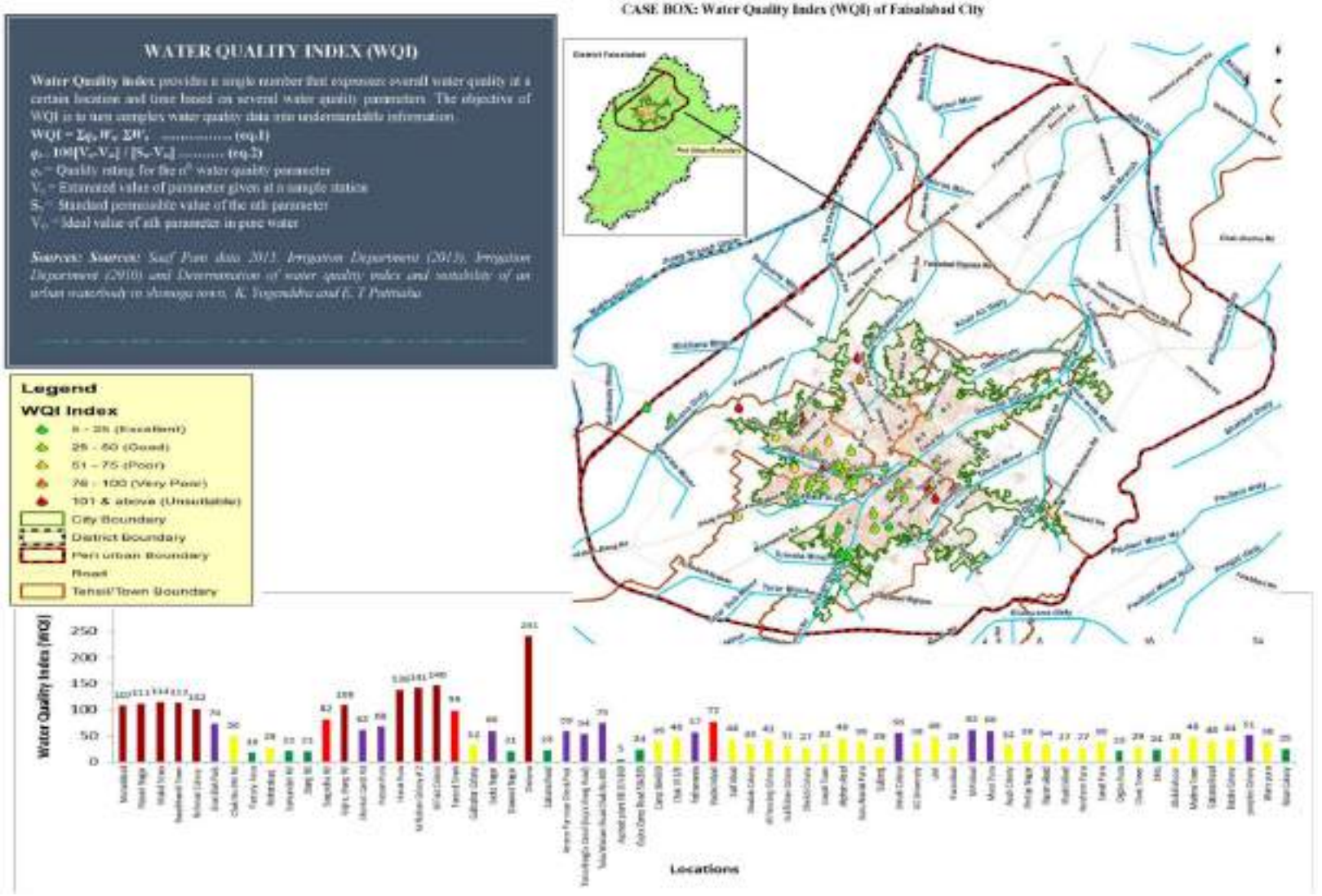
[25] UNICEF-PHED 2014

Figure 10.14: Nitrate distribution in ground water sources across the Punjab[26]



[26] UNICEF-PHED 2014

Figure 10.15: Case box: Water Quality Index of Faisalabad city



Soil quality

The pressure on all kinds of ecosystems in the province is increasing with time. The process of soil degradation has affected a large portion of the agricultural land. Soils represent the single-most important natural resource on which human existence and prosperity depend. A large variety of soils are found in Punjab, which vary significantly in kind and distribution. This entails adopting different approaches to optimally and sustainably use this resource. Soil pollution is another form of land pollution where the upper layer is damaged due to overuse of chemical fertilizers and other pest control measures. It is quite evident that effect of this kind of land pollution can lead to the loss of ecosystem.

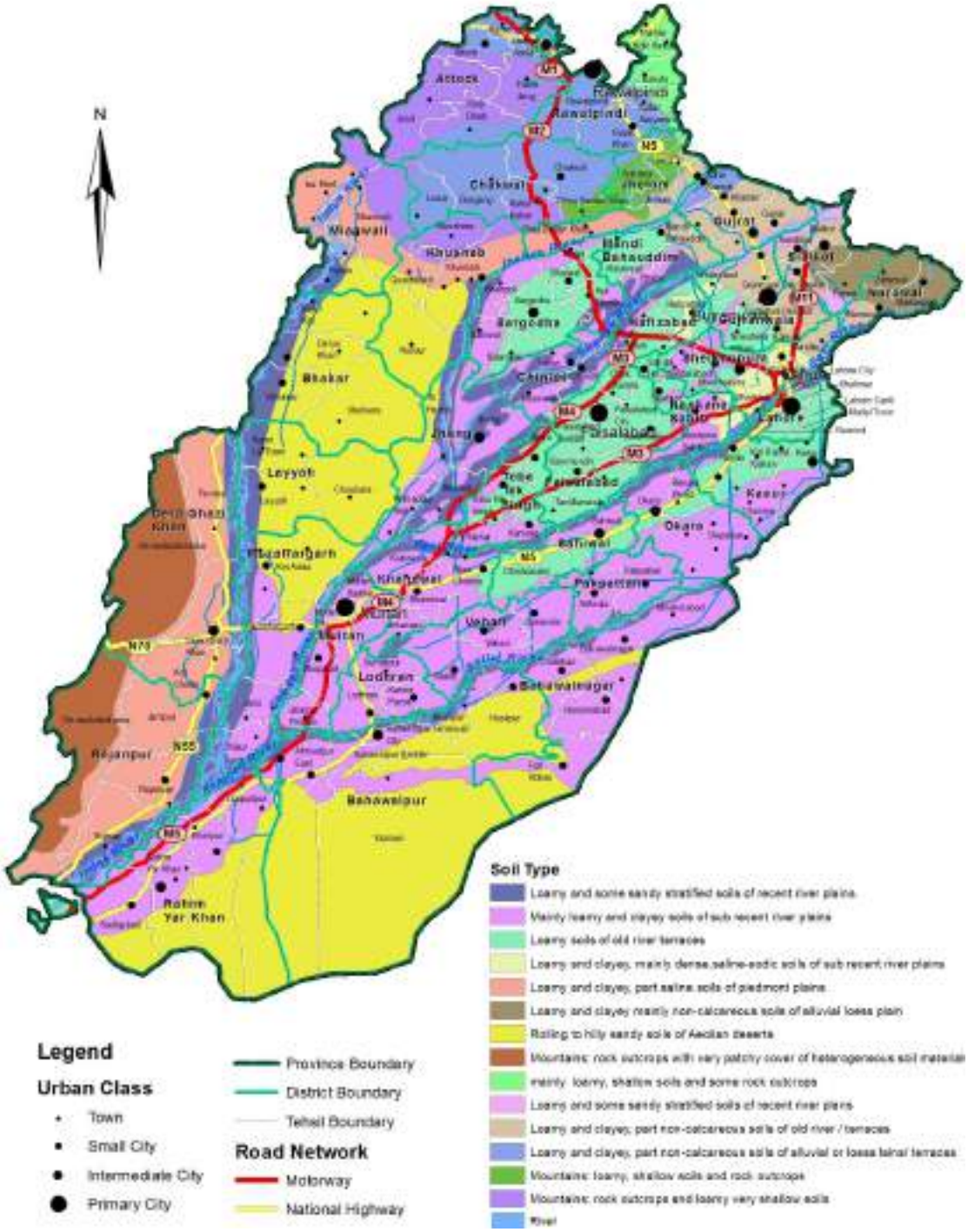
Although soil resources in Punjab province are immense, good quality soil that forms prime agricultural land are limited. The two contribution in soil types of Punjab are mainly loamy and clayey soil extended at eastern side of Punjab, rolling to hilly sandy soils of Aeolian deserts in south eastern and western side of Punjab, loamy and some sandy soils in north eastern side and along the riverside in Punjab as shown in **Figure 10.16**. The extent of such soils can be increased only a little by improving a part of relatively poorer quality soil, though this would be at formidable cost. Ultimately, Punjab has to rely on the existing soil resources. The need of time is to protect prime agricultural land from misuse and minimize its degradation or loss. Major problems related to soil conservation are; air and water erosion, water logging and salinity, flooding and ponding, livestock grazing pressure, soil pans, soil nutrient degradation and non-agricultural use of prime agriculture land.

Solid waste management

With population of 110 million people, urban population in Punjab is around 31.1% which is residing in 190 cities of different scales generating approximately 15000 tons/day. There are thousands of waste heaps lying in the urban and rural landscape of Punjab destroying its beauty and the future of public. There are risks of diseases, aesthetic nuisance as well as accumulation of pollutants in to the food chain. Waste management can no longer be neglected and it requires long term solution that caters all environmental constraints. In medium term, thousands of waste heaps should be reduced to few hundred by collecting waste in a proper manner and transporting it to dedicated dump sites. In the longer term, all the waste should be directed to few dozen technically designed and maintained landfill sites. This approach needs to be employed to safeguard the future.

Government of Punjab has established Waste Management Companies (WMCs) in 7 large cities (Bahawalpur, Faisalabad, Gujranwala, Multan, Rawalpindi and Sialkot) of the Punjab to serve in the Urban Areas. Solid Waste Management services delivery in these cities have considerably improved over the last few years. However, small and medium sized cities are still performing at 40-60% efficiency due to archaic model of SWM and deficiency of professionals SWM engineers to properly plan and manage the SWM on modern grounds. Furthermore, Collection of solid waste is usually confined to the city centers and high income neighborhoods, and even there the service is usually irregular. To cater this problem, The Government of Punjab is launching 'Saaf Dehat Program' to clean the rural areas and transport the waste to disposal sites. The existing dumpsites and proposed regional landfill sites in Punjab is presented in **Figure 10.17**.

Figure 10.16: Soil texture of the Punjab province[27]



[27] Data Source : Redrawn from Pakistan Generalized Soil Map, 1993

Figure 10.17: Landfill/ Dumpsites of the Punjab province

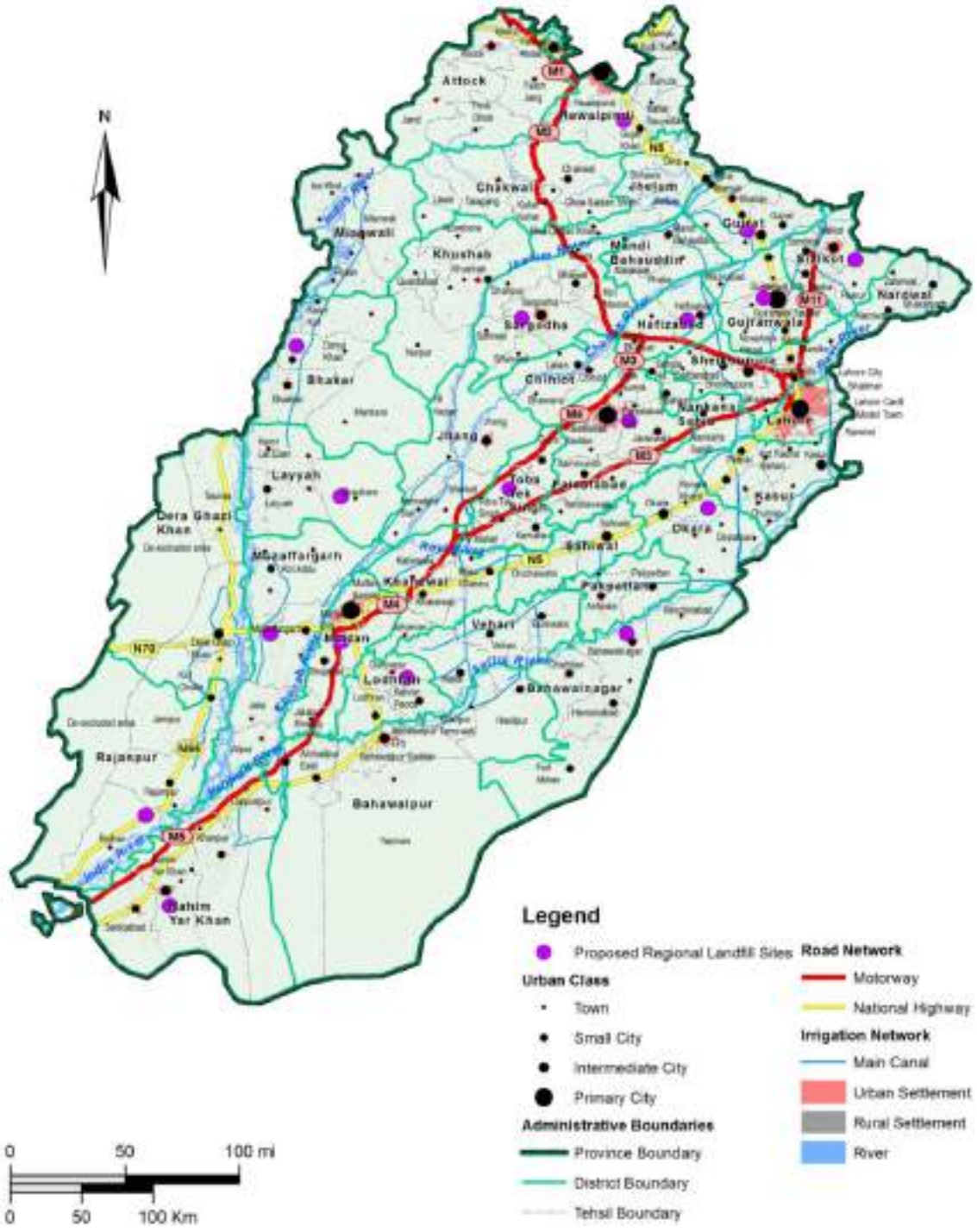
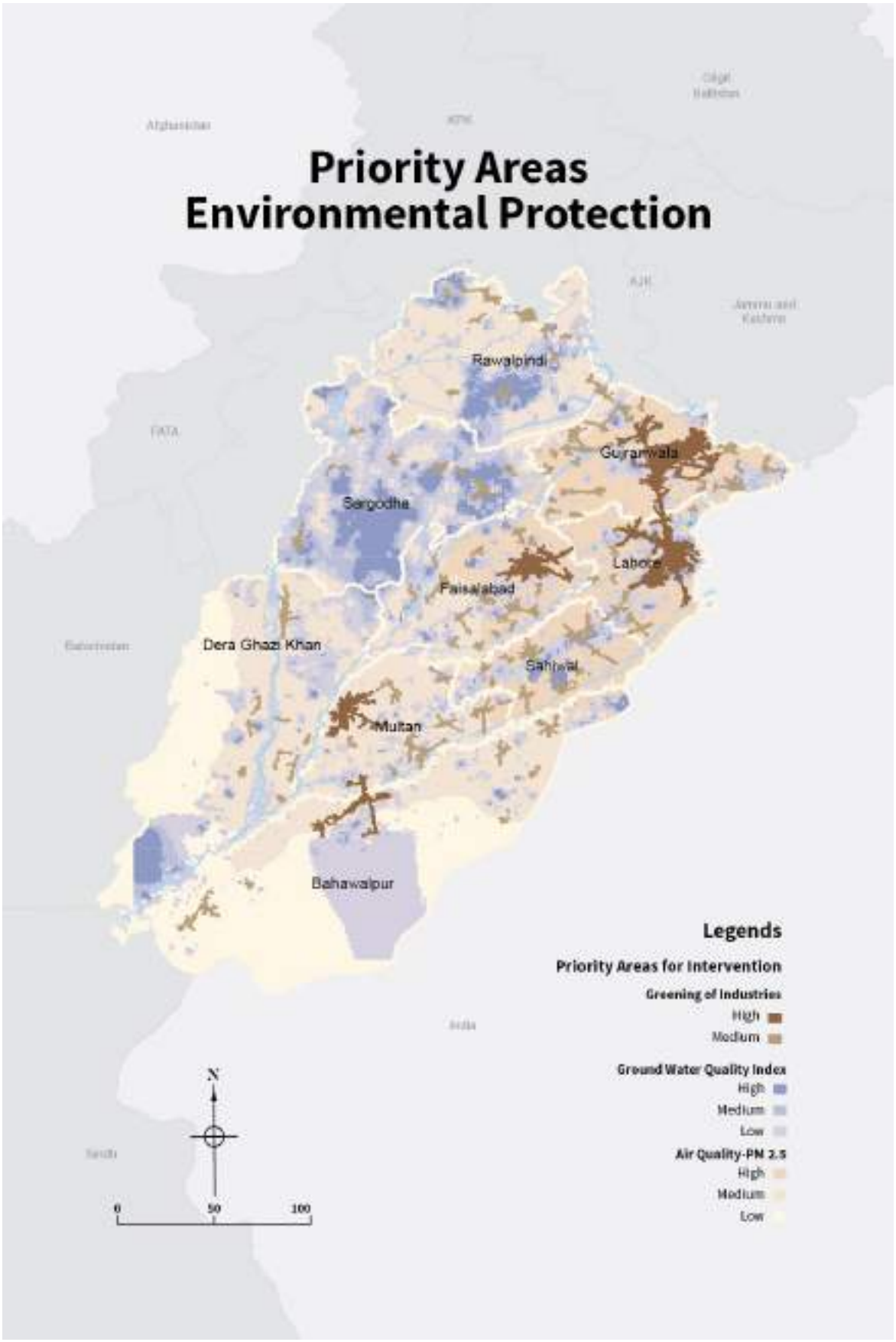


Figure 10.18: Priority areas for Environmental Protection



10.2.2 Biological Environment

Punjab Province has been divided into five main agro-ecological zones. About 80% of the country is arid and semi-arid, along with 12% sub-humid and 8% humid, with two distinct seasons (i.e. summer and winter). The monsoons bring a major portion of annual rainfall to most of the country. Winter rains are usually scarce. Because of its uneven distribution, precipitation is generally inadequate for productive rain-fed agriculture. There are vast areas of arid and semi-arid habitat which host important biodiversity resources in the country. In addition, the Arabian Sea region around the country is rich in phytoplankton and zooplankton. [28] According to World Cities Culture Forum, the lowest quartile of cities reported with percentage of public green space includes Dubai (2%), Istanbul (2.2%), Mumbai (2.5%) and Shanghai (2.8%)[29]. Cities in Punjab are expected to match at least these values

Forest

Forests have vital global, ecological and socio-economic importance as a renewable resource. According to the Food and Agriculture Organization (FAO, 2012), the forest degradation rate in Pakistan is the highest in Asia and the country is ranked at 110th in respect of forest cover of the world. In the province of Punjab, the area under forest and allied purposes like Range Management and Wildlife is 1.66 million acre.

As per Landsat image 2012-13 the total area of Punjab is 50.95 million acres. Out of which area under tree cover in state as well as private land is 3.49 million acres. Hence total tree cover of Punjab comes to be 6.85%.

A major threat to Punjab's forests is uncontrolled and unsustainable logging for living purposes and timber products.

The total area of Punjab is 50.95 million acres. The recorded forests area is 1.66 million acres (excluding) Linear Plantations, which constitutes 3.26 % of the geographic area of the Punjab. Major forest types occurring in the province are Irrigated Plantation, Riverain Forest, Scrub Forest, Range Lands and Coniferous Forest. Irrigated Plantations comprises 25.6%, Riverain Forests 10.6%, Scrub Forest 40.7%, Range lands 12.2%, Desert 2.3%, Coniferous forests 6.8% and Mix Forests (Coniferous/Scrub) constitute 1.8% of the total forest area of Punjab. Punjab Province has been divided into three zones (southern, central and northern zones) for administration purposes. Zone wise forest area statement as per legal classification is presented in **Table 10.1.**

Table 10.1 Forest area of Punjab by legal classification

Legal Status	Punjab (Acre)
Reserved Forest	797,632
Protected Forest	542,778
Un-classified Forest	278,476
Section -38	34,342
Choas Act	197
Civil Rakh	243
Resumed land	5,231
Municipal Reserved Forest	3,582
Miscellaneous	12
Total	**1,662,493**

Policy Statements:

Conserve and enhance biodiversity & environmental value of Punjab

Greening of cities for improving livability

Indicator	Target 2027	Target 2037	Target 2047
Forest Area	Increase Punjab's forest cover to 6%	Increase Punjab's forest cover to 10%	Increase Punjab's forest cover to 15%
Percentage of public green space	Increase percentage of public green space to 3% in 5 major cities of Punjab	Increase percentage of public green space to 4% in 10 major cities of Punjab	Increase percentage of public green space to 5% in 25 major cities of Punjab
Urban Forest	Increase urban forest cover by 6%	Increase urban forest cover by 10%	Increase urban forest cover by 15%

Implementation Strategy

The environmental baseline section has spatially identified the total tree cover in Punjab which is 6.58%, far less than the required standard. Due to deforestation, a dozen of animals are on the brink of extinction because of the devastation of their natural environment. In the baseline section of the PSS's environment section, forest area has been mapped with major forest types in the region. In order to improve the forest cover,

[28] Daud, M. *et al*. 2017. Drinking Water Quality Status & Contamination in Pakistan. *BioMed Research International*. pp. 6

[29] World Cities Culture Forum (http://www.worldcitiesculturefforum.com/data/of-public-green-space-parks-and-gardens)

following steps will be made part of the implementation strategy;

- Development and implementation of Biodiversity Action Plan for Punjab and biodiversity inventory
- Restructuring of Environment Protection Department for improved environmental governance
- Prepare and implement plantation projects with special focus on greening cities
- Expand and improve the information base on the Biodiversity of Punjab by appointing provincial center to coordinate biodiversity identification and monitoring activities e.g. through introduction of Forest Management Information System

Biodiversity

Punjab, the land of five rivers, is amongst the most heavily irrigated landscapes on earth with a canal system spread all over the province. Approximately 80 mammals, 10 amphibians, 85 reptiles, and 500 birds have been reported from Punjab. Rates of endemism vary from group to group but overall diversity is high[30].

The topography of Punjab is very diverse in the sense that it encompasses mountains, wetlands, rangelands, and deserts, in addition to flat plains. Most of the area is fertile alluvial plains, formed by the long-term deposition of sediments by the river Indus and its major tributaries i.e. Jhelum, Chenab, Ravi, and Sutlej. Approximately seventeen wetland sites have been delineated in Punjab including Ucchali lake, Nammal lake, head Islam, Taunsa barrage, Marala headworks, etc.[31].

Approximately 499 species of birds have been recorded in different areas of Punjab. Out of these, 21 species have IUCN status whereas 11 species are vulnerable. Out of the 80 mammals found in Punjab, 6 species are threatened according to the IUCN red list. The reasons for their endangerment are habitat fragmentation and inbreeding depression due to construction of barrages.

Protected areas

Protected areas are essential not only for conservation of biological heritage but also provide ecological goods and services for the social and economic wellbeing of the people. In Punjab, there is a single Administrative Department, who has three attached departments namely Forest, Wildlife & Fisheries. The set up in Punjab provides an opportunity to address the issue of Protected Areas especially for sites, which are required to be declared as protected areas are also state forest land. Hence, it provided two legislative covers i.e. Punjab Forest Act (Amended) 2010 and Wildlife Act 2007. It is due to the reason that most of the Game Reserves, Wildlife Sanctuaries and National Parks are on forest land. In Punjab, the **protected areas** protect the majority of wildlife in addition to threatened species such as Punjab Urial and Indus blind dolphin. However, the national parks cover only 1.03% of the total area of Punjab, and there is a need for more protected areas for conservation. Protected areas of Punjab is presented in a given in **Figure 10.20**.

With the rise in human population, agricultural practices have intensified and Punjab has undergone major landcover changes. Natural habitats and associated wildlife are depleting rapidly due to the conversion of natural ecosystems for agriculture and housing. Various ecosystems have suffered due to the construction of barrages and human control over the river Indus. Almost all of the natural ecosystems present in Punjab are now critically endangered.

Specie Environmental Modelling

Spatial prioritization analysis in the form of conservation value map is shown in **figure 10.20**. These maps are generated by integrating biodiversity features, natural habitat and human impact components to build spatial prioritization model through weighted overlay in Arc GIS. These raster maps have an evaluation scale of 0-1 where 0 represents areas with lowest conservation value while 1 represents areas with highest conservation value. These maps show areas of high and low conservation value in Punjab according to each climate change scenario.

This analysis suggests that areas of high conservation value are present along major rivers and in divisions of Rawalpindi, Sargodha, Bahawalpur. Most of the area in Rawalpindi division has high conservation value which can be explained by presence of important forests, protected areas, suitable habitat area for most of the species and less human impact. Important factors affecting the conservation value of different areas in future include precipitation seasonality, annual precipitation, annual temperature range, temperature seasonality and isothermality respectively.

The element of uncertainty is inevitable in each analysis. Relying on our knowledge, it can be safely predicted that there will be negative consequences of climate change. The magnitude of these impacts is uncertain as the natural habitat features and human impact features, which are kept constant in this analysis, are subject to variations in future. Hence, protection of biodiversity habitat areas by implying best practice rules for conservation is imperative. The impact of climate change has been examined on the suitable habitat of threatened wildlife species in this spatial prioritization analysis.

In brief, the total area of high conservation priority in Punjab is approximately 63,695 km^2 (29.72%). There is 12,0788 km^2 (56.35%) of area with moderate conservation value, and 29,870 km^2 (13.93%) of area with low conservation priority.

[30] Baig, M. B. and Al-Subaiee, F. S. 2009. Biodiversity in Pakistan: Key issues. *Journal of Biodiversity*.**10**: 20-29.

[31] Khan, A.A., Arshad, S., 2014. Wetlands of Pakistan: Distribution, Degradation and Management. *Pakistan Geographical Review*. **69**: 28-45.

Policy Statement: Conserve and enhance biodiversity & environmental value of Punjab

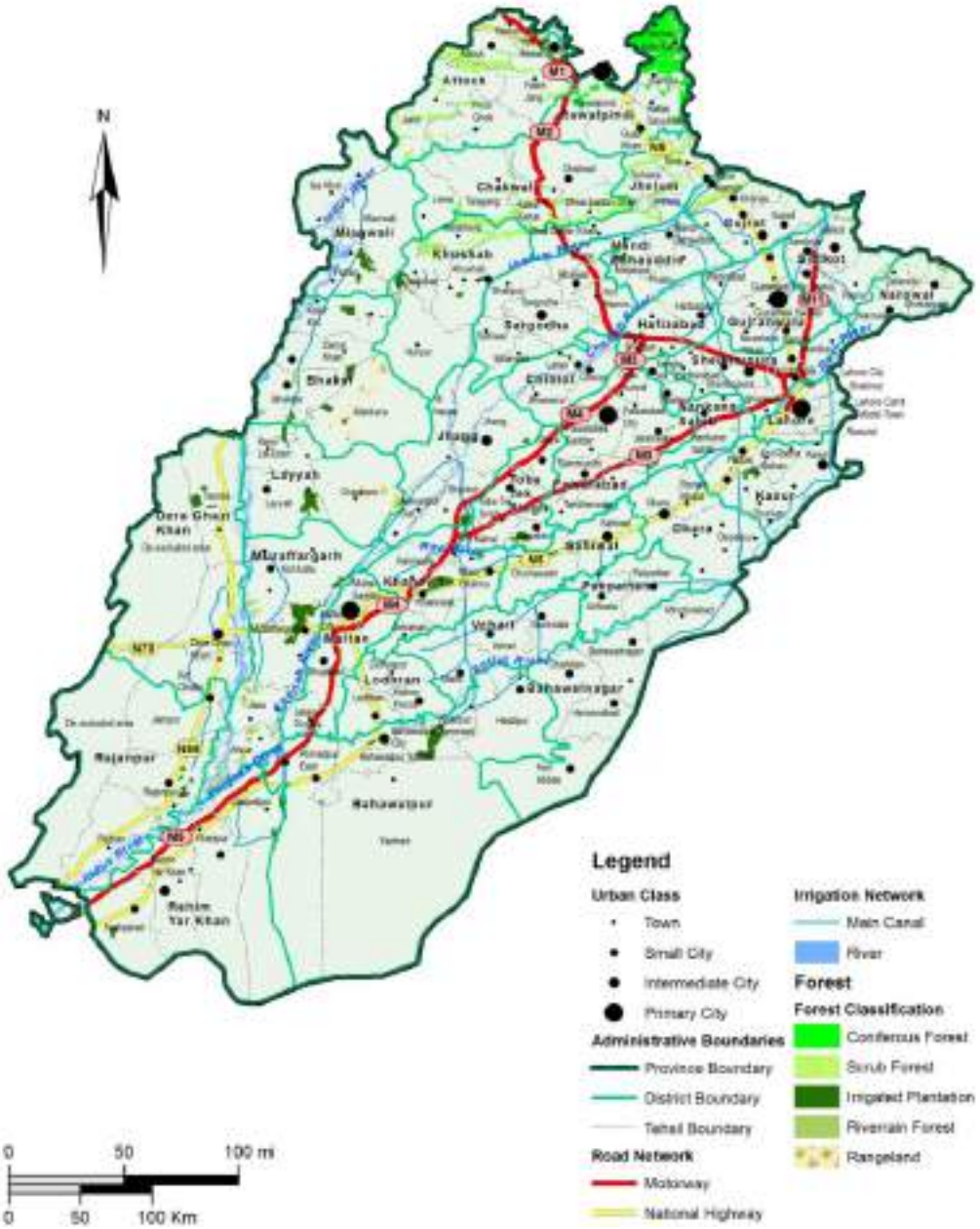
Indicator	Target 2027	Target 2037	Target 2037
High value conservation areas transformation into protected areas	The protected areas network will be expanded through at least 2 new areas so as to cover at least 18% of Punjab's terrestrial area	The protected areas network will be expanded through at least 3 new areas so as to cover at least 20% of Punjab's terrestrial area	The protected areas network will be expanded through at least 4 new areas so as to cover at least 22% of Punjab's terrestrial area

Implementation Strategy

Punjab is home to a rich biodiversity and subsequently unique ecological assemblages as identified in the PSS chapter. In order to conserve biodiversity, the following steps will be made part of the implementation strategy;

- Development and implementation of Biodiversity Action Plan for Punjab and biodiversity inventory
- Promoting factors contributing to biodiversity richness and restoration of protected sites
- Development & institutionalizing of regular monitoring by the agencies responsible for conservation & sustainable use of natural resources
- Expand and improve the information base on the Biodiversity of Punjab by appointing provincial center to coordinate biodiversity identification and monitoring activities e.g. through introduction of Forest Management Information System
- Develop an effective legal framework and SOPs for implementation of the Convention on Biological Diversity, along with provincial linking mechanism with the federal entities e.g. Ministry of Climate Change

Figure 10.19: Forest cover based on classification in the Punjab province[32]



[32] Forest, Wildlife and Fisheries Department, Government of the Punjab; http://fwf.punjab.gov.pk/sites/fwf.punjab.gov.pk/files/Forests.jpg

Figure: 10.20: Map of the protected areas of Punjab

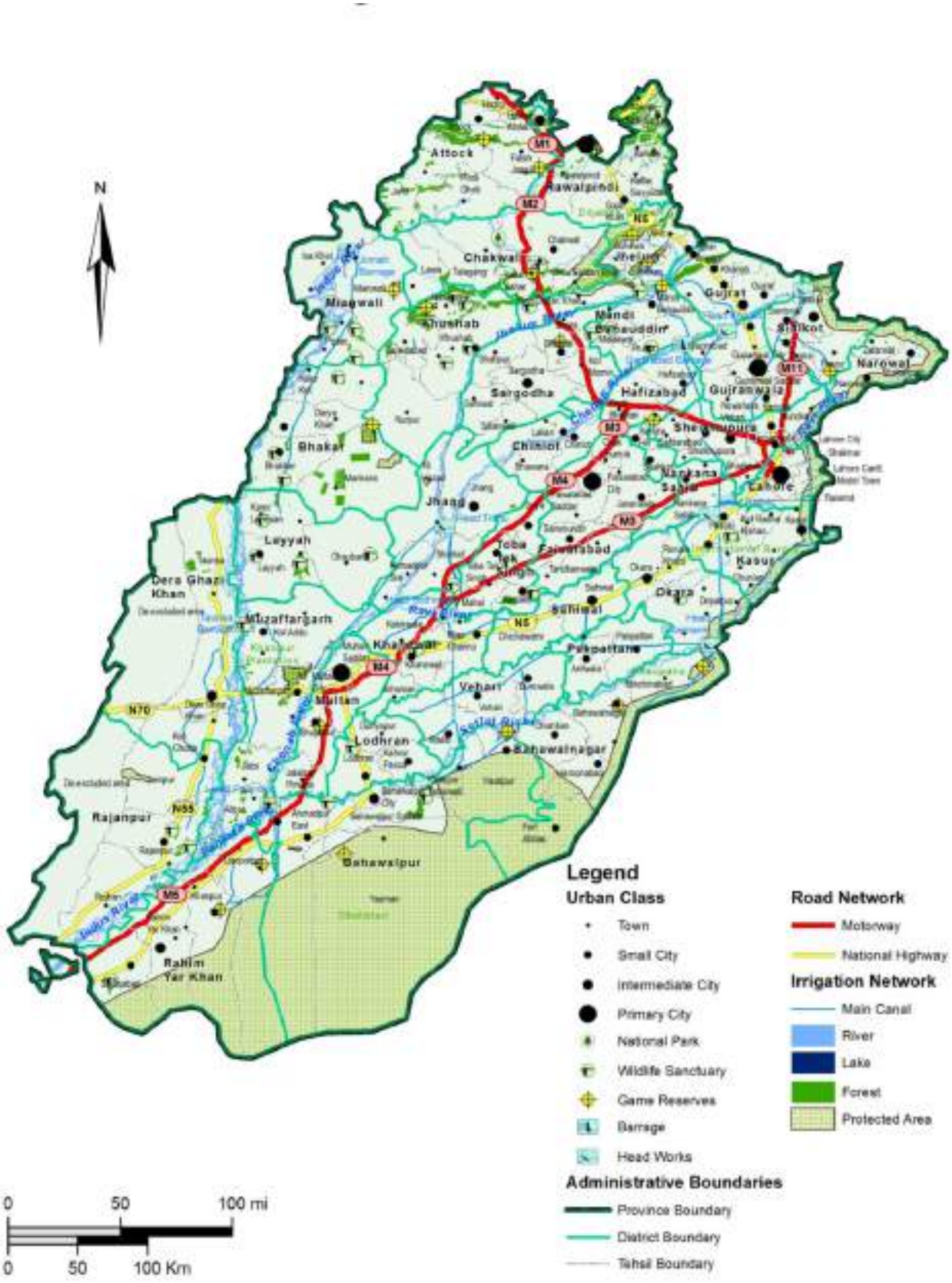


Figure 10.21: Proposed Conservation Areas

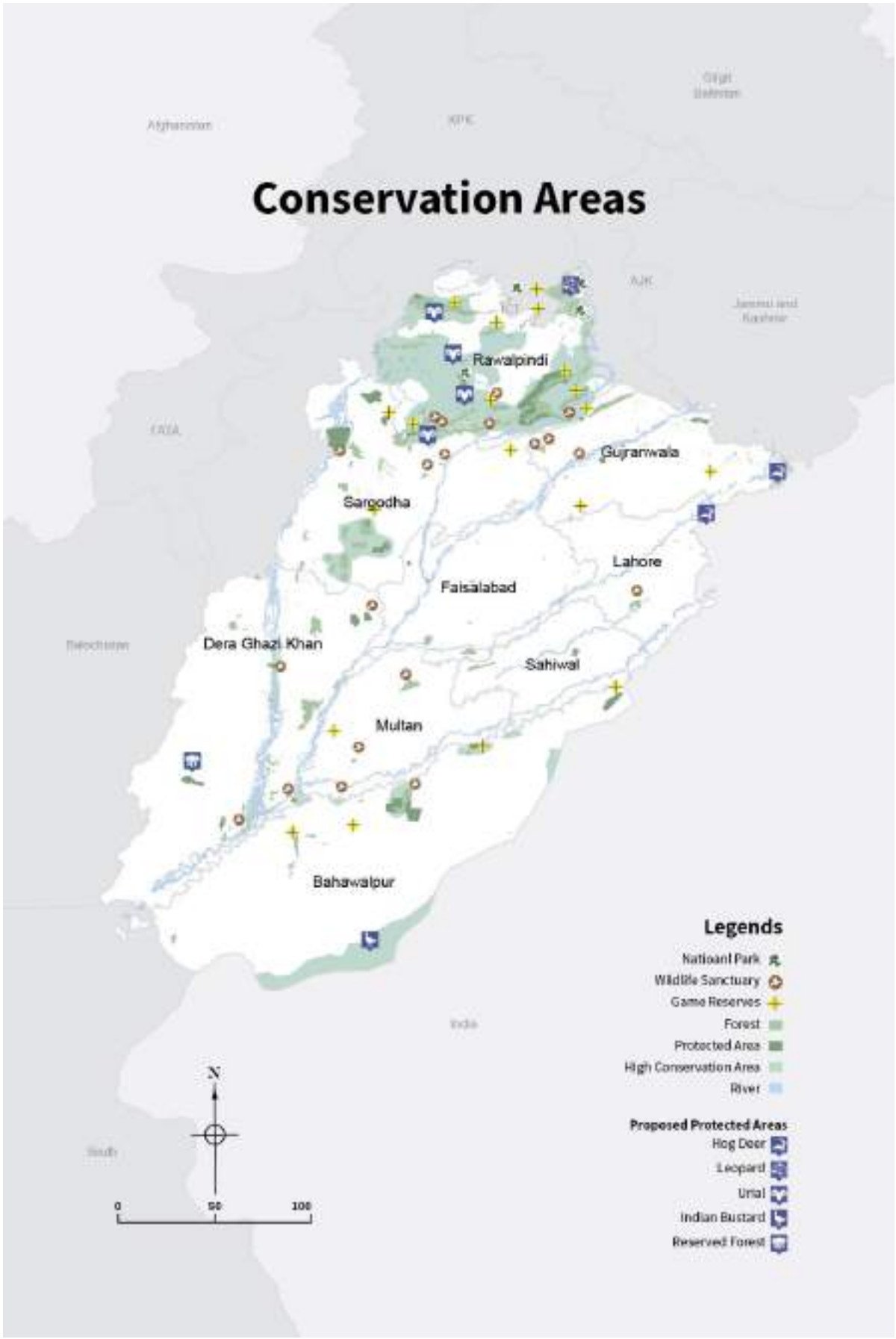
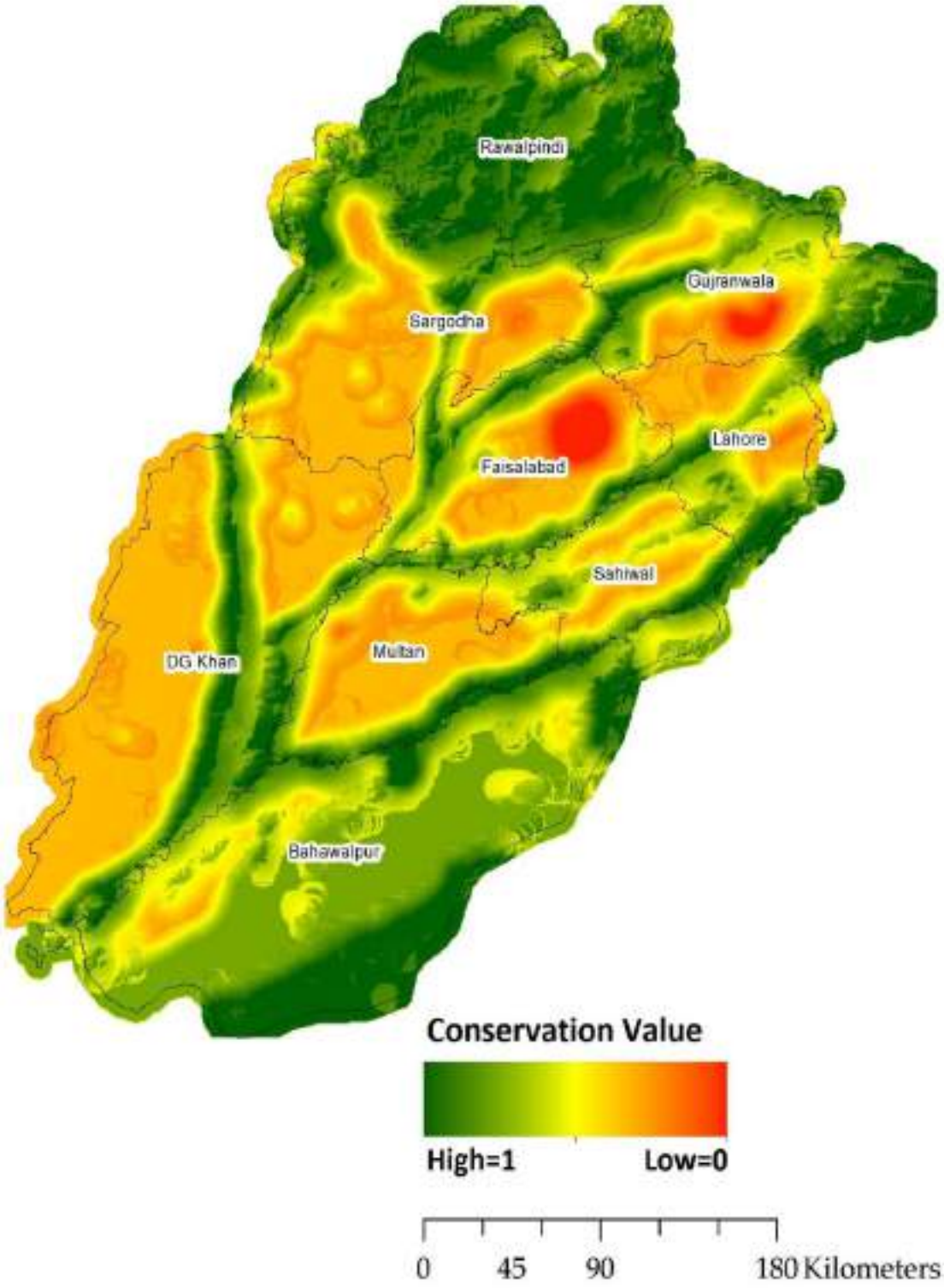


Figure 10.22: Conservation Value map



10.3 THE ENVIRONMENT CHALLENGES

Punjab is facing numerous environmental challenges including rising level of air, land and water pollution. The major contributors to environmental pollution are industries, transportation, cities and agricultural activities

10.3.1 Industries

Industrial emissions in Punjab's cities remain well above the standards as compared to urban areas in developed countries[33]. According to Censes for Manufacturing Industries (CMI) 2015 more than 65,000 industries are present in the province. Majority of these are cement, fertilizer, sugar units, power plants and steel furnaces. In 2001, Environment Protection Department issued Self-Monitoring and Reporting by Industry (SMART) Rules, in which industries were classified into two schedules; on the basis of industrial effluents and emissions. In CMI 2015, industries have been classified as per SMART rules 2001 (presented in **Figures 10.23** and **10.24**) to analyze the extent of problem and devise ways and means to tackle this industrial pollution.

10.3.2 Transport

The transport and energy sectors contribute more than two-thirds of PM, nearly half of NO_x, two-thirds of CO, and about half of hydrocarbon emissions. PM is the pollutant associated with the largest economic damage due to its effect on human health in Punjab[34]. Based on available data, it is estimated that mobile sources are the largest contributor of air pollutants, particularly $PM_{2.5}$, in large urban centers. Preliminary estimates indicate that the road transport sector is responsible for 85% of total $PM_{2.5}$ emissions and 72% of the PM_{10} emissions. While other sectors, particularly industries, also contribute to Punjab's severe urban air pollution[35]

10.3.3 Cities

Punjab's rapid urbanization and unplanned growth has led to problems which adversely affect the natural ecosystem as well as the life of citizens. In order to enjoy the benefits of cities we must focus on key priority areas that include conservation of natural environment, green and open spaces, supply of potable drinking water and its efficient use; provision of effective and efficient sewerage and drainage system; environment friendly disposal of sewage; safe and efficient roads infrastructure; provision of solid waste management services; strategic planning for growth of cities on scientific lines including efficient land use planning and regulatory building controls.

10.3.4 Agriculture

Excessive use of fertilizers, pesticides and insecticides are the main nonpoint source of soil and ground water pollution. Application of nutrients in excess of crop requirements can increase both the cost of production and the risk of adverse environmental effects. Leaching of nitrates and phosphorous into surface water and groundwater leads to acidification and heavy-metal accumulation in soil[36]. Crop burning is also one of the major causes of air pollution. Experts say that smog in Pakistan is a trans-boundary phenomenon and the cause of this smog seems to be wide scale crop burning in Indian Punjab. As per reports, farmers burn an estimated 32 million tonnes of the leftover straw to make room for planting their winter wheat crop.

10.3.5 Natural Disaster Profile

The province of Punjab is vulnerable to most kinds of disasters, with particularly river flood and hill torrents frequently occurring since 2010 due to climatic changes. There have also been examples of tornadoes and earthquakes in the province but their frequency have been quite low.

[33] http://environment.gov.pk/PRO_PDF/PositionPaper/PAKISTAN%20CLEAN%20AIR%20PROGRAMME.pdf

[34] Colbeck, I., A. Zaheer, and A. Zulfiqar. 2010. *The State of Ambient Air Quality in Pakistan*: A Review. Environmental Science and Pollution Research. **17**: 49–63

[35] Milkha S. A. *et al.* 2009. *Water Pollution Related to Agricultural, Industrial, and Urban Activities, and its Effects on the Food Chain: Case Studies from Punjab.* Journal of New Seeds. **10**(2): 112-137.

[36] Milkha S. A. *et al.* 2009. *Water Pollution Related to Agricultural, Industrial, and Urban Activities, and its Effects on the Food Chain: Case Studies from Punjab.* Journal of New Seeds. **10**(2): 112-137.

Figure 10.23: Industrial classification on the basis of Liquid Effluents

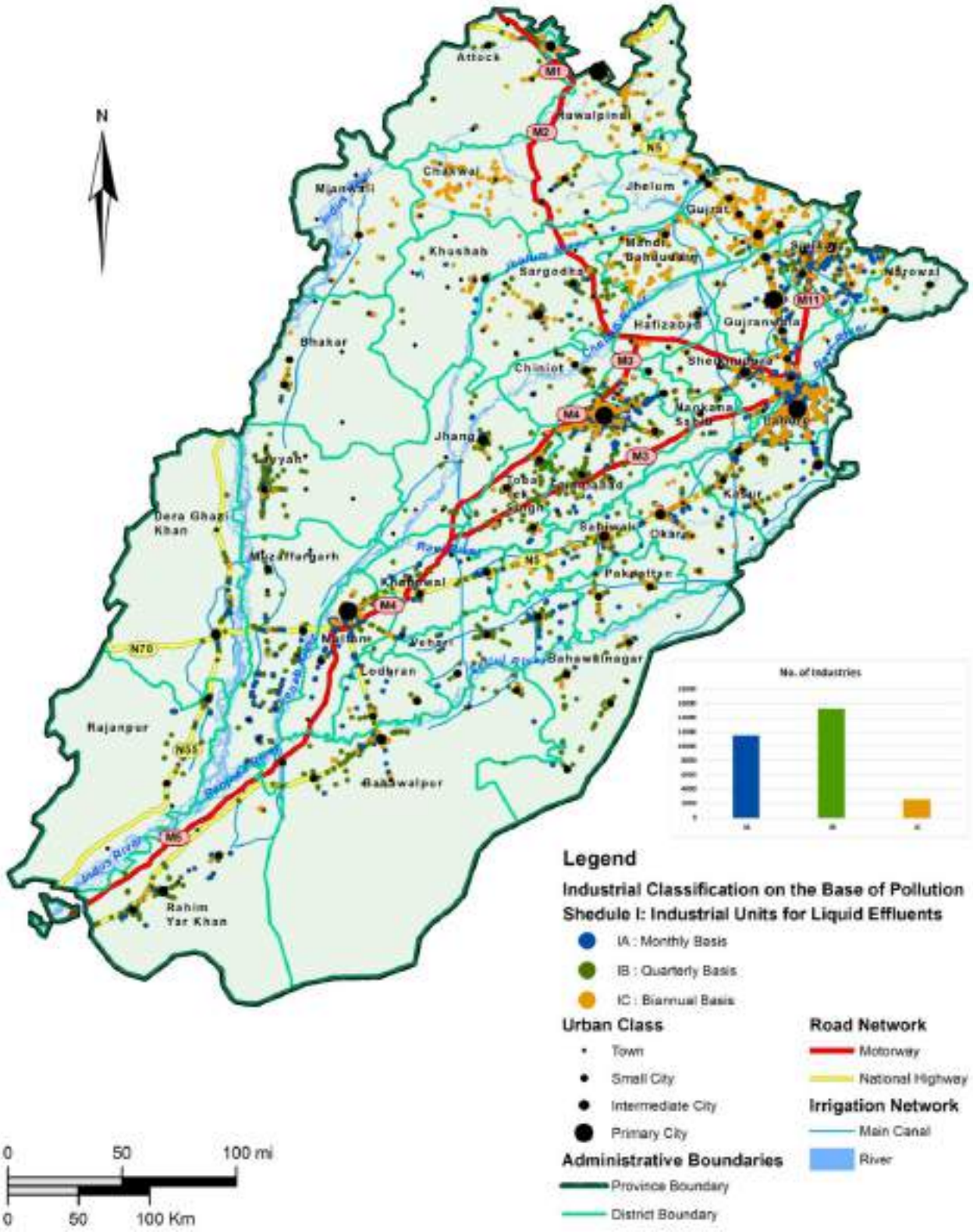


Figure 10.24: Industrial classification on the basis of Emissions

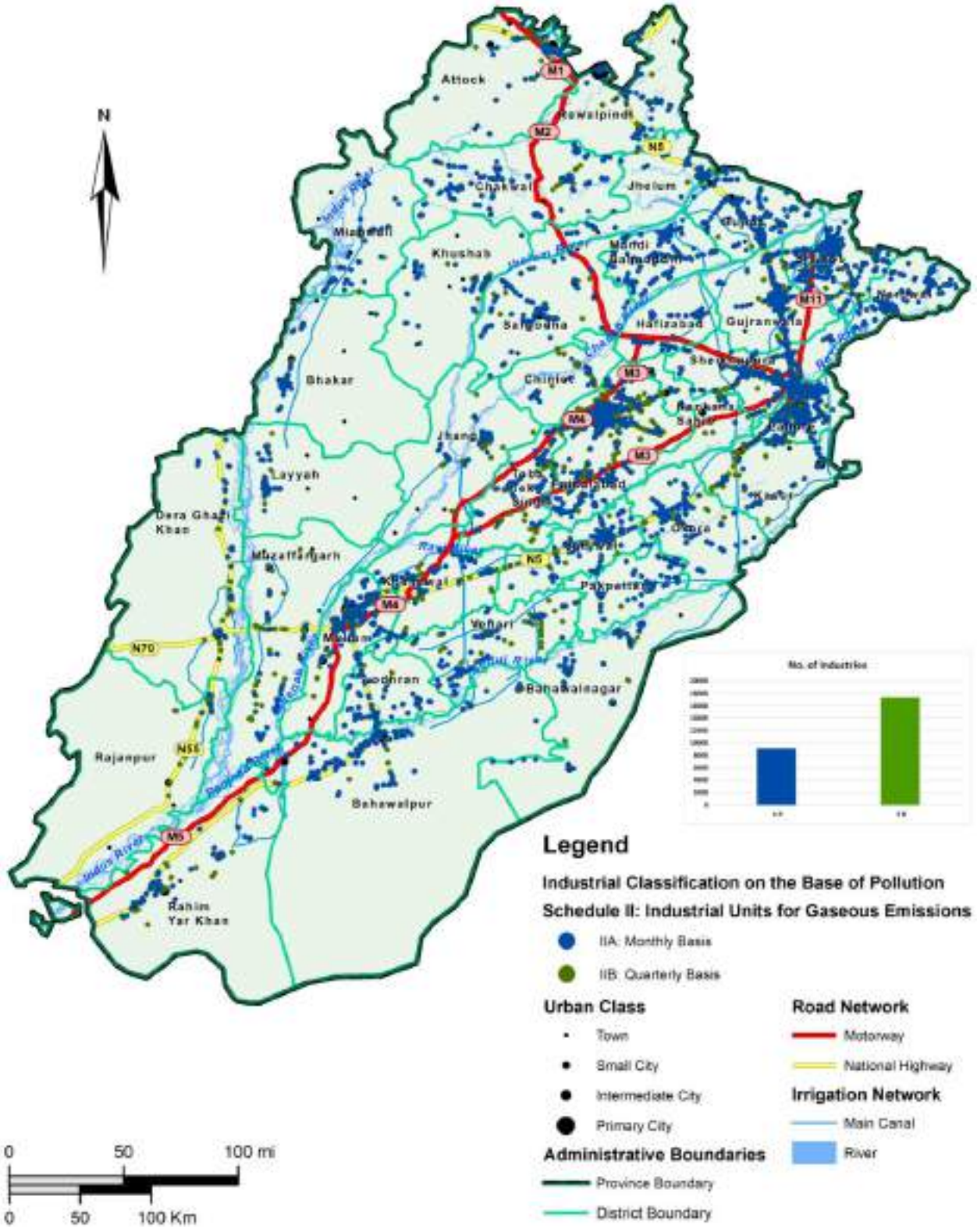


Table 10.3 Punjab disasters & districts vulnerability[37]

Disaster Type		Vulnerable Districts/ Areas
Riverine Flooding	Indus	Mianwali, Bhakkar, Layyah, Muzaffargarh, DG Khan, Rajanpur, R.Y. Khan
	Jhelum	Jhelum, M.B. Din, Khushab, Jhang
	Chenab	Gujranwala, Gujrat, Sialkot, Sargodha, Chiniot, Hafizabad, Jhang, Khanewal, Multan
	Ravi	Lahore, Sheikhupura, Nankana Sahib, Okara, Sahiwal, Khanewal
	Sutlej	Kasur, Pakpattan, Vehari, Lodhran, Bahawalnagar, Bahawalpur
Flash Floods		Mianwali, D.G. Khan, Rajanpur
Droughts		The areas of Cholistan in district Bahawalpur, Bahawalnagar and R.Y. Khan
Forest Fires		Changa Manga, Pabbi, Margala and Murree

Earthquake

Punjab has low to moderate level of seismicity. It has been subjected to severe shaking in the past due to earthquakes in the Himalayas. Known main active fault of the Himalayas is the Main Boundary Thrust (MBT), which passes at a distance of about 180 km from Lahore towards northeast along the Himalayan front. Earthquakes of magnitude greater than 8 have been recorded along this fault during the past century. The epicenters of low to moderate magnitude earthquakes, recorded in the Punjab plain are associated with the subsurface fractures in the basement rocks, which are concealed by thick alluvial deposits[38]. Probabilistic seismic hazard assessment was carried out for Punjab Province as part of Seismic Provisions of the Building Code of Pakistan has been shown in **Figure 10.26**.

Flood

Punjab was hit by super flood in 2010 during monsoon season with devastating effect on 11 districts. Rehabilitation of displaced flood affectees and damaged, infrastructure took several months. Although Punjab experienced floods over the years 2011-2013, but the intensity of these floods were not alarming. In 2014 Southern Nullahs and River Chenab swelled its banks affecting adjoining districts of Punjab; mainly districts of Jhang, Muzafargarh, and Multan. The western districts of province face the risk of flash floods originating in the western mountain ranges. Districts such as Rajanpur, DG Khan, Mianwali and Khushab are vulnerable to flash floods due to heavy rains. **Figure 10.25** shows the maximum extent of recent floods in Punjab Province.

Smog

Smog is a yellowish/ blackish atmospheric haze created by a mixture of air pollutants. It gets its name from the words 'smoke' and 'fog'. Smog can also be defined as a mixture of various gases with dust and water vapour.

In Lahore and its adjoining areas, over the last decade, a smog descends every November/December. It is so thick that even airplane flights to/from Lahore are cancelled as a result. In the last 5 years, this smog has grown way worse, owing to poor air quality and high amount of pollution caused by vehicles and factories. Deforestation and rapid industrialization has not helped matters as well, something that the development-focused authorities should do well to heed as well. Lahore is now considered as one of the most polluted cities in Asia. In winter months, all the pollutants tend to accumulate in the lower layer of atmosphere due to rains, cold spells and dry condition.

Urban Heat Island (UHI)

UHI formation and heating effect in urban is a property associated with urban and land transformation that is the key interest in scientific disciplines. All the negative impacts happen as a result of reduction in latent heat flux and also an increase in sensible heat in populated areas.

Temperature difference map has been drawn to assess the urban heath island. It reveals drastic results depicting 1 to 3 degree upsurge in Cities of Punjab. This situation can be lethal and challenge the efforts are being made for provision of quality foods, health facilities, housing, education and adequate infrastructure for the public. Urban heat islands in Punjab based on day time temperature differences are presented in **Figure 10.27**.

[37] Punjab Disaster Response Plan, 2017, PDMA
[38] National Engineering Services Pakistan (NESPAK) (2007), "Seisimic Building Code of Pakistan", Ministry of Housing and Works.

Figure 10.25: Seismic zoning map of Punjab

Figure 10.26: Flood extent in Punjab province

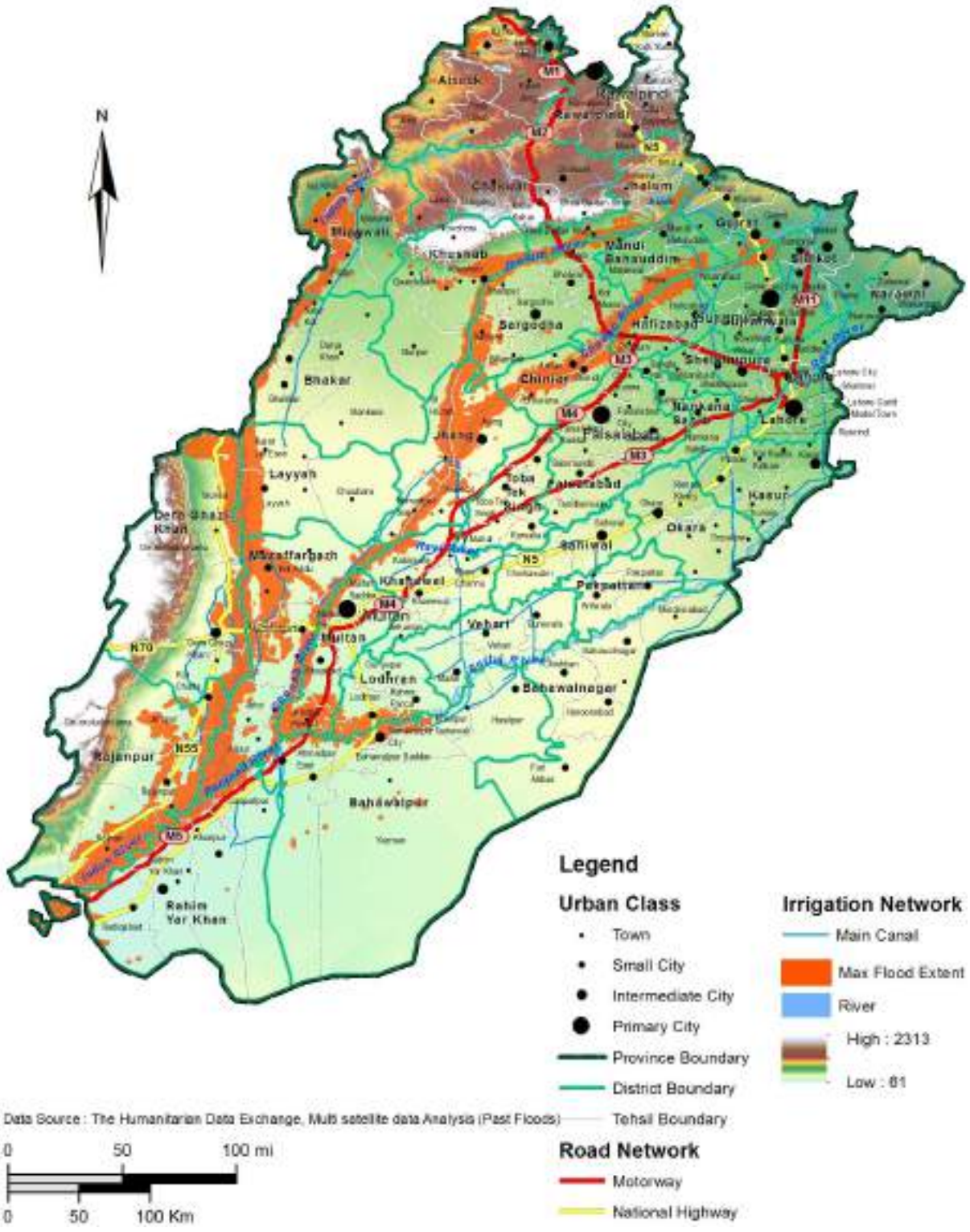
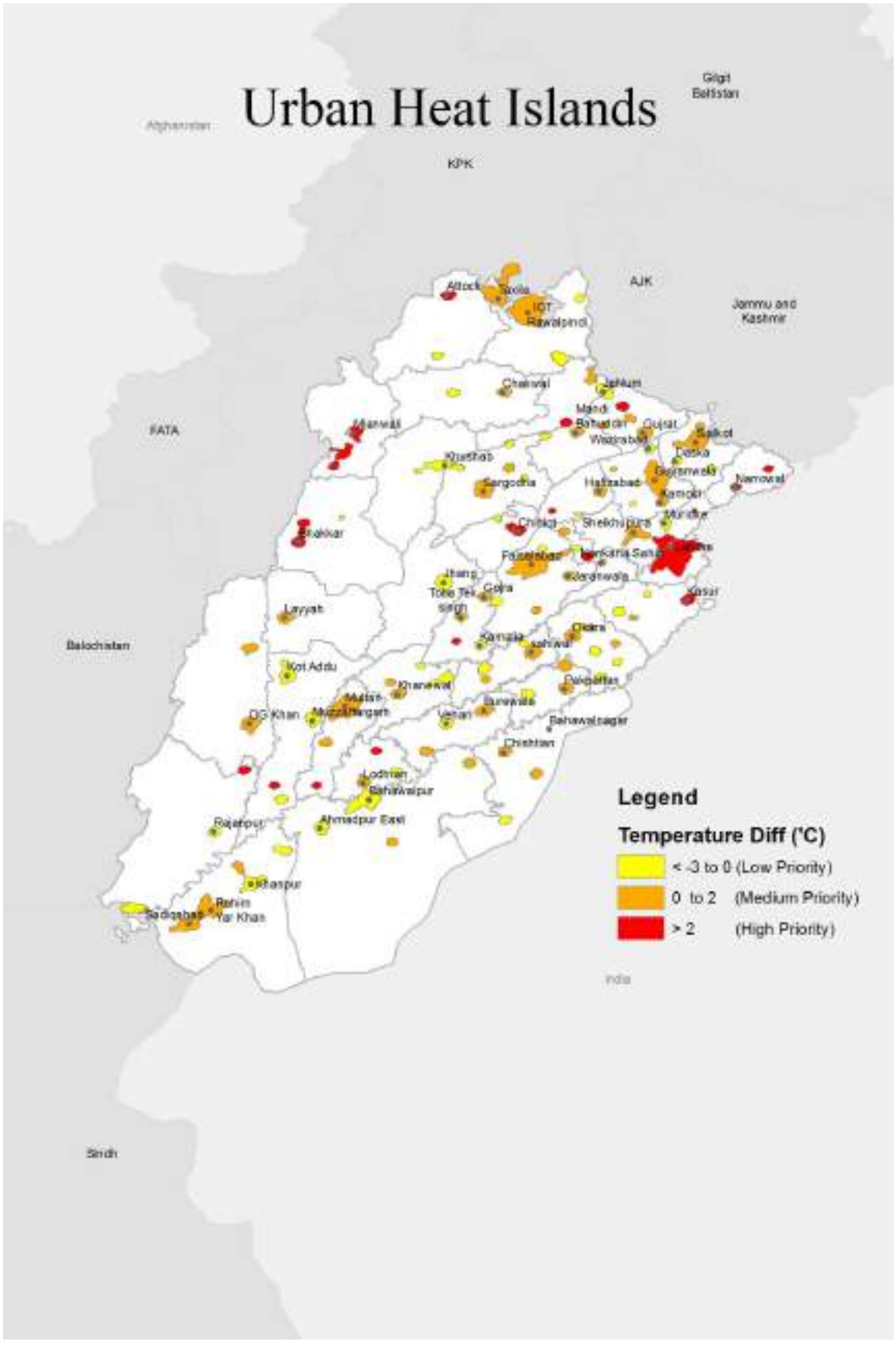


Figure 10.27: Urban heat islands in Punjab – day time temperature difference



10.4 STRATEGIC ENVIRONMENTAL MANAGEMENT TOOLS

In order to conserve natural resources and protect the environment by encouraging sustainable development as an output of Punjab Spatial Strategy, following tools have been suggested as environmental strategic management tools;

Figure 10.28: Strategic environmental management tools

10.4.1 Implementation Framework for Strategic Environmental Management Tools

In order to effectively utilize aforementioned strategic environmental management tools identified for the Punjab Spatial Strategy, an implementation framework (presented in **figure 10.28**) has been developed. This implementation framework will provide a mechanism to select not only specific tools during different stages (i.e. strategies, plan and projects) of PSS but also set primary and secondary responsibilities.

As per implementation framework, Punjab Spatial Strategy has been linked with the Environmental Management tool, i.e. Environmental and Social Management Framework (ESMF), with the intention of aligning Punjab Spatial Strategy with the principle of sustainable development. The key responsibility of this task would lie with P&D Department with assistance from EPD and Punjab Spatial Commission. For Regional development plans, i.e. mid-term development framework (MTDF), it is advisable that EPD Punjab coordinates with Punjab Spatial Commission to prepare Strategic Environmental Assessment (SEA) and Integrated Sustainable Development Infrastructure Framework (ISDIF) in order to allow environmental considerations in the decision making process.

Furthermore, in order to screen the development projects it is recommended that all projects should conduct environmental assessments (IEE/ EIA) with emphasis on project specific environmental impacts and mitigations that will help protect the environment. This task can be carried out by EPD Punjab with linkages in all relevant departments. Industries that are playing an important role in Punjab's economy should be encouraged to adopt best available technologies (BAT) that not only reduce the overall operational cost of the process but also ensure environment protection. EPD Punjab will also be advised to focus more on market based instruments in coordination with command and control approach.

Capacity building plan

One of the key to effective implementation of strategic environmental management tools is the capacity building of departments, related agencies and contractors. The tools has been identified and its implementation framework has been provided in Punjab Spatial Strategy, however there is a dire need to enhance the capacities of decision makers and implements agencies to utilize these environmental management tools as part of their decision making process. For this a capacity building plan will be designed and trainings sessions will be developed with the aim to give hands on training for better understanding and proper execution of these tools.

An environmental expert will be housed in Punjab Spatial Commission that will act as a support unit and provide the overall guidance on implementation of environmental management tools at policy, program and project levels. Likewise departments will be asked to designate focal persons both at provincial as well as divisional level for the coordination with Spatial Commission on making environmental consideration and ensure utilization of tools in developing policies, programs and projects. These focal persons will be given comprehensive training on environmental management tools.

Figure 10.29: Implementation Framework of Strategic Management Tool