DISTRICT ADAPTATION PLAN CHARSADDA

APRIL 2026

Adapting Today for a Sustainable Tomorrow

SDPI
Sustainable Development Policy Institute

National Adaptation Plan of Pakistan
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Disclaimer: The views, thoughts, and opinions expressed in this report are solely those of the author(s) and do not necessarily reflect the official policy or position of the Ministry of Climate Change and Environmental Coordination (MoCC&EC), or that of UNEP and GCF.

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Acknowledgements

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1. Executive Summary

Context and Rationale

Charsadda District, covering an area of approximately 996 km², lies in the central Peshawar Valley at the confluence of the Kabul, Swat, and Jindi Rivers. Its geographic setting makes it one of the most flood-prone areas in Khyber Pakhtunkhwa (KP). With a population of 1.84 million as per the 2023 Census, comprising 950,872 males, 884,613 females, and 19 transgender persons, Charsadda remains predominantly rural (84 percent). Agriculture is the mainstay of the local economy, supporting nearly 70 percent of households either directly or indirectly. However, recurrent floods, erratic rainfall, rising temperatures, and declining groundwater levels have significantly undermined the district's productive sectors and community resilience. The 2022 floods alone inundated 10,921 acres of cropland, destroyed vital infrastructure, and displaced thousands, revealing the urgency of developing a localized climate adaptation plan.

Observed & Projected Climate Trends

Historical climate data (1979–2024) show a consistent warming trend, with mean annual temperatures rising and extreme heat days peaking during May and June. Precipitation patterns have become increasingly erratic, ranging between 300 and 625 mm annually, with rainfall concentrated in the July–August monsoon period and prolonged dry spells outside it. Hydrological analyses indicate earlier spring flows and higher monsoon peaks, leading to increased flood frequency, erosion, and siltation along riverbanks. Groundwater levels are falling as tube wells reach depths of 280–400 feet, while water quality surveys show microbial contamination in 35–40 percent of shallow aquifers. These factors collectively intensify the risks of both water scarcity and contamination, undermining human health and agricultural productivity.

Downscaled CMIP6 climate models project that average annual temperatures in Charsadda will increase by 0.8–1.0°C by 2040, 1.8–2.5°C by 2070, and up to 4.1°C by the end of the century, depending on emissions scenarios (RCP4.5–RCP8.5). Precipitation projections show greater variability, with the likelihood of longer dry spells punctuated by intense monsoon downpours, expected to increase total rainfall by 5–15 percent by 2100. These climatic shifts are expected to heighten evapotranspiration, alter river discharge, and increase runoff peaks by 8–10 percent, resulting in more severe and unpredictable flood events. The implications for agriculture, water resources, and livelihoods are profound, with growing risks of crop failure, infrastructure damage, and disease outbreaks.

Socioeconomic Vulnerability Profile

Charsadda's high dependence on climate-sensitive sectors, weak infrastructure, and limited institutional capacity compound its vulnerability. Floods, droughts, and heatwaves disproportionately affect smallholder farmers, landless labourers, women-headed households, and children. Damage to schools, health centres, and roads during disasters disrupts access to essential services, exacerbating poverty and inequality. The district's literacy rate stands at 54 percent, and access to clean water, sanitation, and healthcare remains below provincial averages. The absence of climate-specific budgeting and limited coordination among departments further constrain effective adaptation planning and implementation.

Institutional and Community Capacities

The Deputy Commissioner (DC) and District Disaster Management Authority (DDMA) currently lead disaster response and coordination efforts in Charsadda. However, the district lacks a dedicated climate coordination cell or climate finance mechanism. Communication systems among officials are largely informal, though functional during emergencies. Local NGOs such as CESVI, NIDA Pakistan, and SRSP contribute significantly to livelihood recovery, community-based disaster preparedness, and capacity-building. Community consultations reveal strong social networks and indigenous coping mechanisms, such as adaptive planting schedules and flood-tolerant crop varieties, which can be scaled through structured institutional support and technical guidance.

Adaptation Priorities and Strategic Actions

The DAP outlines seven priority sectors for adaptation, aligned with the Pakistan National Adaptation Plan (NAP) and KP Climate Change Policy (2022).

1. Agriculture-Water Nexus

Agriculture contributes the largest share to district livelihoods but remains highly vulnerable to floods, droughts, and inefficient water use. Frequent inundation of farmland, loss of topsoil, and canal breaches disrupt cropping cycles, while rising temperatures increase evapotranspiration. The DAP prioritizes climate-smart agriculture and efficient irrigation practices to ensure water productivity and food security. Key measures include promoting drip and sprinkler irrigation, rehabilitating canal and drainage systems, introducing drought- and flood-resilient crop varieties, and establishing farmer field schools for climate advisory services and early warning dissemination.

2. Natural Capital

Charsadda's natural ecosystems, rivers, wetlands, forests, and rangelands are rapidly degrading due to unregulated extraction, logging, and soil erosion. The weakening of these ecosystems has diminished their capacity to buffer floods and recharge groundwater. The DAP calls for ecosystem-based measures suited to local conditions. Priority interventions include riverbank and canal-side stabilization using bioengineering methods, rehabilitation of degraded riverine greenbelts, improvement of natural drainage corridors, and management of floodplains to reduce erosion and moderate flood impacts. Where feasible, targeted plantation along embankments, irrigation channels, and abandoned river courses will help strengthen soil stability and enhance local biodiversity.

3. Urban Resilience

Charsadda City and its adjoining towns face mounting challenges from urban flooding, poor drainage, and solid waste accumulation. Rapid unplanned expansion has intensified vulnerability to climate hazards, with limited capacity for maintenance of municipal infrastructure. The DAP emphasizes climate-resilient urban development through drainage rehabilitation, improved waste management, and the incorporation of climate risk screening into all infrastructure projects. Urban greening, flood zoning, and resilient road design are also recommended to mitigate the Urban Heat Island effect and protect livelihoods in peri-urban areas.

4. Health Capital

Climate-induced contamination of water sources and damaged sanitation infrastructure have increased waterborne diseases in rural and peri-urban areas. Health systems remain under-resourced, with limited capacity to respond to extreme heat or vector-borne outbreaks. The DAP focuses on expanding access to safe drinking water, improving sanitation, and integrating health adaptation measures. Actions include installing solar-powered filtration plants, promoting rainwater harvesting, strengthening health surveillance systems, and integrating climate resilience into public health and nutrition programs.

5. Disaster Risk Management (DRM)

Charsadda's repeated exposure to floods and droughts demands a robust DRM framework. Current mechanisms are reactive and focus primarily on relief rather than preparedness and mitigation. The DAP seeks to institutionalize proactive risk reduction through strengthened early warning systems, updated hazard and vulnerability mapping, and the establishment of community-level disaster committees. Investments in flood forecasting infrastructure, emergency shelters, and contingency financing are essential to enhance the district's capacity to "build back better" after disasters.

6. Gender, Youth, and Social Inclusion

Women, youth, and marginalized groups face heightened vulnerabilities to climate impacts due to unequal access to resources, education, and decision-making processes. Women's workloads

increase during crises, while disruptions in education and livelihoods leave youth particularly exposed. The DAP mainstreams gender-responsive and inclusive adaptation by empowering women through livelihood diversification, supporting youth-led climate awareness programs, and ensuring participation of marginalized groups in local planning and monitoring. Inclusive approaches are integrated across all sectors to promote equitable resilience building.

Implementation and Financing Framework

The DAP adopts a phased implementation approach:

- **Phase I (2026–2028):** Institutional setup, pilot interventions, and capacity development.
- **Phase II (2029–2033):** Scaling-up of successful models and integration into district development planning.
- **Phase III (2033 onward):** Long-term institutionalization and sustainable financing mechanisms.

Financing will draw from multiple sources, including district and provincial Annual Development Programmes (ADPs), national climate funds, donor programs, and public–private partnerships. The DAP proposes the creation of a District Climate Finance Facilitation Cell (CFFC) to prepare bankable project proposals, monitor expenditures, and coordinate resource mobilization. Innovative financing mechanisms, such as green bonds, ecosystem payment schemes, and climate budget tagging, will also be explored to enhance fiscal sustainability.

Monitoring, Evaluation, and Learning

A three-tier monitoring and evaluation (M&E) framework, covering strategy, program, and project levels, will guide adaptive management. Participatory and gender-sensitive monitoring approaches will ensure that vulnerable groups' perspectives are integrated. Regular reviews every five years will help refine priorities and improve accountability and learning across sectors.

Summary

The Charsadda District Adaptation Plan represents a transformative step toward building climate resilience at the local level. By embedding adaptation within district governance structures and aligning with provincial and national frameworks, the plan aims to reduce flood and drought damages, safeguard livelihoods, and protect natural resources. Effective implementation will enable communities to transition from reactive disaster response to proactive resilience-building, securing a safer, more sustainable, and climate-resilient future for Charsadda and its people.

Charsadda District at a Glance

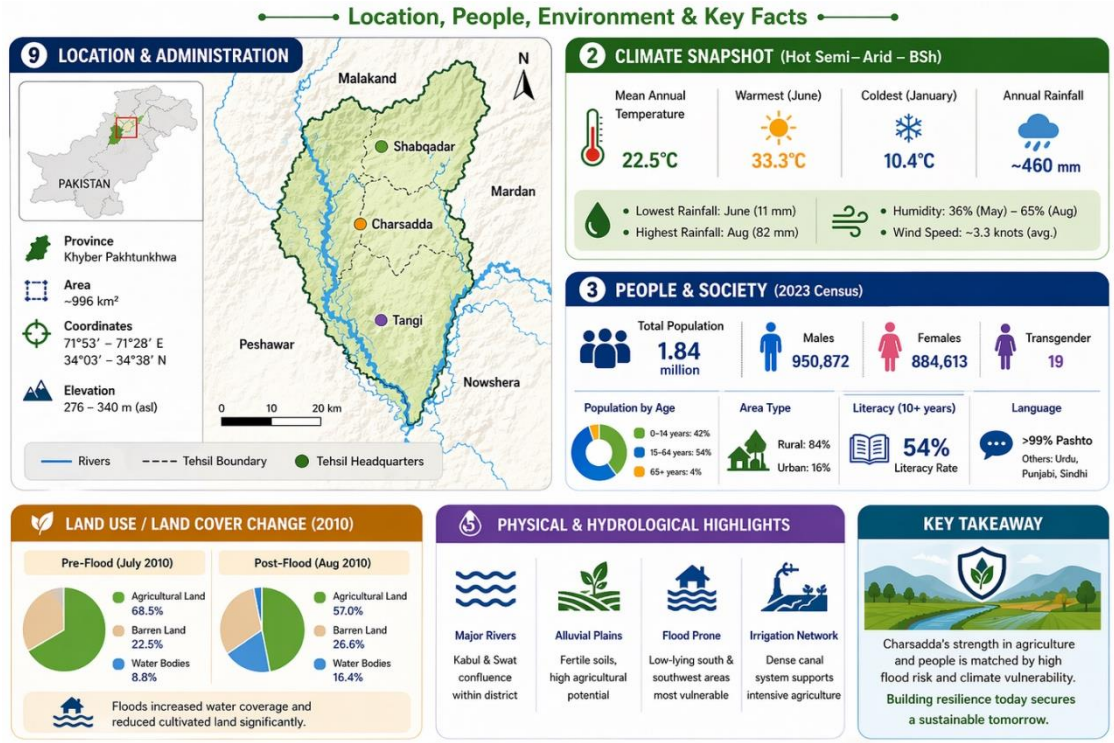

Figure 1: Summary of Climate and socio-economic profile of Charsadda .

2. Introduction

Context

The accelerating impacts of climate change have fundamentally redefined Charsadda's landscape of vulnerability, disaster management, and development. Located at the confluence of the Kabul, Swat, and Jindi rivers, Charsadda lies in one of Khyber Pakhtunkhwa's most hazard-exposed zones. The district's alluvial plains, dense settlements, and agriculture-based economy make it exceptionally sensitive to climate-induced shocks. Evidence from the Climate Risk and Vulnerability Assessment (CRVA) shows that Charsadda now experiences an increasing frequency of floods, flash floods, heatwaves, and soil erosion, driven by changing temperature and precipitation patterns across the Swat-Kabul basin.

According to Meteoblue data, observed climate trends over the last four decades show a consistent rise in mean annual temperature in Charsadda.[1] These shifts have led to alternating drought and flood cycles, severely disrupting agricultural productivity and livelihoods. Between 2000 and 2023, over 70 percent of the district's population was directly or indirectly affected by flood-related disasters, with the catastrophic 2010 floods submerging large parts of the district, displacing over 70,000 households, and causing long-term land degradation and income loss.

Charsadda's groundwater and canal system, vital for irrigated agriculture, are under increasing stress. The CRVA reveals that groundwater tables in several rural union councils have declined while flood events further exacerbate this contamination by breaching embankments and mixing surface pollutants into shallow aquifers. Conversely, prolonged dry periods in summer trigger over-abstraction, threatening long-term water security. Land and ecosystem degradation are also accelerating. Overgrazing, riverbank erosion, and conversion of riparian forests have diminished soil fertility and ecosystem services.

The human and economic toll of climate variability in Charsadda is profound. Repeated disasters erode household assets, damage essential infrastructure, and disrupt education and health services. Each major flood inflicts direct economic losses exceeding PKR 8–10 billion, while cumulative damages reduce local GDP growth and delay recovery. Vulnerable groups-especially women, children, and elderly populations, bear the greatest burden of displacement, health risks, and food insecurity. Climate change in Charsadda is therefore not only an environmental phenomenon but also a social and developmental crisis that deepens inequality and undermines resilience.

Future projections under the CRVA indicate continued warming, more erratic rainfall, and intensified flood-drought cycles. Without urgent and coordinated adaptation measures, significant parts of the district's southern and peri-urban areas may face periodic uninhabitability due to recurrent inundation and groundwater depletion. This calls for immediate, integrated action that safeguards ecosystems, strengthens infrastructure, and enhances adaptive capacity at all levels of governance.

District profile

Charsadda District covers approximately 996 km^2 in the central Peshawar Valley of Khyber Pakhtunkhwa Province, Pakistan, located between 71°53′-71°28′ E longitude and 34°03′-34°38′ N latitude. It shares boundaries with District Malakand to the north, Mardan District to the east, Nowshera and Peshawar Districts to the south.[2] [3]

Administratively, the district is divided into three tehsils Charsadda, Tangi, and Shabqadar, which are further subdivided into multiple union councils. These boundaries are georeferenced in GIS

[1] https://www.meteoblue.com/en/climate-change/charsadda_pakistan_1181439
[2] http://mdpi.com/2073-4441/14/7/1176
[3] https://geologicalbehavior.com/gbr-02-2021-40-46/

layers for administrative mapping, hazard zonation, and resource planning. The terrain is predominantly alluvial plains formed by the Kabul, Swat, and Jindi Rivers, with elevations ranging from 276 m to 340 m above sea level. DEM (Digital Elevation Model) analysis shows that southern and southwestern areas are lower in elevation, making them more prone to riverine flooding.[4]

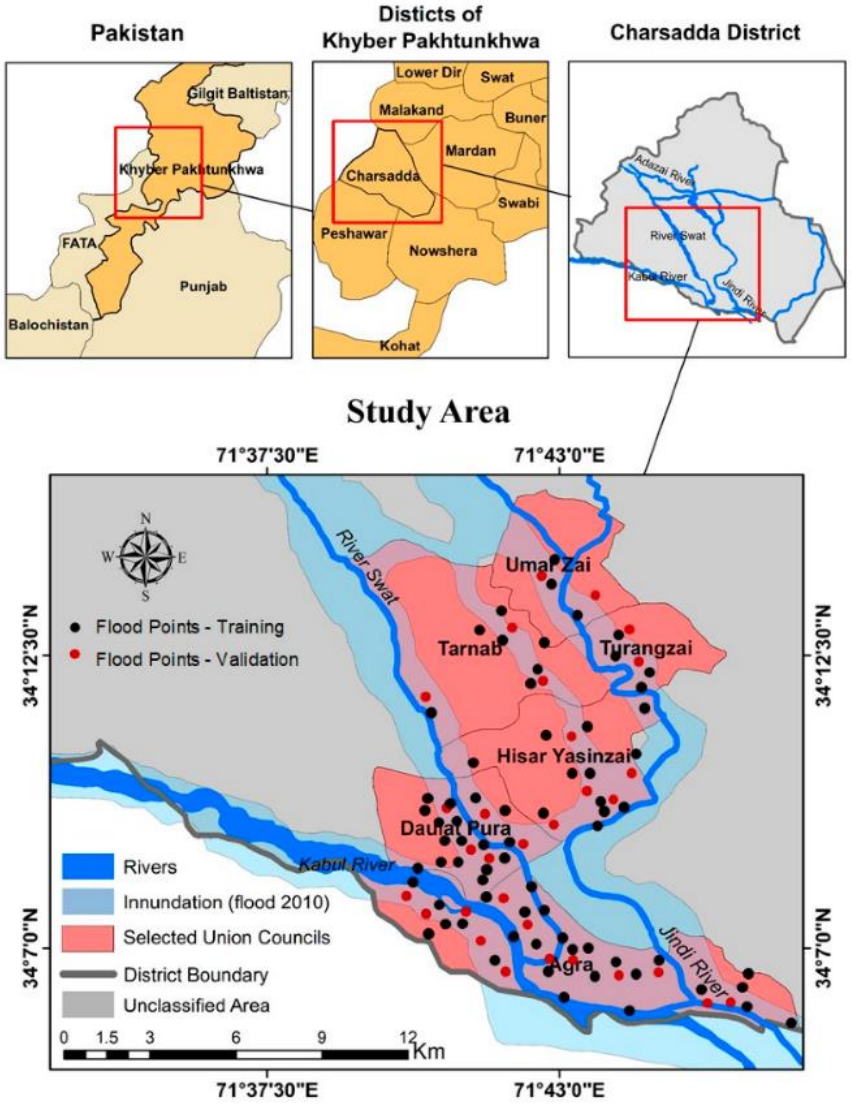

Figure 2: Reference map of Charsadda district.

The district is home to two rivers and streams, including the Swat and Kabul Rivers, where flooding is a frequent phenomenon during the monsoon season.[5] The Kabul River forms a major hydrological boundary with Peshawar, while the Swat River converges within the district before joining the Kabul. Seasonal snowmelt from the Hindu Kush and monsoon precipitation contribute to high discharge volumes, peaking between June and August.[6] The district's river network is complemented by a dense canal irrigation system, mapped through high-resolution imagery for agricultural zoning. Flow accumulation and slope analyses in GIS highlight the flood pathways along the Kabul and Swat Rivers, with hazard intensity increasing in the southern low-lying union councils, notably Agra, Daulat Pura, and Hisar Yasinzai.[7]

[4] http://mdpi.com/2073-4441/14/7/1176
[5] http://mdpi.com/2073-4441/14/7/1176
[6] https://geologicalbehavior.com/gbr-02-2021-40-46/
[7] https://geologicalbehavior.com/gbr-02-2021-40-46/

Charsadda exhibits a hot semi-arid climate, classified as BSh (Hot Steppe Climate) under the Köppen-Geiger system, which denotes arid regions with steppe vegetation and mean annual temperatures above 18°C. The district experiences considerable seasonal variation, with a mean annual temperature of 22.5°C. June is the warmest month, averaging 33.3°C, while January is the coldest, with an average temperature of 10.4°C. The annual temperature amplitude reaches 22.9°C, indicating a pronounced thermal contrast across seasons. Rainfall is generally sparse and uneven, with an average annual precipitation of 460 mm. June records the lowest rainfall at 11 mm, whereas August receives the highest at 82 mm, resulting in a 71 mm differential between the two. Relative humidity also varies throughout the year, ranging from 36% in May to 65% in August, with annual fluctuations falling between 42% and 69%. Climatologically, the region experiences four distinct seasons: winter (December to March), pre-monsoon (April to June), monsoon (July to September), and post-monsoon (October to November). Wind speeds average around 3.3 knots annually, peaking at 5.9 knots in June, with mostly variable wind directions except for south-westerly winds in December.[8]

From a land use/land cover (LULC) perspective, pre-flood satellite imagery (Landsat-7, July 2010) classified 68.5% of the area as agricultural land, 22.5% as barren land, and 8.8% as water bodies. Post-flood imagery (August 2010) revealed a marked increase in water bodies to 16.4%, alongside reductions in cultivated land to 57.0%, indicating significant inundation impacts. The fertile alluvial soils make the district a major agricultural hub, but the high-water table and sedimentation patterns mapped via remote sensing indicate persistent flood vulnerability.[9]

According to the 2023 Population and Housing Census, Charsadda district has a total population of 1.84 million, comprising 950,872 males, 884,613 females, and 19 transgender individuals. The population is predominantly within the working-age bracket (15–64 years), which accounts for 994,472 people (54%), followed by children aged 0–14 years (775,547 people; 42%) and an elderly population aged 65 years and above (65,117 people; 4%). A more detailed age distribution highlights that 542,879 children are under 10 years old, and 418,520 youth are between 10–19 years, indicating a significant youth bulge with implications for education, employment, and future service demand.[10]

Charsadda remains predominantly rural, with 1,543,078 residents (84%) living in rural areas and only 292,426 (16%) in urban centers. The literacy rate among individuals aged 10 years and above is 54%, with 697,011 literate and 595,246 illiterate persons. The population is overwhelmingly Pashto-speaking (1,828,826 people; >99%), followed by minor proportions speaking Urdu (991 people), Punjabi (338 people), and Sindhi (155 people).[11]

Combating Climate Change

Given Charsadda's high exposure to multiple hydro-meteorological hazards, climate adaptation is a development imperative for the district. While Pakistan's greenhouse gas emissions remain globally marginal, the local impacts of climate change are disproportionately severe, necessitating a shift toward resilience-focused planning and investment. Adaptation, not mitigation, is therefore the most relevant and urgent response for Charsadda's sustainable future. The economic cost of inaction is substantial. Damage to agriculture, irrigation networks, housing, and transport infrastructure from recurring floods continues to undermine local development gains. Investing in adaptation now, through soil conservation, flood-resilient infrastructure, riverine and wetlands

[8] Urban Policy and Planning Unit, Planning and Development Department, Government of Khyber Pakhtunkhwa. (2020). *Final land use plan of District Charsadda – Provincial Land Use Plan (PLUP)*. Government of Khyber Pakhtunkhwa. https://urbanpolicyunit.gkp.pk/wp-content/uploads/2020/07/DLUP-Charsadda-2020-NEW.pdf

[9] https://geologicalbehavior.com/gbr-02-2021-40-46/

[10] Pakistan Bureau of Statistics. (2023). *7th Population and Housing Census – Detailed Results* [PDF]. Retrieved from https://www.pbs.gov.pk/digital-census/detailed-results

[11] Ibid.

ecosystem restoration, and climate-smart agriculture, offers both economic and humanitarian dividends.

Guided by national frameworks such as the National Adaptation Plan (NAP 2023), the National Climate Change Policy (2021), and the Khyber Pakhtunkhwa Climate Change Policy and Action Plan (2022), Charsadda's DAP serves as a localized extension of these commitments, translating national adaptation goals into district-level action. At the national level, the Ministry of Climate Change and Environmental Coordination (MoCC&EC) provides the strategic direction for adaptation through the NAP framework. This framework emphasizes inclusivity, evidence-based planning, and integration of adaptation priorities into sectoral and subnational development agendas. In Khyber Pakhtunkhwa, the Planning and Development Department (P&DD) leads provincial implementation through its Climate Action Board and Climate Change and Environment Cell, ensuring coherence between provincial policies and district-level adaptation planning.

Charsadda's DAP is designed to move beyond reactive disaster response toward proactive and sustained resilience-building. It emphasizes community participation, integration of scientific and indigenous knowledge, and the mainstreaming of climate adaptation into local planning, budgeting, and service delivery. By fostering cross-sectoral coordination among district line departments, the DAP ensures that adaptation becomes an integral part of district development governance. This document also serves as a practical guide for mobilizing and channelling resources toward priority adaptation measures. By aligning local actions with national frameworks, it provides the foundation for accessing domestic and international climate finance mechanisms, including the Green Climate Fund (GCF) and Adaptation Fund, while encouraging partnerships with NGOs, academia, and the private sector.

In structure, the Charsadda DAP mirrors the logic of Pakistan's NAP process:

- **Chapter 1** outlines the district context, climate hazards, and disaster impacts.
- **Chapter 2** presents the climate vulnerability and capacity assessment findings.
- **Chapter 3** explains the DAP process, vision, guiding principles, and stakeholder engagement.
- **Chapter 4** identifies the district's priority adaptation systems and cross-cutting areas.
- **Chapter 5** details costing, financing, and opportunities for innovative funding.
- **Chapter 6** provides an implementation and monitoring framework, including institutional responsibilities, capacity-building plans, and communication strategies.

Through this structured approach, the Charsadda DAP seeks to operationalize adaptation as a cornerstone of district development, reducing climate risks, protecting livelihoods, and ensuring that the people of Charsadda can thrive in a changing climate while contributing to Pakistan's broader vision of sustainable and climate-resilient growth.

3. Climate Vulnerability and Capacity Assessment

Climate change presents an increasingly urgent challenge to Pakistan's sustainable development, threatening ecosystems, livelihoods, infrastructure, and public health. While Pakistan contributes less than 1% to global greenhouse gas emissions, it consistently ranks among the most climate-vulnerable countries worldwide.[12] The German watch Global Climate Risk Index (2022) placed Pakistan at the top of its vulnerability ranking, citing the unprecedented 2022 floods that inundated one-third of the country, killed over 1,700 people, and caused more than USD 30 billion in economic losses.[13]

Khyber Pakhtunkhwa (KP) face distinct yet severe climate challenges due to their geographic and socio-economic conditions. In KP, glacial retreat and extreme weather events dominate climate risks. The province has over 3000 glaciers, many receding due to rising temperatures, increasing the threat of glacial lake outburst floods (GLOFs). [14] Districts like Chitral, Upper Dir, and Swat face recurrent GLOF-induced flooding, exemplified by the 2024 event in Upper Chitral that displaced 30 families.[15] Flash floods and heatwaves compound vulnerabilities, with the 2022 floods alone affecting millions and causing billions in losses.[16]

Charsadda District, located in the central Peshawar Valley of Khyber Pakhtunkhwa (KP), is one of the most climate-sensitive regions of Pakistan due to its location at the confluence of the Kabul, Swat, and Jindi rivers. Covering approximately 996 km^2, the district's fertile alluvial plains support intensive agriculture, yet this geographic advantage is also its greatest vulnerability as it increases exposure to riverine flooding and soil erosion.[17]

Climate variability has amplified these risks, with rising maximum temperatures, erratic rainfall patterns, and increasing frequency of extreme weather events directly affecting the district. Socio-economic fragility, characterized by poverty, low literacy, and reliance on daily wage labor further reduces household resilience. Weak institutional capacities, including fragmented coordination, lack of climate finance, and outdated flood protection infrastructure, exacerbate these vulnerabilities.[18]

Charsadda is highly exposed to recurring floods, heatwaves, seasonal drought spells, and land degradation, making it a hotspot of climate vulnerability in Pakistan.[19] [20] [21]

Methodology

The assessment builds directly on the findings of the Charsadda District's Climate Risk and Vulnerability Assessment (CRVA) conducted under the framework of Pakistan's NAP process, supported by the United Nations Environment Programme (UNEP), Pakistan's Ministry of Climate Change & Environment Coordination (MoCC&EC), and implemented locally by the Sustainable

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[12] MoCC&EC, 2023. *Pakistan National Adaptation Plan 2023.* [online] Available at: https://unfccc.int/sites/default/files/resource/National_Adaptation_Plan_Pakistan.pdf
[13] https://www.aa.com.tr/en/environment/pakistan-ranked-as-most-vulnerable-country-to-climate-change-in-2022/3480075#
[14] https://tnnenglish.com/illegal-glacier-harvesting-threatens-khyber-pakhtunkhwas-ecosystem-amid-climate-crisis
[15] Government of Pakistan, 2024. *Climate Change Adaptation Action Plan 2024.* [online] Available at: https://epakp.gov.pk/wp-content/uploads/2025/03/Final-CCAAP-25-1-25.pdf
[16] https://www.gavi.org/vaccineswork/new-climate-report-khyber-pakhtunkhwa-warns-grave-health-impacts-2050
[17] Field observations conducted by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[18] Ibid.
[19]Anwar, M., Khan, H., Rehman, S. U., & Khan, M. (2023). Assessing urban flood risk and vulnerability in Pakistan: An integrated GIS and hydrological modeling approach. Water Security, 20, 100064.
[20] Hashmi, M., Zhang, W., & Ali, A. (2022). Climate-induced vulnerability and adaptation in South Asia: A systematic review. *Water*, 14(7), 1176.
[21] Shah, S. A., Khan, N., & Iqbal, M. (2024). Climate vulnerability and adaptive practices in Pakistan's rural communities. Crisis, 2(3), 36.

Development Policy Institute (SDPI). The DAP methodology refines and applies the CRVA evidence base to identify priority vulnerabilities, institutional gaps, and feasible adaptation measures that can be mainstreamed into district development planning.

Analytical Framework

The analytical framework follows the risk-based approach adopted in the SOPs for DAP Development by ADPC, which defines climate risk as a function of hazard exposure, sectoral sensitivity, and adaptive capacity. The assessment also draws upon the Asian Development Bank's Climate Risk and Vulnerability Assessment Tool (2018)[22] and the Global Covenant of Mayors (GCoM) Climate Risk and Vulnerability Assessment Methodology[23], ensuring compatibility with international standards and best practices for local adaptation planning.

Data Sources and Inputs

The DAP assessment builds upon the datasets and analytical outputs generated through the CRVA. Secondary data included historical climate trends, socio-economic indicators, infrastructure and land use data, and sectoral statistics obtained from the Pakistan Meteorological Department (PMD), Provincial Disaster Management Authority (PDMA-KP), Planning and Development Department (P&DD-KP), and Pakistan Bureau of Statistics (PBS).

Primary data were collected during the CRVA phase through 43 Key Informant Interviews (KIIs) across district and provincial institutions, one community Focus Group Discussion (FGD) representing diverse livelihood groups, and a multi-stakeholder consultation workshop held in June 2025. Future climate projections were derived from downscaled CMIP6 ensemble models for RCP 4.5 and RCP 8.5 scenarios through the SMHI/WMO Climate Information Portal and Meteoblue website.[24] [25]

DAP-Level Refinement

Building on the CRVA results, the DAP methodology involved a process of refinement and contextualization. Vulnerability findings were synthesized across key sectors, agriculture, water, health, infrastructure, and livelihoods, to identify adaptation entry points. Institutional and financial capacity assessments were conducted to evaluate the feasibility of implementing adaptation measures within existing governance and budgetary frameworks. Additional consultations with district departments and stakeholders were held to validate findings, ensure community priorities were reflected, and identify potential co-benefits with ongoing development initiatives (**Error! Reference source not found.**).

Output and Integration

The resulting Climate Vulnerability and Capacity Assessment provides a consolidated profile of climate risks, sectoral sensitivities, and adaptive capacities for Charsadda District. It highlights spatially explicit risk zones, sector-specific vulnerabilities, and institutional capacity constraints. These findings form the evidence base for prioritizing adaptation actions, strengthening governance systems, and developing an investment-oriented District Adaptation Plan aligned with provincial and national adaptation objectives.

Observed Climate Trends

Over the period 2010-2022, Charsadda has undergone significant climatic shifts, in line with regional changes observed across the Hindu Kush–Karakoram–Himalayan system. Rising temperatures, erratic precipitation, recurring extreme weather events, altered hydrological regimes, and accelerated soil erosion collectively illustrate a trajectory of heightened climate stress. These local observations are consistent with peer-reviewed studies on climate vulnerability and

[22] https://www.adb.org/projects/documents/reg-46470-001-tacr-7
[23] https://www.mwcog.org/file.aspx?&A=y9hD4xqfpcWZWNKMavuARxo%2F55JL8iQeVoRwGQPSGZY%3D
[24] https://ssr.climateinformation.org/ssr/
[25] https://www.meteoblue.com/en/climate-change/charsadda_pakistan_1181439

hydrological change in Pakistan, which emphasize the dual role of monsoonal variability and snowmelt in shaping hazard exposure.[26] [27] [28]

- **Temperature:** Regional climate analyses indicate a statistically significant warming trend in northern Pakistan, with mean annual temperatures rising steadily since 2010. In Charsadda, this trend is reflected in hotter summers, with June-July maximum temperatures frequently exceeding 40 °C, and an increase in the number of heatwave days. Like other South Asian semi-arid districts, heat extremes have placed stress on public health and reduced wheat and maize productivity. Winters have become comparatively milder, reducing chilling hours and affecting crops dependent on cold dormancy.[29]

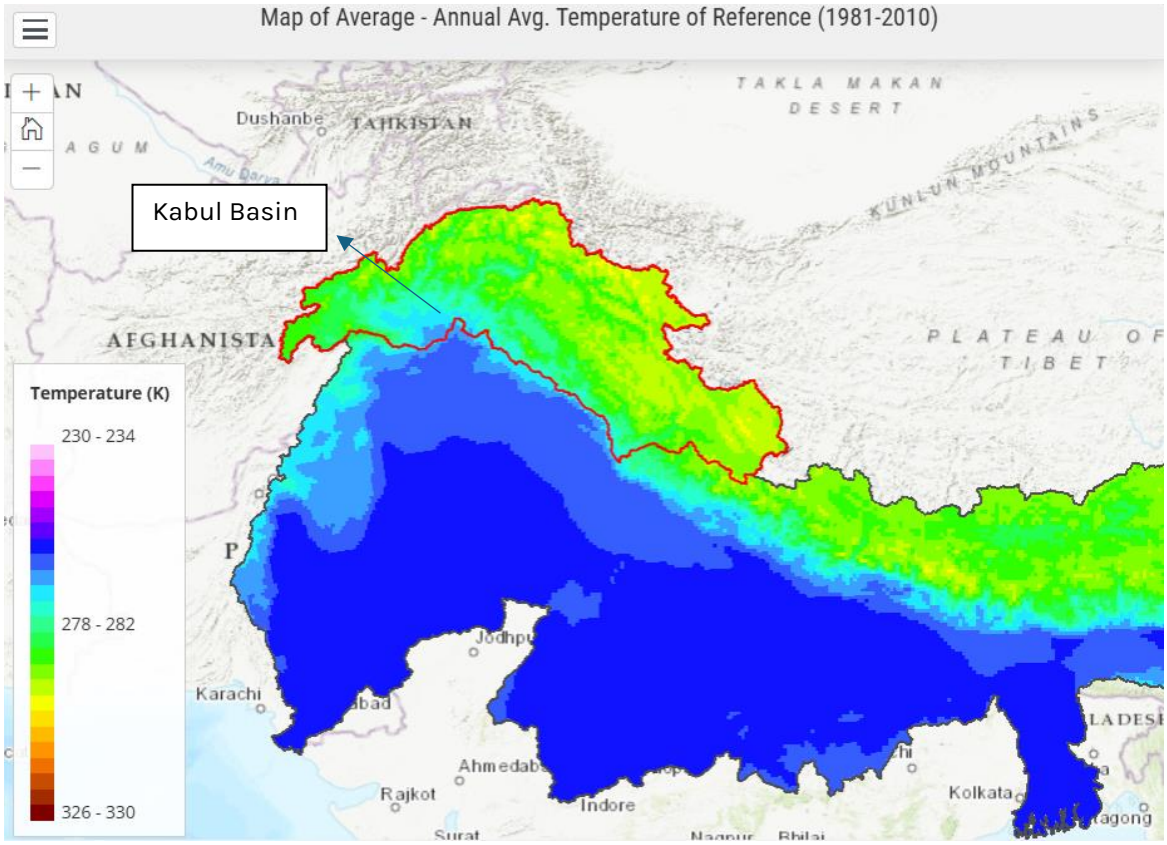

Figure 3: Map of average temperature of Upper Indus Basin (1981-2010)[30]

[26] Anwar, M., Khan, H., Rehman, S. U., & Khan, M. (2023). Assessing urban flood risk and vulnerability in Pakistan: An integrated GIS and hydrological modeling approach. Water Security, 20, 100064.
[27] Hashmi, M., Zhang, W., & Ali, A. (2022). Climate-induced vulnerability and adaptation in South Asia: A systematic review. *Water*, 14(7), 1176.
[28] Shah, S. A., Khan, N., & Iqbal, M. (2024). Climate vulnerability and adaptive practices in Pakistan's rural communities. Crisis, 2(3), 36.
[29] Ibid.
[30] https://geoapps.icimod.org/HICHAP/

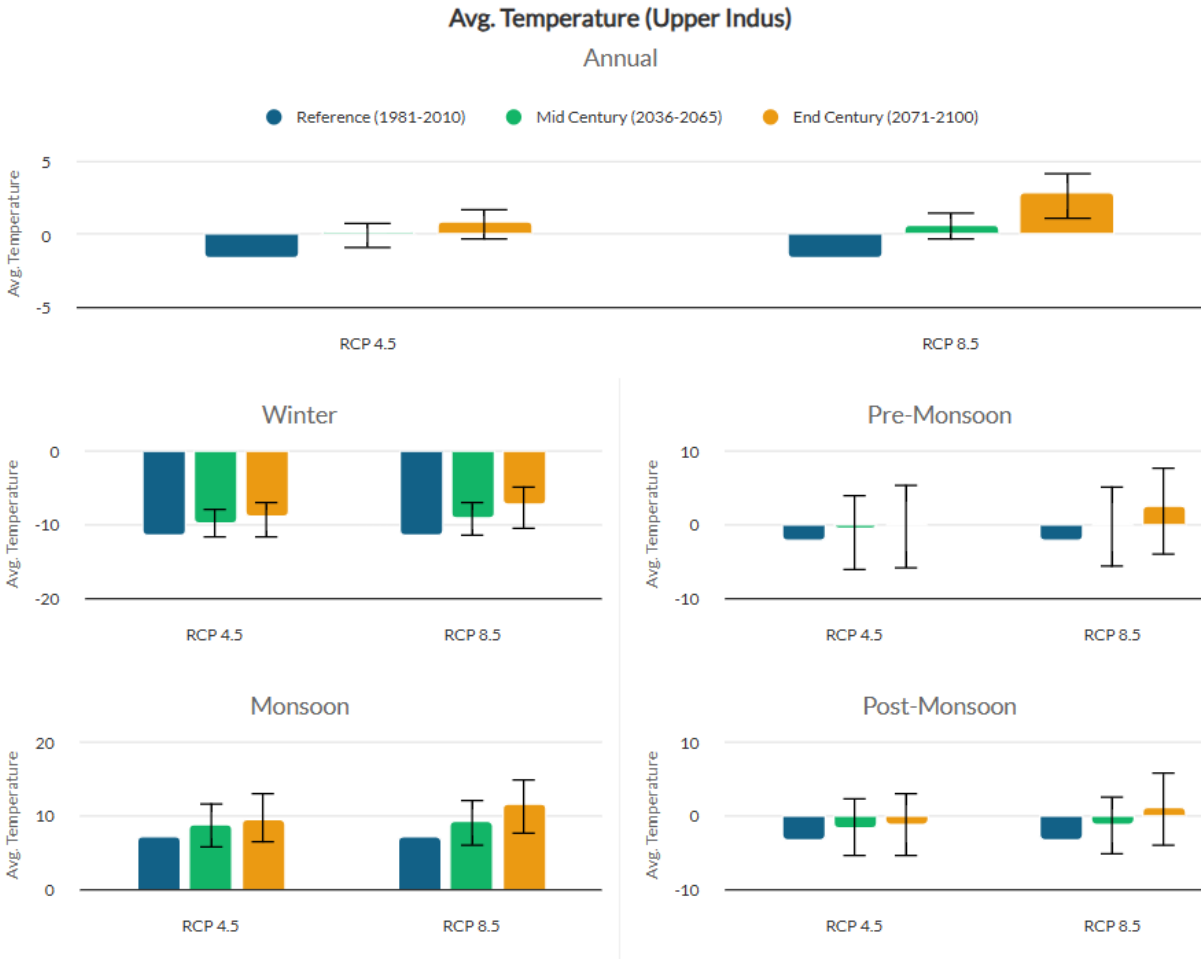

Figure 4: Projected changes in average temperature over the Upper Indus Basin under different Representative Concentration Pathways (RCPs) and time horizons.

Source: ICIMOD, HI-CHAP[31]

- **Precipitation:** Precipitation in Khyber Pakhtunkhwa has become highly variable, showing sharp year-to-year fluctuations that have directly impacted Charsadda. Annual rainfall in the district fluctuates between 300 and 625 mm, but irregular seasonal distribution has become more pronounced. Two distinct wet seasons remain evident: winter precipitation from Western Disturbances and summer monsoonal rainfall. However, the timing and intensity of these rainfall regimes have become less predictable, mirroring broader national trends of erratic rainfall and increasing frequency of heavy precipitation events.

[31] Ibid.

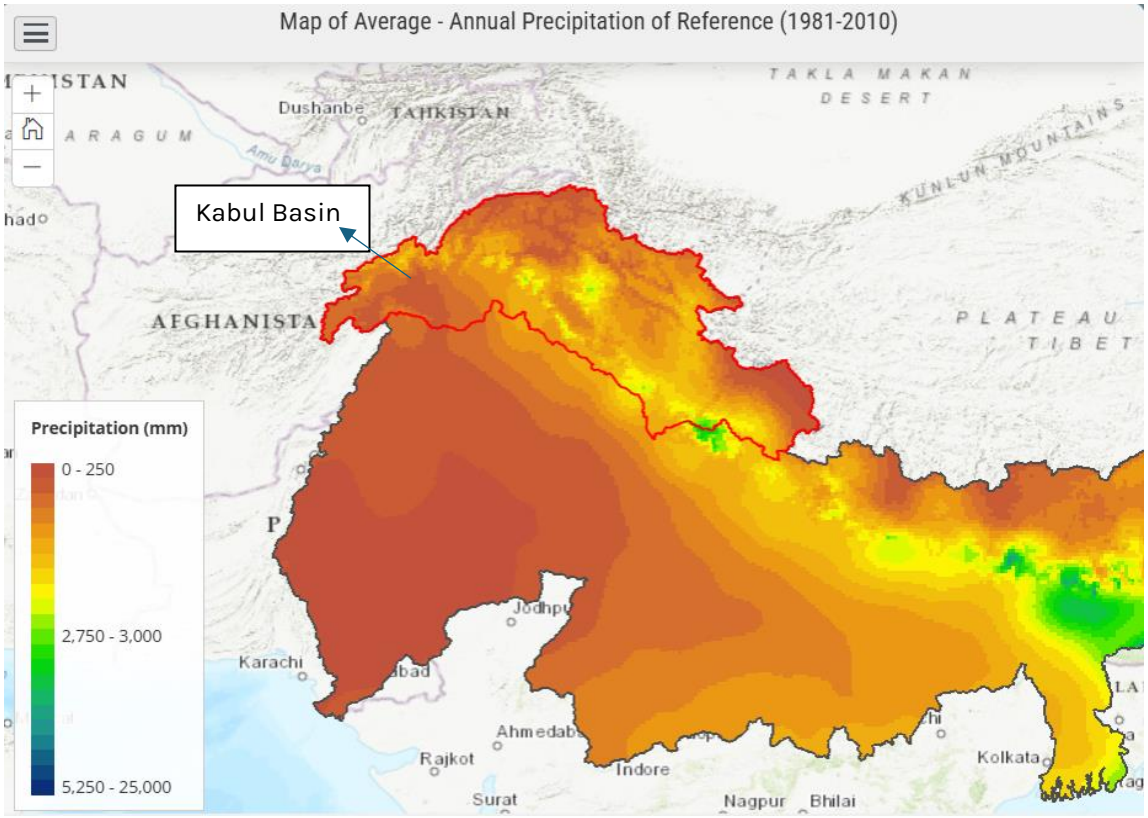

Figure 5: Map of average precipitation of Upper Indus Basin (1981-2010)

Figure 6: Projected changes in average precipitation over the Upper Indus Basin under different Representative Concentration Pathways (RCPs) and time horizons

- **Extreme Weather Events:** Charsadda's recent history highlights the rising frequency and severity of major floods, intense rainfall events, and prolonged heatwaves, all of which have

significantly increased climate-related risks for communities. The catastrophic 2010 and 2022 floods were triggered by intense monsoon rainfall combined with snowmelt, causing widespread inundation and displacement.[32] In addition, flash floods generated by short-duration, high-intensity rainfall in the upper Swat and Kabul catchments have become more frequent, eroding embankments and disrupting rural connectivity. Heatwaves, particularly intense in 2018 and 2021, have added to the burden of climate extremes, a trend echoed in South Asian climate assessments.[33] Sporadic hailstorms and windstorms have also damaged crops in selected years.[34]

- **Hydrology:** Hydrological regimes in Charsadda are strongly influenced by snowmelt and glacial runoff from the Hindu Kush, combined with rainfall variability. Flows in the Swat and Kabul rivers typically rise in late February, peak in June–July and subside by January. However, between 2010 and 2022, these discharge cycles have become more erratic, with earlier spring surges and sudden monsoon peaks overwhelming embankments and canals.[35] These changes align with hydrological modeling studies that attribute higher flood frequencies to the interaction of accelerated snowmelt and extreme rainfall events in northern Pakistan.
- **Soil Erosion and Riverbank Retreat:** Accelerated erosion and riverbank retreat have become prominent hazards over the last decade. High-sediment flows, especially during the 2010 and 2022 floods, destabilized embankments and caused lateral channel migration, leading to permanent loss of cultivable land.[36] Deposition of coarse sediments after major floods has hardened soils and reduced agricultural productivity, forcing farmers to adapt through seed diversification and soil amendments. These processes are consistent with regional findings on land degradation and agricultural vulnerability under intensified hydrological stress.[37]

Projected Climate Trends and Impacts

Projected Changes in Temperature:

The ensemble indicates a clear warming trend across all periods (Table 1). Mean annual temperature is projected to rise by +0.8–1.0 °C by 2040, +1.8–2.5 °C by 2070, and +2.1–4.1 °C by 2100 under RCP 4.5 and RCP 8.5 respectively (Figure). Warming is robust across all models, with high ensemble agreement. By 2050, mean temperatures will have risen by about 1 °C, intensifying heat stress, evapotranspiration, and crop water demand. Under RCP 8.5, by 2100, Charsadda could experience 4+ °C average warming, doubling the number of hot days (>35°C) and substantially increasing heat-related health and agricultural risks.[38]

Table 1: Projected Change in Mean Annual Temperature (°C) for Charsadda

Time Period	RCP 4.5	RCP 8.5	Interpretation
2011–2040	+0.84 °C (0.73–1.10)	+1.00 °C (0.97–1.10)	Warming already observable; consistent with post-2000 observed rise.
2041–2070	+1.8 °C (1.5–2.1)	+2.5 °C (2.2–2.7)	Accelerated warming; greater summer heatwaves and evapotranspiration.
2071–2100	+2.1 °C (1.9–2.7)	+4.1 °C (3.9–4.6)	Divergence: mitigation limits warming to ~2 °C; high emissions double this.

[32] Anwar et al., 2023
[33] Hashmi et al., 2022
[34] Shah et al., 2024
[35] Anwar et al., 2023
[36] Shah et al., 2024
[37] Hashmi et al., 2022
[38] https://ssr.climateinformation.org/ssr/

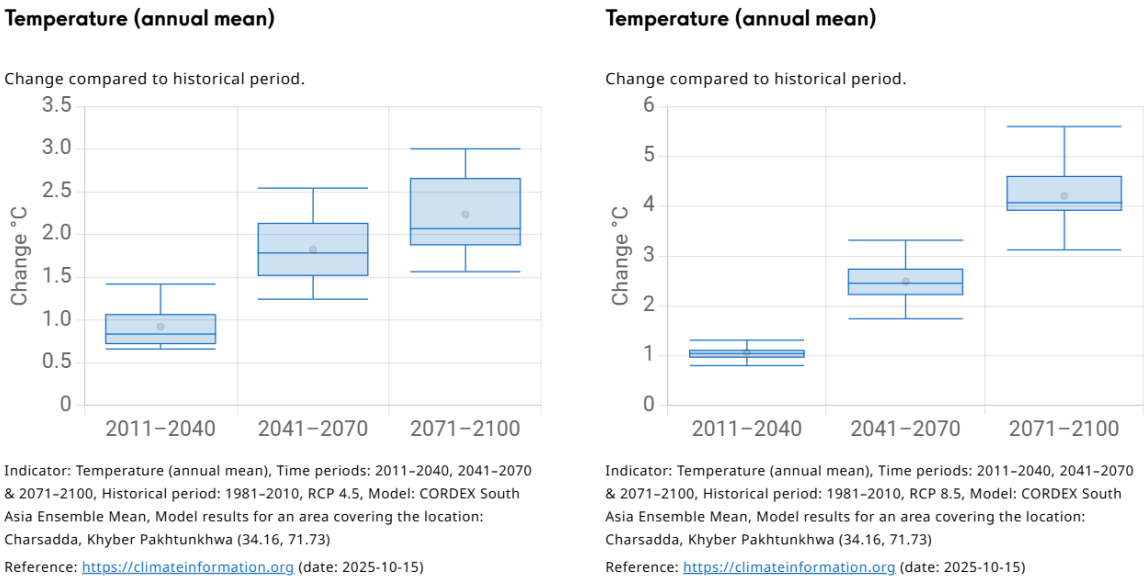

Figure 7: Projected Mean Annual Temperature Change, RCP 4.5 vs RCP 8.5, 2011–2100.

According to Meteoblue data, observed climate trends over the last four decades show a consistent rise in mean annual temperature in Charsadda. The yearly temperature change graph illustrates that cooler years dominated the 1980s-1990s, while after 2000, warm years became predominant, reflected in deep red "warming stripes." This indicates a future of hotter summers, longer warm seasons, and heightened risks of heat stress (Figure). Monthly temperature anomalies further confirm that red (warmer-than-normal) months now dominate, while cold anomalies have nearly disappeared, signalling intensified summer heat extremes and reduced natural cooling periods (Figure). The maximum temperature diagram (Figure) underscores that extreme heat days are most frequent in May and June, meaning that pre-monsoon months will remain the highest-risk period for health, energy demand, and agricultural productivity.[39]

[39] https://www.meteoblue.com/en/climate-change/charsadda_pakistan_1181439

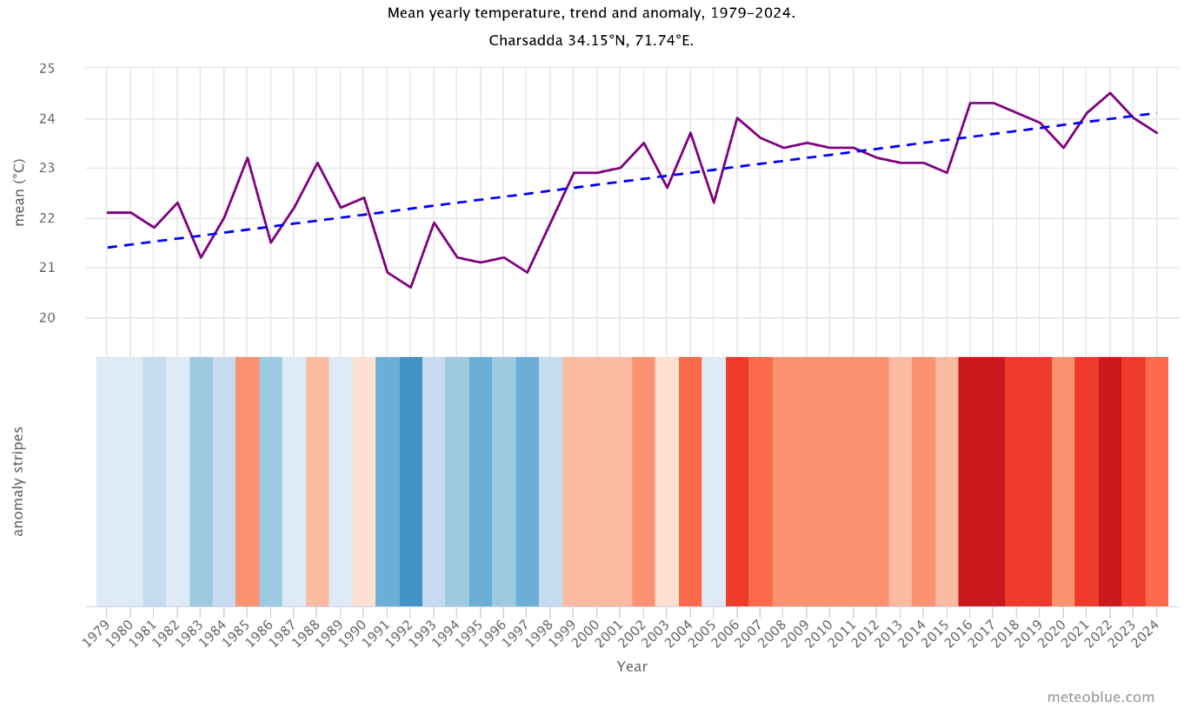

Figure 8: Yearly Temperature Change in Charsadda (1979-2024) showing consistent warming with predominance of hotter years since 2000.

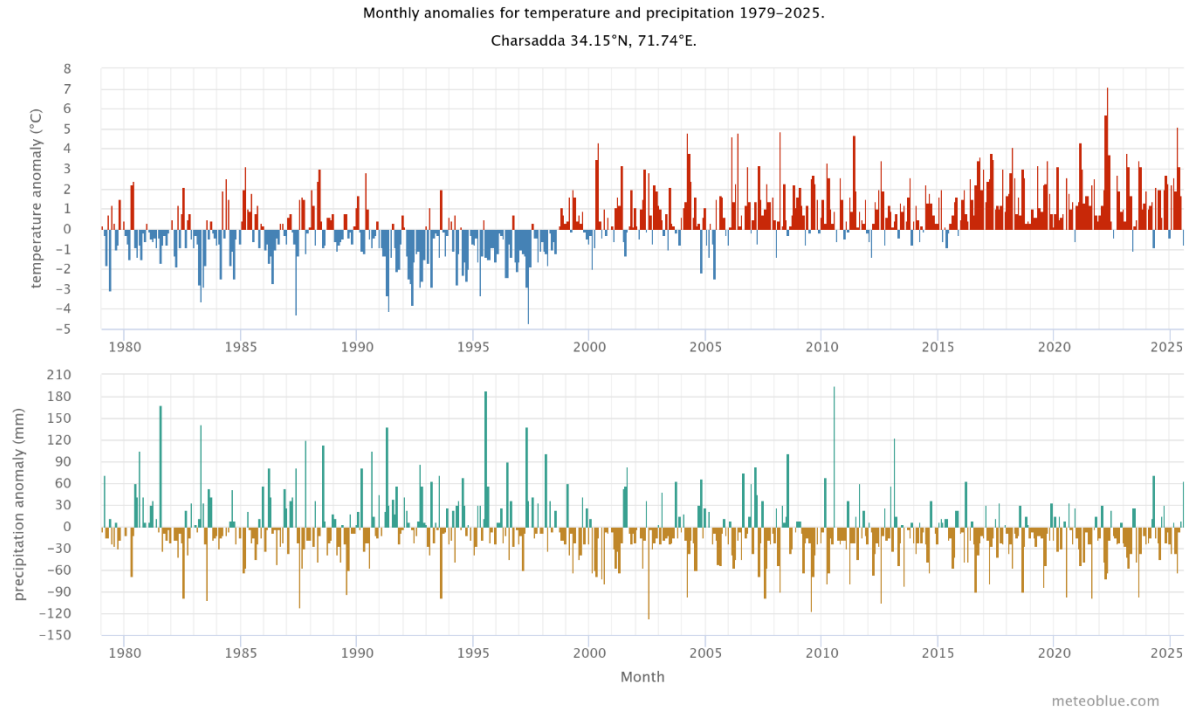

Figure 9: Monthly Temperature and Precipitation Anomalies (1979-2024) illustrating a clear shift toward warmer-than-normal months in recent decades.

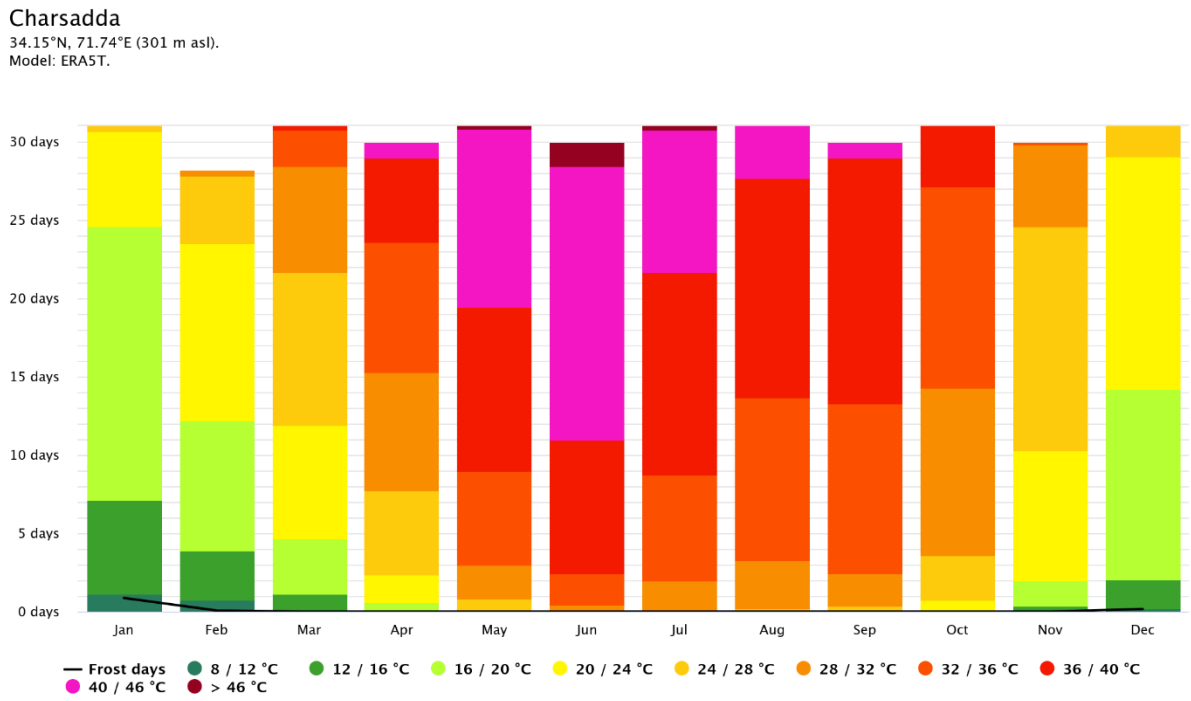

Figure 10: Maximum Temperature Diagram highlighting the high frequency of extreme heat days during May-June.

Projected Changes in Precipitation:

Precipitation projections display greater variability among models (Table 2). Overall, the ensemble suggests slight drying in the near term followed by a gradual intensification of the monsoon cycle toward mid- and late-century. Both RCPs project more variable precipitation, with longer dry spells and heavier rain events. Under RCP 8.5, rainfall intensification (+15%) by 2100 is likely to amplify flood frequency and magnitude, particularly along Agra, Daulatpura, and Shabqadar floodplains. Concurrently, pre-monsoon dry months may lengthen, causing seasonal droughts and irrigation stress.[40]

Table 2: Projected Change in Mean Annual Precipitation (%) for Charsadda

Time Period	RCP 4.5	RCP 8.5	Interpretation
2011–2040	+0.7 % (−1.8 → +6.2)	−3.2 % (−6.7 → +3.7)	Near-term uncertainty; slight drying under RCP 8.5.
2041–2070	+5.8 % (−1.6 → +12)	+7.6 % (+3 → +13)	Monsoon strengthening, increasing seasonal floods.
2071–2100	+5.6 % (−3.7 → +13)	+15.0 % (−1.8 → +23)	Heavier rainfall bursts, higher inter-annual variability.

[40] https://ssr.climateinformation.org/ssr/

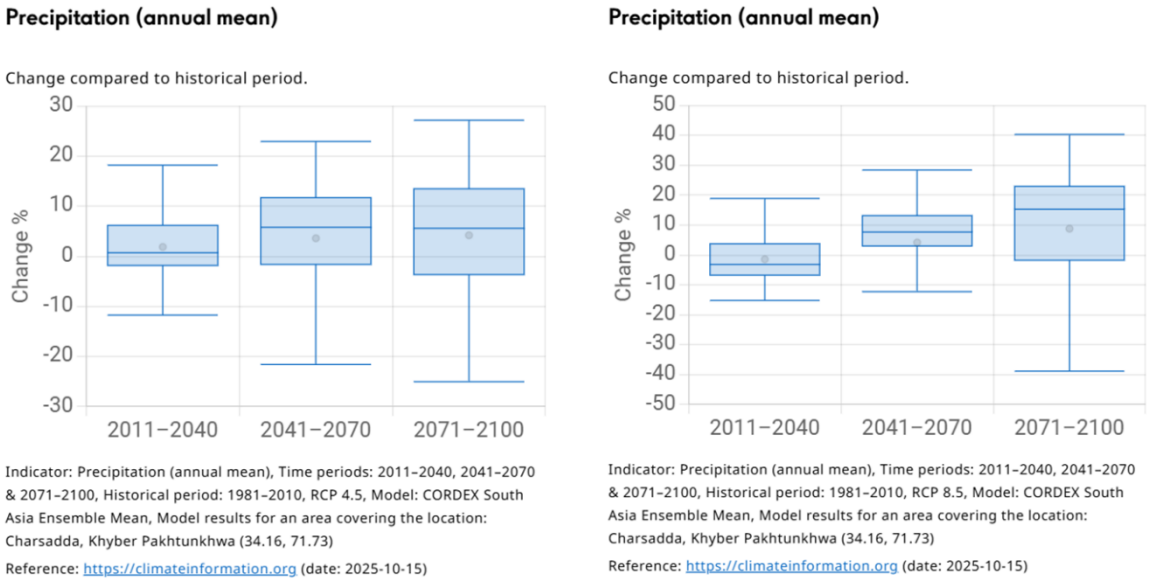

Figure 11: Projected Annual Precipitation Change, RCP 4.5 vs RCP 8.5

Annual precipitation in Charsadda shows high variability with alternating wet and dry years, but the long-term trend is slightly downward. The yearly precipitation changes graph reveals an increase in brown precipitation stripes in recent decades, indicating more frequent dry years (Figure). Monthly precipitation anomalies highlight sharp swings between wetter-than-average and drier-than-average months, underscoring the growing irregularity of rainfall (Figure).

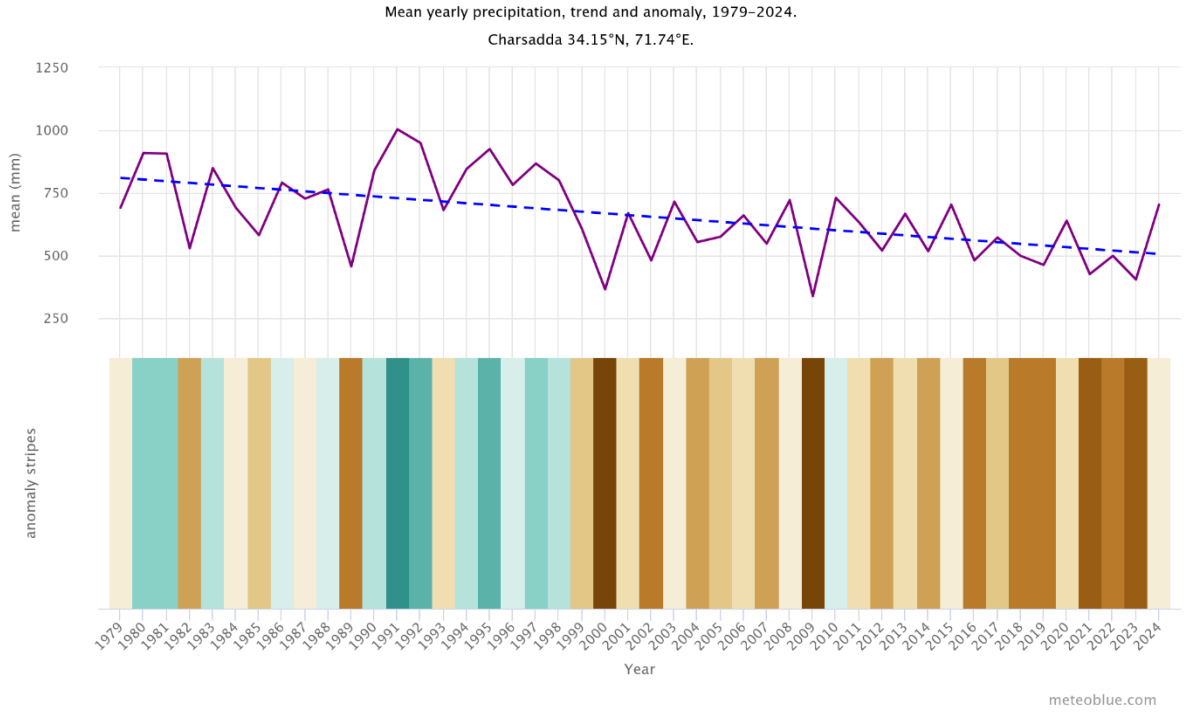

Figure 12: Yearly Precipitation Change in Charsadda (1979–2024) showing high variability with a slight drying trend.

The climate diagram further emphasizes the strong seasonality of precipitation, with most rainfall confined to July-August during the monsoon, while the rest of the year remains dry (Figure). Supporting figures on cloudy, sunny, and rainy days (Figure) confirm this concentration, with July–August showing the highest number of rainy and overcast days compared to extended sunny periods

across other months. The precipitation amount diagram illustrates that heavy rainfall days are clustered in the monsoon months, elevating risks of flash floods and erosion (Figure). Wind speed patterns remain moderate throughout the year, but seasonal variations contribute to dust storms and evaporation losses, aggravating water scarcity during hot and dry periods (Figure).[41]

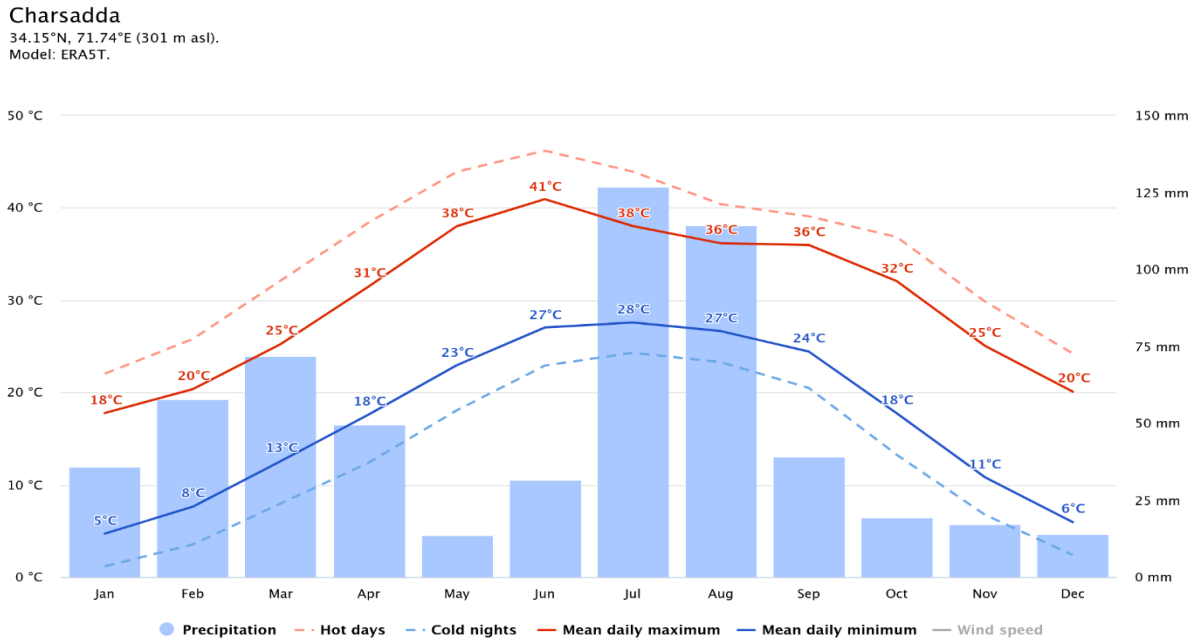

Figure 13: Climate Diagram of Average Temperatures and Precipitation highlighting extreme summer heat and monsoon rainfall peaks.

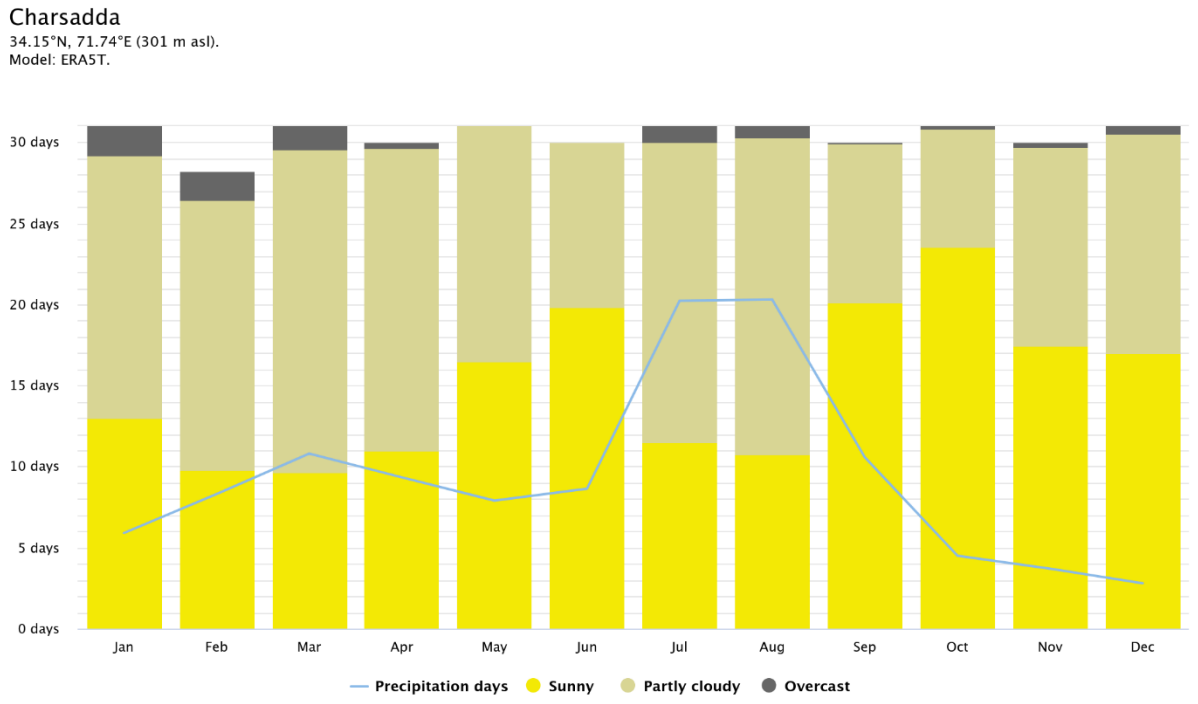

Figure 14: Cloudy, Sunny, and Precipitation Days Diagram showing high concentration of rainy days during July–August.

[41] https://www.meteoblue.com/en/climate-change/charsadda_pakistan_1181439

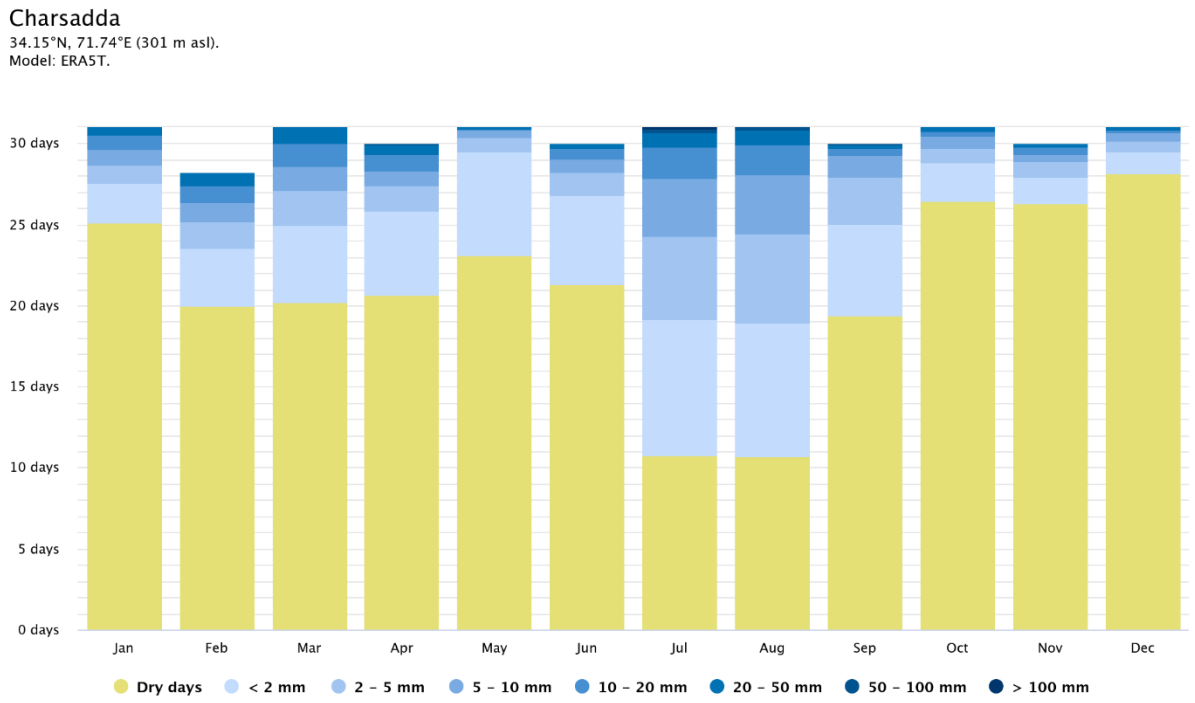

Figure 15: Precipitation Amounts Diagram illustrating clustering of heavy rainfall days in the monsoon season.

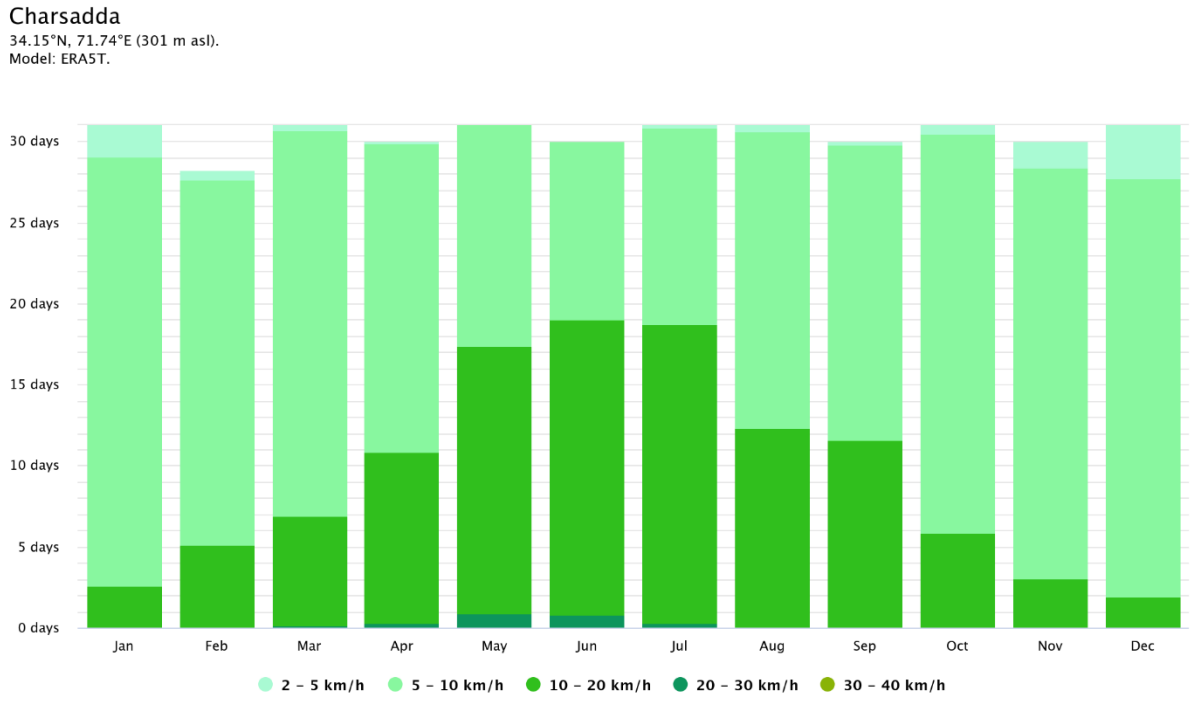

Figure 16: Wind Speed Diagram showing moderate but seasonally variable wind conditions.

Changes in Runoff and Water Discharge:

Water discharge and surface runoff are projected to increase modestly (Table 3), with higher model uncertainty. Projected +8–10% increase in runoff and discharge by mid to late century implies more frequent high-flow events and increased sedimentation, exacerbating flood hazards in low-lying

Union Councils. Conversely, soil moisture deficits (–3%) during pre-monsoon months suggest growing irrigation demand.[42]

Table 3: Projected Change in Runoff and Water Discharge (%) for Charsadda

Time Period	RCP 4.5	RCP 8.5	Key Implications
2011–2040	+6.7 % (–8.8 → +17)	–8.1 % (–18 → +8.9)	Divergent near-term response; evapotranspiration dominates under high emissions.
2041–2070	+8.8 % (–11 → +27)	+8.0 % (–15 → +19)	Convergence toward 8–9 % rise; higher monsoon peaks.
2071–2100	+8.2 % (–10 → +40)	+9.9 % (+4.6 → +29)	Late-century amplification; significant flood-peak uncertainty.

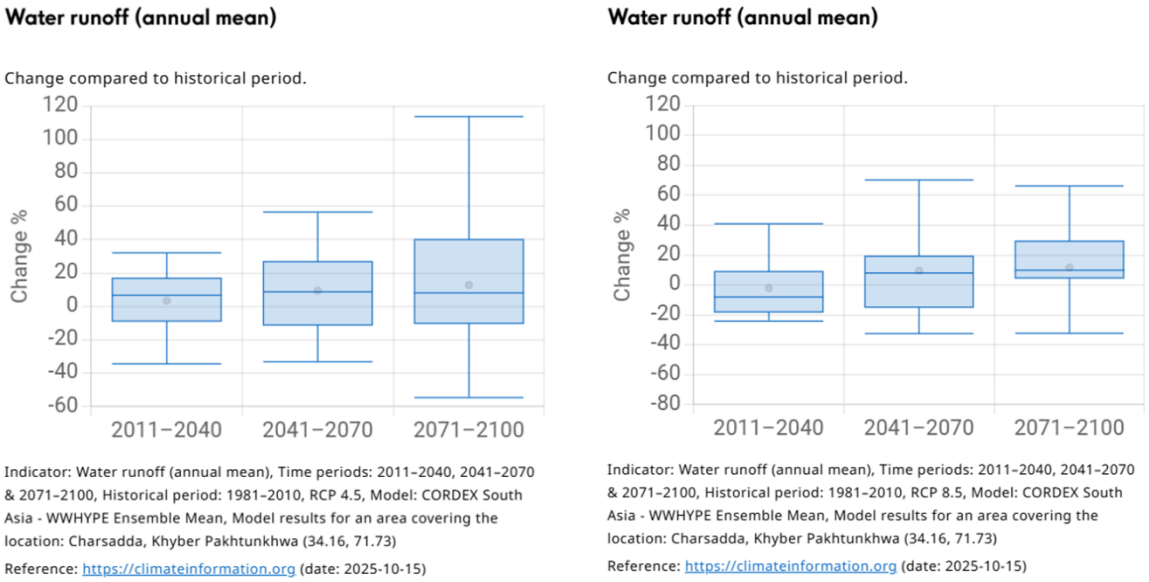

Figure 17: Projected Change in Annual Runoff and Discharge

The comparison between RCP 4.5 and RCP 8.5 highlights the critical value of mitigation. Under RCP 4.5, adaptation investments can effectively manage a +2 °C world. Under RCP 8.5, however, compounding effects, extreme heat, flash flooding, drought, and infrastructure damage, would demand transformative adaptation and relocation measures.[43]

Table 4: Comparative Assessment of RCP Pathways

Parameter	RCP 4.5 (Stabilization)	RCP 8.5 (High Emission)	Implications
Temperature rise by 2100	+2.1 °C	+4.1 °C	Doubling of heat exposure under high emissions.
Precipitation change	+5–6 %	+15 %	More intense and erratic monsoon rains.
Runoff and discharge	+8 %	+10 %	Heightened flood peaks; drainage stress.
Soil moisture	–2–3 %	–4–5 %	Drying trend threatens crop yields.
Livelihood exposure	Moderate	Severe	Increasing hazard frequency and economic losses.

[42] https://ssr.climateinformation.org/ssr/
[43] Ibid.

Socioeconomic Vulnerabilities

Charsadda's vulnerabilities are shaped by a combination of economic fragility, high livelihood dependence on climate-sensitive sectors, poor infrastructure, and entrenched social inequalities. The district is predominantly agrarian, with more than two-thirds of households directly or indirectly reliant on agriculture and livestock for subsistence.[44] This dependence creates a structural exposure to climate hazards, as both crop production and livestock rearing are extremely sensitive to rainfall variability, riverine flooding, and droughts.[45] At the same time, poverty and limited diversification of income sources leave households with little buffer against repeated shocks. According to the KP Bureau of Statistics, a significant share of Charsadda's population lives below the poverty line, with landless farmers and sharecroppers particularly vulnerable.[46] When floods destroy crops and livestock, these groups face both income loss and food insecurity, often forcing temporary migration or reliance on humanitarian aid.[47]

The infrastructure base in Charsadda is weak and repeatedly undermined by floods. Poorly constructed houses (katcha and semi-pucca), inadequate drainage, and weak embankments increase the exposure of communities. In 2010, thousands of homes were washed away across KP, with Charsadda among the worst affected.[48] In 2022, 160 houses were fully destroyed and 221 partially damaged, once again leaving hundreds of families without shelter.[49] Loss of rural roads and bridges further isolates communities, restricting access to markets and healthcare during crises. Charsadda's literacy rate remains below the provincial average, with female literacy particularly low. This constrains access to climate-related information, disaster preparedness training, and alternative livelihoods. The low skill base also reduces the ability of communities to diversify away from agriculture, perpetuating a cycle of climate-sensitive livelihoods.

In both 2010 and 2022, the destruction of sanitation and water systems led to outbreaks of diarrhoea, hepatitis, and typhoid.[50] Damage to healthcare facilities in 2022 alone further reduced emergency response capacity. Women and children are disproportionately affected, with high rates of malnutrition reported in flood-affected households.[51] Climate-induced stress is also linked to increasing mental health risks, including climate anxiety.[52]

The social structure of Charsadda adds to its vulnerability. Gender inequality restricts women's access to resources, mobility, and participation in decision-making. During both the 2010 and 2022 floods, women faced increased caregiving responsibilities, reduced access to relief, and heightened risks of exploitation in displacement camps (Consultation Report, 2025). The poor and landless remain trapped in low-lying, hazard-prone settlements due to a lack of secure land tenure, exposing them disproportionately to repeated flooding.

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[44] Hamidi, A. R., Jing, L., Shahab, M., Azam, K., Tariq, M., & Ng, A. W. M. (2022). Flood exposure and social vulnerability analysis in rural areas of developing countries: An empirical study of Charsadda District, Pakistan. *Water*, 14(7), 1176. https://doi.org/10.3390/w14071176

[45] Cui, P., et al. (2025). Insights from the 2022 Pakistan mega-flood and climate adaptation lessons. *Nature Water*. https://doi.org/10.1016/j.wds.2023.100064

[46] CRVA. (2025). *Climate Risk and Vulnerability Assessment (CRVA) of Charsadda District*. Sustainable Development Policy Institute (SDPI)

[47] Younas, A., Khan, A., Abubakar, H. M., Tahseen, Z., Arshad, A., Taj, M., & Nazir, U. (2024). Remote sensing assessment of agricultural and urban damage from the 2022 Pakistan floods. *ISPRS Archives*, XLII-4-W9, 105–112

[48] Waseem, H. B., et al. (2023). Floods in Pakistan: A state-of-the-art review of causes, impacts, and management. *Water and Disaster Science*, 100064.

[49] Mahmood, I., et al. (2024). Provincial Disaster Management Authority (PDMA) Flood Damage Report for Charsadda, Khyber Pakhtunkhwa. *Journal of Disaster Studies*.

[50] Field observations by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.

[51] Hamidi et al., 2022

[52] Cui et al., 2025

Human Toll

The 2010 super-floods had severe impacts on Charsadda due to its location at the confluence of the Kabul and Swat rivers. More than 70,000 households in the district were affected, with widespread displacement as entire settlements in low-lying union councils were inundated. The Swat River, known for its meandering behaviour as it enters Charsadda from the Tangi side, triggered destructive flash floods, while Jindi Nullah and Shuban Nullah also overtopped, damaging homes, agricultural fields, and village infrastructure. Beyond local losses, the event was part of Pakistan's most catastrophic flood on record, which claimed nearly 2,000 lives and caused major public health outbreaks nationally, underscoring the scale of vulnerability that Charsadda continues to face.[53] [54] The 2022 floods again devastated the district: over 3 million people were affected in KP, nearly 1 million displaced, and Charsadda was one of the worst-hit districts.[55] Local reports documented the destruction of 160 houses and partial damage to 221 more, forcing families into temporary shelters and further exacerbating vulnerabilities.[56]

Economic Losses

The 2010 floods caused economic damages nationwide of nearly USD 10 billion, with Charsadda suffering severe losses to agriculture, roads, and housing.[57] In 2022, the district recorded direct damages of approximately PKR 450 million, including destruction of 11 roads, damage to three health facilities, and widespread crop losses.[58] Across KP, the 2022 floods generated total economic losses of PKR 201,414 million, underlining the scale of the disaster. Repeated shocks like these erode household savings and local development gains, reinforcing long-term economic vulnerability.[59]

Agricultural Productivity and Food Security

Charsadda's predominantly agrarian economy is highly climate sensitive. In 2010, vast areas of cropland were destroyed, disrupting seasonal crop cycles and causing food shortages.[60] Similarly, in 2022, 10,921 acres of farmland were submerged, with staple crops such as maize, sugarcane, and wheat lost, leaving thousands of farming households without income.[61] Livestock deaths were also substantial: in 2010, losses were recorded across KP, while in 2022, Charsadda alone reported 273 animal deaths.[62] These events highlight the district's vulnerability to food insecurity, which is already acute in many rural households.

Competition for Resources

Displacement during the 2010 floods placed enormous strain on host communities, with competition over food, shelter, and sanitation facilities leading to local tensions.[63] The 2022 floods

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[53] National Disaster Management Authority. (2010). Pakistan floods 2010: Preliminary damage and needs assessment. Government of Pakistan.
[54] World Health Organization. (2011). Disease Early Warning System (DEWS) annual report 2010–2011. WHO Pakistan Office.
[55] Cui, P., et al. (2025). Insights from the 2022 Pakistan mega-flood and climate adaptation lessons. *Nature Water*. https://doi.org/10.1016/j.wds.2023.100064
[56] Mahmood, I., et al. (2024). Provincial Disaster Management Authority (PDMA) Flood Damage Report for Charsadda, Khyber Pakhtunkhwa. *Journal of Disaster Studies*.
[57] Waseem, H. B., et al. (2023). Floods in Pakistan: A state-of-the-art review of causes, impacts, and management. *Water and Disaster Science*, 100064.
[58]Mahmood, I., et al. (2024). Provincial Disaster Management Authority (PDMA) Flood Damage Report for Charsadda, Khyber Pakhtunkhwa. *Journal of Disaster Studies*.
[59] Hamidi, A. R., Jing, L., Shahab, M., Azam, K., Tariq, M., & Ng, A. W. M. (2022). Flood exposure and social vulnerability analysis in rural areas of developing countries: An empirical study of Charsadda District, Pakistan. *Water*, 14(7), 1176. https://doi.org/10.3390/w14071176
[60] Waseem, H. B., et al. (2023). Floods in Pakistan: A state-of-the-art review of causes, impacts, and management. *Water and Disaster Science*, 100064.
[61] CRVA. (2025). *Climate Risk and Vulnerability Assessment (CRVA) of Charsadda District*. Sustainable Development Policy Institute (SDPI)
[62] Mahmood et al., 2024
[63] Waseem et al., 2023

produced similar patterns: displaced households sought refuge in schools, public buildings, and safer villages, increasing pressure on scarce resources.[64] Additionally, recurrent riverbank erosion has reduced cultivable land, intensifying competition among smallholder farmers and landless tenants for limited fertile plots.[65]

Vulnerable Population Groups Most at Risk

Flood impacts are socially differentiated. In 2010, women, children, and landless farmers were among the most severely affected, due to poor housing, limited mobility, and exclusion from decision-making. In 2022, these vulnerabilities were reaffirmed: women faced increased caregiving burdens and barriers to relief access, while poor households in katcha and semi-pucca houses were disproportionately displaced.[66] Marginalized groups lacking access to education, healthcare, or financial safety nets remain chronically exposed and are repeatedly pushed into poverty traps.[67]

Institutional and Community Adaptive Capacities

Institutional Capacity

The institutional landscape for climate adaptation in Charsadda comprises a diverse mix of actors, including the district administration, line departments, non-governmental organizations (NGOs), and community-based organizations (CBOs), each operating with varying degrees of capacity, coordination, and resource access. The District Disaster Management Authority (DDMA) and the District Administration play a central role in coordinating disaster response and early warning dissemination. The Deputy Commissioner's (DC) office provides strong leadership and acts as the central node for inter-departmental coordination, effectively utilizing informal communication channels such as WhatsApp groups to relay warnings and coordinate actions across 25-line departments. However, despite these operational strengths, the DDMA lacks a formalized coordination mechanism dedicated specifically to climate adaptation. The absence of a District Climate Cell or Resilience Coordination Committee has resulted in fragmented planning, limited data sharing, and inadequate monitoring of adaptation initiatives.

Line departments, including Rescue 1122, Irrigation, Agriculture, Communication & Works (C&W), Social Welfare, and Tehsil Municipal Administration (TMA), demonstrate a clear understanding of how climate risks affect their respective mandates. Several have prepared sector-specific plans, such as Rescue 1122's draft District Disaster Rescue Plan and the Irrigation Department's approved PC-1s for flood protection. Moreover, these departments possess technically skilled staff capable of designing and implementing adaptation projects. Nonetheless, operational capacity remains severely constrained. For instance, Rescue 1122 has only five trained divers for the entire district. Departments also lack dedicated adaptation budgets and rely heavily on delayed provincial allocations through the Annual Development Programme (ADP) or uncertain donor financing. Coordination among departments is largely ad hoc and informal, with no standard operating procedures (SOPs) to guide collaborative action.

Non-governmental organizations and CBOs contribute significantly to bridging institutional gaps and enhancing community resilience. Organizations such as CESVI, NIDA Pakistan, and the Sarhad Rural Support Programme (SRSP) have been instrumental in community mobilization, training Community Emergency Response Teams (CERTs) across 11 Union Councils, piloting tehsil-level adaptation planning under the BRAVE Project and providing livelihood recovery support through initiatives like the Women and Children's Community Centres (WCCC). Despite these valuable contributions, NGO operations face bureaucratic constraints as all assistance must be channelled through the Provincial Disaster Management Authority (PDMA), often resulting in delays.

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[64] Cui et al., 2025
[65] CRVA. (2025). *Climate Risk and Vulnerability Assessment (CRVA) of Charsadda District*. Sustainable Development Policy Institute (SDPI)
[66] Field observations by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[67] Hamidi et al., 2022

Furthermore, most CBOs registered with the Social Welfare Department are currently inactive due to the blockage of the Flood Impacted Trust Fund (FITF), undermining grassroots service delivery and weakening community-led adaptation mechanisms.

Community Capacity

Local communities in Charsadda act as the frontline responders to climate shocks, displaying significant inherent resilience and a wealth of adaptive knowledge rooted in local traditions and social organization. At the community level, adaptive capacity is shaped by strong social capital, traditional coping strategies, and livelihood diversification. Rural households have long relied on kinship networks, communal resource-sharing, and informal credit systems to withstand and recover from disasters. During the 2022 floods, when formal institutions were overwhelmed, community-based organizations (CBOs) and local volunteers mobilized evacuation operations, provided boats for rescue, and established emergency shelters, underscoring the critical role of community-led response systems.

Communities also demonstrate adaptive ingenuity through autonomous practices. Farmers have adjusted their agricultural calendars by 10–20 days and reverted to indigenous, flood-tolerant seed varieties based on traditional knowledge. Strong social cohesion enables local Jirgas and volunteer groups to manage rescue operations and distribute aid effectively, while livelihood diversification, through remittances from overseas family members and access to microfinance loans, serves as an important coping strategy in the aftermath of disasters. These mechanisms collectively highlight the strength of Charsadda's informal adaptation systems. However, they remain largely reactive and short-term. Without formal institutional support, adequate funding, or integration into district-level adaptation planning, these indigenous practices cannot evolve into sustainable resilience frameworks.

Despite strong community solidarity, adaptive capacity remains uneven across socio-economic groups. Wealthier landowners are often able to rebuild quickly, whereas poorer and landless households experience prolonged displacement, asset depletion, and persistent poverty cycles. Gender inequalities further restrict resilience: women are frequently excluded from decision-making spaces, face cultural mobility constraints, and shoulder disproportionate caregiving responsibilities during disasters, all of which limit their active participation in adaptation planning. Similarly, the lack of formal platforms for women, youth, and persons with disabilities to engage in climate-related decision-making perpetuates inequities in resilience-building.

Knowledge and technology gaps further constrain community-level adaptation. Although some farmers have begun adopting improved crop varieties and water-saving techniques, uptake remains limited due to weak agricultural extension services, inadequate financial resources, and the absence of institutional support. The lack of formal insurance mechanisms for crops and livestock also leaves households financially vulnerable to recurrent shocks, eroding long-term resilience. Moreover, while initiatives like the BRAVE Project successfully introduced Village Climate Adaptation Forums (VCAFs), these remain project-based and have not been institutionalized within government structures.

Nevertheless, Charsadda's communities possess considerable latent adaptive potential. Repeated experiences of collective action during floods, strong social networks, and the active involvement of NGOs such as CESVI, NIDA Pakistan, and SRSP have created a foundation upon which formal institutions can build. Strengthening linkages between community structures and district planning, enhancing financial and technical support, and ensuring inclusive participation can transform these informal coping systems into sustainable, long-term resilience mechanisms.

Infrastructure and Financial Capacity

Charsadda's infrastructure and financial capacity to manage climate risks remain inadequate and poorly aligned with emerging climate realities. The district's limited physical infrastructure, outdated systems, and lack of financial autonomy hinder its ability to effectively respond to and prepare for future climate scenarios.

In terms of Early Warning Systems (EWS) and Disaster Risk Reduction (DRR) infrastructure, some basic mechanisms are in place. The district operates an informal EWS that relies on upstream river discharge data from Swat and Malakand, which is relayed through the Deputy Commissioner's office to local communities using Patwaris and mosque loudspeakers. This traditional network plays an important role in alert dissemination and has proven useful during major flood events. However, the system remains fragmented, non-digital, and overly dependent on manual communication channels. Rescue 1122 lacks GPS-enabled dispatch systems and digital coordination tools that could significantly enhance response efficiency. Similarly, much of the critical DRR infrastructure, such as flood protection walls, embankments, and drainage systems, is outdated, under-capacity, or damaged. Repair and maintenance activities are often stalled by chronic funding bottlenecks. The absence of an engineered landfill site and the persistence of unplanned waste disposal practices further compound vulnerability, as waste blockages in drainage systems exacerbate urban flooding and health risks.

Access to finance represents perhaps the most critical constraint to climate adaptation in Charsadda. The district currently has no climate-tagged budgeting mechanism, and all line departments remain heavily dependent on the provincial Annual Development Programme (ADP), which is characterized by delays and limited allocations. Even when climate-resilient projects, such as irrigation infrastructure rehabilitation or flood protection measures, are approved through PC-1s, they often remain unfunded or partially implemented. Furthermore, Charsadda has no institutional capacity or technical expertise to access international climate finance sources such as the Green Climate Fund (GCF) or the Adaptation Fund. The lack of trained personnel capable of developing bankable proposals and navigating complex financial mechanisms prevents the district from tapping into global adaptation resources.

Overall, Charsadda's adaptive capacity reflects a sharp divide between a resilient, self-reliant community and a constrained, resource-limited institutional system. Bridging this gap is essential for sustainable climate resilience. This requires institutionalizing community participation in local planning, reforming governance structures to improve coordination and financial autonomy, and investing in modernized infrastructure, technology, and knowledge systems. Transitioning from reactive, short-term coping toward proactive, climate-resilient development will depend on integrating financial reform, digital infrastructure upgrades, and inclusive local governance into the district's long-term adaptation framework.

4. DAP Process, Vision, and Principles

DAP Process Overview

District Adaptation Plans (DAPs) are increasingly recognized as the most effective mechanism for translating national climate policy into localized and actionable strategies. They serve as the subnational implementation instruments of Pakistan's National Adaptation Plan (NAP 2023-2033), aiming to reduce district-level vulnerabilities by developing medium- to long-term climate-resilient strategies and integrating adaptation into local planning, budgeting, and investment processes. While the NAP provides national direction and coordination, the DAP process grounds adaptation in the unique ecological, socioeconomic, and institutional realities of each district, enabling context-specific solutions that directly address community needs and vulnerabilities.

Pakistan's Updated Nationally Determined Contributions (NDCs) and the National Climate Change Policy (NCCP) were both approved in 2021, while the National Adaptation Plan (NAP) followed in 2023. Collectively, these policy instruments underscore the urgent need to strengthen the capacities of subnational entities, particularly district, in reducing climate vulnerabilities and advancing climate adaptation and resilience actions. Pakistan also recently submitted its NDC 3.0 in 2025 and it positions adaptation as a central pillar of Pakistan's climate response, highlighting district-level planning and resilience-building as key mechanisms to reduce climate vulnerabilities in agriculture, water, health, ecosystems, and livelihoods. It explicitly calls for the preparation of District Adaptation Plans (DAPs) to operationalize the NAP's vision and ensure that adaptation is mainstreamed into provincial and local development processes. Given Pakistan's ranking among the world's most climate-affected countries, facing escalating hazards such as glacial melt, floods, droughts, and heatwaves, a localized adaptation approach is imperative. Developing DAPs is therefore a critical step in realizing national policy priorities, fostering coherence between federal, provincial, and district actions, and building long-term resilience for communities, ecosystems, and economies.

The DAP process is designed to shift the focus from short-term, reactive responses to climate hazards toward long-term, systemic resilience building. It encompasses activities that enhance adaptive capacity and transform development pathways so that livelihoods, infrastructure, and ecosystems can withstand and recover from the growing impacts of climate change. Adaptation measures in this context may include actions that strengthen institutional systems, deploy nature-based and community-driven solutions, and modify socioeconomic and environmental practices to minimize climate-induced damage. The ultimate objective is to transition from adaptation as a response to resilience as an outcome, where local systems not only adjust to climate stresses but also thrive in the face of change.

Developing effective district adaptation plans requires a comprehensive understanding of each region's unique socio-economic and environmental dynamics. Factors such as geography, resource availability, population density, existing infrastructure, and historical exposure to climate hazards are critical for shaping local resilience strategies. The DAP process for Charsadda recognizes that climate risks cannot be addressed through a one-size-fits-all approach. Instead, it adopts a bottom-up, inclusive, and participatory planning model that engages local communities, government departments, academia, civil society organizations, and private sector stakeholders. This approach ensures that adaptation measures are not only scientifically sound but also socially relevant and institutionally feasible, fostering local ownership and long-term sustainability.

Furthermore, integrating scientific evidence, traditional knowledge, and innovative technologies is central to enhancing the effectiveness and resilience of district adaptation planning. Climate data, risk assessments, and predictive modeling provide valuable insights into future climate scenarios and associated risks, enabling evidence-based decision-making. Meanwhile, indigenous and community-based knowledge, rooted in centuries of interaction with the local environment, enriches adaptation planning by incorporating time-tested coping and resilience practices. The DAP

process thus bridges modern science with traditional wisdom to design adaptive pathways that are technically robust and culturally appropriate.

The DAP process for Charsadda has been developed under the National Standard Operating Procedure (SOP) and Template for District Adaptation Plans (2024), officially endorsed by the Ministry of Climate Change and Environmental Coordination (MoCC&EC) with technical support from the Asian Disaster Preparedness Center (ADPC) and the World Bank's CARE for South Asia Project. The SOP outlines a continuous, iterative, and participatory framework aligned with the principles of transparency, inclusivity, and evidence-based planning. Following this national protocol, the Charsadda DAP has been structured around a seven-step process: (i) preliminary data collection and stakeholder engagement; (ii) assessment of climate vulnerabilities and adaptive capacities; (iii) identification and prioritization of adaptation options; (iv) costing and identification of financial sources; (v) integration of adaptation measures into district development and budgeting frameworks; (vi) monitoring, evaluation, and learning (MEL); and (vii) capacity building and awareness raising.

This structured approach ensures that adaptation planning is embedded within existing district systems and synchronized with provincial and national policy frameworks. It also recognizes that climate adaptation and disaster risk reduction (DRR) are deeply interconnected. Accordingly, the Charsadda DAP is closely linked with the District Disaster Management Authority (DDMA) and the Provincial Disaster Management Authority (PDMA) to mainstream climate resilience into disaster preparedness and recovery planning.

Building on the evidence from the Climate Risk and Vulnerability Assessment (CRVA) for Charsadda, the DAP identifies locally relevant adaptation priorities aligned with the NAP's thematic systems, namely, the *Agriculture-Water Nexus, Natural Capital, Urban Resilience, Human Capital, Disaster Risk Management, and Gender, Youth, and Social Inclusion*. It also establishes mechanisms for integrating these priorities into the District Development Plan (DDP) and annual budgetary processes. As a living and adaptive document, the DAP will be reviewed and updated every five years, consistent with the revision cycles of the NDC and NAP, to reflect new data, lessons learned, and emerging climate realities.

Ultimately, the Charsadda DAP represents a shift from fragmented, project-based interventions to a coherent, programmatic, and participatory approach to climate adaptation. It strikes a balance between scientific analysis and community engagement, blending technical evidence with local experience. Through this integrated and inclusive process, the DAP provides a framework for achieving resilience that is locally grounded yet nationally aligned, strengthening Charsadda's ability to safeguard its people, livelihoods, and ecosystems while contributing to Pakistan's broader adaptation and sustainable development goals.

Rationale for DAP

The rationale for the District Adaptation Plan (DAP) of Charsadda stems from the district's heightened vulnerability to climate change and the urgent need to build local resilience through an integrated, evidence-based, and participatory framework. Situated at the confluence of the Swat and Kabul Rivers, Charsadda lies within one of Khyber Pakhtunkhwa's most flood-prone zones. The district's flat topography, dependence on agriculture, and growing population density have amplified its exposure to recurrent floods, erratic rainfall, heatwaves, and droughts. The devastating flood events of 2010 and 2022 alone displaced thousands, damaged critical infrastructure, and disrupted livelihoods, demonstrating that climate risks are not only environmental challenges but also major development threats.

The DAP responds directly to this context by providing a structured and localized mechanism to identify, prioritize, and implement climate adaptation measures. While Pakistan's National Adaptation Plan (NAP 2023) and the Updated Nationally Determined Contributions (NDC 3.0) set the national vision for climate resilience, the DAP operationalizes these commitments at the district level. It bridges the gap between national policy and local implementation, ensuring that adaptation

is not an abstract agenda but a tangible, locally owned process that addresses the district's specific vulnerabilities and capacities.

First, the DAP provides a strategic framework for reducing vulnerability and building resilience. It enables systematic assessment of local hazards and adaptive capacities, drawing on findings from the CRVA. It supports evidence-based decision-making for sectors most affected by climate change, including agriculture, water resources, health, and infrastructure. By translating complex scientific information into locally actionable strategies, the DAP empowers district institutions and communities to plan and respond more effectively to climate risks.

Second, the DAP ensures mainstreaming of adaptation into district planning and governance systems. Historically, adaptation efforts in Pakistan have often been fragmented and project-based, lacking integration with existing planning and budgeting frameworks. The DAP corrects this by embedding adaptation measures within the District Development Plan (DDP) and Annual Development Programme (ADP), ensuring that climate resilience becomes a routine consideration in development decisions. This institutional integration enhances inter-departmental coordination and strengthens vertical linkages between the district, provincial, and federal levels, creating a cohesive and accountable system for climate action.

Third, the DAP contributes to safeguarding and climate-proofing development gains. Charsadda's recurring exposure to floods, droughts, and temperature extremes continues to erode progress in key sectors such as agriculture, livelihoods, education, and public health. By integrating resilience principles into infrastructure design, water management, land-use planning, and social service delivery, the DAP helps protect past investments, minimize future losses, and secure the foundations of sustainable local development. In doing so, it aligns with national priorities of promoting climate-resilient growth and reducing the economic burden of climate-related disasters.

Fourth, the DAP strengthens the district's capacity to mobilize financial resources for adaptation. By providing a well-defined set of adaptation priorities, cost estimates, and implementation pathways, it serves as a credible planning and investment instrument for attracting funding from domestic and international sources such as the National Disaster Risk Management Fund (NDRMF), the Green Climate Fund (GCF), and the Adaptation Fund. It also enables exploration of innovative financing options, such as public-private partnerships, green bonds, and microfinance, to support local resilience initiatives.

Fifth, the DAP fosters collaboration, inclusivity, and knowledge co-production. Its preparation has involved active engagement of local communities, line departments, civil society organizations, academia, and youth representatives, ensuring that diverse voices and perspectives inform decision-making. This participatory approach enhances the plan's legitimacy, ownership, and long-term sustainability. It also emphasizes the importance of combining scientific knowledge with indigenous and traditional practices that have helped local populations cope with environmental variability for generations.

Sixth, the DAP enhances social equity and inclusion by integrating gender and youth perspectives across all adaptation priorities. Women, youth, and marginalized groups often bear a disproportionate share of climate impacts but also possess critical knowledge and skills for community resilience. The DAP ensures their active participation in the design, implementation, and monitoring of adaptation actions, thereby advancing social justice and leaving no one behind.

Finally, the DAP reinforces Pakistan's national and international climate commitments. At the subnational level, it operationalizes the objectives of the NAP and NCCP, while contributing to the national targets under the NDCs. At the global level, it supports the realization of the Sustainable Development Goals (SDGs), particularly SDG 13 on Climate Action, and aligns with the Paris Agreement and the Sendai Framework for Disaster Risk Reduction (2015-2030).

In summary, the District Adaptation Plan of Charsadda is both a strategic necessity and an opportunity for transformative local development. It provides the foundation for shifting from reactive crisis response to proactive risk management, from vulnerability to resilience, and from

isolated interventions to an integrated, multi-sectoral, and inclusive approach to climate action. Through the DAP, Charsadda can protect its people and ecosystems, enhance institutional capacities, and contribute meaningfully to Pakistan's overarching vision of a climate-resilient and sustainable future.

Foundation

The foundation of the Charsadda District Adaptation Plan (DAP) is built on the recognition that climate change impacts are multi-dimensional, cross-sectoral, and highly localized. Effective adaptation requires a participatory, evidence-based approach that combines scientific knowledge, traditional practices, and local community insights. The DAP rests on the following foundational principles:

- **Evidence-Based Planning:** Leveraging data from the Climate Risk and Vulnerability Assessment (CRVA), hazard mapping, and adaptive capacity analyses to identify district-specific climate challenges.
- **Participatory Engagement:** Involving local communities, government departments, civil society organizations, academia, and the private sector in planning and decision-making.
- **Integrated Approach:** Linking adaptation actions across sectors, including agriculture, water, health, infrastructure, and ecosystems, to achieve systemic resilience.
- **Adaptive Management:** Treating the DAP as a iteratively updated document, updated periodically to reflect new data, lessons learned, and emerging climate risks.
- **Resilience-Oriented Development:** Focusing on long-term resilience rather than short-term responses, enabling social, economic, and ecological systems to withstand and recover from climate shocks.

These principles ensure that the Charsadda DAP is practical, context-specific, and sustainable, providing a robust foundation for local adaptation planning.

Policy Framework

Pakistan's approach to climate adaptation is guided by a layered policy framework of international, national, provincial, and sectoral commitments. Collectively, these provide the mandate for district-level adaptation planning, ensuring that local priorities contribute to both national goals and global climate resilience commitments. The Charsadda District Adaptation Plan (DAP) aligns with this framework to localize adaptation actions in ways that are both context-specific and nationally consistent.

At the international level, Pakistan is a party to the UN Framework Convention on Climate Change (UNFCCC) and has ratified the Paris Agreement, committing to pursue low-carbon, climate-resilient development. It has also endorsed the Sendai Framework for Disaster Risk Reduction and the Global Methane Pledge, which emphasize resilience, risk reduction, and sustainability. Beyond these ratifications, Pakistan has built a strong track record in climate diplomacy, positioning itself as a leading advocate for the concerns of climate-vulnerable countries. At COP27 in 2022, Pakistan played a pivotal role in championing the establishment of the Loss and Damage Fund, a landmark decision that recognized the need to compensate developing countries for the unavoidable impacts of climate change. Beyond securing this historic outcome, Pakistan also used its platform to press for greater climate finance commitments from developed nations, highlighting the urgency of providing resources to enable adaptation and resilience in vulnerable contexts.

This leadership was reaffirmed at COP29, where Pakistan called for the summit to be a "Finance COP," underscoring the need for trillions of dollars in financial flows to support the clean energy transition and adaptation in developing countries. By consistently advocating for equitable climate finance and greater accountability from developed nations, Pakistan has strengthened its credibility on the global stage. Importantly, these diplomatic efforts are backed by a growing portfolio of domestic adaptation and resilience initiatives, which not only demonstrate Pakistan's own

commitment to climate action but also reinforce its role as a voice for developing countries in global negotiations.

Nationally, several policy frameworks provide direction for adaptation. The updated Nationally Determined Contribution (NDC 3.0)[68] commits Pakistan to reducing greenhouse gas emissions by 50% by 2030, conditional on international support, while placing strong emphasis on adaptation in priority sectors such as agriculture, water, health, and disaster risk management. The National Climate Change Policy, first issued in 2012 and updated in 2021[69], broadens the national vision by articulating objectives across resilient infrastructure, water security, ecosystem protection, and health safeguards, while mandating the creation of climate change cells in line ministries to strengthen coordination. The Framework for Implementation of NCCP (2014-2030) goes further by detailing sectoral adaptation actions across climate-sensitive areas including agriculture, forestry, biodiversity, and health, with a focus on institutional strengthening, awareness raising, and capacity building. Most recently, the National Adaptation Plan (NAP 2023-2033)[70] has consolidated these directions into a ten-year strategy. It prioritizes seven thematic systems, the agriculture-water nexus, natural capital, urban resilience, human capital, disaster risk management, and social inclusion, and calls for mainstreaming adaptation across all governance tiers while strengthening early warning systems, promoting risk-informed recovery, and ensuring inclusive participation.

At the provincial level, Khyber Pakhtunkhwa has articulated its own commitments through the KP Climate Change Policy (2022)[71] and the KP Climate Change Action Plan (2022)[72]. Together, these provide the province with a roadmap for addressing local vulnerabilities, focusing on water resource management, sustainable forestry, disaster resilience, and climate-smart agriculture. Complementary legislation such as the KP Water Act (2020)[73], the KP Forest Amendment Act (2022)[74], and the Khyber Pakhtunkhwa Environmental Protection Act (2014)[75] further strengthen the province's mandate to regulate natural resources, conserve ecosystems, and manage pollution. Provincial disaster legislation, including the National Disaster Management (Khyber Pakhtunkhwa) Amendment Act of 2012[76], aligns the province with the federal National Disaster Management Act of 2010[77] and ensures that institutional anchors such as the Provincial and District Disaster Management Authorities are legally empowered to act. The National Disaster Risk Reduction (NDRR) Policy of 2013[78] complements these frameworks by emphasizing preparedness, contingency planning, and the mainstreaming of DRR across all development processes.

In addition to these policy commitments, several sectoral strategies and national flagship programs offer opportunities for integration at the district level. The National Water Policy (2018)[79] and the Living Indus Initiative[80] promote integrated basin management and flood mitigation, directly relevant to Charsadda's hydrological vulnerabilities. The National Agricultural Emergency Programme advances drought- and flood-tolerant crops, while national initiatives such as the Ten

[68] https://unfccc.int/sites/default/files/2025-09/Pakistan_NDC3.0_24%20Sep.pdf
[69] https://mocc.gov.pk/SiteImage/Policy/NCCP%202021.pdf
[70] https://unfccc.int/sites/default/files/resource/National_Adaptation_Plan_Pakistan.pdf
[71] https://epakp.gov.pk/wp-content/uploads/2022/09/Khyber-Pakhtunkhwa-Climate-Change-Policy-2022.pdf
[72] https://epakp.gov.pk/wp-content/uploads/2022/09/Khyber-Pakhtunkhwa-Climate-Change-Action-Plan-August-2022-English.pdf
[73] https://kpcode.kp.gov.pk/uploads/The_Khyber_Pakhtunkhwa_Water_Act_2020_Act_No_XXV_of_2020.pdf
[74] https://www.pakp.gov.pk/wp-content/uploads/2024/03/The-Khyber-Pakhtunkhwa-Forest-Amendment-Act-2022-Khyber-Pakhtunkhwa-Act-No.-XXXI-of-2022.pdf
[75] https://kpcode.kp.gov.pk/uploads/THE_KHYBER_PAKHTUNKHWA_ENVIRONMENTAL_PROTECTION_ACT_2014.pdf
[76] https://www.pakp.gov.pk/act/the-national-disaster-management-khyber-pakhtunkhwa-amendment-act-2012/
[77] https://kpcode.kp.gov.pk/uploads/Federal_National_Disaster_Management_Act_2010.pdf
[78] https://knowledge.unv.org/sites/default/files/2022-05/National%20DRR%20policy%20Pakistan.pdf
[79] https://mowr.gov.pk/SiteImage/Misc/files/National%20Water%20Policy.pdf
[80] https://livingindus.org.pk/

Billion Tree Tsunami[81] reinforce afforestation and ecosystem restoration. The National Health Vision 2016-2025[82] addresses climate-related health risks, including disease surveillance and heatwave preparedness, and the Alternative & Renewable Energy Policy (2019)[83] encourages the adoption of off-grid solar pumping solutions for rural irrigation. At the same time, large-scale resilience initiatives such as Recharge Pakistan[84], the Living Indus Initiative, and the GLOF-II Project[85] provide district-level opportunities for alignment with national adaptation programs, financing, and technical assistance.

Taken together, these international commitments, national frameworks, provincial policies, and sectoral initiatives create a strong enabling environment for the Charsadda District Adaptation Plan. They collectively provide the legal, institutional, and programmatic basis for integrating climate adaptation into water management, agriculture, forestry, biodiversity, health, and disaster risk reduction. However, while the policy environment is robust, the translation of these national and provincial priorities into effective district-level action remains constrained by gaps in capacity, coordination, and financing. It is within this context that the Charsadda DAP emerges as a critical tool for operationalizing adaptation, bridging policy frameworks with on-the-ground realities, and ensuring that global and national commitments are realized through locally owned, context-specific resilience measures.

Institutional Framework

The institutional framework for the implementation of the Charsadda's DAP aligns with Pakistan's multi-level governance structure, linking national policy direction with provincial coordination and district-level execution. At the national level, the Ministry of Climate Change and Environmental Coordination (MoCC&EC) serves as the primary authority for climate governance. It acts as the national focal point for the UN Framework Convention on Climate Change (UNFCCC), the Paris Agreement, and other multilateral environmental commitments. The Ministry provides overarching policy guidance, coordination, and oversight for climate adaptation across all sectors and tiers of government. Under the Pakistan Climate Change Act (2017), the MoCC&EC established the Pakistan Climate Change Authority, which provides high-level policy direction, approves adaptation strategies, and monitors their implementation. The Ministry ensures that the National Adaptation Plan (NAP 2023-2033), National Climate Change Policy (2021), and related national frameworks are effectively operationalized through provincial and district institutions.

At the provincial level, the Government of Khyber Pakhtunkhwa (KP) leads adaptation coordination through the Planning and Development Department (P&DD), which functions as the central implementing and monitoring agency for climate action. The P&DD houses the Climate Change and Environment Cell and the KP Climate Action Board, serving as the province's key institutional mechanisms for adaptation and mitigation. The Board ensures that provincial adaptation priorities, as outlined in the KP Climate Change Policy (2022) and KP Climate Change Action Plan (2022), are implemented across all line departments, such as Agriculture, Irrigation, Forestry, Health, Education, and Communication & Works (C&W), through integrated planning, resource allocation, and performance monitoring. The KP Environmental Protection Agency (EPA), established under the KP Environmental Protection Act (2014), complements these functions by enforcing environmental regulations, supporting ecosystem-based adaptation, and ensuring that environmental safeguards are incorporated into development planning.

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[81] https://mocc.gov.pk/ProjectDetail/M2QzOWJmMjUtZTU3MC00NmFkLWE4YmMtZDFhMmRlOGU2NGRh

[82] https://extranet.who.int/countryplanningcycles/sites/default/files/planning_cycle_repository/pakistan/national_health_vision_2016-25_30-08-2016.pdf

[83] https://power.gov.pk/PolicyDetail/ZmNkNjE3MzgtZWE0Ni00N2E0LTk2OTktMzdjNTg4ZGMxNTNh

[84] https://www.wwfpak.org/our_work_/recharge_pakistan_/

[85] https://www.undp.org/pakistan/projects/scaling-glacial-lake-outburst-floods-risk-reduction-northern-pakistan-glof-ii-project

At the district level, the Charsadda District Administration serves as the implementing arm of provincial climate action. The DAP will be executed through relevant district line departments under the overall supervision of the Deputy Commissioner (DC), who oversees coordination and ensures that climate adaptation measures are embedded in local development planning and disaster risk management processes.

At the community level, adaptation actions will be supported and implemented through Union Councils, Village Development Committees (VDCs), and Water User Associations (WUAs), with the potential establishment of Village Climate Adaptation Forums (VCAFs) to promote participatory planning and local ownership. These community institutions play a vital role in executing locally relevant adaptation measures, such as water management, agriculture extension, and early-warning dissemination, under the technical guidance of district line departments and the district administration.

Objectives of the DAP

The DAP seeks to:

- Enhance resilience of climate-sensitive sectors and livelihoods.
- Reduce exposure and vulnerability to recurrent floods, heatwaves, and droughts.
- Strengthen institutional coordination and adaptive capacity.
- Promote nature-based and ecosystem-based adaptation for long-term sustainability.
- Mainstream gender and social inclusion into adaptation planning; and
- Facilitate access to climate finance through evidence-based project pipelines.

Vision and guiding principles

Vision

"A climate-resilient Charsadda where communities possess strong socioeconomic and environmental adaptive capacities, collaborating to ensure prosperity, wellbeing, and protection of ecosystems through inclusive and sustainable approaches."

The achievement of this vision is anchored in the six pillars and four foundations of Pakistan's NAP, localized for district needs:

Six Pillars for Charsadda's Climate Resilience:

1. **Green Jobs and Livelihoods**: Promote climate-smart agriculture, resilient livelihoods, eco-tourism, and renewable energy-based employment to strengthen household incomes.
2. **Inclusive Growth and Social Equity**: Ensure marginalized groups, women, and youth have equitable access to resources, opportunities, education, and health services.
3. **Sustainable Infrastructure and Services**: Develop resilient housing, flood protection works, irrigation systems, and municipal services that can withstand climate shocks.
4. **Environmental Conservation and Biodiversity Protection**: Protect rivers, forests, and rangelands; restore degraded ecosystems; and strengthen biodiversity conservation for food and water security.
5. **Good Governance and Policy Alignment**: Strengthen institutional coordination, integrate climate priorities into district development planning, and ensure transparent, accountable decision-making.
6. **Responsible Corporate Practices**: Engage local businesses, industries, and SMEs in adopting sustainable practices, reducing emissions, and supporting community resilience initiatives.

Four Foundational Enablers:

1. **Capacity Building and Knowledge Management**: Strengthen district-level data, early warning systems, and institutional knowledge for informed decision-making.

2. **Collaboration and Partnerships**: Promote collaboration among government departments, CSOs, academia, private sector, and local communities.
3. **Technology and Innovation**: Apply digital tools, modern irrigation methods, and renewable energy technologies to support adaptation.
4. **Strategic Investments and Policy Reforms**: Mobilize resources and advocate for supportive policies to enable climate-resilient and low-carbon development pathways.

Guiding Principles

In line with Pakistan's National Adaptation Plan (NAP), the formulation and implementation of District Adaptation Plans will be guided by the following principles:

1. **Mainstream Climate Adaptation:** Integrate climate adaptation into all district-level planning, governance, and decision-making processes. This includes agriculture, water management, infrastructure, urban development, and disaster preparedness to ensure resilience to climate impacts.
2. **Think Strategically:** Adopt a long-term, intergenerational approach that anticipates evolving climate risks and develops adaptive strategies capable of withstanding future uncertainties.
3. **Make Evidence-Based Decisions**: Rely on scientific assessments complemented by local and indigenous knowledge to design effective and context-specific adaptation actions.
4. **Promote Nature-Based Solutions (NbS):** Prioritize ecosystem-based approaches such as watershed protection, afforestation, soil conservation, and sustainable agriculture, which provide multiple co-benefits including biodiversity conservation and climate resilience.
5. **Act Locally:** Design adaptation interventions that directly respond to district-specific risks, vulnerabilities, and opportunities while considering community-level perspectives.
6. **Leave No One Behind:** Ensure inclusivity by integrating the voices and needs of vulnerable groups, including women, youth, the elderly, persons with disabilities, and marginalized communities, into adaptation planning and implementation.
7. **Think Ahead and Stay Flexible:** Build adaptive management systems that are proactive, flexible, and responsive to emerging challenges, while ensuring predictability and minimizing disruption for communities and businesses.
8. **Address Inequity:** Promote climate justice by reducing structural and social inequalities that heighten vulnerability, ensuring fair distribution of resources, and avoiding maladaptation.
9. **Coordinate and Collaborate:** Strengthen partnerships and coordination across government departments, civil society, private sector, academia, and communities to pool resources, knowledge, and expertise for more effective adaptation.
10. **Build Capacity and Knowledge:** Invest in awareness, education, training, and institutional strengthening at the district level to equip all stakeholders with the skills and knowledge needed for climate-resilient development.

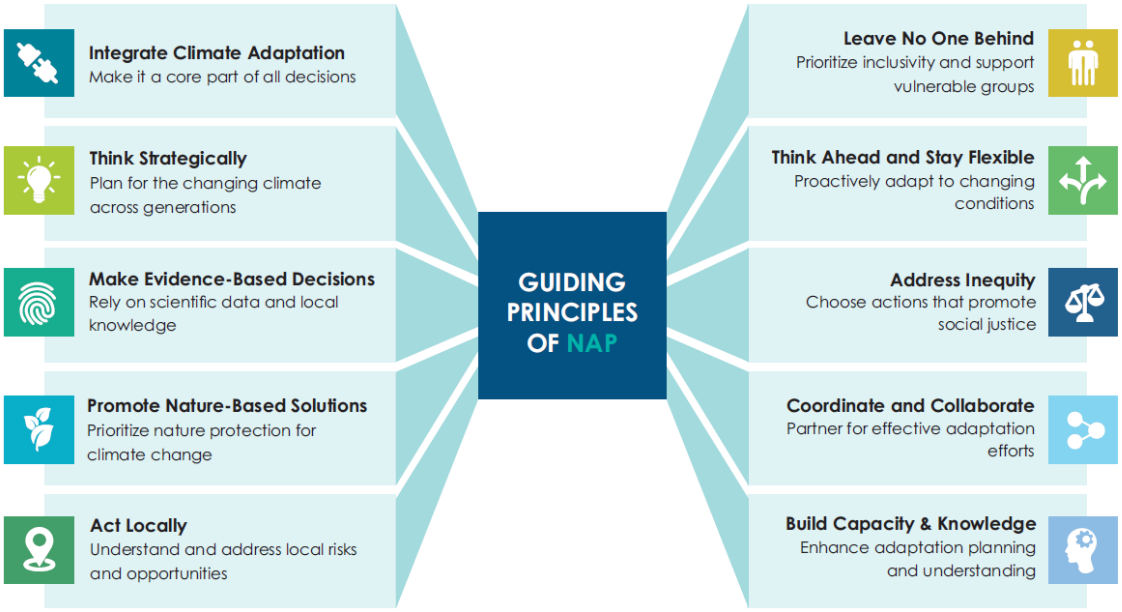

Figure 18: Guiding Principles for Pakistan's NAP

Charsadda's DAP Preparation Process

The preparation of the District Adaptation Plan (DAP) for Charsadda followed a structured, inclusive, and iterative process, anchored in the National Standard Operating Procedure (SOP) and Template for District Adaptation Plans (2024). While Pakistan's NAP was developed through a five-step national process, ranging from internal assessments and stakeholder engagement to identification of priorities and action planning, the DAP adapts these principles to the district level through a seven-step framework designed to reflect local contexts and realities.

The process in Charsadda unfolded as follows:

1. **Preliminary Data Collection and Stakeholder Engagement**: District profiles were compiled covering geography, demographics, livelihoods, climate hazards, and institutional structures. Key stakeholders, including district departments, academia, civil society, farmer groups, women's representatives, and private sector actors, were identified and engaged at the outset to ensure inclusivity.
2. **Climate Vulnerability and Capacity Assessment (CRVA)**: A district-level assessment was conducted to identify priority climate hazards, sectoral vulnerabilities, and adaptive capacities. The CRVA provided the evidence base for decision-making, combining climate data, risk modeling, and community-based insights.
3. **Identification and Prioritization of Adaptation Options**: Through multi-stakeholder consultations and workshops, adaptation needs were mapped across thematic areas (Agriculture-Water Nexus, Natural Capital, Urban Resilience, Human Capital, Disaster Risk Management, and Gender, Youth & Social Inclusion). Options were prioritized using criteria such as effectiveness, feasibility, cost-benefit, and equity.
4. **Costing and Identification of Financial Sources**: Each prioritized adaptation option was analyzed for costing requirements and potential financing streams, including district and provincial budgets, federal support, international climate finance, and private sector engagement.
5. **Integration into District Development Plans (DDPs) and Budgeting**: The adaptation priorities were aligned with ongoing district development programs and annual budgetary cycles, ensuring institutional embedding rather than standalone interventions.
6. **Monitoring, Evaluation, and Learning (MEL)**: A results-based MEL framework was developed, including key performance indicators (KPIs), baselines, and reporting

mechanisms to track progress, assess effectiveness, and inform iterative revisions of the DAP.

This seven-step preparation process ensured that Charsadda's DAP was developed in a participatory, evidence-based, and context-specific manner. It combines the national vision of the NAP with district-level realities, creating a localized adaptation framework that is technically sound, socially inclusive, and institutionally feasible.

Stakeholder engagement outcomes

Stakeholder engagement formed the cornerstone of Charsadda's District Adaptation Plan (DAP), ensuring that the process was inclusive, participatory, and reflective of diverse perspectives. A wide range of actors, including government departments, local communities, civil society organizations, academia, and private sector representatives, were consulted through key informant interviews (KIIs), focus group discussions (FGDs), and a multi-stakeholder workshop. Key outcomes of these engagements include:

1. **Shared Understanding of Climate Risks**
    a. Stakeholders collectively identified floods, heatwaves, and droughts as the most pressing climate hazards for Charsadda.
    b. There was consensus that agriculture, water, and livelihoods remain the most vulnerable systems, with cascading impacts on health, education, and local infrastructure.
2. **Sectoral Prioritization**
    a. Local farmers and agricultural officers emphasized the urgent need for climate-resilient agriculture, improved irrigation systems, and soil conservation.
    b. Health and education departments highlighted rising climate-sensitive diseases, heat stress, and school disruptions.
    c. Women and youth representatives emphasized social vulnerabilities, including unequal access to resources and limited participation in decision-making.
3. **Integration of Local and Indigenous Knowledge**
    a. Community elders shared traditional coping practices such as crop rotation, water storage methods, and collective disaster preparedness, which were incorporated into adaptation options.
    b. Women's groups highlighted the role of household-level water management and informal care networks in building resilience.
4. **Identification of Adaptation Options**
    a. Consultations generated a menu of adaptation measures, ranging from flood-resilient infrastructure and improved municipal services to renewable energy, ecosystem restoration, and livelihood diversification.
    b. Stakeholders ranked these options based on effectiveness, feasibility, and equity, feeding into the prioritization process.
5. **Strengthening of Institutional Linkages**
    a. Engagement fostered collaboration between the District Disaster Management Authority (DDMA), line departments, and non-state actors, ensuring better coordination for implementation.
    b. NGOs, including Nida Pakistan and Cesvi Pakistan, have been instrumental in supporting disaster risk reduction and climate adaptation projects, including community mobilization and capacity-building for Climate Emergency Response Teams (CERT) and Community-Based Disaster Risk Reduction (CADR) efforts.
    c. Stakeholders expressed ownership of the process and commitment to supporting the implementation of the DAP, enhancing prospects for sustainability.

Overall, stakeholder engagement ensured that the Charsadda DAP is not only evidence-based but also socially relevant and widely supported. This process built trust, promoted local ownership, and established a foundation for collaborative action toward climate resilience.

5. District Adaptation Priorities

The Agriculture – Water Nexus

Sectoral Context

Agriculture constitutes the central pillar of Charsadda's socio-economic system, engaging more than 70 percent of households in farming and livestock-based livelihoods. The district's fertile alluvial plains, shaped by the Kabul and Swat rivers and supported by an extensive canal network, provide a productive foundation for crop cultivation and agro-pastoral systems. However, this agricultural economy is increasingly under stress from recurrent flooding, erratic monsoon patterns, declining groundwater tables, and progressive soil degradation. As part of the fertile Peshawar Valley, Charsadda contributes significantly to staple food production at both provincial and national levels, positioning it as a key component of Pakistan's food security architecture. Yet, the agriculture, food system remains constrained by climate variability, resource degradation, and rapidly changing consumption patterns. Productivity continues to fall short of potential due to structural challenges in water and land management, making the district's agrarian base highly vulnerable to climatic shocks and long-term resource stress.

Agriculture Food System

- The agriculture food system in Charsadda is the backbone of its rural economy, directly supporting over 70% of households through crop and livestock-based livelihoods. At the national level, agriculture contributes about 19–20% of GDP, employs 37–40% of the labor force, and provides the main source of income for nearly 63% of the rural population, with Charsadda playing a key role in staple food and cash crop production.[86] [87]
- Wheat and maize dominate cropping patterns in the district, occupying nearly 40% of cultivated land, while sugarcane, tobacco, and vegetables form the main cash crops. Despite fertile alluvial soils, productivity is consistently below potential: wheat yields in Khyber Pakhtunkhwa average 2.6 t/ha, compared to an attainable 4.5–5.0 t/ha, and remain 2–5 times lower than international best practice.[88]
- Extreme climate events have compounded production losses. The 2010 super-floods, which had a devastating impact on the region due to its location at the confluence of the Kabul and Swat rivers, affected more than 70,000 households. Entire settlements in low-lying union councils were inundated, leading to widespread displacement., These floods were part of Pakistan's most catastrophic flood on record, claiming nearly 2,000 lives nationwide and leading to public health crises. The 2022 floods inundated 10,921 acres of farmland in Charsadda, causing significant crop losses, long-term soil fertility decline, and severe food supply disruptions. Both events underscore the scale of vulnerability Charsadda faces due to extreme climate hazards..[89] [90]
- Water insecurity further constrains the agricultural food system. Canal irrigation supplies more than 70% of cultivated land, but recurring floods silt canals and reduce conveyance efficiency. Groundwater, which supplements irrigation, is increasingly stressed: tube wells typically draw

[86] Haq, I., Shehzad, K., Nawab, K., Saqib, R., Rahmatullah, F. S., Ullah, K., Saud, S., & Rahman, W. U. (2020). *Upshots of Climate Change on Farming Community in Charsadda, Pakistan.* NHESS Preprints. https://nhess.copernicus.org/preprints/nhess-2020-255/

[87] Government of Pakistan. (2023). *Pakistan Economic Survey 2022–23.* Finance Division, Government of Pakistan, Islamabad.

[88] Ishaque, W., et al. (2019). Assessment of drinking water quality and human health risk in Pakistan. *Environmental Monitoring and Assessment*, 191, 7651. https://doi.org/10.1007/s10661-019-7651-5

[89] Younas, M., et al. (2024). Flood impacts and agricultural vulnerability in Khyber Pakhtunkhwa, Pakistan. *Water*, 14(7), 1176. https://doi.org/10.3390/w14071176

[90] Mahmood, A., et al. (2023). Water-related disasters and climate change in Pakistan. *Weather and Climate Extremes*, 39, 100064. https://doi.org/10.1016/j.wds.2023.100064

water from 280–400 ft, but shallow aquifers (4–15 m) face microbial contamination rates of 35–40%, while nitrate leaching from fertilizers threatens both food safety and health outcomes.[91]

- Shifts in food demand driven by urbanization in the Peshawar Valley and changing dietary preferences are placing new pressures on smallholders. While there is rising demand for vegetables, dairy, and diversified nutrition sources, Charsadda's fragmented landholdings, low mechanization, and weak market linkages limit the capacity to meet this demand, leading to reliance on imports for food staples.[92]
- Livestock forms an integral component of the agricultural food system, providing both household nutrition and income. However, fodder scarcity due to recurrent floods, rangeland degradation, and heat stress on animals reduces productivity, undermining food and livelihood security.[93]
- Agriculture food system in Charsadda faces interlinked stresses from climate change, water scarcity, soil degradation, and weak institutional support. These vulnerabilities not only threaten local food availability but also undermine Pakistan's broader food security ambitions, emphasizing the need for integrated, climate-resilient agriculture and water management systems.[94] [95]

Agriculture Land

- Charsadda district covers 99,600 hectares, of which 73,319 ha (74%) are under cultivation and 25,322 ha (26%) remain uncultivated. The fertile alluvial plains, enriched by the Kabul and Swat rivers, are highly productive but increasingly stressed due to intensive agricultural practices and unsustainable land management.[96]
- The soils are predominantly sandy loam to silty clay, slightly alkaline (pH 7.2–8.1) with moderate organic matter content in riparian zones. However, 35% of irrigated land is waterlogged and 30% is saline, reducing agricultural productivity by an estimated 25%, particularly in canal-fed tracts where excessive irrigation and fertilizer use have accelerated salinization and topsoil depletion[97].
- The 2010 floods triggered significant land-cover shifts within a 5 km buffer of the Kabul River. Agricultural land shrank from 68.55% to 55.10%, water bodies expanded from 8.81% to 16.40%, and barren soil increased from 22.50% to 26.30%. Over 27 villages were severely damaged, with extensive crop and soil losses, highlighting the district's acute vulnerability to recurrent flooding (**Error! Reference source not found.**).[98]
- Rapid urban expansion along the Charsadda corridor has resulted in the conversion of prime farmland into residential colonies, commercial hubs, and roads. This rural-to-urban

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[91] Ishaque, W., et al. (2022). Groundwater contamination and its implications for health and irrigation in Pakistan. *International Journal of Environmental Science and Technology*, 19, 12411–12428. https://doi.org/10.1007/s13762-022-04077-z

[92] Mahmood, A., et al. (2023). Water-related disasters and climate change in Pakistan. *Weather and Climate Extremes*, 39, 100064. https://doi.org/10.1016/j.wds.2023.100064

[93] Haq, I., Shehzad, K., Nawab, K., Saqib, R., Rahmatullah, F. S., Ullah, K., Saud, S., & Rahman, W. U. (2020). *Upshots of Climate Change on Farming Community in Charsadda, Pakistan*. NHESS Preprints. https://nhess.copernicus.org/preprints/nhess-2020-255/

[94] ISPRS. (2018). Assessment of flood damages in Pakistan using remote sensing and GIS. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-4-W9, 105–111. https://isprs-archives.copernicus.org/articles/XLII-4-W9/105/2018/

[95] Younas, M., et al. (2024). Flood impacts and agricultural vulnerability in Khyber Pakhtunkhwa, Pakistan. *Water*, 14(7), 1176. https://doi.org/10.3390/w14071176

[96] Khyber Pakhtunkhwa Agriculture Department. (2023). *Agricultural Statistics of Khyber Pakhtunkhwa 2022–2023*. Government of Khyber Pakhtunkhwa, Peshawar.

[97] Pakistan Council of Research in Water Resources (PCRWR). (2021). *Water Quality Status Report of Pakistan*. Islamabad: PCRWR.

[98] Khan, A. N., Khan, B., Qasim, S., & Khan, S. N. (2020). Causes, effects and remedies: A case study of rural flooding in District Charsadda, Pakistan. *Natural Hazards and Earth System Sciences Discussions*, 20, 1–19. https://doi.org/10.5194/nhess-2020-255

transformation, if unchecked, is projected to reduce Charsadda's cultivated land by 15–20% by 2035, threatening both local and provincial food security.[99]

- The Palai Dam irrigation scheme in Mouza Qilla, Charsadda has altered cropping patterns over 4,600 acres, reducing tube-well dependence from 81.6 acres pre-dam to 37.4 acres post-dam. While this improved water availability, it has also shifted cultivation intensity and land-use patterns, requiring adaptive governance.[100]
- Natural riverine forests, once dominated by Acacia nilotica and Morus spp., have declined by 30% since 2000, primarily due to agricultural expansion and fuelwood extraction. Overgrazing on 61.74 km² of culturable waste and rangeland areas, combined with canal siltation during monsoon floods, continue to degrade soil structure and fertility.[101]
- Despite land degradation, Charsadda sustains significant biodiversity. Surveys recorded 146 vascular plant species across 58 families, with Asteraceae (9.6%), Poaceae (8.2%), and Solanaceae (5.5%) as dominant families, along with 40+ butterfly species in Tangi tehsil. Wetlands and riparian habitats along the Kabul and Swat rivers host migratory waterfowl populations, underscoring the ecological importance of agro-ecosystems in the Indus Basin flyway.[102]
- The conversion of agricultural and natural landscapes, combined with untreated wastewater discharge and encroachment, is diminishing vital ecosystem services such as flood attenuation, nutrient cycling, fodder provision, and pollination, increasing long-term vulnerability of both the agricultural economy and household food security.

Water Management for Irrigation

- Charsadda spans 73,319 hectares of cultivated land, of which approximately 60,693 hectares are canal-irrigated under the government system. The remaining area depends on private irrigation sources, including tube wells, lift pumps, and dug wells, underscoring the centrality of the irrigation system for sustaining agricultural production in the district.[103]
- The Palai Dam irrigation project, completed in 2011 in Tehsil Tangi, provides irrigation to approximately 4,600 acres of agricultural land across four villages. It comprises two canal systems: the right bank canal (3.5 km, 6.5 cusecs) irrigates nearly 1,000 acres, while the left bank canal (11.7 km, 23.5 cusecs) services about 3,680 acres. Post-dam assessments indicate significant improvements in household agricultural revenues, which nearly doubled between 2008–09 and 2016–17, and yield gains in major crops such as wheat (from ~1,450 kg/acre to ~2,300 kg/acre) and sugarcane, reflecting the transformative role of regulated irrigation.[104]
- Despite this infrastructure, irrigation efficiency remains low. More than 50% of water is lost through seepage in unlined canals and earthen watercourses. This not only reduces water availability at the farm gate but also contributes to waterlogging and salinity, conditions that affect nearly 35% of irrigated land in Charsadda and result in yield reductions of up to 25% in affected zones. [105]
- In addition to canal irrigation, tube wells drilled between 280–400 feet provide supplementary irrigation and domestic water. However, unregulated abstraction is leading to groundwater depletion and quality deterioration. Recent pilot initiatives under the Water Resource

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[99] Field observations conducted by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[100] ResearcherLinks. (2022). Impacts of Palai Dam on land use and cropping pattern of Mouza Qilla, District Charsadda, Khyber Pakhtunkhwa, Pakistan. *Journal of Agriculture and Sustainable Development*, 14(1), 1–12. https://researcherslinks.com/current-issues/Impacts-of-Palai-Dam-on-Land-use-and-Cropping-Pattern-of-Mouza-Qilla-District-Charsadda-Khyber-Pakhtunkhwa-Pakistan/14/1/373/html
[101] CRVA. (2025). *Climate Risk and Vulnerability Assessment (CRVA) of Charsadda District.* Sustainable Development Policy Institute (SDPI)
[102] Ibid.
[103] KP Development Statistics (2018-19). *Irrigation Network – Charsadda District.* Government of Khyber Pakhtunkhwa.
[104] Nasir, M. J., Khan, A. S., Rahman, A. U., Akhtar, W., & Khan, H. U. (2024). Reducing poverty through irrigation investment: A study of Palai Dam irrigation canal, District Charsadda. *Sarhad Journal of Agriculture, 40*(3), 799-809. https://doi.org/10.17582/journal.sja/2021/37.1.43.51
[105] UNICEF. (2021). *Water Quality Assessment Report: District Charsadda, Khyber Pakhtunkhwa.* UNICEF Pakistan

Accountability Programme (WRAP) by IWMI have begun geo-tagging tube wells in Charsadda to enable systematic groundwater monitoring and improved irrigation scheduling.[106]

- Irrigation infrastructure in Charsadda is highly vulnerable to flood damage. During the 2022 floods, breaches in canal embankments, watercourse washouts, and damage to protective spurs disrupted irrigation across thousands of acres of farmland. More recently, in 2025, Charsadda alone incurred irrigation losses exceeding PKR 1.71 billion, the highest among KP districts, due to breaches in irrigation canals and the collapse of embankments.[107]
- Field consultations and secondary data highlight significant governance challenges, including delayed canal desilting, inadequate embankment maintenance, and weak coordination among irrigation, agriculture, and PHED departments. These gaps increase vulnerability to both flood-related irrigation failures and dry-season water shortages, pointing to the urgent need for integrated irrigation management.

Livestock

- Livestock is central to Charsadda's rural economy, functioning as both a source of subsistence and marketable surplus. More than 70% of rural household's rear animals as part of mixed crop livestock systems, with income from livestock contributing between 30–40% of household earnings.[108] The sector provides food security, employment, and a safety net during climate shocks.
- According to district-level data, Charsadda maintains a substantial livestock base: 239,899 cattle, 110,697 buffaloes, 173,211 goats, 47,694 sheep, 451 camels, and 2,368 horses.[109] The district also supports around 18,358 asses and 421 mules, essential for transport and draught purposes in rural areas. Charsadda is a major milk producer, with an estimated 4.4 million liters of milk per day (~940 million liters annually), placing it among the leading milk-producing districts in Khyber Pakhtunkhwa.[110]
- Despite its large population, livestock productivity in Charsadda remains below potential. Average milk yields are 8–10 liters per cow per day, well below improved breed benchmarks of 20–25 liters.[111] Constraints include seasonal fodder shortages, reliance on crop residues (particularly wheat straw), limited vaccination coverage, and weak extension services. Disease outbreaks such as hemorrhagic septicemia and foot-and-mouth disease are recurrent and exacerbate losses during wet seasons and floods.[112]
- Women play an indispensable role in livestock management, responsible for feeding, milking, fodder collection, and small-scale processing. In Charsadda, women's participation exceeds 60% of household-level livestock activities, yet their contributions are undervalued due to patriarchal ownership structures and exclusion from formal markets.[113] Climate hazards amplify these burdens: during floods and droughts, women face additional stress in fodder collection, water supply for animals, and caring for diseased or displaced livestock.

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[106] ternational Water Management Institute (IWMI). (2025). Water Resource Accountability Programme (WRAP) – Geo-tagging of tube wells in KP.
[107] The Peshawar Post. (2025, August 14). Floods inflict Rs 102.64 billion damage to irrigation infrastructure in KP.
[108] Ali, H. L. (2016). Livestock farming and participation of women: A case study of District Charsadda, Pakistan. *Journal of Culture, Society and Development*, 18, 22–31.
[109] Pakistan Livestock Census (2006). *District-wise Livestock Population Statistics*. Government of Pakistan.
[110] KPBoIT. (2021). *Charsadda District Profile: Livestock and Dairy*. Khyber Pakhtunkhwa Board of Investment and Trade
[111] Farooq, U., Samad, H. A., Sher, F., Aslam, M., & Riaz, M. (2019). Small ruminant productivity and adaptation to climate stress in Pakistan. *Small Ruminant Research, 177*, 95–103. https://doi.org/10.1016/j.smallrumres.2019.05.008
[112] Khan, A. N., Khan, B., Qasim, S., & Khan, S. N. (2020). Causes, effects and remedies: A case study of rural flooding in District Charsadda, Pakistan. *Natural Hazards and Earth System Sciences Discussions, 20*, 1–19. https://doi.org/10.5194/nhess-2020-255
[113] Ali, H. L. (2016). Livestock farming and participation of women: A case study of District Charsadda, Pakistan. *Journal of Culture, Society and Development*, 18, 22–31.

- The livestock sector in Charsadda is highly exposed to climate variability. The 2022 floods caused the death of at least 273 animals, eroded grazing pastures, and disrupted fodder supply chains, directly affecting rural food and income security. Rising temperatures and prolonged heatwaves are projected to increase heat stress, reduce milk yields, impair fertility, and raise mortality rates, particularly for high-yielding breeds.[114] Droughts reduce fodder availability, while stagnant floodwaters increase the prevalence of vector-borne livestock diseases. These compounding stresses intensify rural vulnerability and demand urgent climate-resilient adaptation measures.

Farmer Level Challenges

- Farmers in Charsadda struggle with dual water challenges: over-extraction of groundwater in dry months and waterlogging during flood seasons. Seasonal floods breach embankments and inundate fields, depositing silt and debris in irrigation canals, which reduces conveyance efficiency and increases farm-level drainage problems. These cycles of depletion and waterlogging severely affect crop productivity, especially for water-sensitive crops such as maize and sugarcane.[115]
- Mechanization in Charsadda is already widespread, leaving limited room for further productivity gains. In several locations, groundwater abstraction exceeds recharge, while in others, poor on-farm water management (OFWM) has caused waterlogging and secondary salinization, particularly in canal command areas.[116]
- Floods erode fertile topsoil and contribute to sediment deposition that alters soil texture. Farmers respond by intensifying fertilizer and pesticide application to recover yields. This has resulted in progressive salinization and declining soil fertility, while excessive pesticide use harms biodiversity and raises public health concerns. Inundated soils also promote pest outbreaks, further increasing chemical dependence.[117]
- Excessive application of fertilizers and pesticides has degraded soil health, reduced organic matter, and contributed to biodiversity loss. Misuse of pesticides also impacts human health, with Pakistan reporting nearly 500,000 annual pesticide poisoning cases, many linked to intensive farming districts such as Charsadda.[118]
- The 2010 super floods displaced over 70,000 households, destroyed nearly 1,700 acres of cropland, and eroded fertile topsoil along the Kabul River floodplain, damaging irrigation channels, tube wells, and storage facilities.[119] Similarly, the 2022 floods submerged 10,921 acres of agricultural land, killed 273 livestock, and damaged critical irrigation infrastructure. Farmers reported yield reductions of 20–30% in wheat and maize, alongside heavy fodder and seed losses, forcing indebtedness and delayed cropping cycles.[120] The cumulative impacts of these recurrent floods have eroded resilience, driving many smallholders into debt, distress migration, and reduced farm investment, with women disproportionately burdened by recovery responsibilities.[121]

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[114] Farooq, U., Samad, H. A., Sher, F., Aslam, M., & Riaz, M. (2019). Small ruminant productivity and adaptation to climate stress in Pakistan. *Small Ruminant Research, 177*, 95–103. https://doi.org/10.1016/j.smallrumres.2019.05.008

[115] Wahab, M., & Ali, A. (2021). *Assessment of tree growth on farmlands from farmers' perceptions in District Charsadda.* Pakistan Journal of Agricultural Sciences, 58(2).

[116] UNICEF. (2021). *Water Quality Assessment Report: District Charsadda, Khyber Pakhtunkhwa.*

[117] Aziz, M. T., & Khan, A. (2018). *Utilization of ICTs for availing agricultural information in District Charsadda, Khyber Pakhtunkhwa.* Journal of Humanities & Social Sciences, 22(2), 113–125.

[118] Wahab, M., & Ali, A. (2021). *Assessment of tree growth on farmlands from farmers' perceptions in District Charsadda.* Pakistan Journal of Agricultural Sciences, 58(2).

[119] han, A. N., Khan, B., Qasim, S., & Khan, S. N. (2020). Causes, effects and remedies: A case study of rural flooding in District Charsadda, Pakistan. *Natural Hazards and Earth System Sciences Discussions.* https://doi.org/10.5194/nhess-2020-255

[120] Mahmood, M., et al. (2024). *Flood Damage Assessment Report – KP.* Provincial Disaster Management Authority (PDMA).

[121] Ali, H. L. (2016). *Livestock farming and participation of women: A case study of District Charsadda, Pakistan.* Journal of Culture, Society and Development, 18, 22–31.

Impact of Climate Change

Agriculture in Charsadda, central to livelihoods and food security, is increasingly threatened by climate change, which compounds existing structural vulnerabilities across land, water, livestock, and farmer-level systems. Rising temperatures, erratic monsoon rainfall, and recurrent flooding events, most notably in 2010 and 2022, have significantly undermined the resilience of farming households and agro-pastoral systems. The district's fertile alluvial plains, shaped by the Kabul and Swat rivers, have traditionally sustained intensive cultivation; however, floods have eroded topsoil, altered land cover, and caused prolonged waterlogging, leading to declines in crop yields and long-term soil degradation. [122]Climate variability has also accelerated salinization and waterlogging in canal command areas, where nearly one-third of cultivated land shows reduced productivity, intensifying livelihood stress among smallholders.[123] [124]

Water management challenges are exacerbated under changing climate conditions. The district's irrigation system, dependent on surface water diversions from the Kabul and Swat rivers and supplemented by groundwater extraction, faces mounting pressures. Floods routinely damage irrigation canals, spurs, and flood protection structures, reducing conveyance efficiency, while droughts and dry spells increase dependence on groundwater, driving seasonal over-extraction and declining water tables.[125] At the same time, flood events contaminate shallow aquifers with sediments and pathogens, compromising drinking-water safety and irrigation quality. A UNICEF (2021) survey revealed that 42% of drinking-water sources in Charsadda were unsafe, with microbial contamination linked to inundation of rural water points. This dual stress destruction of irrigation infrastructure and declining water quality reduces both agricultural productivity and public health resilience.

Livestock, which contributes substantially to rural incomes, is highly sensitive to climate-induced shocks. Floods in 2010 and 2022 led to large-scale livestock mortality over 273 animals killed in 2022 alone, while also destroying grazing lands and fodder reserves.[126] Heatwaves and prolonged hot spells further compromise livestock health, lowering milk yields and increasing mortality, particularly among small ruminants.[127] In parallel, the degradation of rangelands due to overgrazing, coupled with reduced water availability, limits fodder supply. Women, who play a significant role in livestock management in Charsadda, face disproportionate burdens during such crises, as they are forced to compensate for feed shortages, longer water-fetching distances, and reduced household income.[128] Thus, climate stressors not only threaten livestock productivity but also deepen gendered socio-economic vulnerabilities.

At the farmer level, climate change magnifies pre-existing challenges related to input use, market access, and adaptive capacity. Erratic rainfall and floods disrupt cropping cycles, reduce wheat and maize yields by up to 30%, and cause widespread losses of seed stocks and farm inputs.[129] Excessive reliance on fertilizers and pesticides, already problematic, becomes riskier under variable rainfall, contributing to soil degradation, biodiversity loss, and health risks from contamination.[130] Meanwhile, recurrent flooding damages rural roads, storage facilities, and local markets,

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[122] https://doi.org/10.5194/nhess-2020-255
[123] Wahab, M., & Ali, A. (2021). *Assessment of tree growth on farmlands from farmers' perceptions in District Charsadda*. Pakistan Journal of Agricultural Sciences, 58(2).
[124] UNICEF. (2021). *Water Quality Assessment Report: District Charsadda, Khyber Pakhtunkhwa*.
[125] Iqbal, M., Nawab, K., Khan, A., et al. (2020). *Farmer field school and interaction of extension personnel with farmers: An analysis of District Charsadda*.
[126] PDMA. (2023). *Flood Impact Assessment 2022*. Provincial Disaster Management Authority, KP.
[127] Parveen, S., Gohar, K., & Khan, A. (2016). *Profitability of broiler firms in Tehsil Shabqadar (Charsadda): A domestic study for the agricultural sector*. Industrial Engineering Letters, 6(5), 17–26.
[128] Ali, H. L. (2016). *Livestock farming and participation of women: A case study of District Charsadda, Pakistan*. Journal of Culture, Society and Development, 18, 22–31.
[129] Mahmood, M., et al. (2024). *Flood Damage Assessment Report – KP*. Provincial Disaster Management Authority (PDMA).
[130] Aziz, M. T., & Khan, A. (2018). *Utilization of ICTs for availing agricultural information in District Charsadda, Khyber Pakhtunkhwa*. Journal of Humanities & Social Sciences (Pakistan), 22(2), 113–125.

exacerbating post-harvest losses and undermining household incomes. Farmers also lack timely access to early warning systems and climate advisory services, reducing their preparedness for floods and droughts.[131] These interlinked pressures force many smallholders into debt and distress migration, eroding long-term adaptive capacity and trapping households in cycles of poverty. Collectively, the impacts of climate change across land, water, livestock, and farmer systems in Charsadda demonstrate that adaptation must prioritize integrated watershed management, climate-resilient infrastructure, improved extension services, and community-based disaster risk reduction to safeguard food security and rural livelihoods.

Priority Adaptation Areas and Initiatives

Charsadda's agriculture and water resources form the backbone of its rural economy and food security. However, recurrent floods, soil degradation, waterlogging, salinity, and inefficient irrigation practices are undermining productivity and threatening long-term resilience. Addressing these interconnected challenges requires integrated strategies that strengthen the agriculture water nexus, enhance resource efficiency, and build adaptive capacity among farming communities.

The following objectives outline priority areas for climate-smart interventions aimed at sustaining productivity, safeguarding natural resources, and enhancing the resilience of Charsadda's agrarian systems.

Objective 1: Promote Climate-Smart Land and Crop Management

Charsadda's fertile plains, nourished by the Kabul and Swat rivers, remain the backbone of local food systems, yet increasing land degradation is undermining productivity. Around 35% of irrigated land is waterlogged and 30% saline, leading to a 25% decline in crop yields in some areas. Recurrent floods in 2010 and 2022 eroded fertile topsoil, damaged standing crops, and displaced farming households, aggravating long-term land productivity challenges. Over-application of fertilizers and pesticides has further depleted soil health and threatened agro-biodiversity. Promoting climate-smart practices such as soil conservation, crop diversification, regenerative agriculture, and agroforestry is therefore essential to rebuild soil fertility, reduce erosion, and improve resilience against climatic shocks.

Objective 2: Modernize Irrigation Systems and Strengthen Water Governance

Charsadda's irrigation network, drawing from the Swat and Kabul rivers and extensive canals, is increasingly vulnerable to floods, sedimentation, and mismanagement. Canal breaches and embankment failures during the 2010 and 2022 floods disrupted irrigation flows and exacerbated waterlogging. Groundwater depletion, poor recharge, and limited monitoring add further stress to water availability. Current irrigation practices remain inefficient and supply-driven, with high conveyance losses and weak institutional coordination between departments. A shift toward modern irrigation methods is essential to improve water use and resilience. This includes lining irrigation canals to reduce water loss, allocating water based on actual needs, building flood-resistant infrastructure to protect water systems, creating systems to recharge groundwater for sustainable water supply, and introducing early warning systems that help adjust water schedules before floods or droughts. These steps are critical to making water use more efficient and preparing for future climate challenges.

Objective 3: Strengthen Livestock Systems for Climate Resilience

Livestock plays a pivotal role in Charsadda's rural economy, supporting household income, food security, and resilience against crop failure. However, climate shocks such as the 2010 and 2022 floods caused large-scale livestock mortality, fodder shortages, and disease outbreaks, undermining community resilience. Productivity also remains low due to poor feed availability, weak veterinary services, and lack of climate-resilient breeds. Women, central to livestock management,

[131] Iqbal, M., Nawab, K., Khan, A., et al. (2020). *Farmer field school and interaction of extension personnel with farmers: An analysis of District Charsadda.*

face systemic barriers in accessing extension services and financial support. Strengthening livestock resilience requires investments in disease control and vaccination programs, sustainable fodder production systems, improved breeding for climate adaptation, and targeted support for women-led livestock enterprises.

Objective 4: Enhance Farmer-Level Capacity and Risk Preparedness

Charsadda's farmers face compounding challenges of small landholdings, limited mechanization options, weak market linkages, and lack of access to extension services. Post-harvest losses remain high, while excessive reliance on chemical inputs threatens both soil health and human well-being. Flood events in 2010 and 2022 highlighted the acute vulnerability of farmers, as widespread crop destruction, input losses, and asset damage left households unable to recover without external assistance. Bridging the gap between farmers and extension services, enhancing farmer field schools, promoting ICT-based advisory systems, and improving access to credit and insurance will be vital to increase adaptive capacity and preparedness for climate risks.

Objective 5: Integrate Agriculture Food Systems with Climate-Smart Planning

Charsadda's agriculture–food system is central to national food security, yet it struggles to adapt to rapidly changing consumption patterns and climate risks. The district's yields for major crops remain significantly below international benchmarks due to structural inefficiencies, resource degradation, and recurrent floods. Food insecurity is rising, particularly among vulnerable households reliant on subsistence farming. Developing a climate-smart agricultural growth strategy that integrates food system diversification, nutrition-sensitive agriculture, and linkages with urban markets can help ensure both food availability and livelihood stability. Embedding climate adaptation into agricultural policy, planning, and investment frameworks at the district level will enable long-term resilience.

Table 5: Key Objectives and Initiatives for Agriculture-Water Nexus – Charsadda District

No.	Objective & Initiative	Timeframe	Key Responsible Entity	Priority Vulnerable UCs / Tehsils
Objective 1: Promote Climate-Smart Land and Crop Management				
1.1	Promote soil conservation programmes, crop diversification, regenerative agriculture, and agroforestry to enhance soil fertility, reduce erosion, and improve water retention.	Short (2026–2028)	KP Forest & Wildlife Dept.; Agriculture Dept.; District Admin.; LGRDD; NGOs; Soil & Water Conservation Department; P&DD KP (Climate Action Board)	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai
1.2	Identify and develop a risk management system including crop insurance.	Short (2026–2028)	Agriculture Dept.; KP Climate Change Cell; Research & Extension Services; P&DD KP; Local Banks; Insurance Companies; SUPARCO	Charsadda Tehsil (Agra, Batgram, Daulatpura), Tangi Tehsil (Umarzai)
1.3	Form producer groups in Charsadda City, Nisatta, and Sardheri for high-value crops like vegetables and fruits. Create market linkage forums connecting farmers with local	Medium (2029–2033)	Agriculture Dept.; ZTBL; Microfinance Banks; Local Govt Depts	Charsadda City, Nisatta, Sardheri

	buyers and processing units. Provide supply chain training and storage facilities to improve post-harvest handling and transport.			
1.4	Expand farmer extension services to include livestock vaccination and climate-resilient livestock management, such as improved breeding and sustainable feeding practices. Provide dedicated training programs for farmers on climate-resilient livestock practices and disease prevention.	Medium (2029–2033)	KP Agriculture Dept.; Livestock & Dairy Dev. Board; KP Climate Change Cell	Tangi, Turangzai, Utmanzai
1.5	Restructure existing financial tools to target smallholder farmers and incentivize crop diversification and efficient land management.	Medium (2029–2033)	Finance Dept.; Agriculture Dept.; ZTBL	Batgram, Agra, Daulatpura
Objective 2: Modernize Irrigation Systems and Strengthen Water Governance				
2.1	Upgrade existing canals and embankments, improve hydraulic control, and reduce conveyance losses. Develop new drainage channels to enhance water flow and reduce flood-related risks, particularly in flood-prone areas, ensuring improved floodwater management and minimal land damage.	Short (2026–2028)	Irrigation Dept.; Local Govt Depts.; KP Forest & Wildlife Dept.	Agra, Batgram, Daulatpura, Hassan Zai, Katu Zai
2.2	Implement groundwater monitoring, managed aquifer recharge, and hydro-agro informatics for demand-based irrigation.	Medium (2029–2033)	KP Irrigation Dept.; KP Agriculture Dept.; KP Climate Change Cell	Nisatta, Sardheri, peri-urban Shabqadar
2.3	Link irrigation scheduling with early warning systems and promote efficient irrigation methods (drip, furrow, laser levelling).	Short–Medium (2026–2033)	Agriculture Dept.; OFWM; Farmer Organizations; DDMA	Tangi (Umarzai, Turangzai)
2.4	Strengthen water-quality monitoring and develop decentralized water treatment systems based on PCRWR protocols. Prioritize community-led management and local ownership of these treatment systems, empowering residents to take responsibility for routine maintenance and monitoring of water quality to ensure	Short (2026–2028)	PHED; EPA-KP; PCRWR; District Health Office	Charsadda City, Nisatta, Sardheri

	sustainable access to clean water.			
2.5	Modernize the abiana collection system by implementing structural reforms to address accountability issues, ensuring transparency and efficiency in the process. Introduce financial diversification strategies to support sustainable water management, including exploring new revenue sources for water infrastructure. This will improve the long-term financial sustainability of water management systems.	Short–Medium (2026–2033)	KP Irrigation Dept.; Revenue Dept.; Local Govt Depts	Charsadda Tehsil canal command area (Daulatpura, Katu Zai)
2.6	Develop flexible and participatory institutional arrangements that actively involve local stakeholders, including farmers and community representatives, to ensure equitable and reliable operation of modernized infrastructure.	Short–Medium (2026–2033)	Irrigation Dept.; Agriculture Dept.; P&DD KP (Climate Action Board); District Admin.; NGOs	Charsadda & Tangi Tehsils
Objective 3: Strengthen Livestock Systems for Climate Resilience				
3.1	Implement livestock insurance and emergency support mechanisms.	Short (2026–2028)	KP Livestock & Dairy Dev. Department; KP Finance Dept.; Microfinance Banks; Insurance Companies	Batgram, Dildar Ghali, Mirzadar
3.2	Support women-led adaptive livestock and farm enterprises through training and finance.	Medium (2029–2033)	KP Women Dev. Dept.; KP Livestock Board; MFIs; Banks; Insurance Companies	Sardheri, Nisatta, Shabqadar (peri-urban)
3.3	Promote climate-resilient livestock breeds and locally adapted fodder systems (community fodder banks, small-scale fodder storage).	Medium (2029–2033)	KP Livestock & Dairy Dev. Board; KP Agriculture Dept.; NGOs	Tangi (Turangzai, Utmanzai)
Objective 4: Enhance Farmer-Level Capacity and Risk Preparedness				
4.1	Establish farmer field schools and ICT-based advisory systems.	Short (2026–2028)	KP Agriculture Dept.; KP Climate Change Cell; NGOs	Agra, Daulatpura, Batgram, Katu Zai
4.2	Improve access to credit, crop insurance, and post-harvest storage by facilitating easier access to financial products, including for farmers without formal profiles. Develop post-harvest storage facilities to reduce crop loss and improve	Medium (2029–2033)	KP Finance Dept.; KP Agriculture Dept.; Farmer Cooperatives	Charsadda City, Nisatta, Sardheri

	market access, particularly for smallholder farmers in Charsadda.			
4.3	Promote integrated pest management and sustainable input use.	Medium (2029–2033)	KP Agriculture Dept.; Research & Extension Services; NGOs	Tangi (Umarzai, Turangzai)
Objective 5: Integrate Agriculture-Food Systems with Climate-Smart Planning				
5.1	Develop a climate-smart agricultural growth strategy integrating crop diversification, nutrition-sensitive agriculture, and urban market linkages.	Medium (2029–2033)	KP Agriculture Dept.; P&DD KP; Market Authorities	Charsadda City, Nisatta, Shabqadar
5.2	Embed a proactive and integrated approach to climate adaptation into district agricultural policy, planning, and investment frameworks. Shift from conditional measures to comprehensive climate-resilient strategies, ensuring that all agricultural activities are aligned with climate change adaptation goals.	Long-term (2033 onward)	P&DD KP; District Admin.; KP Agriculture Dept.	District-wide, with policy pilots in Charsadda Tehsil and Tangi Tehsil
5.3	Implement participatory monitoring of food security and climate resilience indicators, ensuring community involvement in data collection, tracking, and analysis. This approach will enhance the accuracy of monitoring and ensure that the data reflects local realities.	Long-term (2033 onward)	Finance Dept.; P&DD KP; District Council; KP Agriculture Dept.; KP Climate Change Cell; Research Institutes	All Tehsils, integrated monitoring with emphasis on southern floodplain UCs (Agra, Batgram) and northern uplands (Tangi).

Natural Capital

Sectoral Context

Charsadda's natural capital, its land, water, and air, forms the foundation of its agrarian economy and ecological resilience. However, the district's ecosystems are increasingly under stress due to unsustainable land use, pollution, and climate variability, which collectively threaten soil productivity, water security, and public health.

Land and Ecosystems

- Charsadda spans 996 km², of which 733.19 km² (74%) is cultivated, and 253.22 km² (25%) remains uncultivated. It comprises fertile alluvial plains shaped by the Swat and Kabul rivers. The soils, largely sandy loam to silty clay, are pH-neutral to slightly alkaline (7.2–8.1) with moderate organic matter in riparian zones.[132] However, intensive cropping, over-irrigation, and fertilizer misuse have accelerated salinization and topsoil depletion, particularly in irrigated tracts along the canal network.

[132] https://www.thepab.org/files/2021/September-2021/PAB-MS-2008-262.pdf

- The 2010 floods along the Kabul River (within a 5 km buffer) caused significant shifts in land cover: agricultural vegetation declined from 68.55% to 55.10%, water bodies nearly doubled from 8.81% to 16.40%, and barren soil expanded from 22.50% to 26.30%. Twenty-seven villages were severely damaged, with extensive crop and soil losses, signaling the district's acute vulnerability to riverine flooding.[133]
- Riverine forests, once dominated by Acacia nilotica and Morus spp., have declined by over 30% since 2000 due to agricultural expansion and wood extraction.[134] Overgrazing and the conversion of rangelands to cultivation further degrade soil structure and increase erosion, a problem intensified by erratic monsoon rainfall. While no government-owned forests exist, private plantations cover approximately 176,877 acres (71,600 ha), primarily along the River Jindi, with linear plantations extending 975 km.[135]
- Overgrazing on culturable waste (61.74 km^2) and uncultivated rangelands, coupled with siltation in canals during monsoon floods and loss of private plantations to agricultural expansion, are major drivers of land degradation.
- Surveys conducted between 2017–2019 recorded 146 vascular plant species across 58 families and 127 genera in Charsadda. The most found families include Asteraceae, Poaceae, and Solanaceae, which are essential to local agricultural systems and natural ecosystems.[136]

Water Resources

- Water security plays a pivotal role in sustaining Charsadda's agrarian economy and human well-being, demanding efficient management of both surface and groundwater resources across its interconnected riverine and canal systems. The district's hydrology is defined by the Swat and Kabul rivers, which provide the main surface water sources for irrigation, supplemented by an extensive canal network that supplies water to over 70 percent of cultivated land. [137]
- Groundwater extraction in Charsadda is primarily through tube wells, which are drilled to depths ranging from 280 to 400 feet. Due to this depth, 89% of tube well sources were found to be safe, while only 11% were unsafe for consumption.[138]
- Despite this robust hydrological base, Charsadda faces serious challenges in maintaining water quality and sustainability. A 2018 Pakistan Council of Research in Water Resources (PCRWR) survey of 649 drinking-water sources revealed that 42 percent of samples were unsafe for human consumption. Microbial contamination remains the dominant threat, with Total Coliforms detected in 35 percent of samples and *E. coli* in 20 percent, primarily due to leakage and cross-contamination in the distribution system. Deep tube wells, accounting for only 12 percent of sources, provided 89 percent safe samples, while shallower systems displayed alarming contamination rates: open wells (85 percent unsafe), hand pumps (47 percent unsafe), and boreholes (32 percent unsafe).[139]
- Chemical contamination is also a localized concern. Although less frequent (<5 percent of samples), exceedances in turbidity, hardness, and nitrate concentrations have been recorded, particularly in agricultural zones where fertilizer leaching is common. Shallow wells, often less than 20 feet deep, are most vulnerable to nitrate infiltration and microbial pollution from nearby sewage and animal waste disposal sites. The deterioration of water quality poses significant public health risks, contributing to diarrheal diseases and nutritional stress, particularly among children and women in rural settlements.

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[133] https://nhess.copernicus.org/preprints/nhess-2020-255/nhess-2020-255.pdf
[134] https://www.thepab.org/files/2021/September-2021/PAB-MS-2008-262.pdf
[135] https://pakistanalmanac.com/kp-charsadda/
[136] https://www.researchgate.net/publication/346030749_Investigating_the_floristic_diversity_indices_of_plant_species_in_district_Charsadda_Khyber_Pakhtunkhwa_Pakistan
[137] https://pcrwr.gov.pk/wp-content/uploads/2020/Water-Quality-Reports/Water-Quality-Report-Charsadda.pdf
[138] Ibid.
[139] Ibid.

- Charsadda's water system is further stressed by the district's exposure to recurring floods and droughts. Historic floods, most notably in 2010 and 2022, submerged low-lying Union Councils, breached embankments, and led to widespread contamination of shallow aquifers.[140]
- Collectively, these trends highlight that Charsadda's water security hinges on strengthening climate-resilient infrastructure, improving groundwater governance, and implementing decentralized water treatment and monitoring systems.

Air Pollution

- Air quality in Charsadda is increasingly affected by a combination of transport emissions, agricultural practices, and household energy use, making it an emerging public health and environmental concern. The district's strategic position along the N-45 highway and the Peshawar-Charsadda corridor has led to a surge in vehicular traffic, which emits fine particulate matter ($PM_{2.5}$) and nitrogen dioxide (NO_2). [141]
- Agricultural activities further contribute to seasonal air pollution, particularly during post-harvest periods when widespread burning of crop residues releases PM_{10} and ozone precursors into the atmosphere. In rural and peri-urban areas, households dependent on biomass fuels for cooking and heating add black carbon and other harmful pollutants, intensifying local air-quality degradation.[142]
- Live monitoring data from Plume Labs indicate that particulate pollution in Charsadda regularly exceeds international safety thresholds. The 24-hour $PM_{2.5}$ concentration averages around 66 $\mu g/m^3$, corresponding to an Air Quality Index (AQI) level classified as "Poor," while annual mean concentrations stand at 19 $\mu g/m^3$, almost four times the World Health Organization (WHO) guideline of 5 $\mu g/m^3$.
- Similarly, PM_{10} levels average 27 $\mu g/m^3$ annually, about 1.8 times higher than the WHO limit of 15 $\mu g/m^3$. Concentrations of NO_2 and O_3 remain moderate (annual averages of 20 $\mu g/m^3$ and 40 $\mu g/m^3$, respectively) but still contribute to cumulative exposure risks, particularly in densely populated and traffic-congested areas.[143]
- The major contributors to Charsadda's deteriorating air quality include vehicle exhaust, dust from unpaved and poorly maintained roads, open burning of agricultural residues, and the continued reliance on biomass fuels in low-income communities. Without targeted interventions, the district's air quality is likely to worsen under the combined pressures of population growth and urban expansion.

Climate Change Impacts

Charsadda's low-lying alluvial plains face recurrent riverine flooding, the most significant climate hazard in the district. Floodwaters from the Swat and Kabul rivers, driven by intense monsoon rainfall and accelerated snowmelt in the Hindu Kush, regularly inundate farmlands, settlements, and infrastructure. The 2010 floods alone displaced over 70,000 households[144], damaged more than 1,700 acres of cropland, and destroyed bridges and roads, severely disrupting connectivity and economic activity.[145] Floodwaters also erode fertile soils, contaminate drinking-water supplies, and lead to long-term land degradation through siltation and riverbank retreat.

Flash floods have become increasingly common due to short-duration, high-intensity rainfall in upstream catchments. The steep river gradients in northern Charsadda funnel runoff into the plains, where limited drainage capacity leads to widespread damage. Flash floods erode embankments,

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[140] https://www.mdpi.com/2073-4441/14/7/1176
[141] https://air.plumelabs.com/air-quality-in-Charsadda-4XIt
[142] Ibid.
[143] Ibid.
[144] National Disaster Management Authority. (2010). Pakistan floods 2010: Preliminary damage and needs assessment. Government of Pakistan.
[145] https://urbanpolicyunit.gkp.pk/wp-content/uploads/2020/07/DLUP-Charsadda-2020-NEW.pdf

deposit sediment in irrigation canals, and destroy rural linkages, posing recurring threats to lives, crops, and property.

In urban and peri-urban areas, inadequate drainage infrastructure, solid waste accumulation, and encroachment on natural waterways have made Charsadda town prone to local flooding during heavy rains. Blocked drains cause prolonged waterlogging that disrupts markets, schools, and mobility while contaminating shallow groundwater. Stagnant, polluted floodwaters increase the risk of waterborne diseases such as diarrhoea, typhoid, and cholera, particularly affecting low-income and densely populated settlements.[146]

Heatwaves are an emerging and intensifying threat in Charsadda. Increasing average temperatures and declining vegetation cover have amplified local heat stress, especially in urbanized zones. Extended periods of extreme heat endanger outdoor workers, children, and the elderly, and are linked to rising rates of dehydration, heatstroke, and respiratory illness. High temperatures also reduce crop yields, impair livestock productivity, and strain the electricity grid due to increased cooling demand, leading to periodic power outages that further affect livelihoods and health.[147] Heat stress also affects crops, livestock, and plantation species, reducing productivity and increasing mortality rates during prolonged hot spells. High temperatures accelerate ozone formation, while drought-driven dust storms elevate particulate matter (PM) levels, worsening air quality and respiratory risks.

Soil erosion and riverbank retreat are worsening as erratic rainfall and high river flows destabilize embankments and farmland along the Swat and Kabul rivers. Repeated flooding displaces communities and transforms productive land into barren tracts. Monsoon floods intensify erosion of alluvial soils, leading to canal siltation and reduced reservoir capacity. Over time, these processes diminish land productivity, with alternating floods and dry spells reducing crop yields by up to 15 percent in flood-prone tehsils of Tangi, Shabqadar, and Charsadda. Sediment accumulation in irrigation canals reduces water delivery efficiency, raising the costs of land maintenance and irrigation infrastructure. The loss of riparian vegetation accelerates these processes, highlighting the need for integrated riverbank stabilization and land management strategies.[148]

While flooding dominates the hazard landscape, seasonal droughts and water scarcity are increasingly affecting Charsadda's agriculture and domestic water supply. Declining winter rainfall and reduced canal inflows have forced over-reliance on groundwater extraction, leading to seasonal over-pumping, groundwater depletion, and reduced baseflow to canals during dry months. These groundwater losses compromise irrigation and drinking-water supplies, intensifying pressure on rural livelihoods. Water shortages diminish crop yields, impair livestock health, and heighten household burdens, especially for women responsible for water collection in rural areas. Prolonged dry spells can exacerbate poverty and food insecurity, forcing households to rely on loans or migrate temporarily for work.[149]

Air quality is increasingly influenced by climatic variability. Rising temperatures and drought-induced dust storms heighten particulate matter ($PM_{2.5}$ and PM_{10}) concentrations, while higher ozone formation under heat stress compounds respiratory and cardiovascular health risks. Transport emissions, residue burning, and biomass use amplify these effects, particularly during dry and stagnant weather conditions.

The spatial distribution of climate risks in Charsadda reflects a clear gradient from north to south. Northern areas such as Harichand and Dhakki experience moderate runoff and relatively lower flood exposure, while southern zones, including Charsadda City, Nisatta, Sardheri, and Pir Qilla, lie in high to very high runoff corridors.[150] These floodplains combine dense population, critical infrastructure, and active river channels, making them the most hazard-prone sectors of the district.

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[146] Ibid.
[147] Field observations conducted by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[148] https://urbanpolicyunit.gkp.pk/wp-content/uploads/2020/07/DLUP-Charsadda-2020-NEW.pdf
[149] Field observations conducted by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[150] https://urbanpolicyunit.gkp.pk/wp-content/uploads/2020/07/DLUP-Charsadda-2020-NEW.pdf

Biodiversity and ecosystems are also being reshaped by climate change. Shifts in species composition have been observed in wetlands and riparian forests, where heatwaves and flood disturbances reduce breeding success among key fauna such as migratory waterfowl. Collectively, these detailed findings underscore that Charsadda's climate risks are multi-dimensional and mutually reinforcing. Soil erosion and flash floods during monsoon peaks, groundwater depletion in dry seasons, heat stress, and increased dust storms are intensifying across the district.

Priority Adaptation Areas and Initiatives

Charsadda's natural capital, its land, water, and air, forms the ecological foundation of its agrarian economy and social wellbeing. However, recurrent floods, heat stress, unsustainable land use, and pollution are degrading soil productivity, water quality, and air purity, thereby intensifying vulnerability to climate change. Protecting and restoring natural capital is therefore critical to sustaining livelihoods, maintaining ecosystem services, and enhancing climate resilience across the district.

To address the interconnected challenges affecting Charsadda's land, water, and air resources, five priority adaptation areas are identified under the Natural Capital theme. These priorities are grounded in the findings of the district field report, which emphasized recurrent flooding, soil erosion, water contamination, air pollution, and weak coordination among key institutions. The proposed objectives and actions integrate community priorities, departmental recommendations, and climate resilience strategies to safeguard Charsadda's natural capital and livelihoods.

Objective 1: Promote Sustainable Land and Ecosystem Management

Sustainable land management is critical to preserving Charsadda's fertile alluvial plains and maintaining ecosystem services that underpin rural livelihoods. The field report identified severe riverbank erosion, declining soil fertility from over-irrigation and fertilizer misuse, and degradation of rangelands due to overgrazing. Restoration of degraded agricultural land, riparian buffers, and private plantations can mitigate soil erosion, reduce flood risks, and enhance biodiversity.

Community-led bioengineering of embankments, afforestation, agroforestry, and rangeland rehabilitation are key interventions to stabilize soils and restore ecosystem functionality. Integrating these ecosystem-based approaches with regenerative farming, crop diversification, and soil conservation practices will improve soil health and carbon sequestration, sustaining productivity and resilience.

Objective 2: Strengthen Integrated Watershed and Water Resource Management

Charsadda's water system is under mounting stress from recurrent floods, siltation, and over-extraction. Infrastructure improvements (percolation ponds, recharge wells, and flood-spreading basins) can enhance aquifer replenishment. Field stakeholders also highlighted the need to link irrigation scheduling with early warning systems to improve efficiency and preparedness. Together, these measures will strengthen water security, reduce siltation, and improve resilience to floods and droughts.

Objective 3: Improve Urban and Rural Water Quality

Unsafe drinking water was consistently cited by community groups, health workers, and PHED officials as a critical challenge. Flooding events contaminate shallow aquifers, while untreated wastewater and fertilizer leaching degrade surface and groundwater quality. Enhancing water quality requires a mix of infrastructure, governance, and awareness actions.

Establishing decentralized filtration and chlorination systems in high-risk Union Councils (UCs), upgrading wastewater treatment and reuse facilities in Charsadda town, and enforcing effluent regulations are urgent priorities. Community-level WASH awareness programs on hygiene and safe handling will complement physical investments. Improved monitoring following PCRWR protocols can ensure early detection of microbial and chemical contamination. These measures collectively strengthen public health and climate resilience.

Objective 4: Enhance Air Quality Management and Reduce Emissions

Air pollution is emerging as a growing public health concern in Charsadda, driven by vehicle emissions, open burning of crop residues, and biomass fuel use. Field consultations confirmed the absence of structured emission controls or air monitoring. Implementing a District Clean Air Action Plan, aligned with the *National Clean Air Policy (2023)*, will provide a framework for emission reduction.

Key measures include vehicle inspection and maintenance systems, adoption of clean cooking and heating technologies (LPG, solar, or biogas), and incentive schemes for composting or biochar use to discourage residue burning. Deploying low-cost air-quality sensors and real-time public data reporting will improve awareness and accountability. These actions collectively reduce particulate pollution, improve health outcomes, and contribute to climate mitigation.

Objective 5: Promote Knowledge, Monitoring, and Governance for Natural Capital

Effective management of land, water, and air resources depends on robust data systems, interdepartmental coordination, and capacity building, areas identified as major weaknesses during field assessments. Establishing a District Environmental Information System (DEIS) will enable integrated monitoring of soil health, groundwater levels, air quality, and flood-prone areas using GIS and remote sensing.

To ensure coordination, the DEIS will be institutionalized within the District Resilience Coordination Committee (DRCC), with active participation from the District Disaster Management Authority (DDMA), PHED, Agriculture, EPA-KP, and Local Government departments. Regular capacity-building for line departments and community representatives will foster participatory governance. Integrating natural capital valuation and climate tagging into district budgeting and project appraisal will help mainstream climate adaptation into local planning and investment processes.

Table 6: Key Objectives and Initiatives for Natural Capital – Charsadda District

No.	Objective & Initiative	Timeframe	Key Responsible Entity	Priority Vulnerable UCs / Tehsils
Objective 1: Promote Sustainable Land and Ecosystem Management				
1.1	Develop and implement a Charsadda Landscape Restoration and Soil Conservation Program focusing on riparian buffer zones, eroded canal banks, and flood-prone farmland through afforestation, agroforestry, and community-led embankment bioengineering.	Short (2026–2028)	KP Forest & Wildlife Dept.; Agriculture Dept.; District Admin.; LGRDD; NGOs/CSOs; P&DD KP (Climate Action Board)	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai
1.2	Promote climate-smart and regenerative agriculture, including minimum tillage, organic amendments, and crop diversification, with a strong focus on providing agro-education to farmers. Offer training on improved seeds, sustainable fertilizers, and climate-smart farming methods to ensure the effective adoption of regenerative practices, enhancing soil fertility and carbon storage.	Short (2026–2028)	Agriculture Dept.; KP Climate Change Cell; Research & Extension Services; P&DD KP	Tangi (Umarzai, Turangzai)

1.3	Expand community-based rangeland rehabilitation and fodder plantations on culturable wastelands to reduce grazing pressure and restore vegetation.	Medium (2029–2033)	Agriculture Dept.; Livestock & Dairy Development; Farmer Cooperatives	Tangi uplands (Sherpao, Harichand)
1.4	Establish biodiversity corridors and ecological monitoring systems in riparian and wetland habitats to conserve pollinators and migratory waterfowl.	Medium (2029–2033)	Forest & Wildlife Dept.; Pakistan Museum of Natural History; Academia; NGOs	Agra, Batgram, Daulatpura
1.5	Integrate land-use zoning and floodplain regulation into District Development Plans to minimize encroachment and ensure sustainable land conversion.	Short (2026–2028)	KP Urban Policy Unit; Revenue Dept.	Charsadda City, Nisatta, Sardheri, Shabqadar (peri-urban)
Objective 2: Strengthen Integrated Watershed and Water Resource Management				
2.1	Construct percolation ponds, recharge wells and flood-spreading basins in vulnerable UCs to enhance aquifer replenishment.	Medium (2029–2033)	PHED; Irrigation Dept.; WUAs; NGOs	Nisatta, Sardheri, Shabqadar (peri-urban) areas.
2.2	Link irrigation scheduling with early warning systems and promote efficient irrigation methods like drip irrigation, furrow irrigation, and laser levelling. The government should provide subsidies and technical support to local farmers to facilitate the adoption of these methods	Short–Medium (2026–2033)	Agriculture Dept.; OFWM; Farmer Organizations; DDMA	Tangi (Turangzai, Utmanzai)
2.3	Strengthen water-quality monitoring and decentralized treatment systems building on PCRWR protocols.	Short (2026–2028)	PHED; EPA-KP; PCRWR; District Health Office	Charsadda City, Nisatta, Sardheri
2.4	Design, rehabilitate and construct climate-resilient flood protection walls, spurs and embankments along vulnerable reaches of the Swat and Kabul rivers using bioengineering and vegetation stabilization.	Short–Medium (2026–2033)	Irrigation Dept.; P&DD KP (Climate Action Board); District Admin.; KP Forest & Wildlife Dept.; NGOs/CSOs	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai
Objective 3: Improve Urban and Rural Water Quality				
3.1	Construct and rehabilitate community-scale filtration and chlorination plants in high-risk UCs.	Short (2026–2028)	PHED; LGRDD; Health Dept.	Charsadda City, Nisatta, Sardheri, Shabqadar (peri-urban)
3.2	Implement wastewater treatment and reuse systems in Charsadda town and peri-urban centres to prevent sewage inflows into rivers.	Medium (2029–2033)	LG&UD Dept.; EPA-KP; Industries Dept.; Development Authorities	Charsadda City, Shabqadar

3.3	Enforce polluter-pays mechanisms for industrial and municipal effluents entering natural waterways.	Medium (2029–2033)	EPA-KP; Industries Dept.; District Admin.	Charsadda City, Nisatta
3.4	Conduct public awareness and hygiene campaigns on safe water handling and sanitation practices under the WASH framework, with a clear participatory mechanism that actively involves local communities in designing, implementing, and monitoring the campaigns.	Short (2026–2028)	Health Dept.; Education Dept.; NGOs/CSOs	Agra, Daulatpura, Batgram, Sardheri, Shabqadar
Objective 4: Enhance Air Quality Management and Reduce Emissions				
4.1	Develop a District Clean Air Action Plan aligned with the National Clean Air Policy (2023), targeting the transport, biomass, and waste sectors. Strengthen biomass management by establishing grading facilities that are accessible to local communities, ensuring more efficient handling and reducing emissions from biomass burning.	Short (2026–2028)	EPA-KP; District Admin.; P&DD KP	District-wide
4.2	Establish vehicle inspection and maintenance systems along the N-45 corridor and Charsadda–Peshawar route.	Medium (2029–2033)	Transport Dept.; Traffic Police; EPA-KP	Charsadda City, Shabqadar
4.3	Promote clean cooking and heating technologies (LPG, solar stoves, biogas) to reduce indoor air pollution and black carbon. Ensure that these technologies are widely available, affordable, and accessible to local communities.	Medium (2029–2033)	Energy Dept.; Women Development Dept.; NGOs	Tangi (Harichand, Daulatpura)
4.4	Implement incentive-based schemes for farmers to discourage residue burning and encourage composting or biochar use.	Short (2026–2028)	Agriculture Dept.; EPA-KP; Farmer Cooperatives	Umarzai, Turangzai, Utmanzai
4.5	Deploy low-cost air-quality sensors for real-time monitoring and public reporting in Charsadda City and peri-urban clusters.	Medium (2029–2033)	EPA-KP; Academia; NGOs/Private Sector	Charsadda City, Sardheri, Shabqadar
Objective 5: Promote Knowledge, Monitoring and Governance for Natural Capital				
5.1	Establish a District Environmental Information System (DEIS) to integrate land, water and air data for decision support.	Short (2026–2028)	EPA-KP; GIS/IT Units; Academia; P&DD KP	District-wide, prioritizing Charsadda Tehsil and Tangi uplands for pilot deployment.

5.2	Build institutional capacity for climate governance through targeted training of line departments and DDMA on environmental monitoring and risk management.	Short–Medium (2026–2033)	KP Climate Change Cell; District Admin.; DDMA; P&DD KP	Charsadda, Tangi, Shabqadar Tehsils
5.3	Mainstream natural-capital valuation and climate tagging into district budgeting and project appraisal to guide adaptation investments.	Long (2033 onwards)	Finance Dept.; P&DD KP; District Council	District-wide

Urban Resilience

Sectoral Context

Urban Development

- Charsadda is undergoing a rapid urban transformation, with over 292,000 residents (approximately 16% of the district's population) living in urban centres such as Charsadda city, Shabqadar, and Tangi.[151]
- Urban expansion remains largely unplanned. Settlements have sprawled into flood-prone zones, aggravating exposure to hazards and stretching already under-resourced municipal services.[152]
- The average built-up expansion of Charsadda's towns exceeds population growth, leading to inefficient infrastructure deployment and environmental degradation.[153]
- Absence of an enforced land use regulation system and incomplete digitization of land records hamper formal urban planning.[154]

Municipal Services

- Drainage infrastructure in Charsadda is underdeveloped. Seasonal monsoon rains routinely inundate streets and homes due to blocked and undersized drains.[155]
- Solid waste management is fragmented; most garbage is dumped in open plots or waterways, worsening flooding and public health risks.[156]
- Water supply relies heavily on groundwater, often contaminated during floods due to leaching from septic tanks and surface runoff.[157]
- Public sanitation coverage is limited, particularly in low-income and peri-urban areas, contributing to disease outbreaks after floods.[158]

Air Pollution

- Urban localities in Charsadda experience deteriorating air quality from a mix of vehicular emissions, crop residue burning, and dust from unpaved roads.[159]

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[151] Pakistan Bureau of Statistics. *2023 Census – Provisional Summary Results*. Islamabad: PBS, 2023.
[152] Urban Policy Unit KP. District Land Use Plan – Charsadda. Peshawar: Government of KP, 2021 (Draft Internal Document).
[153] NDMA. Urban Flooding in Pakistan: Analytical Perspectives. Islamabad: NDMA Pakistan, 2024.
[154] Revenue Department KP. Digitization of Land Records Progress Brief – Charsadda District. Peshawar: Govt. of KP, 2023.
[155] Dawn News. "Families evacuated in Charsadda as river swells after downpour." Dawn, 12 July 2025.
[156] The Guardian. "Rivers of Waste: Pakistan's Recyclers Go Out on Patrol." The Guardian, 27 February 2019.
[157] Pakistan Council of Research in Water Resources (PCRWR). Water Quality Monitoring in KP Province – Annual Report. Islamabad: PCRWR, 2021.
[158] KP Environmental Protection Agency (EPA). State of the Environment Report – Khyber Pakhtunkhwa. Peshawar: EPA KP, 2020.
[159] IQAir. 2022 World Air Quality Report. Geneva: IQAir, March 2023.

- The lack of regulatory enforcement and alternative clean transport options makes mitigation challenging.

Climate Change Impacts

Climate change is amplifying urban climate risks in Charsadda by intensifying flood events, increasing the frequency and duration of heatwaves, and reducing air quality.[160] In recent years, cloudburst incidents have occurred more frequently, overwhelming the already limited drainage network and triggering flash flooding in densely populated areas.[161] Urban Heat Island (UHI) effects are becoming increasingly evident, especially in summer months, where surface temperatures in high-density neighbourhoods remain elevated throughout the night due to limited ventilation, heat absorption from built structures, and the absence of permeable surfaces.[162] Heat stress is further aggravated by declining green cover and inadequate shade provision across public and roadside areas.[163] This results in disproportionate exposure for vulnerable groups, particularly informal outdoor labourers and elderly populations, who are unable to avoid prolonged exposure to high temperatures. As climate impacts deepen, the associated health burden is also projected to rise due to stagnant floodwater (which contributes to waterborne diseases), elevated particulate matter concentrations, and increasing cases of heat-related illness.[164]

Charsadda's towns are acutely exposed because current urban systems are already under strain. Drainage infrastructure is undersized, decades old, and frequently clogged with solid waste, resulting in rapid waterlogging and flash floods during intense rainfall. Solid waste mismanagement compounds this risk, garbage dumped in drains obstructs flow and causes sewer backflow during heavy rain, turning even moderate monsoon spells into prolonged contamination events. These "everyday urban stresses" intensify the impacts of climate hazards, meaning climate change does not create new vulnerabilities as much as it magnifies existing systemic weaknesses. Urban adaptation in Charsadda must therefore prioritise resilient drainage, improved waste collection and community-led maintenance, and climate-responsive urban design to manage heat, reduce exposure, and protect public health.[165]

Priority Adaptation Areas and Initiatives

Objective 1: Promoting Climate-Informed Urban Planning

Urban Charsadda must integrate climate and disaster risk considerations into formal spatial planning, infrastructure development, and land management processes. Climate-sensitive planning principles, such as heat-responsive design, compact neighborhoods, functional density, and risk-aware zoning, are critical to reduce exposure to heatwaves and localized flooding. Integrating green cover, permeable surfaces, and shaded pedestrian zones will help buffer against the Urban Heat Island effect while improving air quality and livability. Furthermore, mapping and formalizing peri-urban expansion, through registration, basic land information structuring, and enforcement of building rules, will reduce unregulated sprawl and create scope for flood-safe growth corridors.

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[160] World Weather Attribution. "Pakistan Floods 2022 – Scientific Analysis." WWA, September 2022.
[161] PDMA KP. Monsoon Contingency Plan 2023. Peshawar: Provincial Disaster Management Authority, 2023.
[162] NASA Earth Observatory. "Beating the Heat in Pakistan." NASA ECOSTRESS Imagery, May 2024.
[163] Ahmed, K. & Shah, S.A. "Urban Heat Island Effect in Peshawar: Mitigation via Green Infrastructure." Pakistan Journal of Urban Affairs, Vol. 3, Issue 2, 2021.
[164] Clean Green Pakistan Movement. Urban Sanitation and Health Overview. Islamabad: Ministry of Climate Change, 2022.
[165] Urban Climate Resilience and Development in Pakistan, National Policy Paper https://cansouthasia.net/wp-content/uploads/2023/11/Urban-Climate-Resilience-and-Development-in-Pakistan-National-Policy-Paper.pdf#:~:text=severe%20urban%20flooding%20due%20to,was%20caused%20by%20unplanned%20development

Objective 2: Improving Municipal Service Delivery

Strengthening municipal services is central to building resilience because disruptions in water supply, drainage, sanitation, and waste systems magnify the impacts of extreme events. In Charsadda's context, priority actions include improving stormwater drainage to prevent waterlogging during high-intensity rainfall, enhancing solid waste collection to avoid drain blockages, and investing in reliable water supply infrastructure, including renovation of pipes, pressure management, and leak reduction. Service delivery reforms should emphasize equitable access, resilience of service nodes (pumps, filters, waste transfer points), and climate-responsive operation and maintenance.

Objective 3: Expanding Green Infrastructure and Ecosystem-Based Adaptation

Nature-based solutions should be scaled within Charsadda's urban and peri-urban zones to address heat stress, improve rainwater infiltration, and reduce flash-flood impacts. Interventions such as urban forestry, pocket parks, riparian green belts, bioswales, and bioretention basins, can support stormwater management and urban cooling simultaneously. These interventions complement built infrastructure, reduce drainage burdens, and provide co-benefits for public health and recreation. Where feasible, targeted NBS interventions may also generate measurable carbon sequestration benefits, which in future could inform carbon finance opportunities.

Objective 4: Strengthening Municipal Financial Capacity

Delivering climate-smart urban services requires predictable and diversified financing. Charsadda's municipal institutions need to enhance their revenue base while also leveraging external support mechanisms. Viable pathways include public–private partnerships for infrastructure service delivery, performance-linked climate resilience grants, and systematic improvement in user charges and cost recovery for select municipal services. Improved revenue streams will not only help reduce operational subsidies but also enable forward-looking investment planning, thus increasing fiscal space for urban adaptation.

Table 7: Key Objectives and Priority Initiatives for Urban Resilience – Charsadda District

No.	Objective & Initiative	Timeframe	Key Responsible Entity	Priority Vulnerable UCs / Tehsils
Objective 1: Promoting Climate-Informed Urban Planning				
1.1	Develop and enforce climate-risk-informed master plans for all urban settlements, including strict regulations on encroachment along flood-prone rivers, canals, and drainage channels. Implement setback regulations and no-construction zones to reduce flood risks and improve resilience.	Short (2026–2028)	KP Urban Policy Unit; District Administration; TMA; P&DD KP	Charsadda City, Tangi, Shabqadar
1.2	Enforce setback regulations and no-construction zones along flood-prone rivers, canals, and drainage channels.	Short (2026–2028)	Revenue Dept.; Irrigation Dept.; District Admin.; LGRDD	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai, Nisatta
1.3	Integrate peri-urban zones into formal planning through land registration, zoning delineation, and urban boundary demarcation.	Medium (2029–2033)	Revenue Dept.; District Admin.; TMA; KP Urban Policy Unit	Sardheri, Nisatta, peri-urban Shabqadar
Objective 2: Improving Municipal Service Delivery				

2.1	Upgrade drainage infrastructure using Sustainable Urban Drainage Systems (SUDS) to address pluvial and flash-flood risks. Prioritize an encroachment removal drive to clear blocked drains and improve the effectiveness of upgraded drainage systems.	Short–Medium (2026–2033)	C&W Dept.; TMA; LGRDD; KP Urban Policy Unit	Charsadda City, Nisatta, Sardheri, Shabqadar
2.2	Modernize waste collection and disposal systems, introducing segregation, transfer stations, and controlled disposal.	Short (2026–2028)	TMA; LGRDD; EPA-KP; Private-Sector Operators	Charsadda City, Sardheri, Shabqadar
2.3	Introduce solar-powered water filtration and pumping for off-grid urban clusters and low-lying settlements.	Short–Medium (2026–2033)	PHED; Energy Dept.; NGOs/Private Sector	Peri-urban Shabqadar and Nisatta
Objective 3: Expanding Green Infrastructure & Ecosystem-Based Adaptation				
3.1	Restore natural floodplains to function as buffer zones during high-intensity rainfall.	Medium (2029–2033)	Irrigation Dept.; Forest Dept.; District Admin.	Agra, Batgram, Daulatpura, Katu Zai
3.2	Expand urban tree plantation, micro-green spaces and parks under ongoing KP greening programmes.	Short–Medium (2026–2033)	Forest Dept.; TMA; Education Dept.; NGOs	Charsadda City, Sardheri, Shabqadar
3.3	Pilot green roofs and walls in public buildings (e.g., tehsil offices, hospitals) to reduce UHI and improve thermal comfort.	Short (2026–2028)	C&W Dept.; KP Health Dept.; District Admin.; Academia	Charsadda City, Tangi, Shabqadar
Objective 4: Strengthening Municipal Financial Capacity				
4.1	Improve municipal user-fee collection (solid waste, parking, water supply) to ensure cost recovery for services.	Short–Medium (2026–2033)	TMA; Finance Dept.; District Admin.	Charsadda City, Shabqadar
4.2	Pilot performance-based climate resilience grants for municipal service improvement, with performance-based certificates issued to concerned officials to incentivize efficient service delivery and ensure commitment to climate resilience.	Medium (2029–2033)	P&DD KP; Finance Dept.; Donor Agencies	Charsadda and Shabqadar TMAs
4.3	Promote PPP models for solid waste, recycling, water treatment, and distribution systems.	Medium (2029–2033)	TMA; KP PPP Unit; Private Sector; Finance Dept.	Charsadda City and Nisatta

Human Capital

Sectoral Context

Health

- Charsadda's human capital faces deep vulnerabilities driven by poverty, low healthcare coverage, and the limited adaptive capacity of local institutions. The district has 33 Basic Health Units (BHUs), one District Headquarters Hospital (DHQ), and 8 Rural Health Centres (RHCs), many of which are located in flood-prone areas. Health infrastructure remains weak, recurrent floods (notably in 2010, 2022, and 2024) damaged multiple BHUs in Shabqadar and Tangi tehsils, disrupting essential services. Poor WASH (Water, Sanitation, and Hygiene) facilities further compound vulnerability; around 43% of rural households lack access to safe drinking water, and over 55% use pit latrines, heightening the risk of waterborne diseases.[166]
- Post-flood disease outbreaks of diarrhea, dengue, and hepatitis are frequent, while heat stress events have led to a documented increase in dehydration and respiratory ailments. Women face additional burdens during emergencies; they lack access to reproductive health services, hygiene kits, and privacy, as reported by the Social Welfare Department[167]. The absence of climate-resilient infrastructure (e.g., cooling systems, water purification units, backup energy supply) and poor integration of climate health data into the district's health MIS reflect institutional fragility.

Education

- Charsadda's literacy rate stands at 49.5%, below the KP provincial average (55%). Floods in 2022 damaged more than 80 public schools, and temporary closures due to heatwaves and waterlogging have disrupted learning continuity. Many schools, particularly in Shabqadar and Tangi, double as evacuation shelters but lack flood-resistant construction, ventilation, and reliable electricity. Gender disparity remains stark; female literacy (38%) lags far behind male literacy (62%). Girls' education is further constrained by unsafe routes to schools during floods, early marriage, and household caregiving burdens.[168]
- Special education institutions for children with disabilities are particularly vulnerable to extreme heat and poor infrastructure. The Social Welfare Department reported that children with disabilities experienced higher absenteeism during heatwaves due to a lack of cooling systems and transport facilities. This demonstrates how climate impacts deepen pre-existing inequalities and learning poverty in Charsadda.

Labor and Economic Productivity

- Charsadda's economy is largely agrarian as around 72% of the working population is employed in agriculture, followed by 10% in construction and 7% in services. Informal labor predominates, particularly among women engaged in home-based embroidery, food processing, and handicrafts. Extreme weather events have repeatedly disrupted employment and income stability.[169] The 2022 flood submerged thousands of acres of farmland, causing crop losses in wheat and maize, reducing household incomes, and forcing temporary migration to urban areas. Heatwaves have also reduced labour productivity, with outdoor workers in construction, sanitation, and transport facing unsafe working conditions.[170]

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[166] WHO (2021). *Climate Change and Health Country Profile: Pakistan* (https://www.who.int/teams/environment-climate-change-and-health/climate-change-and-health/evidence-monitoring/country-profiles)
[167] ADB (2025). *Climate-Resilient Health Development: High-Level Health Care Climate Action Principle 1.* (http://dx.doi.org/10.22617/WPS250167-2)

[168] UNESCO (2024). *Education in a Climate Crisis.* (https://www.unesco.org/gem-report/en/2024ccec)
[169] ILO (2021). *World Employment and Social Outlook: Climate Change and Labour.* (https://www.ilo.org/publications/world-employment-and-social-outlook-trends-2021)
[170] NRDC (2019). Ahmedabad Heat Action Plan Case Study (*https://heathealth.info/resources/ahmedabad-heat-action-plan-2019/*)

- The collapse of small-scale fisheries along the River Jindi and limited diversification opportunities further constrain economic mobility. Vocational training coverage remains low, less than 5% of youth have formal skills certification and access to finance for climate-resilient enterprises, particularly for women entrepreneurs, is almost nonexistent.

Climate Change Impacts

Charsadda, located at the confluence of the Swat and Kabul rivers, remains one of Pakistan's most climate-vulnerable districts, where recurrent floods (2010, 2022, 2024), heatwaves, water contamination, and declining groundwater continue to disrupt public health systems, education continuity, and labour productivity. These shocks are eroding human capital and weakening labour income, ultimately reducing socio-economic resilience and long-term development gains for the district.

Climate-induced health risks are escalating rapidly as extreme weather events increasingly translate into direct disease outbreaks and disruption of essential medical services. Floods in 2010, 2022, and 2024 generated widespread water stagnation, triggering large increases in diarrhoea, dengue, malaria, and skin infections, particularly in Union Councils around Shabqadar, Agra, and Umerzai. Field evidence indicates that over 40 percent of BHUs were either non-functional or inaccessible during peak flood months in 2022, demonstrating how climate shocks can instantly collapse the primary healthcare delivery chain. Simultaneously, intensifying heatwaves, with temperatures frequently crossing 45°C, are creating heat-stress emergencies among outdoor labourers, sanitation workers, and schoolchildren, depressing both labour productivity and school attendance. Floodwater contamination of groundwater is also expanding the burden of gastroenteritis and hepatitis A/E, while prolonged agricultural losses are entrenching nutrition insecurity; malnutrition among under-five children exceeded 17 percent in 2023 in flood-affected clusters. Repeated WASH infrastructure failures, damaged water supply lines, broken hand pumps, and dysfunctional sanitation systems further heighten disease transmission risks. In addition, reproductive health needs remain poorly addressed in emergency shelters, and psychosocial trauma (especially for children, women, teachers, and front-line responders) continues to be an invisible and unprioritized burden.

The education sector is equally affected, with repeated floods destroying school infrastructure and disrupting learning continuity. The 2022 event alone damaged more than 150 schools in Charsadda, displacing almost 30,000 students. Schools used as temporary shelters rarely have resilient design, drainage, or WASH facilities, and during heatwaves, non-ventilated classrooms become unsafe, further depressing attendance. Prolonged closures, exceeding 40 days in some Union Councils, created major learning losses, disproportionately affecting girls and rural households. Disability-inclusive facilities for evacuation, cooling, or temporary instruction remain absent, deepening inequities. Meanwhile, the lack of psychosocial support for trauma-affected children has resulted in behavioural stress, concentration difficulty, and anxiety that remains unrecognised in formal education planning.

Climate shocks have profound implications for labour, occupational safety, and productivity. Workers in agriculture, brick-kilns, construction, and informal urban services, sectors that dominate Charsadda's labour market, are increasingly exposed to heat stress, with field data indicating productivity declines exceeding 20 percent in 2022–24 heatwave periods. Flood-driven crop losses and small-enterprise destruction are pushing workers into unstable, low-wage informal work, with female home-based workers especially disadvantaged due to market disruption and poor social protection. The collapse of fisheries along the Kabul River has eliminated entire income pathways for youth[171], while a significant skill gap persists; there is no pipeline for green jobs, such as renewable energy, sustainable construction, or climate-smart agribusiness. Infrastructure disruption, from road damage to supply chain delays, further increases business transaction costs.

[171] ICRISAT (2021). *Climate-Smart Agriculture in South Asia.* (https://icrisat.org/research/climate-adaptation-and-mitigation/about)

Combined with illness-related absenteeism, these dynamics directly reduce household income and the district's economic contribution to KP's GDP.

Priority Adaptation Areas and Initiatives

The key priority areas for strengthening human capital and community resilience in Charsadda District focus on integrating climate adaptation into social-sector policies, enhancing emergency preparedness, and building workforce capacities to support a green and resilient economy.

Objective 1: Mainstreaming Climate Adaptation in Social-Sector Policies

Sectoral plans in health and education should be aligned with national climate policies and international commitments to strengthen institutional preparedness in the district. Resilient design features, such as solar backup systems, elevated foundations in flood-prone areas, and safe WASH facilities, should be integrated into new constructions and the rehabilitation of BHUs and schools. Embedding climate-sensitive indicators, including heat-related illnesses, student absenteeism during extreme events, and service disruptions, into district MIS will support evidence-based decision-making. In addition, incorporating climate change and disaster management modules into teacher training and medical staff development programs will enhance the capacity of frontline personnel to respond effectively to emerging climate risks.

Objective 2: Enhancing Community Resilience and Emergency Preparedness

Investing in climate-resilient infrastructure is critical for maintaining essential health and education services during extreme weather events. District Health and Education Emergency Preparedness Plans should cover hazards such as floods, heatwaves, and disease outbreaks, detailing protocols for rapid response and service continuity. Mobile emergency health camps providing maternal and reproductive care during crises will ensure essential services reach vulnerable populations. Regular school and community evacuation drills, alongside public awareness campaigns, will strengthen preparedness and promote community engagement. In addition, retrofitting public facilities, including schools, hospitals, and multipurpose shelters, with climate-resilient WASH systems and backup power will reduce the vulnerability of infrastructure while improving operational continuity during disasters.

Objective 3: Building Workforce Capacities and Green-Livelihood Transition

To support long-term climate resilience, it is essential to equip the workforce with skills that address climate risks while fostering sustainable livelihoods. Green Vocational Centres under TEVTA can offer training in solar energy, sustainable agriculture, and eco-construction, preparing youth and workers for emerging green job opportunities. Livelihood diversification schemes targeting flood-affected farmers and women entrepreneurs, including solar-powered agribusiness and climate-smart food processing, will enhance economic resilience. Integrating climate-risk management into microfinance and SME capacity-building programs will strengthen adaptive capacity at the household and enterprise level. Finally, implementing occupational safety standards and heat-protection protocols for outdoor workers will safeguard labour productivity while addressing the direct impacts of extreme heat and climate exposure.

Table 8: Key Objectives and Initiatives for Human Capital - Charsadda District

No.	Objective & Initiative	Timeframe	Key Responsible Entity	Priority Vulnerable UCs / Tehsils
Objective 1: Mainstream Climate Adaptation in Social-Sector Policies				
1.1	Integrate resilient design (e.g., solar backup, elevated foundations, WASH upgrades) into new and rehabilitated BHUs and	Medium (2029–2033)	Health Dept KP; Education Dept KP; Local Govt Dept	Agra, Batgram, Daulatpura, Katu Zai, Shabqadar, Nisatta

	schools, while ensuring the development of alternative road networks and well-maintained access routes to enhance connectivity and disaster resilience.			
1.2	Embed climate-sensitive indicators (heat illness, absenteeism) in district MIS systems.	Short–Medium (2026–2030)	DHO; DEO; PDMA KP	Charsadda City, Sardheri, Shabqadar
1.3	Integrate climate change and disaster management modules into teacher and medical training curricula.	Short (2026–2028)	Provincial Training Institutes; MoCC&EC; PDMA KP	District-wide application, prioritizing health and education staff from Shabqadar and Tangi
Objective 2: Enhance Community Resilience and Emergency Preparedness				
2.1	Develop District Health and Education Emergency Preparedness Plans covering floods, heatwaves, and disease outbreaks.	Short (2026–2028)	DC Charsadda; Rescue 1122; PDMA KP	Charsadda, Shabqadar, Tangi Tehsils
2.2	Establish mobile emergency health camps with maternal and reproductive services during crisis periods, involving local community organizations in the establishment and operation of these camps.	Short (2026–2028)	DHO; Social Welfare Dept; NDMA; Rescue 1122; CSOs	Agra, Daulatpura, Batgram, Katu Zai
2.3	Conduct regular school and community evacuation drills and awareness sessions.	Medium (2029–2033)	Education Dept; Rescue 1122; PDMA KP	Tangi (Umarzai, Turangzai) and Shabqadar
2.4	Retrofit public facilities (schools, shelters, hospitals) with climate-resilient WASH systems and backup power.	Medium (2029–2033)	Local Govt Dept; TMA; Development Authorities	Nisatta, Sardheri, Shabqadar
Objective 3: Build Workforce Capacities and Green-Livelihood Transition				
3.1	Establish Green Vocational Centres under TEVTA for solar energy, sustainable agriculture, and eco-construction.	Medium (2029–2033)	TEVTA KP; Labour Dept; WCCIC	Charsadda City and Tangi
3.2	Launch livelihood diversification schemes for flood-affected farmers and women entrepreneurs (solar agribusiness, food processing).	Short–Medium (2026–2033)	Social Welfare Dept; Agriculture Dept; Microfinance Institutions	Agra, Daulatpura, Batgram, Katu Zai, Sardheri, Shabqadar
3.3	Introduce climate-risk management modules in microfinance and SME capacity-building programs.	Medium (2029–2033)	WCCIC; MoF; Microfinance Institutions	Charsadda City, Nisatta, Shabqadar
3.4	Implement occupational safety standards and heat protection protocols for outdoor workers.	Short (2026–2028)	Labour Dept; Municipal Admin; PDMA KP	Charsadda City, Sardheri, Shabqadar

6. Cross-Cutting Areas

Disaster Risk Management

Sectoral Context

Disaster Risk Landscape

- Charsadda faces a high level of multi-hazard exposure, especially to floods, flash floods, heatwaves, earthquakes, windstorms, and smog. It lies at the confluence of the Kabul, Swat, and Jindi Rivers, major tributaries whose overflowing regularly inundates surrounding settlements.[172]
- Approximately 60% of the district's population resides in high-risk flood zones, many in informal settlements along riverbanks or on low-lying terrain.[173]
- Historical records show significant loss and damage during major climate disasters: the 2010 mega-floods displaced over 70,000 families in Charsadda alone, while the 2022 super floods again inundated large swathes of the district.[174]
- Earthquake risk remains latent, with Charsadda located in a seismically active region adjacent to major fault lines in northern Pakistan.[175]

Institutional Framework

- The District Disaster Management Unit (DDMU), under the Deputy Commissioner's office, leads local DRM planning and coordination. It operates under the KP Provincial Disaster Management Authority (PDMA) and NDMA at the federal level.[176]
- The legal framework for DRM is guided by the National Disaster Management Act (2010), KP DRM Policy (2018), and Monsoon Contingency Plans issued annually.
- Despite these structures, operational challenges persist: early warnings often do not reach at-risk communities; preparedness drills are rare; and local responders lack rescue boats, safety gear, and logistics support.[177]

Climate Change Impacts

Climate change is increasing both the frequency and intensity of disasters in Charsadda. The district is now experiencing more erratic rainfall patterns, heavier precipitation events, and prolonged dry spells.[178] Glacial melt and inconsistent upstream flows from the Swat basin have intensified flash flooding downstream, making flood events more severe and unpredictable.[179] The 2022 floods overwhelmed the district's existing embankments and stormwater channels, resulting in widespread inundation of health facilities, schools, markets, and agricultural fields.[180] Heatwaves have also become more frequent and life-threatening, placing additional pressure on already limited emergency health and response systems.[181] With continued urban expansion into hazard-prone

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[172] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Charsadda District. Sustainable Development Policy Institute (SDPI)
[173] Field observations conducted by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[174] NDMA. Pakistan Floods 2010: Preliminary Damage and Needs Assessment. 2011. https://www.gfdrr.org/sites/default/files/publication/pda-2010-pakistan.pdf
[175] Geological Survey of Pakistan. Seismic Hazard Zonation of Khyber Pakhtunkhwa. 2020.
[176] PDMA KP. Monsoon Contingency Plan 2022 and Annual Reports.
[177] Government of Pakistan. National Disaster Management Act, 2010. http://ndma.gov.pk/publications/ndma_act2010.pdf
[178] Field observations conducted by the author during site visits to Charsadda and Peshawar, 12–24 June 2025.
[179] Pakistan Meteorological Department. Climatological Trends & Forecasts – KP Region. https://www.pmd.gov.pk
[180] ICIMOD. HKH Glacial Watch – Swat Basin Focus (2022). https://www.icimod.org/resource/hkh-glacial-watch-2022/
[181] UNDP & GoKP. Post-Flood Damage Assessment – KP Floods 2022 (Internal Report).

areas, these climate impacts are increasingly concentrated in peri-urban slums and riverine settlements, where infrastructure is weak and exposure is highest.[182]

Priority Adaptation Areas and Actions

Objective 1: Strengthening Early Warning and Forecasting Systems

Strengthened early warning and hydro-meteorological intelligence is a top priority for Charsadda. Strengthen the existing early warning systems for weather and river conditions by upgrading and integrating current monitoring stations. Enhancing the accuracy and timeliness of data will improve the district's ability to issue alerts and support rapid community-level response during flood and other weather-related emergencies.. Developing community-based flood risk maps and clearly defined evacuation protocols in high-risk UCs will further ensure that households understand what actions to take when warnings are issued. Collectively, these measures will enable anticipatory action rather than reactive response, reducing loss of life and asset damage during flash floods and extreme rainfall events.

Objective 2: Improving Local Response and Emergency Preparedness

A more prepared local response architecture is essential to manage climate-driven disasters. Equipping the District Disaster Management Unit (DDMU) and TMAs with boats, megaphones, ropes and emergency kits will allow first responders to operate effectively during peak flood periods. Regular monsoon drills, conducted annually in flood-prone UCs through coordination between DDMA, Rescue 1122 and Civil Defense, are critical for institutional preparedness. Training community volunteers in basic first aid, evacuation support and relief distribution will strengthen the district's surge capacity and reinforce the link between formal disaster institutions and local citizen networks.

Objective 3: Reducing Risk through Infrastructure and Land Use

Reducing physical exposure to hazard zones will require a combination of structural and regulatory interventions. Reinforcing embankments and riverbanks at priority erosion hotspots, particularly along the Kabul River, will help reduce flood overtopping and riverbank collapse. Constructing elevated flood shelters in low-lying settlements of Charsadda and Shabqadar will provide safe refuge during high-flow events. In parallel, tightening land-use controls, including prohibiting new construction in flood-prone zones and relocating high-risk informal settlements, will help correct decades of unplanned expansion into hazard-exposed corridors.

Objective 4: Strengthening Disaster Governance and Financing

Stronger governance and predictable financing are necessary to transition Charsadda from relief-focused to resilience-focused disaster management. Annual updating and localization of the District DRM Plan, with full stakeholder participation, will institutionalize learning and ensure relevance of actions. Establishing a District Emergency Fund will enable rapid procurement, relief delivery and early response mobilization at the local level. Further, systematic resource mobilization through national adaptation finance, PDMA allocations, and donor partnerships can unlock the scale of investment needed for resilient infrastructure and preparedness systems.

Objective 5: Mainstreaming Community-Based Disaster Risk Management (CBDRM)

Community-centered mechanisms are foundational for localized resilience. Forming neighborhood-level disaster response committees, with meaningful participation of women and youth, will embed preparedness at the scale where hazard impacts are felt. Strengthening school safety programmes and integrating hazard awareness modules in education will help build a new generation of climate-aware citizens. Institutionalizing CBDRM within the DDMU, with dedicated staff and budget lines,

[182] World Weather Attribution. Pakistan Heatwave 2022 – Attribution Study. https://www.worldweatherattribution.org/extreme-heat-in-pakistan-and-india-in-2022/

will ensure that community structures are not ad-hoc or project-dependent but formally integrated into Charsadda's resilience architecture.

Table 9: Key Objectives and Initiatives for Disaster Risk Management - Charsadda District

No.	Objective & Initiative	Timeframe	Key Responsible Entity	Priority Vulnerable UCs / Tehsils
Objective 1: Strengthen Early Warning and Forecasting Systems				
1.1	Strengthen existing early warning systems for weather and river monitoring. Focus on upgrading and integrating current monitoring stations to enhance data accuracy, timeliness, and community-level response during flood and weather-related crises.	Short (2026–2028)	PDMA KP; Pakistan Meteorological Department; Irrigation Dept.; District Administration; Agriculture Dept.	Upstream Tangi (Swat–Jindi catchments) and southern Charsadda (Agra, Batgram)
1.2	Develop a Charsadda-specific mobile app for residents to receive timely flood warnings, share community insights, and access real-time flood forecast data, improving community engagement and disaster preparedness. Identify and train community leaders to manage and relay alerts effectively.	Short (2026–2028)	DDMA; PDMA KP; TMAs; Telecom Operators; Agriculture Dept.	Agra, Batgram, Daulatpura, Katu Zai, Shabqadar, Nisatta
1.3	Develop community-based flood risk maps and evacuation protocols for high-risk UCs, involving the creation of multiple community groups to ensure inclusive participation. Identify safe spots clearly on the flood maps and ensure that evacuation routes and procedures are well-communicated to all community members.	Short–Medium (2026–2030)	DDMA; District Admin; NGOs/CSOs; Academia	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai and Tangi (Umarzai, Turangzai)
Objective 2: Improve Local Response and Emergency Preparedness				
2.1	Equip Rescue 1122 with the necessary rescue boats, megaphones, ropes, and emergency kits to enhance their capacity for disaster response in Charsadda, Shabqadar, and Tangi Tehsils. Leverage the existing capacity of Civil Defence personnel for rescue operations without additional equipping, as they already have the necessary posts and training for such efforts.	Short (2026–2028)	DDMA; TMAs; Rescue 1122; Civil Defence	Charsadda, Shabqadar, Tangi Tehsils

2.2	Support and strengthen existing emergency drills conducted by Civil Defence in schools, colleges, and communities across flood-prone UCs. Ensure coordination with Rescue 1122 and DDMA for annual monsoon preparedness drills, focusing on community-wide readiness and effective flood response.	Short–Medium (2026–2033)	DDMA; Rescue 1122; Civil Defence	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai; Shabqadar (peri-urban lowlands)
2.3	Train community volunteers in first aid, evacuation, and relief distribution following Civil Defence guidelines.	Short (2026–2028)	Civil Defence; DDMA; Health Dept.; NGOs/CSOs	Floodplain UCs (Agra, Batgram, Daulatpura, Katu Zai) and peri-urban Shabqadar, Nisatta
Objective 3: Reduce Risk through Infrastructure and Land Use				
3.1	Reinforce embankments and riverbanks at priority erosion hotspots along the Kabul River, where active channel migration and lateral erosion are causing permanent land loss and increased settlement exposure.	Short–Medium (2026–2033)	Irrigation Dept.; District Admin; P&DD KP	Agra, Batgram, Daulatpura, Katu Zai, Hassan Zai
3.2	Construct elevated flood shelters in low-lying / high-risk localities of Charsadda and Shabqadar.	Medium (2029–2033)	PDMA KP; DDMA; TMAs; NGOs	Charsadda City, Shabqadar (peri-urban), Nisatta, Sardheri.
3.3	Prohibit new construction in flood-prone zones and relocate high-risk informal settlements.	Medium (2029–2033)	KP Urban Policy Unit; Revenue Dept.; District Admin	Agra, Daulatpura, Batgram, Katu Zai and Shabqadar fringes
Objective 4: Strengthen Disaster Governance and Financing				
4.1	Update and localize Charsadda's District DRM Plan every three years with active stakeholder participation.	Short–Medium (2026–2033)	DDMA; District Admin; PDMA KP	District-wide, with particular focus on flood-prone southern and peri-urban northern belts.
4.2	Establish a District Emergency Fund for rapid response procurement and relief delivery in Charsadda Tehsil. In addition, establish a community-level emergency fund in high-risk areas to ensure localized response capacity and immediate relief delivery during disasters.	Short (2026–2028)	District Admin; Finance Dept.; PDMA KP	Charsadda Tehsil
4.3	Conduct a thorough assessment of flood-prone areas in Charsadda to guide resource allocation for adaptation and DRR financing. Mobilize funding	Short–Medium (2026–2033)	P&DD KP; PDMA KP; District Admin	District-wide, targeting Agra–Batgram floodplain and Tangi uplands for

	through PDMA allocations, donor grants, and national climate finance, ensuring that resources are directed towards the most vulnerable areas			prioritized resilience investment.
Objective 5: Mainstream Community-Based Disaster Risk Management (CBDRM)				
5.1	Form neighbourhood-level disaster response committees with women and youth representation.	Short (2026–2028)	DDMA; Social Welfare Dept.; NGOs/CSOs; Civil Defence	Shabqadar, Nisatta, Sardheri, Agra
5.2	Promote school safety programs and hazard awareness modules in schools.	Short–Medium (2026–2033)	Education Dept.; DDMA; Civil Defence	Tangi (Umarzai, Turangzai), Shabqadar, Nisatta
5.3	Institutionalize CBDRM within the DDMU with dedicated staff and budget lines.	Medium (2029–2033)	DDMA; District Admin; P&DD KP	District-wide, enabling coordinated community preparedness across all high-risk tehsils.

Gender, Youth, and Social Inclusion

Sectoral Context

Charsadda District, located in Khyber Pakhtunkhwa, Pakistan, is a rapidly growing district with a population of 1.7 million in 2019, projected to reach 3.15 million by 2039.[183] The population is youthful, with nearly two-thirds under the age of 30, creating both opportunities and challenges for economic growth, service provision, and sustainable land use. Population growth, combined with urban expansion, educational attainment, labour force participation, and dependency ratios, significantly influences land use, housing demand, and economic development. Proper planning for housing, education, health, industry, and trade is crucial to accommodate population growth while preserving prime agricultural land.

Gender

- Women in Charsadda exhibit low labour force participation, with fewer than 25% of women engaged in formal economic activities compared to over 75% of men.[184] Many women are engaged in unpaid domestic work or informal sectors, limiting their economic independence and decision-making power.
- Only about 50% of girls in Charsadda complete primary education, compared to around 70% of boys. Adult female literacy is approximately 46%, compared to 69% for men.[185]
- Limited availability of schools, safety and transportation concerns, societal norms favouring boys' education, and insufficient female teachers contribute to low female literacy and employment. Lack of access to family planning and reproductive health services further restricts women's autonomy and economic participation.

[183] Final Land Use Plan of District Charsadda- Provincial Land Use Plan (PLUP) Urban Policy and Planning Unit
[184] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit, Peshawar.
[185] https://doi.org/10.47264/idea.lassij/3.2.21

- Traditional gender roles restrict women's mobility, participation in politics, and community decision-making. Early marriages, gender-based harassment, and cultural biases often prioritize boys' education and work over girls'.[186]
- Low literacy and limited skills restrict women's access to formal employment, entrepreneurship, and financial resources, perpetuating cycles of poverty and dependency.
- Expand girls' access to education at all levels, increase the availability of female teachers, provide safe school environments, promote women's entrepreneurship and financial inclusion, and integrate gender-responsive policies into housing, health, education, and industrial development planning.[187]

Youth

- Charsadda has a significant youth population, with nearly two-thirds under 30 years and about 30% below age 10, presenting both opportunities and challenges for education, employment, and social services.[188]
- Around 35% of youth aged 15–24 is neither enrolled in education nor employed, with the rate higher for young women at 56%. Limited access to schools, vocational training, and skill development programs reduces youth employability.[189]
- The youth in Charsadda face limited opportunities due to low skills, lack of market-aligned training, and socio-cultural barriers. Programs like the Ehsaas Naujawan Programme provide financial support and entrepreneurship opportunities, but gaps remain in broader skill development and employment creation.[190]
- Key barriers include poor education quality, inadequate vocational training centers, gender norms restricting participation of young women, and limited access to mentorship and financial services.[191]

Social Inclusion

- Vulnerable groups, including women, PWDs, transgender individuals, and minorities, face systemic barriers to education, employment, and decision-making, affecting inclusive development.
- Many vulnerable populations in Charsadda, particularly women and PWDs, face barriers to accessing quality education and skill-building programs. Female literacy in the district stands at approximately 40.36%, compared to 66.55% for males, while a significant portion of youth is neither enrolled in school nor vocational training.
- Vulnerable groups have limited participation in formal economic activities. Women's engagement in the workforce is low, and PWDs face challenges in finding accessible employment. Rural poverty, estimated at 42.79%, further limits opportunities for marginalized populations. Social protection programs, including Ehsaas, BISP, and the Prime Minister's Youth Programme, provide financial support, scholarships, and employment opportunities, but coverage gaps remain, particularly in rural areas.
- Challenges include educational disparities, employment inequality, social stigma, and cultural discrimination, which limit participation in economic, social, and political spheres.[192]

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[186] UNDP. (2021). *Human Development Report Pakistan 2021: Gender and Development*
[187] UN Women. (2021). Progress of the World's Women: Gender Equality in Pakistan. UN Women Regional Office for Asia and the Pacific.
[188] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit, Peshawar.
[189] Final Land Use Plan of District Charsadda- Provincial Land Use Plan (PLUP) Urban Policy and Planning Unit
[190] Directorate of Youth Affairs KP. (2025). Monthly Progress Report – April 2025
[191] UNDP. (2021). *Human Development Report Pakistan 2021: Gender and Development*
[192] UN Women. (2021). Progress of the World's Women: Gender Equality in Pakistan. UN Women Regional Office for Asia and the Pacific.

Impact of Climate Change

Climate change in Charsadda District has profound implications for youth, women, and socially marginalized groups, shaping both their daily lives and long-term resilience. Women, who already face low labour force participation (less than 25%) and limited access to education (female literacy 46% compared to 69% for men), are disproportionately affected by climate-induced shocks such as floods, droughts, and heatwaves.[193] During the 2022 floods, women in Charsadda reported heightened risks of displacement, lack of privacy in shelters, disruption of maternal and child healthcare, and increased exposure to gender-based violence.[194] Youth who constitute nearly 63% of the district's population face systemic barriers in education and employment that are worsened by climate disasters. Floods in 2022 damaged over 1,500 schools in Khyber Pakhtunkhwa, including dozens in Charsadda, displacing thousands of students and exacerbating already low school completion rates.[195] Such repeated disruptions contribute to eco-anxiety among young people, as uncertainty about future livelihoods, displacement, and food insecurity generates psychological distress and a sense of climate injustice.[196] [197]

Climate change also raises questions of equity and justice in Charsadda, as socially marginalized groups, including women-headed households, persons with disabilities, and minority communities, face the greatest barriers in accessing relief, recovery, and long-term adaptation programs. Limited access to clean drinking water, agricultural inputs, and healthcare during disasters further entrenches social inequalities. For example, nearly 38% of households in Charsadda lack piped water, making women and girls responsible for water collection more vulnerable during floods.[198] Despite Pakistan's increasing focus on adaptive social protection, integration remains weak at the district level. Programs like the Benazir Income Support Programme (BISP) and Ehsaas Emergency Cash provided immediate relief during the 2022 floods, but they lacked built-in climate adaptation features such as support for crop/livestock insurance, climate-resilient housing, or vocational skills for green livelihoods.[199] Adaptation projects implemented by NGOs, such as flood-resilient housing and community disaster preparedness initiatives, have yet to be systematically aligned with social protection systems, limiting their sustainability and reach.

The compounded effects of eco-anxiety, inequitable access to resources, and weak integration of social protection within climate adaptation efforts highlight that climate change in Charsadda is not only an environmental crisis but also a deeply social one. Addressing these challenges requires gender-responsive, youth-centered, and socially inclusive adaptation strategies that integrate climate-adaptive social protection to ensure that vulnerable communities are not left behind.[200]

Priority Adaptation Areas and Initiatives

Objective 1: Strengthen the Capacity of Vulnerable Groups through Education, Skills, and Livelihood Diversification

With Charsadda's population projected to nearly double from 1.7 million in 2019 to 3.15 million by 2039, the demand for education, housing, and employment opportunities will sharply rise.[201] Climate change further threatens agriculture-based livelihoods, which dominate the district's economy.

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[193] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit, Peshawar
[194] UN Women. (2022). Gendered Impact of Pakistan's Floods
[195] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit,
[196] Clayton, S. (2020). Climate Anxiety: Psychological Responses to Climate Change. Journal of Anxiety Disorders, 74, Ali, S., & Khan, R. (2023). Climate Anxiety among Rural Youth in Pakistan: Emerging Psychological Challenges. Journal of Environmental Psychology, 86(4), 102-118. 102-116.
[197]
[198] PBS. (2017). Population Census of Pakistan 2017 – District Charsadda. Pakistan Bureau of Statistics.
[199] World Bank. (2020). Pakistan Gender Review: Challenges and Opportunities
[200] World Bank. (2020). Pakistan Gender Review: Challenges and Opportunities
[201] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit,

Strengthening vulnerable groups, particularly women and youth, through climate-resilient vocational training, climate-smart agriculture, and small-scale enterprise development can reduce economic vulnerability. Expanding access to secondary and technical education particularly for girls who currently face a 24% literacy gap compared to boys will enhance adaptive capacity and reduce outward migration.[202]

Objective 2: Ensure Inclusive Participation in Policy and Planning

Marginalized groups, including women, youth, and persons with disabilities, are often excluded from local decision-making on land use, disaster preparedness, and resource allocation. Inclusive planning mechanisms that institutionalize quotas for youth and women in village councils and disaster management committees can enhance resilience by ensuring that adaptation initiatives respond to diverse community needs. For instance, planning for housing expansion where demand will exceed 290,000 units over the next 20 years must integrate women's safety, accessibility for persons with disabilities, and youth employment opportunities in construction and services.

Objective 3: Promote Climate-Responsive Social Protection Systems

Adaptive social protection is critical for building resilience in flood-prone districts like Charsadda. While programs like BISP and Ehsaas provide temporary financial relief, they are not yet tailored to climate shocks. Integrating climate triggers into social protection schemes, for example, scaling up cash transfers during floods, linking social safety nets to crop/livestock insurance, and offering health coverage for displaced households would directly benefit women-headed households, landless farmers, and daily wage youth workers. During the 2022 floods, many women and disabled persons were unable to access relief due to poor targeting and lack of inclusive infrastructure, highlighting the urgency of reform.[203]

Objective 4: Enhance Access to Resources and Services for Marginalized Groups

Inequitable access to resources such as land, water, and healthcare exacerbates vulnerability in Charsadda. Nearly 38% of households lack piped water, increasing women's workload during climate shocks, while poor health facilities reduce community resilience.[204] Expanding decentralized health centers, providing reproductive healthcare for women, and ensuring accessible shelters for persons with disabilities during disasters are crucial adaptation priorities. Land use regulations that prevent conversion of prime agricultural land also need to be paired with secure land tenure for smallholders and equitable distribution of irrigation resources to avoid reinforcing existing inequalities.

Objective 5: Address Climate Justice and Eco-Anxiety through Community Engagement and Awareness

Youth in Charsadda face growing eco-anxiety as repeated floods disrupt education, training, and job opportunities, undermining long-term aspirations.[205] Community-based awareness programs, psychosocial support services, and green entrepreneurship schemes can channel youth anxiety into climate action and innovation. Promoting recreational and cultural spaces such as Sardaryab and Hazrat Baba-ul-Din Nimoun Forest as eco-tourism hubs can create employment while fostering collective ownership of natural resources. Climate justice requires that adaptation projects prioritize those most affected women, youth, and marginalized groups by providing equitable access to benefits and recognizing their rights in resource management.

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[202] Final Land Use Plan of District Charsadda- Provincial Land Use Plan (PLUP) Urban Policy and Planning Unit
[203] SDPI. (2023). *Climate-Induced Disasters and Social Protection in Pakistan: Policy Gaps and Opportunities.*
[204] Pakistan Bureau of Statistics (PBS). (2017). *Population and Housing Census 2017 – District Charsadda.* Government of Pakistan, Islamabad.
[205] https://doi.org/10.1016/j.janxdis.2020.102263

Table 3: Key Objectives and Initiatives for Gender, Youth, and Social Inclusion – Charsadda District

No.	Objective & Initiative	Timeframe	Key Responsible Entity	Priority Vulnerable UCs / Tehsils
Objective 1: Strengthen Capacity of Vulnerable Groups through Education, Skills, and Livelihood Diversification				
1.1	Establish Youth Climate Volunteer Networks to support disaster preparedness, early warning dissemination, and relief efforts.	Short (2026–2028)	DDMA; Education Dept.; Local Universities; Youth Affairs Dept.; Local NGOs	Agra, Batgram, Daulatpura, Shabqadar, Tangi (Umarzai)
1.2	Develop Green Skills Training Hubs in renewable energy, climate-smart agriculture, water management, and eco-entrepreneurship.	Medium (2029–2033)	TEVTA KP; Agriculture Dept.; Energy Dept.; Local Universities; Education Dept.	Charsadda City, Shabqadar, Tangi
1.3	Expand Women and Youth Climate-Resilient Livelihood Programs (small livestock, kitchen gardening, handicrafts, ICT).	Medium (2029–2033)	Agriculture Dept.; Livestock Dept.; NRSP/SRSP; Cooperatives	Shabqadar, Nisatta, Sardheri, Daulatpura
1.4	Provide proactive counselling services and disaster management skills/trainings as part of pre-disaster preparedness to address eco-anxiety, psychosocial stress, and gender-based vulnerabilities. Develop counselling centers at universities and local community spaces to support problem-solving, resilience-building, and mental health before and during disasters.	Short–Medium (2026–2033)	Social Welfare Dept.; Health Dept.; NGOs	Agra, Batgram, Shabqadar, Nisatta.
Objective 2: Ensure Inclusive Participation in Policy and Planning				
2.1	Ensure Representation of Women, Youth, Minorities, and Persons with Disabilities in UC- and District-level Disaster Committees.	Short (2026–2028)	DDMA; Local Govt.; CSOs	District-wide, with priority inclusion from Shabqadar, Tangi, and Charsadda.
2.2	Institutionalize Gender & Youth Quotas in Climate Adaptation Planning at district level.	Medium (2029–2033)	P&DD KP; District Council; Women Development Dept.	District-level policy measure, representation from Tangi (Umarzai) and Shabqadar.
2.3	Create Local Knowledge Platforms led by youth and women to document community-led adaptation practices. Leverage student societies and faculty to engage the community, helping them document and share local adaptation practices.	Medium (2029–2033)	Academia; NGOs; CSOs; HEIs	Agra, Batgram, Turangzai, Shabqadar
Objective 3: Promote Climate-Responsive Social Protection Systems				

3.1	Introduce Shock-Responsive Cash Transfers linked to climate disasters (floods, droughts).	Short (2026–2028)	BISP; Social Welfare Dept.; P&DD KP	Agra, Batgram, Daulatpura, Katu Zai, Tangi
3.2	Pilot Micro-Insurance Schemes for small farmers, women entrepreneurs, and flood-affected households.	Medium (2029–2033)	State Bank; Insurance Companies; Farmer Cooperatives	Charsadda Tehsil (Batgram, Daulatpura) and Tangi (Umarzai)
3.3	Integrate Maternal & Child Health Services into disaster shelters and relief programs.	Short (2026–2028)	Health Dept.; Population Welfare Dept.; PRCS	Shabqadar, Nisatta, Sardheri, Daulatpura
Objective 4: Enhance Access to Resources and Services for Marginalized Groups				
4.1	Establish decentralized health centers in flood- and drought-prone UCs, with reproductive and maternal care units. In addition, engage Internally Displaced Persons (IDPs) in risk reduction activities at these centers, helping to reduce their stress and trauma while building community resilience and supporting disaster preparedness efforts.	Short (2026–2028)	Health Dept.; Population Welfare Dept.; District Admin.; NGOs	Agra, Daulatpura, Batgram, Tangi (Umarzai, Turangzai)
4.2	Ensure disability-inclusive disaster shelters with ramps, assistive devices, and trained staff.	Short (2026–2028)	DDMA; Social Welfare Dept.; NGOs/CSOs	Shabqadar, Nisatta, Charsadda City
4.3	Introduce land tenure security programs for smallholders, especially women farmers, alongside land-use regulation enforcement.	Medium (2029–2033)	Revenue Dept.; Agriculture Dept.; LGRDD	Southern Charsadda (Batgram, Agra)
4.4	Develop equitable irrigation water distribution mechanisms using Water User Associations (WUAs).	Medium (2029–2033)	Irrigation Dept.; Farmer Organizations; P&DD KP	Tangi (Turangzai, Umarzai) and Charsadda (Daulatpura, Katu Zai)
4.5	Provide targeted WASH facilities for vulnerable households, focusing on women and children in peri-urban areas. Involve female students from relevant university departments in planning and implementing these facilities to ensure that community needs are met, while also fostering academic involvement in gender-sensitive WASH interventions.	Short (2026–2028)	PHED; Health Dept.; NGOs; Local Universities	Shabqadar, Nisatta, Sardheri, Charsadda City
Objective 5: Address Climate Justice and Eco-Anxiety through Community Engagement and Awareness				
5.1	Launch community-based awareness and climate education programs in schools, madrassas,	Short (2026–2028)	Education Dept.; DDMA; Youth	Tangi (Umarzai), Shabqadar, Charsadda City

	youth clubs, and community learning centres, ensuring programs are accessible to all forms of educational institutions to maximize reach and impact. Additionally, design programs targeting women at the household level, offering education on climate adaptation and sustainability practices, to engage women who may not be able to attend formal institutions.		Affairs Dept.; NGOs	
5.2	Establish psychosocial support services in disaster-prone UCs, including counseling and peer-support groups.	Short (2026–2028)	Health Dept.; Social Welfare Dept.; CSOs	Agra, Batgram, Shabqadar
5.3	Develop green entrepreneurship programs for youth (eco-tourism, renewable energy kiosks, sustainable crafts).	Medium (2029–2033)	SMEDA; KP Youth Affairs Dept.; Local Chambers; NGOs	Charsadda City, Shabqadar, Sardaryab corridor
5.4	Promote recreational and cultural spaces such as Sardaryab and Baba-ul-Din Nimoun Forest as eco-tourism hubs, ensuring that safety measures and the provision of basic necessities (e.g., clean water, restrooms, and shelters) are in place at river sites. Additionally, utilize available space at public universities to develop cultural and recreational areas.	Medium (2029–2033)	Tourism Dept.; District Admin.; Forest Dept.; Private Sector; Public Universities	Sardaryab, Nisatta, Shabqadar belt

Costing and Financing

Detailed costing of prioritized adaptation measures

The DAP translates priority climate actions into a structured investment package comprising 98 initiatives across 27 strategic objectives, amounting to a total estimated requirement of PKR 228.23 Billion (USD 815.09 Million) for phased implementation. Costing has been derived through activity-based estimation, drawing on unit cost norms of government line departments, recent PC-I/PC-II benchmarks, market price references, and comparable infrastructure projects completed in similar hazard contexts.

Investment allocation reflects hazard exposure patterns and sectoral risk drivers identified in the CRVA. The highest share of financing is allocated to Natural Capital (PKR 127.93 Billion) and Urban Resilience (PKR 79.52 Billion), reflecting the district's exposure to riverine flooding, drainage failures, erosion, and waterlogging. These two areas comprise more than ninety percent of the overall financial envelope, indicating that ecosystem rehabilitation and resilient urban systems are the core pillars of transformative adaptation in the district.

Costing is structured by focus area, and each focus area is mapped to thematic objectives and initiatives. The detailed costing sheet disaggregates financing at the initiative level, including both capital-intensive structural interventions (embankments, drainage systems, riparian restoration, recharge structures, and resilient infrastructure) and non-structural enablers (capacity building, governance, risk communication, gender inclusion, and community resilience measures). This

allows for transparent cost tracking, prioritization, and sequencing. Costs are presented according to the following six focus areas:

Sr. No.	Focus Area	No of Objectives	No. of Initiatives	Estimated Cost (PKR Million)	Estimated Cost (USD Million)
1	Agriculture-Water Nexus	5	20	8456.6	30.20
2	Urban Resilience	4	12	79521	284.00
3	Natural Capital	5	21	127926	456.88
4	Human Capital	3	11	3300	11.79
5	Disaster Risk Management	5	15	3895	13.91
6	Gender, Youth and Social Inclusion	5	19	5127	18.31
	Total	27	98	228225.6	815.09

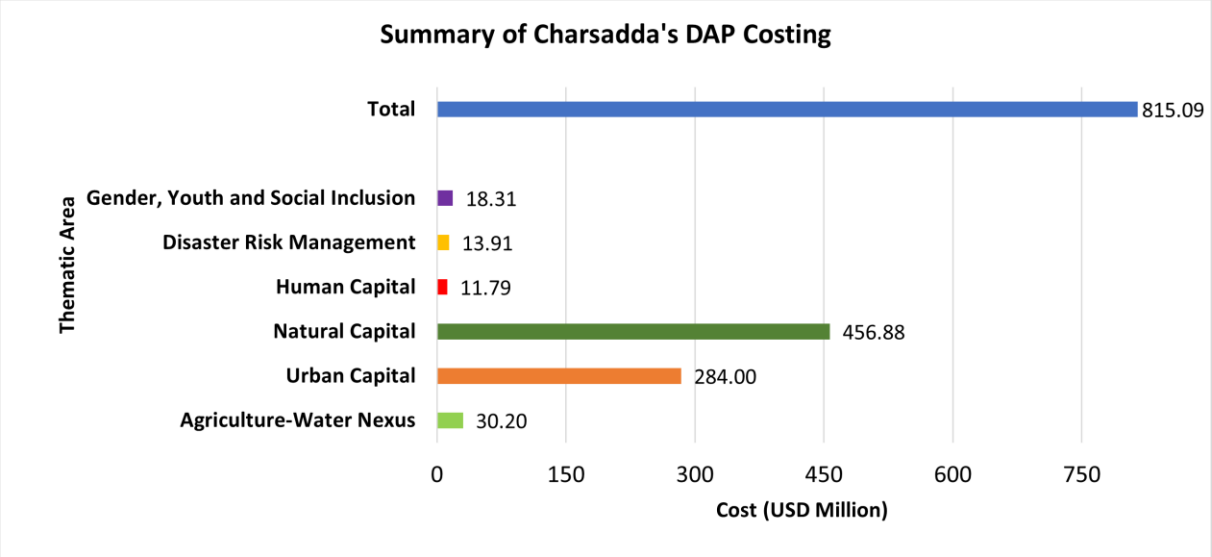

Figure 19: Summary of Charsadda's DAP Costing

The costing for the DAP has been derived through a rigorous methodology that ensures alignment with national-level standards while addressing the specific needs of Charsadda. The national NAP Costing Tool - Scenario 2 (Full National Implementation) was the primary reference, with a district-level scaling factor of 3.5% applied to adjust costs based on Charsadda's share of national resources, population size, agricultural land, and exposure to climate risks. This approach ensures that the allocated funds are proportionate to the district's unique vulnerabilities and priorities. Costs for each focus area, including Agriculture-Water Nexus, Natural Capital, Human Capital, Urban Resilience, DRM and GYSI, were adjusted for Charsadda's local context using relevant benchmarks and unit cost data from Khyber Pakhtunkhwa's existing climate adaptation programs. Additionally, all estimates were converted to PKR using a fixed exchange rate of 1 USD = 280 PKR, and the figures were rounded for clarity. Timeframe weighting was applied to reflect the varying intensity of interventions, with medium-term projects receiving a higher proportion of funding. By using this robust methodology, the costing framework not only provides a detailed financial overview but also ensures that the allocation of resources is both realistic and responsive to the district's climate adaptation needs.

The district will adopt a phased implementation approach, with priority initiatives geographically anchored in high-vulnerability UCs identified in the CRVA and sequenced to available fiscal space. This costing framework, therefore, not only quantifies resource requirements but also enables

alignment with annual ADP cycles, climate finance mobilization, and future public investment planning. The full initiative-wise costing breakdown is provided separately in ***Error! Reference source not found.***.

Potential sources of finance

Financing Charsadda's adaptation priorities will require a multi-layered approach, combining domestic public resources, development partner support, private sector contributions, and international climate finance. Drawing on both national strategies and district-level mechanisms, potential sources include:

1. Domestic Public Finance

Charsadda can leverage district-level budget mechanisms to secure dedicated and predictable financing for adaptation initiatives. Building on KP's provincial Climate Budget Tagging (CBT) framework, the district can institutionalize a dedicated budget head or sub-program within the District Annual Development Programme (ADP), titled "Climate Resilience and Adaptation."[206] Initial allocations can cover recurrent adaptation activities, including pre-monsoon drain clearance, embankment maintenance, operation of early warning systems, and small-scale flood mitigation works. Over time, allocations can increase based on performance metrics, completion of priority PC-1s, and integration of climate resilience objectives in sectoral plans. Climate budget tagging will also strengthen reporting to provincial and national climate finance frameworks, thereby facilitating co-financing from the Green Climate Fund (GCF), Adaptation Fund (AF), and PDMA/NDMA resilience programs.

In addition to climate-tagged budgets, Charsadda can establish a district-managed pooled adaptation fund under a Climate Adaptation Committee or focal cell. This fund can draw contributions from the district government, provincial resilience grants, donor agencies, and community cost-sharing for selected works. Such a fund would allow the district to finance small-scale urgent works, provide matching grants, or co-finance larger PC-1 projects, reducing reliance on slower provincial or federal funding channels and ensuring rapid deployment of resources.

Adaptation initiatives can also tap into existing national and provincial schemes, such as NFPP-IV, FPSP-III, or donor-supported programs like GCF/WFP early warning interventions in KP. These programs provide ready financing for flood protection infrastructure, ecosystem management, and anticipatory climate risk management. Furthermore, sectoral green growth programs across agriculture, water, urban resilience, health, and forestry can be leveraged to mainstream adaptation into ongoing development budgets. Seed funding from the National Climate Change Fund (NCCF) can catalyse co-financing from development partners, creating a dedicated endowment for high-priority adaptation actions.

2. Development Partner and International Finance

Development partners and international climate funds represent a critical source of financing for Charsadda, particularly for capital-intensive and high-impact interventions. Access to multilateral climate funds, including the GCF, Global Environment Facility (GEF), Adaptation Fund (AF), and Climate Investment Funds (CIFs), can support riverine embankments, recharge structures, urban drainage systems, ecosystem restoration, and community resilience initiatives. Bilateral development partners can provide grants, concessional loans, and technical assistance to strengthen project preparation, execution, and monitoring and evaluation at the district level. Such support is essential for building local institutional capacity and ensuring alignment with international standards for climate finance.

[206] Government of Khyber Pakhtunkhwa, Planning & Development Department (2023). Climate Budget Tagging 2023-24

3. Private Sector and Community Contributions

Private sector and community involvement is indispensable for scaling up adaptation interventions in Charsadda. Public–private partnerships (PPPs) can attract private investment for resilient infrastructure, climate-smart agriculture, and water management projects, sharing risk and returns while increasing resource availability. Small and medium enterprises (SMEs) can be supported to adopt climate-resilient practices through green financing, technical support, and capacity-building. At the community level, local contributions, in-kind support, and microfinance mechanisms can complement public and donor funding, enhancing ownership and sustainability of small-scale adaptation measures.

4. International Finance

Given the scale of adaptation needs in Charsadda, external concessional finance is essential to supplement domestic and private resources. Large-scale infrastructure, ecosystem restoration, and urban resilience projects require access to concessional loans and grants through multilateral development banks (MDBs), climate funds, and bilateral programs. Strengthening district-level technical capacity to develop bankable proposals aligned with international climate funds will be crucial to unlock these resources effectively.

Opportunities for innovative financing

Beyond conventional funding, Charsadda can leverage innovative financing mechanisms to expand resources, reduce fiscal pressures, and enhance the sustainability of adaptation interventions.

Issuance of district-level green or blue bonds, including Shariah-compliant sukuk, can attract private investment for climate-resilient infrastructure, water management, and ecosystem-based projects. Debt-for-climate or nature swaps can convert external debt obligations into financing for high-priority adaptation interventions, particularly for natural capital restoration and flood mitigation. Payment for ecosystem services (PES) programs, such as forest conservation, watershed management, and wetland protection, can generate sustainable revenue streams while delivering co-benefits, including biodiversity conservation and flood risk reduction.

Climate risk insurance products for vulnerable households and farmers can mitigate the economic impacts of floods, droughts, and extreme weather events. Contingent credit facilities can provide rapid post-disaster financing, reducing long-term fiscal burdens. Blended finance approaches, combining concessional finance, development partner grants, and private investment, can reduce risk and attract capital for capital-intensive interventions. Results-based financing mechanisms ensure that disbursements are linked to measurable adaptation outcomes, enhancing accountability and impact.

Carbon markets and climate credits provide additional opportunities to monetize climate-resilient outcomes and generate revenue for adaptation projects. Enabling private sector participation through green credit guarantees, technical support, and regulatory incentives can further mobilize investment for climate-smart agriculture, resilient construction, and urban infrastructure.

Finally, establishing a district-level Climate Finance Facilitation Cell can strengthen the project pipeline by supporting the preparation of bankable PC-1 proposals, liaising with provincial and federal agencies, monitoring fund disbursement, and ensuring timely execution. This mechanism improves access to both domestic and international climate finance while enhancing transparency, accountability, and effectiveness in implementing Charsadda’s adaptation priorities.

7. Implementation Plan and Roll-Out

Implementation of the Charsadda's DAP will follow the NAP implementation logic, applying the whole-of-government approach, targeted prioritisation, operational planning, resource mobilisation, and iterative learning. While the NAP provides national-level direction, this DAP defines district-level delivery pathways through existing line departments, district coordination mechanisms, and annual budget cycles.

Implementation Plan

The implementation of Charsadda's DAP will operationalize the identified adaptation priorities through phased and coordinated actions across seven thematic sectors. This plan serves as the district's roadmap for translating adaptation priorities into tangible, results-oriented outcomes, supported by clear institutional responsibilities, stakeholder participation, and sustainable financing mechanisms. The implementation strategy is grounded in five guiding principles:

1. **Localization:** Leveraging existing district institutions and programs rather than establishing new parallel structures.
2. **Integration:** Mainstreaming adaptation actions into departmental Annual Development Plans (ADPs), PC-1s, and budgetary cycles.
3. **Phased Delivery:** Sequencing interventions over short (2026–2028), medium (2029–20333), and long-term (2033+) horizons.
4. **Partnerships:** Engaging civil society, academia, the private sector, and community-based organizations in co-implementation.
5. **Transparency and Accountability:** Aligning progress tracking with the M&E framework and ensuring regular reporting to the Provincial Planning and Development Department (P&DD) and Climate Cell.

Detailed cost estimates, timelines, and responsible institutions are provided in Error! Reference source not found..

Agriculture-Water Nexus

The Agriculture-Water Nexus represents a cornerstone of Charsadda's adaptation agenda, given the district's dependence on agriculture and exposure to water scarcity and floods. Implementation will begin (2026–2028) with agro-ecological zoning and the introduction of water-efficient technologies such as drip and sprinkler irrigation systems in pilot areas. The Agriculture and Irrigation Departments, with technical support from the PMD and KP Agriculture Research Institute, will lead these efforts.

During 2029–2033, successful technologies and crop models will be scaled up through WUAs and climate-smart extension services. Farmer field schools will promote integrated pest management, soil conservation, and drought-resilient crop varieties. By 2033 and beyond, adaptive water governance mechanisms and digital agro-advisory systems will be institutionalized through district MIS integration. These actions aim to improve agricultural productivity, water efficiency, and resilience of smallholder farmers.

Natural Capital

Preserving and restoring Charsadda's ecosystems is essential for maintaining its natural buffers against floods, droughts, and land degradation. From 2026–2028, the Forest Department and KP-EPA will initiate baseline assessments of forest cover, wetlands, and riparian habitats. Concurrently, community-based afforestation programs and school-led tree campaigns will begin in degraded catchments, especially along the Swat-Kabul river corridors and the Doāba floodplain area. These efforts will focus on riverbanks, riparian zones, and regions identified as high-flood and high-erosion risk.

Medium-term actions (2029–2033) will prioritize ecosystem restoration along flood-prone riverbanks and degraded agricultural land through riparian reforestation and soil conservation techniques. The focus will be on small-scale afforestation and bioengineering of canal embankments to stabilize land and reduce erosion. Community-led Forest committees will be formed to ensure local management and sustainable use of natural resources. Alongside, alternative livelihoods (e.g., small-scale beekeeping, eco-tourism) will be piloted in areas where restoration efforts show signs of success, ensuring the sustainability of both local economies and ecosystem health. By 2033+, Charsadda will operationalize a district biodiversity monitoring cell integrated with the KP Forest Information System. These initiatives will increase vegetation cover, improve ecosystem services, and contribute to nature-based resilience.

Urban Resilience

Rapid urbanization and climate variability pose growing challenges for Charsadda's built environment. Unplanned urban expansion, inadequate drainage, and the increasing frequency of extreme rainfall events have amplified flood risks and infrastructure vulnerability. To address these challenges, the Tehsil Municipal Administration (TMA) and the Communication and Works (C&W) Department, in coordination with the Local Government and Rural Development Department, will jointly lead the implementation of resilience initiatives targeting both urban systems and critical infrastructure.

In the short term (2026–2028), efforts will focus on integrating climate resilience criteria into building by-laws, conducting climate risk screening for critical facilities (roads, bridges, schools, and health centres), and mapping urban flood zones to guide land-use planning. Concurrently, pilot projects on solid waste segregation, recycling systems, and rainwater harvesting installations in public buildings will be initiated.

During the medium term (2029–2033), priority investments will include upgrading stormwater drainage systems, retrofit high-risk infrastructure, and applying climate-resilient materials and design standards developed in coordination with the Pakistan Engineering Council (PEC) and NESPAK. These measures will be complemented by urban greening initiatives, such as the development of parks, tree belts, and green corridors to improve air quality and reduce heat stress.

In the long term (2033 and beyond), a District Infrastructure and Urban Resilience Unit will be established under the C&W Department and TMA to institutionalize climate risk screening in all future urban development and public works. The TMA will also operationalize an Urban Climate Information Cell for real-time monitoring of rainfall, drainage performance, and community reporting.

Together, these integrated interventions will enhance adaptive urban governance, improve the safety and durability of critical infrastructure, reduce flood risks, and promote environmentally sustainable urban growth.

Human Capital

Human capital is central to climate resilience, encompassing health, education, and livelihood systems. From 2026–2028, the District Health Department and Public Health Engineering Department (PHED) will strengthen disease surveillance and implement community WASH and health awareness campaigns targeting climate-sensitive diseases such as malaria, dengue, and diarrhea.

The Education Department will integrate climate change content into school curricula and teacher training modules. Between 2029–2033, selected Basic Health Units (BHUs) will be climate-proofed through solar energy and resilient water systems, and vocational centers will provide training on green skills and eco-entrepreneurship. By 2033+, the district will launch a Climate Scholarship and Innovation Fund to support youth and researchers. This integrated approach will strengthen adaptive capacity, improve human well-being, and promote a culture of environmental stewardship.

Disaster Risk Management (DRM)

The DRM component will enhance preparedness, early warning, and response capacities to manage floods, droughts, and other climate-induced hazards. Initial actions (2026–2028) include updating multi-hazard risk and vulnerability maps, forming community-based disaster management committees, and establishing a District Early Warning and Communication System. Between 2029–2033, the District Disaster Management Authority (DDMA) will coordinate mock drills, develop flood protection infrastructure, and strengthen coordination with PDMA and national agencies.

By 2033+, emphasis will shift toward post-disaster recovery frameworks, contingency financing mechanisms, and integration of early warning systems into community-level communication networks. These interventions will build a proactive disaster management culture and minimize losses from extreme events.

Gender, Youth, and Social Inclusion

Ensuring equity and inclusion is a cross-cutting pillar of the DAP. From 2026–2028, the Social Welfare Department and DDMA will conduct a gender and vulnerability assessment across all adaptation sectors and develop a Gender and Youth Inclusion Framework to guide implementation. Between 2029–2033, targeted programs will promote women-led green enterprises, youth climate ambassador initiatives, and inclusive awareness campaigns emphasizing community participation.

By 2033+, gender-responsive indicators will be institutionalized within the DAP's M&E framework, ensuring that adaptation outcomes are measured through an inclusion lens. This theme seeks to empower women, youth, and marginalized groups as active agents of resilience rather than passive beneficiaries.

Coordination and Phasing

Implementation will be coordinated by the Deputy Commissioner's Office and DDMA through a District Climate Resilience Coordination Committee (DCRCC). The DCRCC will ensure inter-departmental coordination, monitoring, and alignment with provincial adaptation frameworks. Phasing of activities will follow this pattern:

Phase	Timeline	Focus Areas
Phase I	2026–2028	Baseline studies, capacity building, pilot projects, institutional setup
Phase II	2029–2033	Scaling and mainstreaming adaptation interventions across sectors
Phase III	2033+	Institutionalization, long-term financing, and sustainability measures

Financing and Resource Mobilization

Successful implementation of Charsadda's District Adaptation Plan (DAP) depends on mobilizing, allocating, and managing resources efficiently. While sources of finance have been identified, the critical focus lies in ensuring predictable funding, timely disbursement, and accountability, aligned with district, provincial, and national climate priorities.

At the district level, climate objectives must be integrated into the Annual Development Plans (ADPs) of relevant departments, ensuring that these interventions are owned and prioritized by the departments themselves. Departments will independently prioritize climate-sensitive projects based on their own assessments and responsibilities, incorporating them into their sectoral plans. The District Administration, led by the Deputy Commissioner (DC), will provide coordination and support to ensure alignment with the overall district adaptation goals, but the responsibility for planning and budgeting will lie with the departments themselves. To ensure accountability, budget allocations for climate-related interventions will be linked to measurable outputs, such as the successful completion of PC-1s, implementation of priority adaptation projects, and progress in key

performance indicators related to flood mitigation and early warning systems. Regular monitoring and feedback mechanisms will be put in place to assess progress and ensure that climate objectives are continuously incorporated into the departmental plans.

In addition, a district-managed pooled adaptation fund will be established to provide flexibility and responsiveness for priority adaptation activities. This fund, overseen by a Climate Adaptation Committee chaired by the DC, will be informed by inputs from line departments, PDMA/NDMA, development partners, and community representatives. The fund will be used to support priority projects that are already integrated into departmental plans, based on urgency, risk reduction, and community impact. The Committee will ensure that the fund is allocated in a transparent manner, with regular evaluations to ensure alignment with departmental priorities and district-wide adaptation goals..

Mobilization from development partners and multilateral funds requires proactive project preparation and coordination. A Climate Finance Facilitation Cell at the district level, reporting to the DC and liaising with P&DD KP, PDMA, and relevant line departments, will assist in preparing "bankable" PC-1 proposals, coordinating with donors, tracking fund flows, and ensuring timely reporting to meet donor requirements. Strengthening institutional capacity in project management, procurement, and financial reporting is essential to maintain credibility and increase access to concessional loans, grants, and climate funds such as GCF, GEF, and the Adaptation Fund.

Engagement of the private sector and communities is a complementary strategy. The DC, in collaboration with line departments such as Agriculture, Water, and Urban Development, will develop frameworks to engage local SMEs, cooperatives, and private actors in resilient infrastructure, climate-smart agriculture, and water management projects. Incentive mechanisms such as co-financing, risk guarantees, and results-based financing will encourage private investment. At the community level, structured mechanisms for micro-levies, labor contributions, and in-kind support can mobilize local resources while fostering ownership and sustainability of adaptation measures.

Finally, strategic sequencing and integration of finance and resource mobilization will enhance efficiency. Prioritizing high-impact, cost-effective interventions during the initial implementation phases ensures early demonstration of results, which can attract additional investment from public, donor, and private sources. Regular monitoring, evaluation, and public reporting, led by the Climate Finance Facilitation Cell and overseen by the Climate Adaptation Committee, will reinforce accountability, inform resource allocation adjustments, and support scaling of successful initiatives.

By clearly defining responsibilities, establishing performance-linked allocation mechanisms, and coordinating across government, private, and community stakeholders, Charsadda can mobilize the resources necessary to implement its adaptation priorities effectively and sustainably.

Integration of adaptation priorities into District Development Plans & budget cycles

Effective implementation of Charsadda's DAP requires that identified adaptation priorities are fully mainstreamed into the district's development planning and financial management processes. By integrating adaptation into the Annual Development Plans (ADPs), departmental workplans, and budget cycles, climate resilience actions can be systematically prioritized, adequately funded, and continuously monitored alongside other development initiatives.

The integration process begins with mapping each adaptation priority to the relevant line departments and sectoral development objectives. This ensures that adaptation actions are aligned with ongoing and planned development programs across key sectors, including water management, agriculture, health, infrastructure, urban planning, and social protection. The District Planning Team, led by the DC Office, will guide this alignment process, ensuring a strategic fit between adaptation priorities and district-level development goals.

Adaptation priorities will also be embedded into the district budget cycle through climate-tagged entries in departmental PC-1s and ADPs. In the short term (2026–2028), this will involve identifying priority adaptation interventions for immediate action, estimating their resource requirements, and allocating budget provisions in upcoming fiscal years. In the medium term (2029–2033), interventions will be scaled based on early results, climate resilience indicators will be incorporated into departmental performance assessments, and allocations will be adjusted to reflect evolving priorities. In the long term (2033 and beyond), climate finance mechanisms will be institutionalized within the district budget, including earmarked funds for recurring adaptation measures, infrastructure maintenance, and community-based resilience programs.

To operationalize this integration, the District Climate Resilience Coordination Committee (DCRCC) will review departmental budgets and ADPs to ensure alignment with DAP priorities and provide guidance on resource allocation. Line departments will be responsible for incorporating adaptation actions into their sectoral ADPs, setting clear targets, timelines, and outputs that feed into the district monitoring systems. The P&DD Climate Change Board will provide technical advisory support and facilitate reporting to provincial adaptation frameworks as well as the national Monitoring, Reporting, and Verification (MRV) system.

Regular monitoring and feedback mechanisms will be critical to track the integration of adaptation into development planning. Quarterly departmental reporting on climate-tagged activities and expenditures, biannual DCRCC reviews of workplans and budgets, and the preparation of annual District Adaptation Performance Reports will document progress, identify gaps, and recommend adjustments to budget allocations and implementation strategies.

This approach ensures that adaptation is not treated as a standalone activity but becomes an integral part of district development planning. By mainstreaming climate resilience into existing planning and budgeting processes, Charsadda will be able to mobilize resources more effectively, track expenditures and results systematically, and enhance accountability in the implementation of its adaptation priorities.

Monitoring, Evaluation & Reporting

Importance of M&E for Charsadda's DAP

Monitoring & Evaluation is a core pillar for the effective implementation of the Charsadda District Adaptation Plan. A robust M&E system ensures that adaptation actions are not only implemented, but continuously assessed, improved, and re-aligned with emerging climate risks, development priorities, and scientific knowledge. Through regular monitoring, the district will be able to track shifts in hazard profiles, exposure, and vulnerability, and incorporate updated evidence into decision-making, prioritisation, and resource allocation.

The M&E process also ensures coherence between district-level action and Pakistan's broader adaptation architecture, including the National Adaptation Plan (2023–2033) and Nationally Determined Contributions (NDCs). By aligning district reporting with the evolving national Monitoring, Reporting and Verification (MRV) system, Charsadda's adaptation progress contributes meaningfully to provincial and national climate accountability and supports harmonised tracking across development and climate reporting processes.

M&E Framework

Charsadda's M&E framework follows the same three-tier logic adopted under the National Adaptation Plan (NAP):

NAP Tier	Expression at District Level
Strategy & Policy Level	Alignment of the DAP with KP Climate Action Plan, KP Climate Policy, NAP & NCCP
Planning & Programme Level	Monitoring climate-tagged PC-1s, ADP submissions, and departmental workplans

Project / Action Level	Tracking progress, outputs and outcomes of specific DAP priority activities

Indicators will include both process indicators (integration, financing, implementation milestones) and outcome indicators (changes in exposure / risk / vulnerability). Indicators will be kept practical and based on existing data sources, PBS administrative data, PMD seasonal advisories, departmental MIS, and BHU registers.

M&E Implementation Responsibilities

Activity	Responsible Entity	Frequency
Implementation of DAP priority actions	Relevant District Line Departments	Continuous
Review of progress & bottlenecks	DC + DDMA	Bi-annual
District Adaptation Performance Report	DC Office / DDMA	Annual
Reporting to provincial climate system	DC → P&DD KP	Annual
Tracking of DAP Priority Actions, Technical advisory and alignment	P&DD Climate Cell	Continuous

Participation of non-government actors, universities, civil society organisations, private sector, farmer groups, will be encouraged, especially in validation of results, local feedback, and learning loops.

M&E Indicators

Indicators lie at the very core of an effective M&E framework that drives targeted action, highlights areas requiring additional efforts, supports informed decision-making, and promotes climate-smart approaches. Well-defined indicators are essential, as they ensure relevance and practicality in terms of data availability, time, and resource requirements.

To establish a robust set of indicators for the Charsadda DAP, a collaborative and iterative process will be undertaken, involving district-level stakeholders, line departments, technical experts, and community representatives. This inclusive approach will enable the selection of indicators that align with sectoral priorities and capture the desired outcomes. Once identified, these indicators will undergo a piloting phase, allowing redundant ones to be filtered out and any missing indicators to be addressed.

The Charsadda DAP M&E indicators will encompass both critical and supporting actions. Regular assessments conducted by the District Administration and line departments will evaluate the preparedness of relevant organizations, including service providers, community committees, and policymakers. Through these assessments, areas for improvement will be identified, ensuring efficient and effective implementation of the DAP. The selected indicators will cover both process and outcome aspects:

- Process indicators will gauge the progress and achievement of defined milestones in DAP implementation. This entails tracking the integration of adaptation priorities into departmental workplans, resource allocation, capacity-building activities, and policy adoption at the district level.
- Outcome indicators will evaluate the extent to which adaptation objectives are being achieved and climate vulnerability is being reduced in Charsadda. These indicators will assess the impact of implemented interventions on key sectors such as agriculture, water, health, forestry, and infrastructure.

To provide a comprehensive assessment of progress, a combination of quantitative and qualitative measures will be utilized. Quantitative data will evaluate the results of sectoral adaptation strategies and priorities, offering tangible insights into progress. Complementing this, qualitative

measures will contextualize the data, providing narrative insights that capture community perceptions, inclusivity, and social impact.

Drawing from these considerations, pertinent entities led by the Deputy Commissioner (DC) and District Disaster Management Authority (DDMA) will collaboratively establish suitable log frame structures. These structures will be rooted in the theory of change for each sector and cross-cutting area, incorporating defined indicators, baselines, targets, time periods, and data sources. This effort will ensure a cohesive and strategic approach to monitoring and evaluation throughout DAP implementation. To streamline data collection, existing sources of information will be leveraged wherever possible, including:

- Household surveys and socio-economic assessments
- Administrative data from district line departments
- Sector-specific MIS and monitoring systems
- Community feedback mechanisms through Village Development Committees (VDCs) and Water User Associations (WUAs)

By tapping into these established sources, the DAP M&E process will benefit from pre-existing data, enhancing effectiveness and timeliness.

A comprehensive District M&E Plan will be developed within six months of DAP initiation. This plan will serve as a roadmap, providing clear guidance on data collection, compilation, and synthesis. It will outline protocols for standardized data collection methods, define timelines for periodic evaluations, and clarify roles and responsibilities of different stakeholders involved in the M&E process, promoting accountability and coordination.

Supporting M&E Implementation

Based on the training needs assessment of district officers being conducted under this project, comprehensive capacity-building programs will be developed to strengthen the ability of all key stakeholders in Charsadda to effectively participate in the DAP M&E process. These programs will aim to promote a shared understanding of M&E concepts, frameworks, and tools, enabling stakeholders to apply evidence-based approaches for tracking adaptation progress. The training modules will be tailored to the specific needs of district government officials, line departments, and implementing partners, ensuring that participants are equipped to collect, analyze, and report data in alignment with provincial and national systems.

Continuous learning and on-the-job mentoring will be embedded into the M&E process to ensure that officials remain informed about evolving methodologies, technologies, and reporting requirements under the KP Climate Action Plan, NAP, and NDCs. Through this approach, government officials and district institutions will be empowered to integrate new knowledge, adaptive management practices, and emerging climate intelligence into planning and implementation cycles, promoting forward-looking and evidence-based adaptation governance.

Technology and digital tools will serve as a cornerstone of the Charsadda DAP M&E system. The District Administration, in collaboration with the P&DD Climate Cell, will explore the use of web-based dashboards and data management platforms to streamline data collection, validation, and visualization of adaptation progress. Protocols for data collection, verification, and metadata documentation will be standardized to ensure transparency and interoperability with provincial and national climate monitoring systems.

To strengthen evidence generation, research institutions and universities in the region will be engaged to address existing knowledge gaps on local climate vulnerabilities, adaptation effectiveness, and socio-economic impacts. Establishing collaborative research and data-sharing mechanisms between government departments, academia, and civil society organizations will foster transparency, inclusivity, and innovation in adaptation monitoring. Open-access data platforms and district-level knowledge repositories will be promoted to ensure that climate and vulnerability information is readily available to researchers, practitioners, and local communities.

In parallel, a system for continuous feedback and adaptive learning will be established. Findings from the DAP M&E process will inform iterative improvements in planning, resource allocation, and policy direction. The DDMA, supported by the Deputy Commissioner's Office and relevant line departments, will convene Annual Adaptation Progress Review Meetings to assess performance, identify gaps, and refine strategies. These reviews will serve as a transparent mechanism for course correction and coordination across sectors.

Periodic updates to the Charsadda DAP will be undertaken every five years or as needed, based on new climate data, evolving risks, and lessons learned from implementation. This review process will adopt a participatory approach, engaging local communities, civil society, and the private sector to ensure that adaptation actions remain relevant, inclusive, and responsive to the district's changing climate and development context.

The knowledge and experience generated through the DAP M&E system will serve as a foundation for continuous improvement, guiding future planning, enhancing coordination with provincial and national adaptation frameworks, and ensuring that Charsadda remains on a sustainable, climate-resilient development pathway.

Communication and outreach strategy

An effective communication and outreach strategy is vital for ensuring the successful implementation, ownership, and sustainability of the Charsadd's DAP. Communication serves not only as a tool for information dissemination but also as a mechanism for stakeholder engagement, awareness building, behavioural change, and transparency in the adaptation process.

The overarching goal of the communication and outreach strategy is to enhance understanding, participation, and coordination among all stakeholders, from government departments and community organizations to private sector actors, academia, and the public, so that the district's collective response to climate change is informed, inclusive, and action oriented.

Stakeholder Mapping and Engagement

A comprehensive stakeholder mapping exercise will be conducted at the outset of DAP implementation to identify all key actors relevant to adaptation planning, execution, and monitoring. This mapping will categorize stakeholders according to their roles, influence, and levels of engagement, including:

- **Governmental stakeholders:** District line departments (Agriculture, Irrigation, Forest, Health, Education, C&W, PHED), DDMA, and the DC Office.
- **Provincial and national agencies:** KP P&DD Climate Cell, PDMA, KP Environmental Protection Agency, MoCC&EC and GCISC.
- **Community-based entities:** Village Development Committees (VDCs), Water User Associations (WUAs), farmer cooperatives, women's groups, and youth organizations.
- **Civil society and NGOs:** Organizations working on livelihoods, natural resource management, and climate awareness.
- **Academia and research institutions:** Universities and technical centres providing data, analysis, and capacity-building support.
- **Private sector and media:** Businesses contributing to resilient supply chains and local media outlets for outreach and advocacy.

The stakeholder mapping will guide the design of targeted communication messages and the selection of appropriate outreach channels to ensure inclusivity and relevance. Regular stakeholder engagement forums and coordination meetings will be held to maintain collaboration and alignment throughout the DAP cycle.

Approach and Guiding Principles

The communication and outreach strategy will adopt a multi-tiered and participatory approach, ensuring that information reaches diverse audiences through appropriate and accessible channels. The approach will be guided by the following principles:

- **Inclusivity:** Ensuring the participation of all groups, particularly women, youth, and marginalized communities.
- **Localization:** Delivering messages in local languages and culturally relevant formats.
- **Transparency:** Sharing data and progress openly to strengthen public trust.
- **Feedback and learning:** Creating two-way communication channels for community input and lessons learned.
- **Partnership and collaboration:** Utilizing existing institutional and community networks for wider outreach.

Awareness and Outreach Campaigns

A series of district-wide awareness campaigns will be designed to promote climate literacy, highlight adaptation actions, and encourage community participation. These campaigns will be led by the DDMA in coordination with the DC Office and relevant departments. Key campaign components will include:

- Community awareness sessions on disaster preparedness, water conservation, flood safety, and sustainable agriculture.
- School and youth engagement programs integrating climate education and competitions on environmental stewardship.
- Mass media campaigns through local radio, television, and newspapers to broadcast early warning messages, success stories, and adaptation tips.
- Social media outreach using the District Administration's official channels to share visuals, updates, and real-time alerts.
- Commemorative events such as Climate Resilience Day, World Environment Day, and Clean River Campaigns to sustain momentum and visibility.
- Information kiosks and mobile exhibitions in high-exposure communities to demonstrate practical adaptation solutions.

These campaigns will ensure that adaptation becomes a shared community priority, promoting behavioural change and strengthening collective action for resilience.

Key Communication Channels and Tools

To ensure broad and effective outreach, multiple communication tools and media will be used:

- **Print and Digital Materials:** Policy briefs, newsletters, brochures, posters, and infographics summarizing adaptation progress.
- **Community-Based Platforms:** Use of VDCs, WUAs, Farmer Field Schools, and women's collectives for local-level communication.
- **Knowledge Products:** Success stories, case studies, and local innovations documented and disseminated to inform future adaptation.
- **Workshops and Consultations:** Regular multi-stakeholder dialogues, capacity-building events, and learning exchanges.
- **Web and Data Platforms:** A dedicated online dashboard or webpage under the District Administration for sharing M&E results and updates.

Institutional Roles and Responsibilities

The Deputy Commissioner's Office will lead the communication and outreach strategy, supported by the DDMA as the coordination and implementation focal point. Line departments will integrate adaptation awareness into their sectoral extension and communication activities. Civil society,

academia, and private sector actors will play supporting roles in outreach, mobilization, and knowledge sharing.

The P&DD Climate Cell will ensure coherence with provincial communication frameworks and alignment with the National Adaptation Plan's communication architecture. A structured monitoring system will assess the effectiveness of communication activities. Key indicators will include:

- Number of stakeholders engaged and diversity of participants.
- Frequency and reach of awareness campaigns and public consultations.
- Level of community awareness and behaviour change (measured through surveys or participatory evaluations).
- Quality of feedback received and integration of suggestions into planning.
- Documentation of communication outcomes and lessons learned.

Community feedback will be regularly collected through interactive meetings, scorecards, and online feedback channels, ensuring that outreach efforts remain dynamic, inclusive, and responsive to local needs.