# DISTRICT ADAPTATION PLAN KARAK

APRIL 2026

Adapting Today for a Sustainable Tomorrow

National Adaptation Plan of Pakistan
**Technical Support by:** Sustainable Development Policy Institute, Islamabad

This report was commissioned by the GCF PAK-RS-003 Project "Building capacity to advance National Adaptation Plan Process in Pakistan" which aims to support the Federal Ministry of Climate Change and Environmental Coordination (MOCC&EC) and its partners at Federal and Province levels to implement the National Adaptation Plan (2023). The Delivery Partner is the United Nations Environment Programme (UNEP).

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# Acknowledgment

The development of the *District Adaptation Plan (DAP) for Karak* is the result of a collaborative and consultative effort, bringing together contributions from government institutions, academia, civil society, the private sector, and local communities.

We extend our sincere gratitude to the **Ministry of Climate Change and Environmental Coordination (MoCC&EC)**for its strategic leadership under Pakistan's National Adaptation Plan framework. We are equally thankful to the **Planning and Development Department, Government of Khyber Pakhtunkhwa**, for its stewardship, coordination, and continued support in advancing district-level climate adaptation planning. We also acknowledge the support of technical team of National Adaptation Plan led by Ms Humaira Jahanzeb supported by the United Nations Environment Programme.

We express our appreciation to the **Commissioner, Kohat Division**, for institutional support and facilitation, and to the **District Administration Karak**, particularly the Office of the Deputy Commissioner and the **District Disaster Management Authority (DDMA)**, for their leadership and active engagement throughout the DAP process. The valuable contributions of all **district line departments**—including Agriculture, Livestock, Irrigation, Forest, Health, Education, Local Government, Communication & Works, Rescue 1122, and Tehsil Municipal Administrations—are gratefully acknowledged for providing technical inputs, data, and coordination support.

We acknowledge the important role of **Oil and Gas Development Company Limited (OGDCL)** and **Pakistan Mineral Development Corporation (PMDC)**, whose engagement reflects the significance of extractive industries in Karak's socio-economic and environmental landscape.

We are grateful to key academic and civil society partners, including **Khushal Khan Khattak University Karak**, **Al Khidmat Foundation Pakistan**, and **Sarhad Rural Support Programme (SRSP)**, for their support in stakeholder engagement, local insights, and community-level contributions.

We extend our heartfelt appreciation to the **local communities of Karak** including farmers, pastoralists, women, youth, and community leaders whose participation through consultations, key informant interviews, and focus group discussions ensured that this plan is grounded in local realities and inclusive of vulnerable groups.

We also recognize the contributions of the technical team at the Sustainable Development Policy Institute (SDPI), led by Dr. Abid Qaiyum Suleri and Ms. Zainab Naeem, including Mr. Ebadat Ur Rehman, Ms. Nelam Pari, Ms. Amna Arook, Mr. Ihtesham Ul Haq and Mr. Umar Farooq, who supported the Climate Risk and Vulnerability Assessment (CRVA) and subsequent DAP formulation through data provision, fieldwork, analytical inputs, costing exercises, and validation processes.

Finally, we acknowledge all experts, practitioners and stakeholders who contributed to this process through their knowledge, time, and collaboration. Their collective efforts have laid the foundation for a resilient, inclusive, and climate-responsive development pathway for Karak District.

# 1. Executive Summary

### Context and Rationale

Karak District, located in the semi-arid southern part of Khyber Pakhtunkhwa (KP), lies at the confluence of multiple climatic and anthropogenic pressures, making it highly vulnerable to climate change impacts. The district's topography, characterized by arid plains, rugged hills, and degraded rangelands, combined with its reliance on rain-fed agriculture and livestock, exacerbates its exposure to droughts, heatwaves, flash floods, and land degradation. The population of Karak, as per the 2023 Census, stands at 815,878, with a predominantly rural population (over 80%). Agriculture, particularly the cultivation of drought-resistant crops and livestock herding, remains the primary source of livelihood for many households in the district. However, increasing climatic stresses such as frequent droughts, rising temperatures, and soil erosion are significantly undermining agricultural productivity and the overall resilience of the community.

### Observed & Projected Climate Trends

Karak District has experienced a consistent warming trend over recent decades, with mean annual temperatures rising by approximately 1.4°C since the early 2000s. Summer temperatures now frequently exceed 40°C, sometimes reaching 46°C, contributing to heat stress and reduced agricultural productivity. Drought years, such as 2012, 2016, 2019, and 2022, caused significant crop losses, particularly in wheat yields, which declined by 30–40%. Precipitation patterns have become increasingly erratic, with rainfall declining by 12–18% but intensifying during monsoon seasons, increasing the risk of flash floods, particularly in areas with poor vegetation cover and steep topography. Groundwater resources are also under severe strain, with water tables dropping by 1–1.5 meters per year, exacerbated by high agricultural and industrial water demand.

Future projections indicate that Karak will continue to experience significant warming, with temperatures expected to rise by 1.5°C to 2°C by 2040 and potentially up to 4°C by the end of the century under high-emission scenarios. This will further exacerbate heat stress, increase evapotranspiration, and heighten irrigation demands, affecting water availability and crop yields. While annual rainfall may increase by 5–15% by 2100, it will likely be concentrated in more intense monsoon events, leading to prolonged dry spells and an increased risk of droughts. The projected rise in runoff by 8–10% will heighten the frequency and intensity of flash floods and soil erosion, particularly in high-risk areas such as Takht-e-Nasrati and Banda Daud Shah.

### Socioeconomic Vulnerability Profile

Karak's socioeconomic vulnerability is closely linked to its climate risks, as the district's economy depends heavily on rain-fed agriculture and livestock herding, both of which are highly susceptible to changing climate patterns. With limited irrigation infrastructure and smallholder farming as the dominant livelihood, the district faces frequent crop failures and livestock mortality due to droughts, heatwaves, and erratic rainfall, threatening food security. This vulnerability is further exacerbated by weak infrastructure and limited institutional capacity, including the absence of climate-specific budgeting, a dedicated climate coordination unit, and early warning systems. The lack of climate-resilient infrastructure and effective community-based disaster risk management frameworks leaves Karak ill-prepared for climate shocks. Vulnerable groups, particularly women, children, and the elderly, are more exposed to these impacts, with women shouldering increased burdens during droughts and heatwaves, and children experiencing disruptions in education and livelihoods. Livestock herders and smallholder farmers are disproportionately affected by fodder shortages, water scarcity, and heat stress, forcing them to adopt unsustainable coping strategies.

### Institutional and Community Capacities

Karak exhibits a mix of institutional capacities and community-based adaptive practices. While the Deputy Commissioner (DC) and the District Disaster Management Authority (DDMA) lead disaster response efforts, the district lacks a dedicated climate adaptation unit or formal climate policy, hindering the integration of climate risks into local governance and planning frameworks. District

departments such as agriculture, health, and municipal services are under-resourced and lack the training needed to effectively tackle climate-related challenges. On the community level, Karak demonstrates resilience through traditional knowledge and coping strategies, such as adaptive planting schedules and the cultivation of drought-tolerant crops. However, these informal measures are often reactive and insufficiently supported by institutional frameworks or technical expertise. Social networks, including tribal jirgas and community groups, play a vital role in disaster support, but formal disaster risk management systems remain weak. While local NGOs contribute to livelihood recovery and disaster preparedness, their impact is limited by a lack of coordination and funding. Community consultations reveal that traditional knowledge is not systematically integrated into district planning, and local communities lack access to technical resources and climate-smart agricultural practices. Strengthening community capacities while enhancing institutional frameworks and access to climate finance is essential for boosting Karak's resilience to climate change.

### Adaptation Priorities and Strategic Actions for Karak District

The District Adaptation Plan (DAP) for Karak outlines key strategic actions across several priority sectors to address the impacts of climate change. These priorities are designed to enhance climate resilience and support sustainable development in the face of escalating environmental stresses.

#### 1. Agriculture-Water Nexus

Agriculture is central to Karak’s livelihoods, but it faces increasing threats from climate change. Water scarcity, rising temperatures, and erratic rainfall are restricting agricultural productivity, while flash floods worsen the situation by washing away topsoil and disrupting irrigation systems. The District Adaptation Plan (DAP) emphasizes climate-smart agriculture to increase productivity and resilience, promoting the use of drought-resistant crops, efficient irrigation techniques such as drip and sprinkler systems, and conservation practices. Water management interventions, including rainwater harvesting and groundwater recharge systems, are vital to address the decreasing groundwater levels and ensure reliable irrigation. Additionally, the DAP focuses on farmer capacity-building, with the establishment of farmer field schools that will provide climate advisory services and early warning systems.

#### 2. Natural Capital

Karak’s natural resources, including its rangelands, forests, and groundwater, are under severe stress due to climate change, overgrazing, and mining activities. The degradation of these ecosystems has diminished the district's ability to buffer against floods, droughts, and soil erosion. The DAP advocates for ecosystem restoration efforts such as afforestation, soil conservation techniques, and the restoration of riverbanks and wetlands to enhance biodiversity and groundwater recharge. Sustainable land management practices, including rotational grazing, agroforestry, and community-based management of rangelands, are critical to combat land degradation. Additionally, pollution control measures are needed to mitigate the environmental damage caused by mining, with a focus on dust suppression and stricter enforcement of pollution regulations.

#### 3. Urban Resilience

Unplanned urban growth in Karak has heightened vulnerability to climate impacts such as floods, water scarcity, and heatwaves. The DAP proposes urban planning and infrastructure improvements to ensure that new developments are climate resilient. This includes integrating climate-risk screening into land-use planning, promoting the construction of flood- and heat-resilient buildings, and expanding green spaces to mitigate the Urban Heat Island effect. The improvement of municipal services is also essential, particularly in enhancing water supply, drainage, and sanitation systems to better cope with extreme weather events. Furthermore, waste management and energy resilience initiatives, including the use of solar-powered solutions for critical infrastructure, are key to reducing flooding risks and ensuring reliable power supply during climate extremes.

### 4. Health Capital

The health sector in Karak is heavily impacted by climate-induced diseases, water scarcity, and poor sanitation. Climate change exacerbates the incidence of heat-related illnesses, respiratory diseases, and waterborne infections. To address these challenges, the DAP emphasizes strengthening health systems to improve access to clean water, sanitation, and healthcare services. This includes retrofitting healthcare facilities to make them more resilient to climate impacts and establishing early warning systems for heatwaves and disease outbreaks. Additionally, community health resilience will be enhanced by training local healthcare workers to recognize and treat climate-linked diseases, especially in remote areas that are highly vulnerable to climate stress.

### 5. Disaster Risk Management (DRM)

Karak is prone to various natural disasters, including flash floods, droughts, and heatwaves. The district's disaster management framework needs to evolve from a reactive to a proactive approach. The DAP highlights the need to enhance early warning systems using technology to provide timely alerts for floods, droughts, and heatwaves, while also implementing community-based risk management strategies. Strengthening disaster response and recovery mechanisms is crucial, including the creation of a District Emergency Fund and improving the resilience of key infrastructure such as roads and bridges. Furthermore, institutional coordination and capacity building are necessary to ensure that all stakeholders are equipped to handle climate-induced disasters, with local communities actively involved in preparedness and response planning.

### 6. Gender, Youth, and Social Inclusion

Climate change disproportionately affects marginalized groups in Karak, including women, youth, and low-income communities. The DAP focuses on promoting inclusive resilience-building by empowering women through livelihood diversification, particularly in sectors like livestock management and climate-smart agriculture and providing training and resources for women-led businesses. Engaging youth in climate awareness programs and capacity-building workshops is another priority, along with involving them in community-based adaptation planning. Social inclusion is also a key focus, ensuring that marginalized groups have access to climate adaptation resources and decision-making processes, thereby promoting equity in the implementation of adaptation measures.

### M&E and Financing Framework

The DAP adopts a phased implementation approach to ensure the effective deployment of climate adaptation measures in Karak:

- **Phase I (2026–2028):** This phase focuses on institutional setup, the formation of a climate coordination unit, initiating pilot interventions, and building the technical and operational capacity of local government officials, community leaders, and stakeholders.
- **Phase II (2029–2033):** The focus will shift to scaling up successful models and integrating them into district development plans. This phase also involves strengthening institutional and financial frameworks to support long-term adaptation measures.
- **Phase III (2033 onward):** The final phase emphasizes the long-term institutionalization of climate adaptation strategies, ensuring their integration into all sectoral plans and securing sustainable financing mechanisms for the district.

Financing for the DAP will be sourced from district and provincial Annual Development Programmes (ADPs), national climate funds (including the Green Climate Fund and Adaptation Fund), donor programs, and public-private partnerships. The creation of a District Climate Finance Facilitation Cell (CFFC) will help coordinate resource mobilization, prepare bankable project proposals, and monitor expenditures. 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 comprehensive three-tier M&E framework will guide the DAP implementation, ensuring alignment with the KP Climate Action Plan and national climate frameworks at the strategy level, tracking climate-tagged PC-1s, departmental work plans, and ADP submissions at the planning and program level, and monitoring specific DAP activities at the project/action level, particularly in sectors like water management, agriculture, and disaster risk management. Process and outcome indicators will be developed to track progress, and a participatory, gender-sensitive approach will ensure the integration of vulnerable groups' perspectives. Regular five-year reviews will refine priorities and ensure alignment with evolving climate risks, while capacity-building programs for district officers and stakeholders, along with technology tools like web-based dashboards for data collection, will strengthen Karak's climate resilience and inform future adaptation strategies.

### Summary

The Karak DAP is a critical step towards enhancing climate resilience at the local level. By incorporating climate adaptation into district governance and aligning with provincial and national frameworks, the plan aims to address key vulnerabilities such as water scarcity, agricultural loss, and infrastructure damage due to extreme climate events. Through phased implementation and strategic financing, Karak will shift from reactive disaster response to proactive climate resilience, ensuring the district's long-term sustainability and the protection of livelihoods, natural resources, and vulnerable communities.

# 2. Introduction

## Context

The escalating impacts of climate change have dramatically reshaped Karak's landscape of vulnerability, disaster management, and socio-economic development. Located in the semi-arid southern part of Khyber Pakhtunkhwa (KP), Karak lies at the confluence of multiple climatic and anthropogenic pressures, which collectively elevate its exposure to climate-induced risks. The district's topography, characterized by arid plains, rugged hills, and degraded rangelands, combined with its dependence on rain-fed agriculture and livestock, makes it particularly vulnerable to the increasing frequency of droughts, heatwaves, flash floods, and land degradation.

According to future climate projections, Karak is experiencing a clear and accelerating warming trend, with mean annual temperatures expected to rise by 1.5°C to 2°C by mid-century and potentially reach 4°C by 2100 under high-emission scenarios (RCP 8.5). This temperature increase will significantly intensify heat exposure, raising heat stress, evapotranspiration, and irrigation demand. In addition, precipitation patterns are projected to become more erratic, with an 11% increase in annual rainfall, leading to more intense monsoon events that could cause flash floods, drainage stress, and soil erosion. Prolonged dry spells are expected to increase the frequency of droughts and further deplete groundwater resources. Furthermore, runoff projections suggest an 18% increase by the late century, heightening the likelihood of high-flow events and sedimentation risks.[1] [2]

Water scarcity is a growing issue in Karak, with declining groundwater levels and increased demand from industrial activities, particularly mining. The expansion of oil, gas, and gypsum mining has worsened water stress, with unsustainable extraction and occasional floods contaminating water sources.[3] Soil erosion and land degradation are accelerating, mainly due to overgrazing, deforestation, and unsustainable mining. This loss of vegetation, especially in the Sheenghar Range and Latamber, is intensifying desertification and threatening agriculture. Prolonged erosion is further reducing agricultural capacity, putting smallholder farmers at risk.

The human and economic impact of climate change in Karak is severe. Repeated droughts and heatwaves undermine livelihoods, disrupt infrastructure, and strain already limited resources. Each major drought or heatwave causes significant economic losses in agriculture and livestock, while the cumulative effects hinder GDP growth and recovery. Vulnerable groups, particularly women, children, and the elderly, face heightened food insecurity, water scarcity, and health risks during extreme weather events.

Future climate projections under the CRVA suggest that without urgent and integrated adaptation measures, Karak will face severe risks to its agricultural, water, and livelihood systems. The district's southern and peri-urban areas are projected to face increased seasonal water scarcity, prolonged droughts, and the risk of uninhabitability due to water depletion and flood-induced damages. These projections highlight the urgent need for coordinated action to safeguard ecosystems, build resilient infrastructure, and strengthen adaptive capacities at all levels of governance. Immediate intervention is required to address water management, land restoration, and disaster risk reduction, ensuring that Karak can withstand the compounding impacts of climate change in the years to come.

[1] https://ssr.climateinformation.org/ssr/
[2] https://www.meteoblue.com/en/weather/historyclimate/change/karak_pakistan_1174074
[3] https://www.brecorder.com/news/40384396/karaks-riches-karaks-wounds

## District profile

Karak is a strategically located district in the southern part of Khyber Pakhtunkhwa, Pakistan, situated along the Indus Highway (N-55) that links Peshawar with Karachi.[4] It lies 123 km from the provincial capital, Peshawar, and shares boundaries with Kohat to the north, Bannu and Lakki Marwat to the south, Mianwali to the east, and North Waziristan to the west.[5] Historically, Karak was ruled by the Teri Nawab until 1940 and remained a part of Kohat District until it was given the status of a separate district on 1 July 1982.[6] Administratively, it is divided into three tehsils Karak, Banda Daud Shah, and Takht-e-Nasrati comprising numerous union councils and villages, with Karak city serving as the district headquarters.[7]

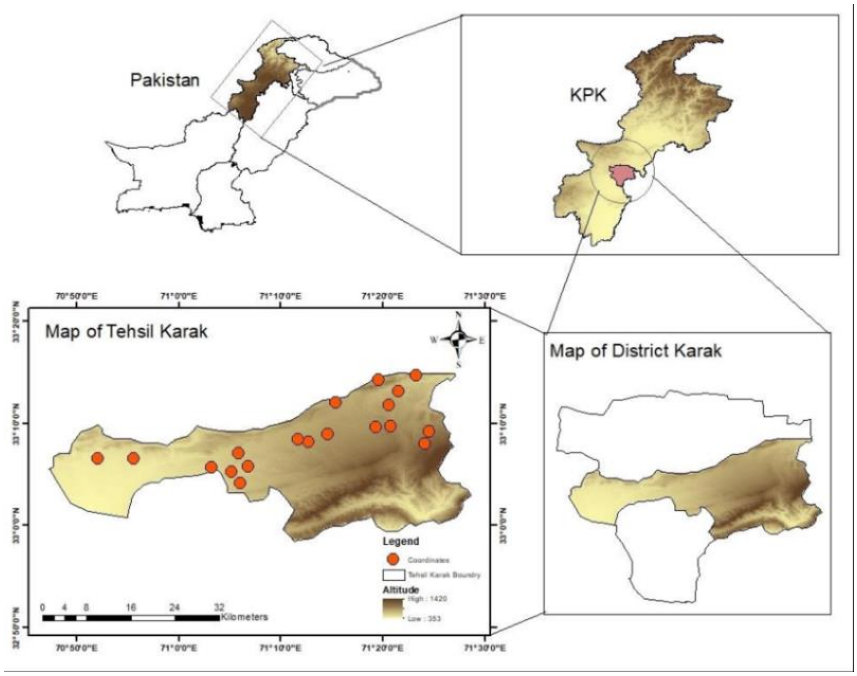


Figure 1: Reference map of Karak district.

According to the latest survey of 2023, the population of Karak District stands at 815,878. Of this, 421,292 are males, 394,575 are females, and 11 individuals are registered as transgender.[8] This reflects a balanced gender distribution, with men slightly outnumbering women. The population is predominantly rural, with urbanization occurring mainly around Karak city and Teri.[9] Land use is primarily agricultural, but the soils are often clayey, sandy, or stony, limiting productivity .[10] Only small patches of loamy and relatively fertile land exist, while a significant portion of the terrain is covered by rangelands and mountains belonging to the Salt Range.[11] Agriculture remains largely rain-fed (barani), producing wheat, maize, groundnut, and gram as the main crops.[12] Livestock herding is

[4] https://karak.kp.gov.pk/
[5] https://pakistanalmanac.com/kp-karak/
[6] https://karak.kp.gov.pk/
[7] CityPopulation. (2023). *Karak District Population Data*
[8] https://www.citypopulation.de/en/pakistan/khyberpakhtunkhwa/admin/610__karak/
[9] https://pakistanalmanac.com/kp-karak/
[10] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. *International Journal of Innovations in Science & Technology, Special Issue,* 43–58.
[11] Ibid.
[12] https://pakistanalmanac.com/kp-karak/

a complementary livelihood, heavily dependent on natural rangelands, which have been increasingly degraded due to overgrazing and shifting vegetation patterns caused by climate change.[13]

The district is rich in natural resources, making it economically significant within the province.[14] Karak is one of the leading oil and gas producing regions of Khyber Pakhtunkhwa and possesses vast deposits of minerals.[15] Large salt mines are in Jatta Ismail Khel, Garh Jawal Khel, and Bahadar Khel, while gypsum is abundant in Jatta Valley and Garh Jawal Khel. Limestone and coal have also been reported.

Karak experiences extreme variations, with scorching summers reaching up to 44°C in June and cold winters with temperatures as low as 5°C in January. The district receives an annual average of 478 mm of rainfall, concentrated in monsoon months and winter spells, which often triggers flash floods in addition to prolonged droughts. Recent studies document significant shifts in the floristic composition of grazing lands, reducing fodder availability and threatening livestock-based livelihoods.[16] These climatic stresses have serious implications for agriculture, rangelands, and biodiversity, with recurring wildfires adding to ecological degradation.[17]

The district's semi-arid climate, undulating topography, and limited irrigation infrastructure restrict extensive cultivation, though smallholder farms sustain drought-tolerant crops such as millet, sorghum, and gram, alongside olive and date plantations supported under provincial dryland agriculture initiatives.[18] Karak's geological richness including salt, gypsum, and hydrocarbon reserves has contributed to the development of extractive industries that increasingly influence local land-use dynamics. However, remote sensing and ecological surveys highlight an expanding trend of rangeland degradation, vegetation loss, and soil exposure driven by overgrazing and deforestation.[19] These processes, coupled with erratic rainfall and rising temperatures, heighten the district's susceptibility to desertification and land productivity decline, underscoring the urgent need for sustainable land and water management interventions.

Overall, Karak's demographic profile is defined by a youthful and largely rural population, high male literacy but persistent female educational gaps, and a linguistically uniform society. These features collectively underscore the importance of targeted investments in rural education infrastructure, gender-focused literacy programs, youth employment initiatives, and inclusive local development planning to harness the district's demographic potential for sustainable growth and resilience.

## Combating Climate Change

Given Karak's high exposure to multiple climate-induced hazards, climate adaptation is essential for the district's sustainable development. While Pakistan's contribution to global greenhouse gas emissions remains minimal, the local impacts of climate change are disproportionately severe, necessitating a shift toward resilience-focused planning and investment. Adaptation, rather than mitigation, is the most relevant and urgent response for Karak's future. The economic cost of inaction is substantial. Damage to agriculture, water systems, livestock, and infrastructure from recurrent droughts, heatwaves, and floods continues to undermine local development. Investing in adaptation now, through sustainable water management, soil conservation, flood-resilient infrastructure, and climate-smart agriculture, will yield both economic and humanitarian benefits.

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[13] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. International Journal of Innovations in Science & Technology, Special Issue, 43–58.
[14] https://karak.kp.gov.pk/
[15] Ibid.
[16] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. International Journal of Innovations in Science & Technology, Special Issue, 43–58.
[17] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.
[18] https://pakistanalmanac.com/kp-karak/
[19] Ullah et al., 2022

In line with national frameworks such as the National Adaptation Plan (NAP 2023), the National Climate Change Policy (2021), and Khyber Pakhtunkhwa's Climate Change Policy and Action Plan (2022), Karak's District Adaptation Plan (DAP) translates these national goals into local 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, emphasizing inclusivity, evidence-based planning, and the 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 efforts.

Karak's DAP aims to shift from reactive disaster response to proactive resilience-building. It prioritizes community involvement, the 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 is embedded in district development governance. The plan also serves as a practical guide for mobilizing resources toward key adaptation measures. Aligning local actions with national frameworks, it sets the stage for accessing both domestic and international climate finance mechanisms, such as the Green Climate Fund (GCF) and the Adaptation Fund, while promoting partnerships with NGOs, academia, and the private sector.

**In structure, the Karak 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 Karak DAP seeks to operationalize adaptation as a cornerstone of district development, reducing climate risks, protecting livelihoods, and ensuring that the people of Karak 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 poses a growing threat to Pakistan's sustainable development, impacting ecosystems, livelihoods, infrastructure, and public health. Despite contributing less than 1% to global greenhouse gas emissions, Pakistan remains one of the most climate-vulnerable countries globally.[20] 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.[21]

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). [22] Districts like Chitral, Upper Dir, and Swat face recurrent GLOF-induced flooding, exemplified by the 2024 event in Upper Chitral that displaced 30 families.[23] Flash floods and heatwaves compound vulnerabilities, with the 2022 floods alone affecting millions and causing billions in losses.[24]

Karak is a strategically located district in the southern part of Khyber Pakhtunkhwa, Pakistan, situated along the Indus Highway (N-55) that links Peshawar with Karachi.[25] It lies 123 km from the provincial capital, Peshawar, and shares boundaries with Kohat to the north, Bannu and Lakki Marwat to the south, Mianwali to the east, and North Waziristan to the west.[26] The district is rich in natural resources, making it economically significant within the province.[27]

Karak experiences extreme variations, with scorching summers reaching up to 44°C in June and cold winters with temperatures as low as 5°C in January. The district receives an annual average of 478 mm of rainfall, concentrated in monsoon months and winter spells, which often trigger flash floods in addition to prolonged droughts. Recent studies document significant shifts in the floristic composition of grazing lands, reducing fodder availability and threatening livestock-based livelihoods.[28] The district's semi-arid climate, undulating topography, and limited irrigation infrastructure restrict extensive cultivation, though smallholder farms sustain drought-tolerant crops such as millet, sorghum, and gram, alongside olive and date plantations supported under provincial dryland agriculture initiatives[29]. Karak's geological richness including salt, gypsum, and hydrocarbon reserves has contributed to the development of extractive industries that increasingly influence local land-use dynamics. However, remote sensing and ecological surveys highlight an expanding trend of rangeland degradation, vegetation loss, and soil exposure driven by overgrazing and deforestation.[30]

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[20] MoCC&EC, 2023. Pakistan National Adaptation Plan 2023. [online] Available at: https://unfccc.int/sites/default/files/resource/National_Adaptation_Plan_Pakistan.pdf
[21] https://www.aa.com.tr/en/environment/pakistan-ranked-as-most-vulnerable-country-to-climate-change-in-2022/3480075#
[22] https://tnnenglish.com/illegal-glacier-harvesting-threatens-khyber-pakhtunkhwas-ecosystem-amid-climate-crisis
[23] 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
[24] https://www.gavi.org/vaccineswork/new-climate-report-khyber-pakhtunkhwa-warns-grave-health-impacts-2050
[25] https://karak.kp.gov.pk/
[26] https://pakistanalmanac.com/kp-karak/
[27] https://karak.kp.gov.pk/
[28] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. International Journal of Innovations in Science & Technology, Special Issue, 43–58.
[29] https://pakistanalmanac.com/kp-karak/
[30] Ullah et al., 2022

## Methodology

The assessment builds directly on the findings of the Karak 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 Development Policy Institute (SDPI). Additionally, the Green Climate Fund (GCF) has played a significant role as the primary donor in supporting the financial aspects of this project. 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)[31] and the Global Covenant of Mayors (GCoM) Climate Risk and Vulnerability Assessment Methodology[32], 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) websites.

Primary data were collected during the CRVA phase through 32 Key Informant Interviews (KIIs) across the district, and two community Focus Group Discussion (FGD) representing farmers, shopkeepers, teachers, students and community leaders, and a multi-stakeholder consultation workshop held in July 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.[33] [34]

### 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 (**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 Karak 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

[31] https://www.adb.org/projects/documents/reg-46470-001-tacr-7
[32] https://www.mwcog.org/file.aspx?&A=y9hD4xqfpcWZWNKMavuARxo%2F55JL8iQeVoRwGQPSGZY%3D
[33] https://ssr.climateinformation.org/ssr/
[34] https://www.meteoblue.com/en/weather/historyclimate/change/karak_pakistan_1174074

systems, and developing an investment-oriented District Adaptation Plan aligned with provincial and national adaptation objectives.

## Observed Climate Trends

Over the past three decades, District Karak has experienced a steady intensification of climate-induced and anthropogenic stresses that have transformed its environmental baseline from semi-arid to predominantly arid conditions. Historical climatic datasets indicate that mean annual rainfall has declined by approximately 12–18% since the early 2000s, accompanied by a 1.4°C increase in mean annual temperature.[35] These shifts have resulted in longer dry spells, a contraction of the monsoon window, and recurrent drought years most notably in 2012, 2016, 2019, and 2022, each marked by acute water shortages and significant reductions in rangeland productivity.[36]

- **Temperature Rise & Heatwaves:** District Karak has experienced a clear and accelerating warming trend over the past two decades, consistent with temperature intensification across the southern semi-arid belt of Khyber Pakhtunkhwa. Recent climatic assessments show that summer maximum temperatures regularly exceed 40°C, with peak extremes reaching 46°C, marking a significant rise in both the frequency and duration of heatwave episodes[37]. Night-time minimum temperatures have also increased, averaging 25–26°C during peak summer months, reducing nocturnal cooling and expanding total daily heat exposure[38]. Health and agricultural data from district departments indicate measurable impacts: outpatient visits for heat-related illness increased by 30–40%, while cereal yields declined by 15–25% during the 2022–2023 summer due to heat-induced moisture stress[39].
- **Drought & Water Scarcity:** District Karak shows a clear shift toward arid conditions, with historical datasets indicating a 12–18% decline in annual rainfall and a +1.4°C rise in temperature since the early 2000s[40]. Groundwater depletion in Takht-e-Nasrati has become increasingly severe, with residents reporting that tubewells have dried up, forcing them to drill deeper in search of freshwater. In recent years, water has only been found at depths of up to 225 meters. Local farmers, has experienced the direct impact, with his 1.6 hectares of land remaining barren since 2013 due to erratic rainfall and the drying of wells. While the exact annual rate of decline is not consistently documented, the observed increase in depth over time indicates a gradual worsening of the situation, with water levels dropping significantly since the early 2010s[41].. A GIS-based aquifer vulnerability assessment classifies 54% of the district as Highly Vulnerable and 10.7% as Very Highly Vulnerable to groundwater stress[42]. Climate-groundwater modelling shows that precipitation, temperature and delayed rainy seasons explain 73% of groundwater decline variance across surveyed villages[43]. Farm-livelihood surveys confirm that 80% of farmers identify water scarcity as the main constraint to crop production [44]. Drought years such as 2012, 2016, 2019 and 2022 caused repeated crop failures and rangeland biomass loss[45]. Household-level studies show widespread dependence on costly tanker water and deep boreholes, with

[35] District Agriculture Office Karak. (2023). Annual Agro-Climatic Data Report 2021–2023. Karak, Khyber Pakhtunkhwa.
[36] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.
[37] Amish, M., Ullah, A., Zaman, S., & Farooqi, J. From Theory to Practice: Implementing Water Management Technology for Climate Resilience in Karak District.
[38] Amish, M., Ullah, A., Zaman, S., & Farooqi, J. From Theory to Practice: Implementing Water Management Technology for Climate Resilience in Karak District.
[39] District Director Office of Agriculture Extension, Karak. (2023). Average Climatic Data of Tehsil Karak (2021–2023). Government of Khyber Pakhtunkhwa.
[40] SDPI (2025). Karak Climate Risk & Vulnerability Assessment (CRVA).
[41] https://www.eco-business.com/news/engineers-warn-of-severe-groundwater-shortage-in-northwest-pakistan/
[42] Frontiers in Water. (2025). Groundwater Vulnerability Assessment for Semi-Arid Districts of Pakistan.
[43] Noor, S., & Shafi, M. (2025). Impact of Climate Change on Confined Aquifer Resources in District Karak.
[44] Amish, M., Ullah, A., Zaman, S., & Farooqi, J. From Theory to Practice: Implementing Water Management Technology for Climate Resilience in Karak District
[45] SDPI (2025). Karak Climate Risk & Vulnerability Assessment (CRVA).

water scarcity strongly linked to declines in livelihood wellbeing[46]. Field reports document explores tubewells drying completely, with some villages drilling down to 225 meters to reach water. Mining and extraction activities further intensify drought risk by altering recharge zones and degrading groundwater quality in Takht-e-Nasrati and Banda Daud Shah[47] .


Figure 2: Drought Hazard Profile of Karak.

| Climate Scenario | SSP245 | | | | | | SSP585 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval | 2011-2040 | | 2041-2070 | | 2071-2100 | | 2011-2040 | | 2041-2070 | | 2071-2100 | |
| Crop Season | Rabi | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi | Kharif |
| Severity | | | | | | | | | | | | |

Normal Mild Moderate Severe Extreme

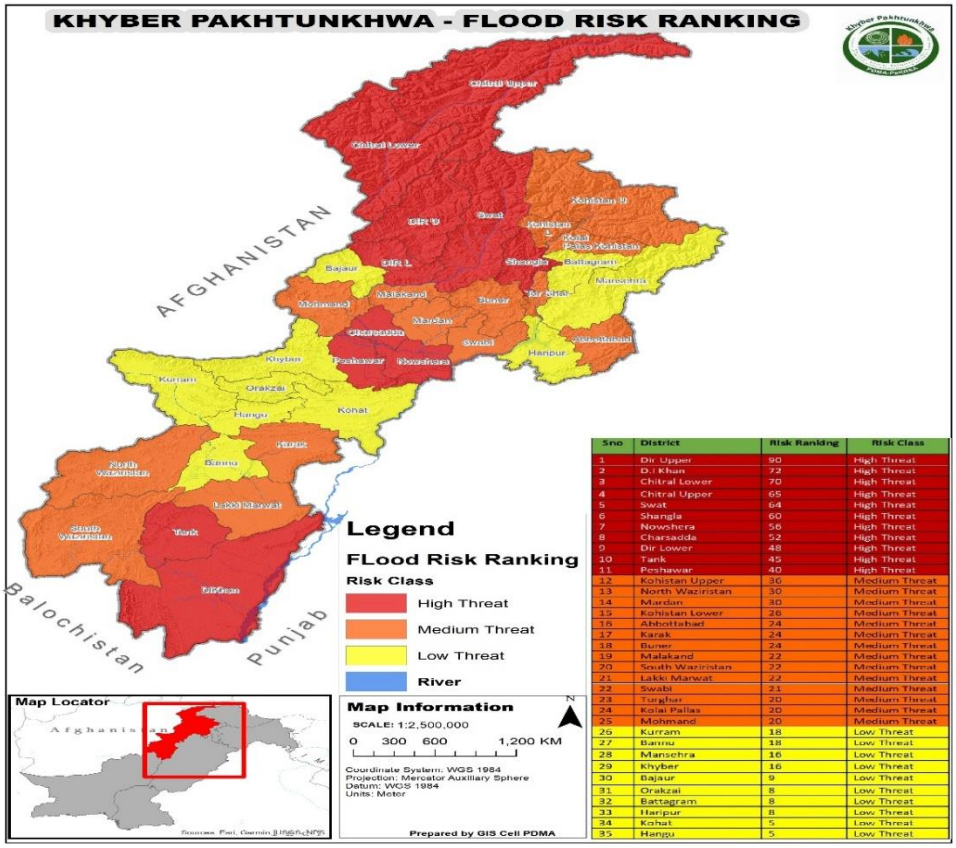
Figure 3: Climate scenario profile of Karak using SSP245 and SSP585[48]

Drought hazard assessment was performed make use of various indicators (precipitation, temperature, soil moisture) and indices (SPI, NDVI) to assess meteorological, hydrological, and agricultural droughts. Meteorological drought was evaluated using SPI derived from rainfall data. Hydrological drought assessment considered indices like SWSI, SMA, and PDSI, along with historical crop yield data. Finally, agricultural drought was analyzed using satellite-derived indices (NDVI, VCI, TCI, VHI). The results from each index were validated against SPI and crop yield variations to identify drought-prone areas.

- **Flash Floods & Runoff:** District Karak, despite low mean annual rainfall (200–350 mm), is highly susceptible to flash floods due to its steep topography, eroded slopes, and expanding

[46] Rasool, M., Khan, F., & Ullah, S. (2023). Water Scarcity and Social Wellbeing in District Karak, Khyber Pakhtunkhwa.
[47] SDPI Consultation Report. (2025). Stakeholder Consultation Report – Karak
[48] https://natcat.ndrmf.pk/reporting.php

barren lands, which reduce infiltration and accelerate surface runoff[4950] . Field observations indicate that even 40–60 mm of rainfall in a single day can trigger destructive overland flow, gully erosion, and channel overflow in villages such as Banda Daud Shah, Sabir Abad, and Takht-e-Nasrati [51]. Land-cover analyses reveal a 22–25% decline in vegetation between 2000 and 2022, further diminishing soil absorption and exacerbating runoff hazards[52]. Historical flood events, including the 2010 and 2022 monsoon floods, caused widespread damage, with ~70% of households inundated in Pai village, collapse of roads, and sedimentation of ponds and drainage channels[53]. Downscaled CMIP6 projections under RCP 8.5 indicate that annual rainfall could increase by 11% by 2100, concentrated in intense events, resulting in up to 18% higher runoff and elevated flash flood probability [54]. Field consultations report that mining and land degradation amplify local flood hazards by altering drainage patterns, increasing sediment loads, and destabilizing slopes[55]. Hydrological assessments indicate that gullies and ephemeral channels transport substantial sediment, reducing pond storage and exacerbating downstream flood damage[56].




| Sno | District | Risk Ranking | Risk Class |
|---|---|---|---|
| 1 | Dir Upper | 90 | High Threat |
| 2 | D.I.Khan | 72 | High Threat |
| 3 | Chitral Lower | 70 | High Threat |
| 4 | Chitral Upper | 65 | High Threat |
| 5 | Swat | 64 | High Threat |
| 6 | Shangla | 60 | High Threat |
| 7 | Nowshera | 56 | High Threat |
| 8 | Charsadda | 52 | High Threat |
| 9 | Dir Lower | 48 | High Threat |
| 10 | Tank | 45 | High Threat |
| 11 | Peshawar | 40 | High Threat |
| 12 | Kohistan Upper | 36 | Medium Threat |
| 13 | North Waziristan | 30 | Medium Threat |
| 14 | Mardan | 30 | Medium Threat |
| 15 | Kohistan Lower | 26 | Medium Threat |
| 16 | Abbottabad | 24 | Medium Threat |
| 17 | Karak | 24 | Medium Threat |
| 18 | Buner | 24 | Medium Threat |
| 19 | Malakand | 22 | Medium Threat |
| 20 | South Waziristan | 22 | Medium Threat |
| 21 | Lakki Marwat | 22 | Medium Threat |
| 22 | Swabi | 21 | Medium Threat |
| 23 | Torghar | 20 | Medium Threat |
| 24 | Kolai Palas | 20 | Medium Threat |
| 25 | Mohmand | 20 | Medium Threat |
| 26 | Kurram | 18 | Low Threat |
| 27 | Bannu | 18 | Low Threat |
| 28 | Mansehra | 16 | Low Threat |
| 29 | Khyber | 16 | Low Threat |
| 30 | Bajaur | 9 | Low Threat |
| 31 | Orakzai | 8 | Low Threat |
| 32 | Battagram | 8 | Low Threat |
| 33 | Haripur | 8 | Low Threat |
| 34 | Kohat | 5 | Low Threat |
| 35 | Hangu | 5 | Low Threat |

Figure 4: Flood Risk Ranking of KP[57]

[49] Ghumman, A. R., Sultan, T., Hashmi, H. N., & Rizwan, A. (2018). Investigation of Groundwater Quality for Irrigation in Karak District.
[50] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[51] Ibid.
[52] SLMP-II Assessment. (2022). *Ecosystem and Land Degradation Evaluation in Southern Khyber Pakhtunkhwa.*
[53] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.
[54] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[55] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.
[56] Ghumman, A. R., Sultan, T., Hashmi, H. N., & Rizwan, A. (2018). *Investigation of Groundwater Quality for Irrigation in Karak District.*
[57] https://www.pdma.gov.pk/maps/6

- **Land Degradation & Soil Erosion:** Karak's land resources have experienced accelerated degradation driven by climatic stress, overgrazing, fuelwood extraction and mining. NDVI-based analyses confirm a 22–25% loss in vegetation cover across rangelands and the Sheenghar Range over the last two decades, contributing to severe soil erosion[58]. Soil-loss measurements indicate erosion rates of 15–25 tonnes per hectare per year, far exceeding sustainable thresholds for dryland ecosystems and causing topsoil depletion, siltation of ponds, reduced infiltration and declining agricultural productivity[59]. Communities report crop yield declines of up to 35% in severely degraded areas, particularly during drought years, forcing farmers to expand cultivation into marginal lands, further accelerating the degradation cycle[60]. Mining activities, especially open-pit gypsum and salt extraction, have worsened slope instability and exposed large areas of soil to rapid runoff and erosion[61].

## Projected Climate Trends and Impacts

### Projected Changes in Temperature:

Climate model ensembles for Karak indicate a consistent warming trend across all projection periods (*Table 1*). Mean annual temperatures are projected to increase 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 scenarios, respectively (*Figure 5*). Warming is robust across all models, showing high ensemble agreement. By mid-century, mean temperatures are expected to rise by 1.5–2 °C, intensifying heat stress, evapotranspiration, irrigation demand, and soil moisture deficits. Under the high-emission RCP 8.5 scenario, Karak could experience around 4 °C average warming by 2100, significantly increasing the frequency and intensity of heatwaves, amplifying heat-related health risks, and reducing productivity in key crops such as wheat, millet, and sorghum[62]. These trends suggest that, without mitigation and adaptation measures, rising temperatures will exacerbate water scarcity, degrade rangelands, and further undermine livelihoods dependent on rainfed agriculture.

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

| Time Period | RCP 4.5 | RCP 8.5 | Interpretation |
|---|---|---|---|
| **2011–2040** | +0.82 °C (0.72–1.0) | +1.0 °C (0.95–1.1) | Early warming already detectable in observed trends. |
| **2041–2070** | +1.6 °C (1.5–2.0) | +2.4 °C (2.1–2.6) | Accelerated rise in temperature; stronger summer heatwaves. |
| **2071–2100** | +2.0 °C (1.9–2.5) | +4.0 °C (3.6–4.5) | Significant late-century warming; high-emission path doubles heat exposure. |

[58] SLMP-II Assessment. (2022). *Ecosystem and Land Degradation Evaluation in Southern Khyber Pakhtunkhwa.*
[59] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[60] Rasool, N., et al. *Water Scarcity and Social Wellbeing in District Karak.*
[61] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.
[62] Rasool, N., et al. Water Scarcity and Social Wellbeing in District Karak.

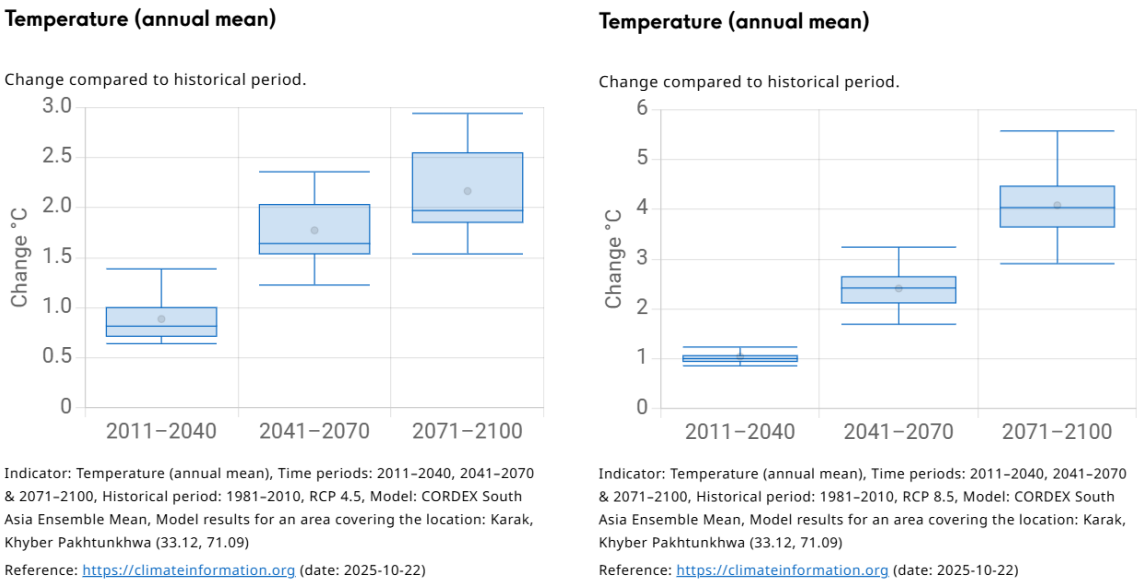



Figure 5: Projected Mean Annual Temperature Change, RCP 4.5 vs RCP 8.5, 2011–2100.

According to Meteoblue (ERA5) data, observed climate trends over the past four decades show a clear warming pattern in Karak District. The yearly temperature change graph indicates that the 1980s and 1990s were dominated by cooler years (blue stripes), whereas after 2000, warmer years (red stripes) became predominant, signifying a consistent upward temperature trend (Figure 6). This pattern points to hotter summers, extended warm seasons, and increased risks of heat stress for both people and crops. Monthly temperature anomalies confirm this warming, with red (warmer-than-average) months now dominating and blue (colder-than-average) months becoming rare, reflecting reduced natural cooling and a rising frequency of heat extremes (Figure 7). The maximum temperature diagram further illustrates that May and June experience the highest frequency of extreme heat days, marking the pre-monsoon period as the most critical for heat-related health and agricultural stress (Figure 8).[63]

[63] https://www.meteoblue.com/en/weather/historyclimate/change/karak_pakistan_1174074

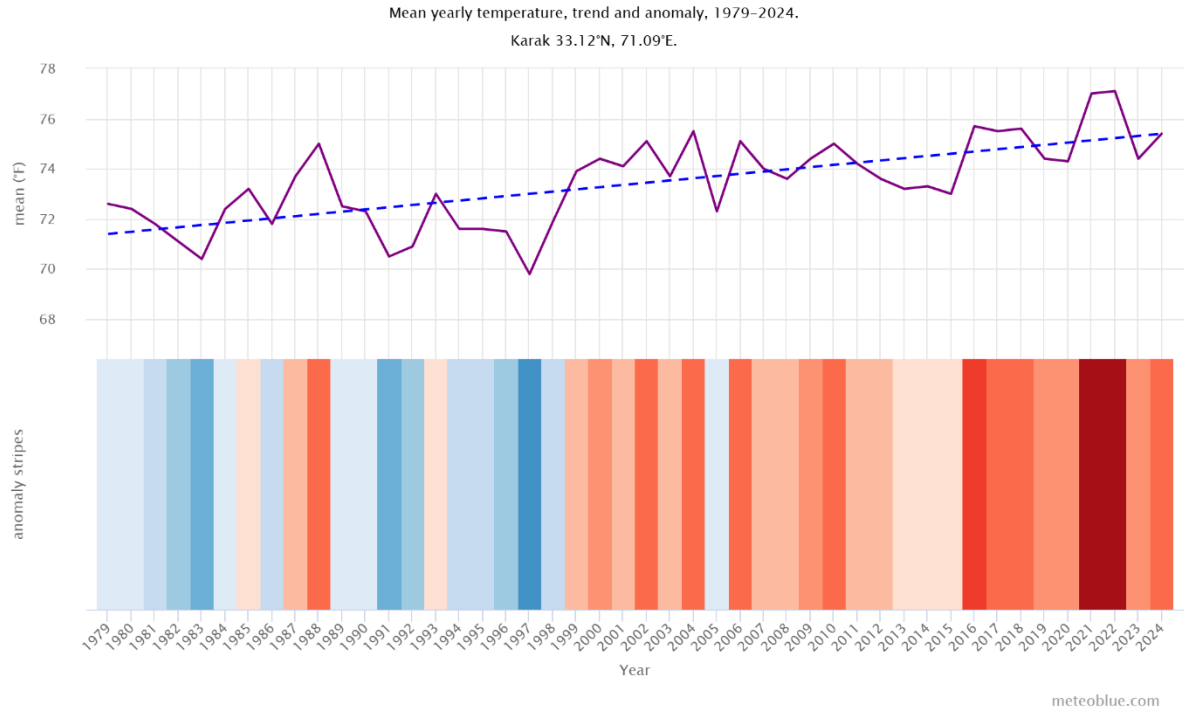



Figure 6: Yearly Temperature Change in Karak (1979–2024), showing a steady warming trend with dominance of hot years post-2000.

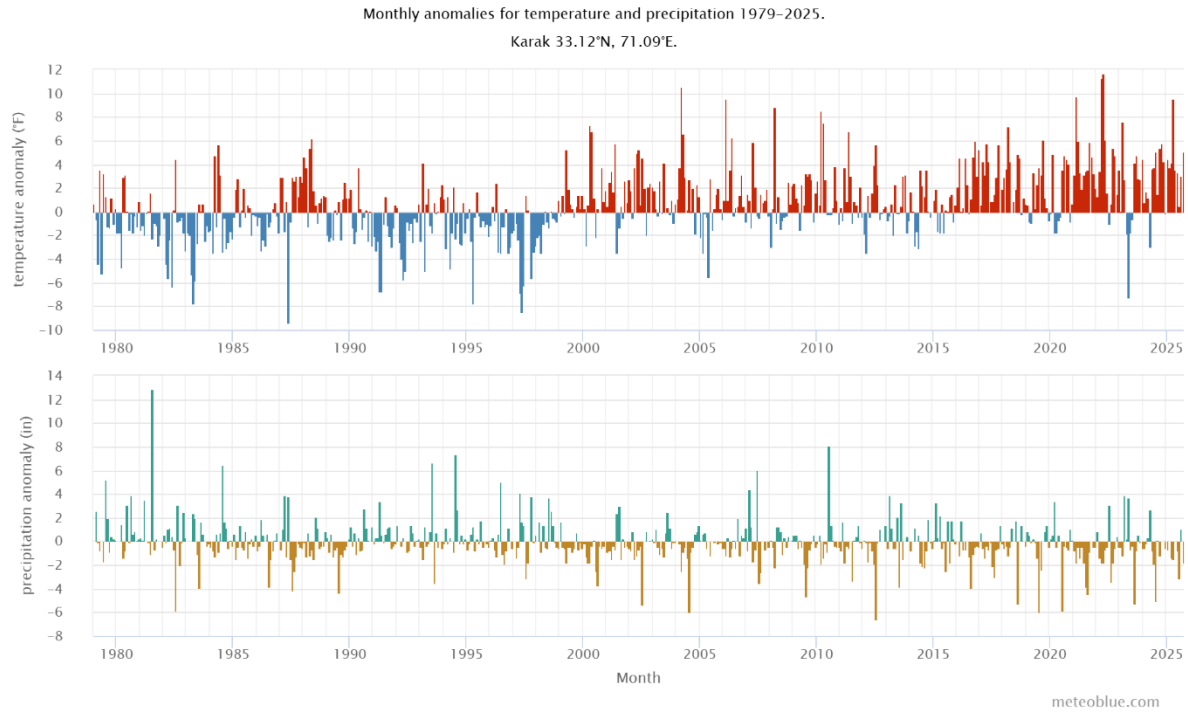



Figure 7: Monthly Temperature and Precipitation Anomalies (1979–2024) illustrating increased frequency of warm months and rainfall variability.

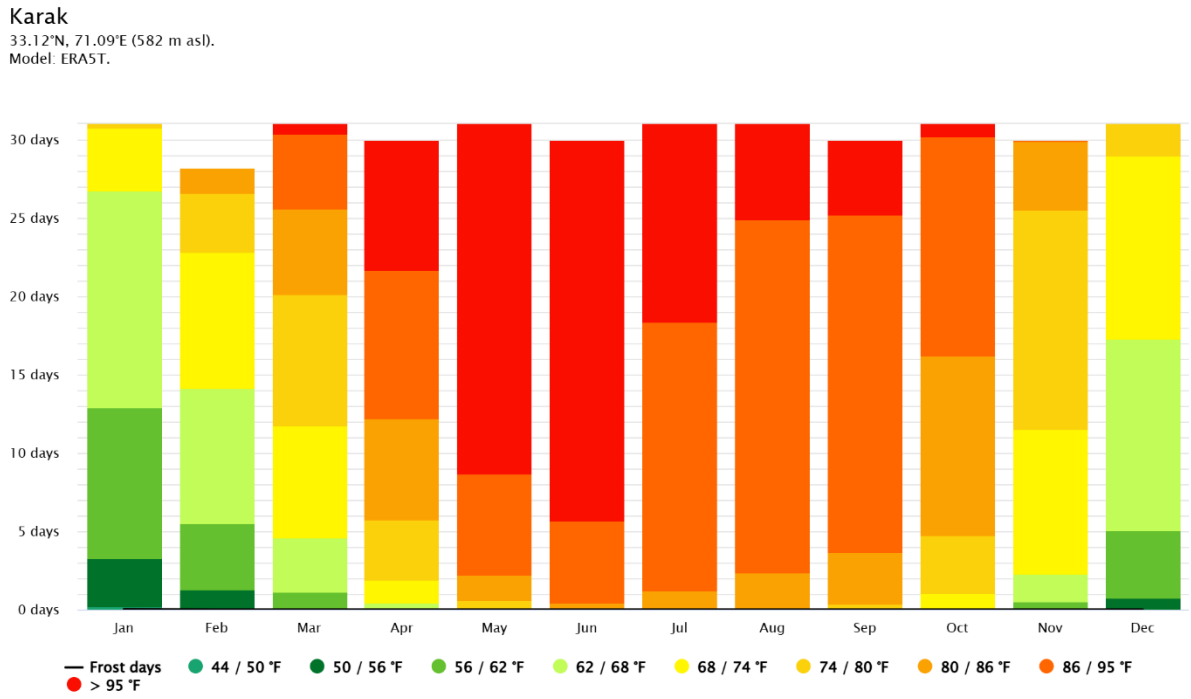


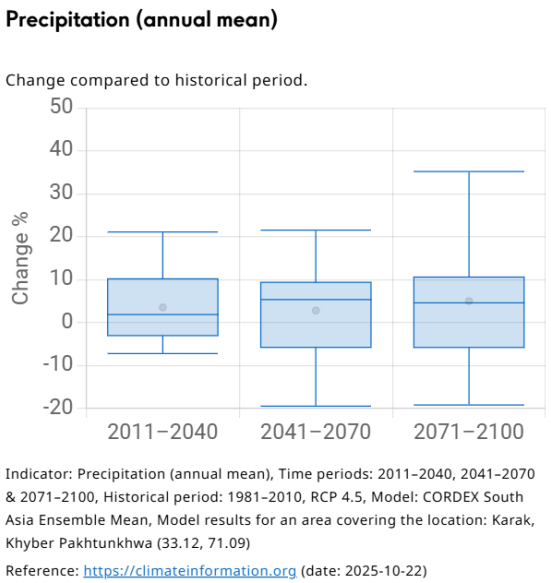

Figure 8: Maximum Temperature Diagram highlighting extreme heat occurrence during May–June, the peak stress period.

**Projected Changes in Precipitation:**

Climate model projections for Karak indicate moderate variability in annual precipitation, with both RCP 4.5 and RCP 8.5 showing slight increases over the century (Table 2). In the near term (2011–2040), annual precipitation is projected to rise marginally by +1.9 % under RCP 4.5 and +1.5 % under RCP 8.5, although uncertainty is high, with possible decreases of up to 3 % or 6.8 % respectively. This suggests that near-term rainfall totals may change little, but variability in timing and intensity could still lead to extreme events. By mid-century (2041–2070), both scenarios indicate a strengthening monsoon influence, with RCP 4.5 projecting +5.4 % and RCP 8.5 +6.7 % increases, accompanied by a wider range of variability. This implies more intense monsoon spells, as well as longer dry periods, increasing the potential for seasonal flooding and soil erosion. By late century (2071–2100), RCP 8.5 shows a substantial rise of +11 %, with a possible range from −5.6 % to +32 %, indicating a higher likelihood of heavy rainfall events. Such extremes could increase flash flood risks, overwhelm drainage systems, and exacerbate sedimentation. At the same time, pre-monsoon dry months are likely to persist, leading to seasonal droughts and higher irrigation demand despite the slight overall increase in precipitation.

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

| Time Period | RCP 4.5 | RCP 8.5 | Interpretation |
|---|---|---|---|
| **2011–2040** | +1.9 % (−3 → +10) | +1.5 % (−6.8 → +4) | Near-term uncertainty; marginal increase in annual totals. |
| **2041–2070** | +5.4 % (−5.7 → +9.4) | +6.7 % (+0.1 → +12) | Strengthening monsoon influence; higher rainfall variability. |
| **2071–2100** | +4.6 % (−5.8 → +11) | +11 % (−5.6 → +32) | Heavier rainfall events expected under high emissions. |



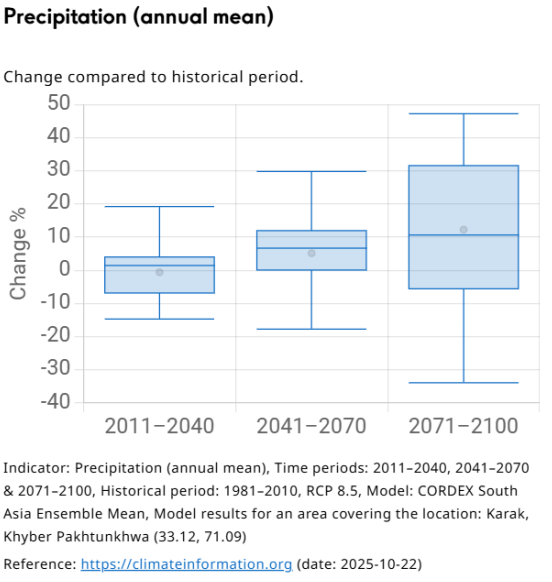




Figure 9: Projected Annual Precipitation Change, RCP 4.5 vs RCP 8.5

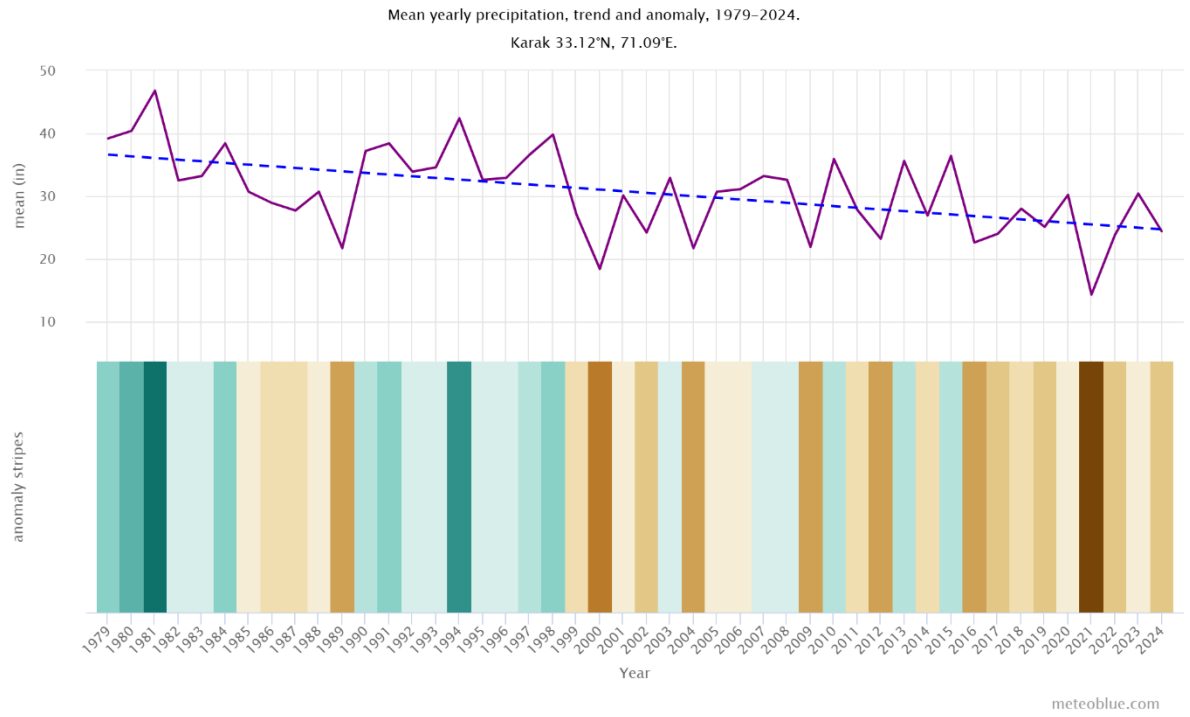



Figure 10: Yearly Precipitation Change in Karak (1979–2024), showing variability with a slightly upward trend.

The yearly precipitation graph shows an increasing presence of green (wetter) stripes, suggesting gradual monsoon strengthening in recent decades. Monthly precipitation anomalies, however, reveal sharp fluctuations between wetter- and drier-than-average months, pointing to growing rainfall irregularity and unpredictability (Figure 10). The climate diagram shows strong seasonality, with most rainfall concentrated in July and August, while the rest of the year remains dry (Figure 11).

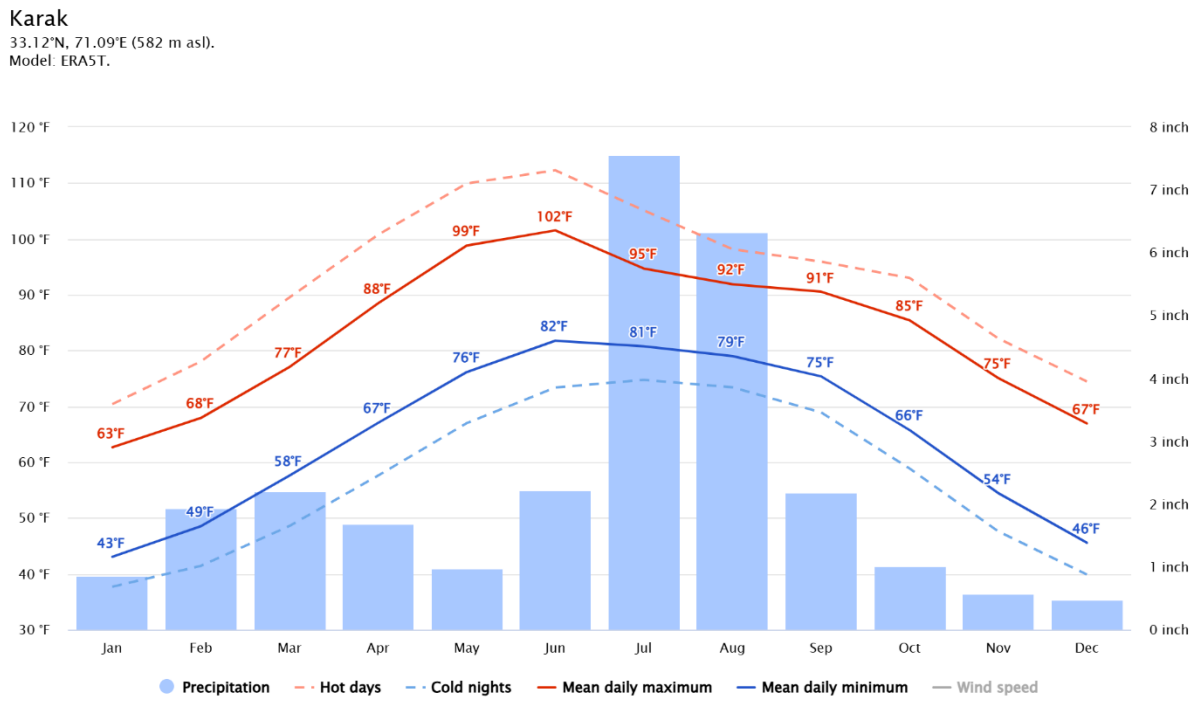



Figure 11: Climate Diagram of Average Temperature and Precipitation showing extreme summer heat and monsoon rainfall peaks.

Supporting diagrams on cloudy, sunny, and precipitation days confirm this pattern, July–August exhibit the highest number of rainy and overcast days, contrasted with extended sunny periods across most other months (Figure 12). The precipitation amount diagram indicates that heavy rainfall events cluster during the monsoon, heightening risks of flash floods, erosion, and surface runoff (Figure 13). Wind speed data show moderate but seasonally variable winds throughout the year. These variations contribute to dust storms and higher evaporation rates, which further aggravate water scarcity during dry and hot months (Figure 14).

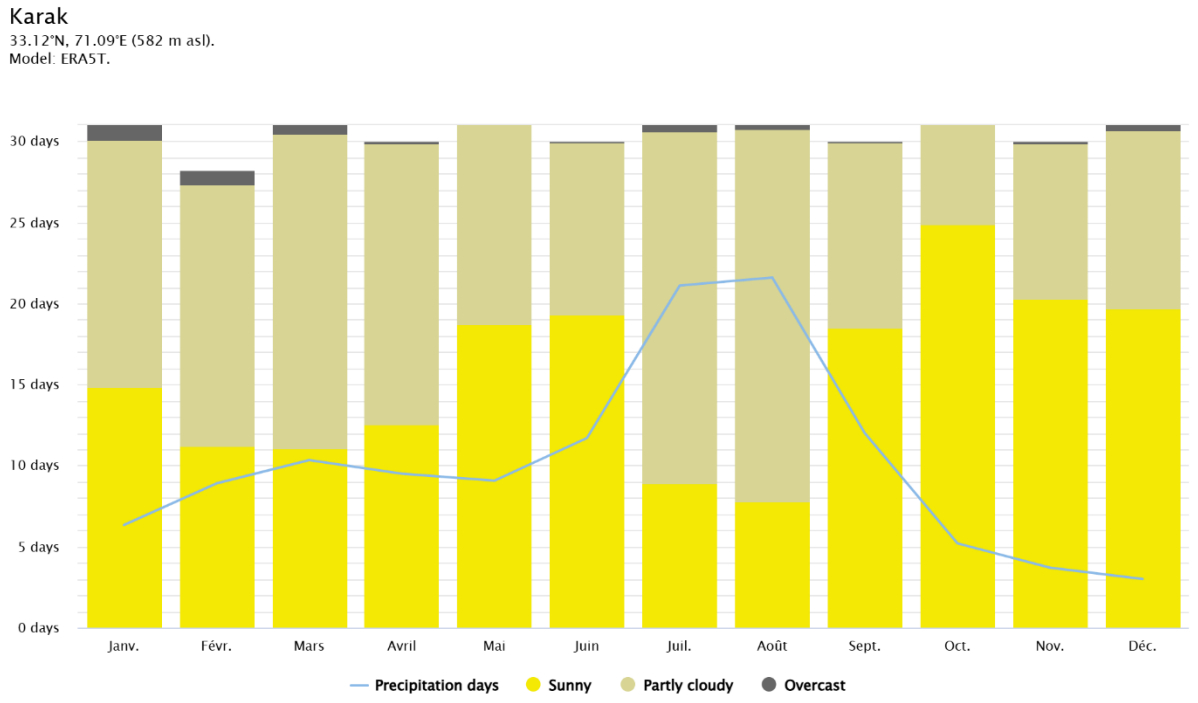


Figure 12: Cloudy, Sunny, and Precipitation Days Diagram showing concentration of rainfall during July–August.

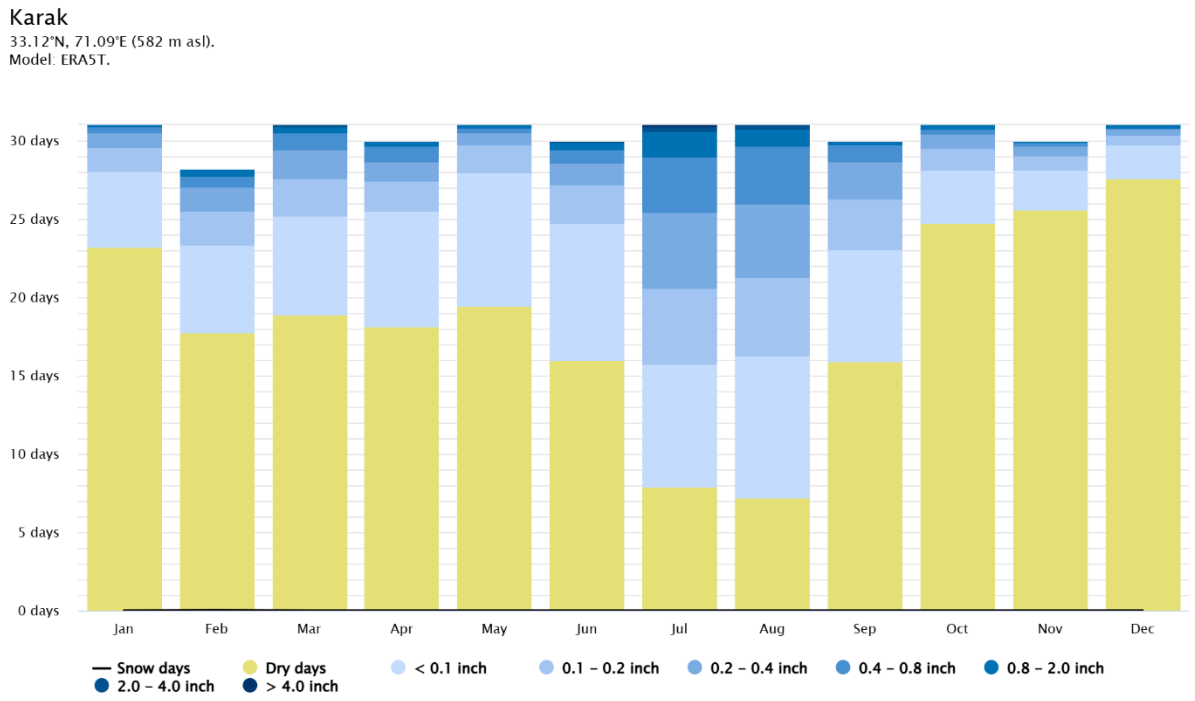



Figure 13: Precipitation Amounts Diagram illustrating clustering of heavy rain days during monsoon months.

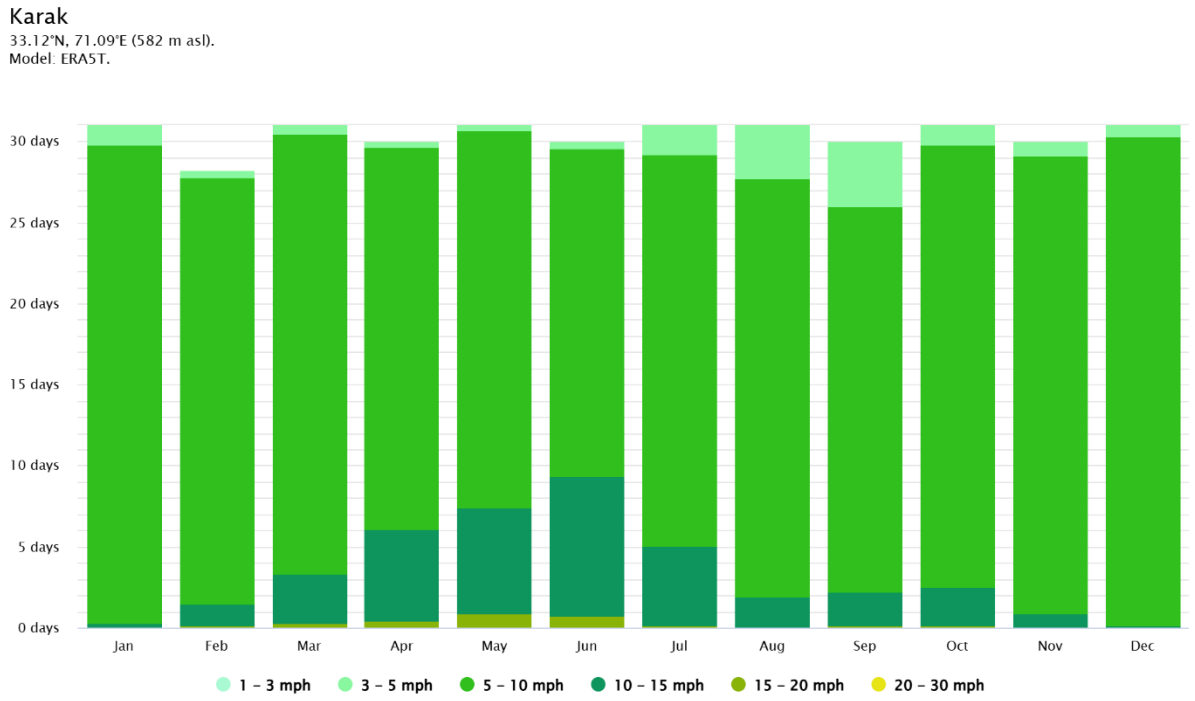



Figure 14: Wind Speed Diagram showing moderate, seasonally variable wind patterns linked to dust and evaporation stress.

## Socioeconomic Vulnerabilities

Karak District's vulnerabilities are deeply shaped by social inequalities, economic fragility, and a heavy reliance on climate-sensitive livelihoods, compounded by insufficient infrastructure and limited access to social protection [64] [65]. The district's population depends primarily on rain-fed agriculture, livestock, and extractive industries, which makes households structurally exposed to recurring droughts, heatwaves, and water scarcity[66] . Poverty is widespread, with over 35% of households estimated to live below the poverty line [67], leaving limited buffers against repeated climate shocks. The intersection of gender, age, and livelihood type further differentiates vulnerability: women, youth, pastoralists, and low-income households face heightened exposure due to restricted access to resources, entrenched social norms, and low adaptive capacity[68] .

Female labor participation remains below 20%, concentrated largely in unpaid agricultural and livestock activities, with restricted access to land ownership, credit, or extension services [69]. Youth, who make up over a third of the district population, encounter increasing employment challenges as erratic rainfall and recurrent droughts reduce farm-based work opportunities, often forcing temporary migration or engagement in low-paid informal labour[70]. Pastoralists and smallholder farmers in Sheenghar and Takht-e-Nasrati tehsils face repeated losses from declining forage, water scarcity, and heat stress, which have increased livestock mortality, disrupted traditional grazing patterns, and fueled local conflicts over communal pastures.[71] Mining-dependent workers in Banda Daud Shah and Bahadar Khel are simultaneously exposed to extreme heat, dust, and unsafe occupational conditions, while unrehabilitated pits exacerbate seasonal flooding and water contamination. Elderly and disabled populations face additional risks due to limited mobility, inaccessible shelters, and gaps in early warning dissemination.

### Human Toll

The cumulative impacts of climate extremes on households are significant. Prolonged droughts and heatwaves have caused depletion of household assets, prompted migration of working-age men and youth, and increased the workload for women, who manage both domestic responsibilities and care for livestock under extreme conditions[72]. Consultations revealed that heatwaves frequently disrupt schooling and skill development, further constraining future income opportunities for youth[73]. Women face compounded burdens in water collection and household management, constrained by social norms that limit mobility and participation in decision-making.

### Economic Losses

Repeated climate shocks directly erode household income and savings while limiting long-term development prospects[74]. Pastoralists, smallholder farmers, and mining-dependent households are particularly vulnerable [75]. In the 2022 monsoon floods, 880 houses were damaged (300 fully destroyed), 105 commercial shops were affected, and 6.5 km of roads collapsed, severely disrupting

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[64] KP Bureau of Statistics. (2023). *Socioeconomic indicators report.* Government of Khyber Pakhtunkhwa.
[65] NDMA. (2022). *National Disaster Risk Profile – Khyber Pakhtunkhwa.* National Disaster Management Authority, Pakistan.
[66] Agricultural Extension Report – KP. (2023). *Climate-sensitive agriculture and livestock productivity in Khyber Pakhtunkhwa.* Government of Khyber Pakhtunkhwa.
[67] KP Bureau of Statistics. (2023). *Socioeconomic indicators report.* Government of Khyber Pakhtunkhwa.
[68] Field observations by the author during site visits to Karak, 14–25 July 2025.
[69] Ibid.
[70] NDMA. (2022). *National Disaster Risk Profile – Khyber Pakhtunkhwa.* National Disaster Management Authority, Pakistan.
[71] Field observations by the author during site visits to Karak, 14–25 July 2025.
[72] Field observations by the author during site visits to Karak, 14–25 July 2025.
[73] Ibid.
[74] NDMA. (2022). National Disaster Risk Profile – Khyber Pakhtunkhwa. National Disaster Management Authority, Pakistan.
[75] NDMA. (2022). National Disaster Risk Profile – Khyber Pakhtunkhwa. National Disaster Management Authority, Pakistan.

livelihoods and local markets[76]. Agricultural and livestock losses further reduced household income and food security: 40 livestock perished, and damaged boundary walls and degraded pastures compounded recovery challenges [77]. The cumulative effect of recurrent droughts and floods has been the intensification of poverty, forcing households to rely on migration, informal labour, and emergency relief for survival.

### Agricultural Productivity and Food Security

Karak's agriculture is predominantly rain-fed, with only 8–10% of cultivated land partially irrigated through small-scale communal channels[78]. Limited soil fertility, declining groundwater tables, and rangeland degradation amplify sensitivity to climatic variability [79]. Successive drought years (e.g., 2012, 2016, 2019, and 2022) have caused wheat yield reductions of 30–40% during drought periods, while erratic rainfall and high temperatures shorten growing seasons for millet, gram, and groundnut[80]. Livestock remains a critical buffer asset, yet fodder shortages and water scarcity during droughts increase mortality rates by 12–15%, reducing milk production and household income. These losses reinforce food insecurity, undermine nutrition, and force households to diversify income through seasonal migration or low-paid labour [81].

### Competition for Resources

Water scarcity, declining pasture quality, and reduced agricultural productivity have heightened competition over natural resources [82]. Communal grazing areas in Sheenghar and Takht-e-Nasrati are increasingly contested, while seasonal displacement of households adds pressure to limited water points, pastures, and arable land [83]. The cumulative effects of resource scarcity contribute to local conflicts, weaken social cohesion, and intensify vulnerability among marginalized households.

### Vulnerable Population Groups Most at Risk

Certain population groups bear disproportionate climate risk. Women face heavy domestic and livelihood burdens exacerbated by heat stress and water scarcity[84]. Youth are exposed to declining agricultural opportunities, disrupted education, and limited alternative livelihoods[85]. Pastoralists and smallholder farmers experience recurrent livestock and crop losses, while mining workers confront unsafe conditions and environmental hazards. Elderly and disabled populations have restricted mobility and limited access to emergency services, increasing exposure to extreme events (NDMA, 2022). Low-income households with limited land tenure, restricted access to credit, and weak social protection remain trapped in cycles of vulnerability and poverty.[86]

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[76] PDMA KP. (2022). *Flood Damage Assessment Report – Karak District.* Provincial Disaster Management Authority, Khyber Pakhtunkhwa.
[77] Agricultural Extension Report – KP. (2023). *Climate-sensitive agriculture and livestock productivity in Khyber Pakhtunkhwa.* Government of Khyber Pakhtunkhwa.
[78] Agricultural Extension Report – KP. (2023). *Climate-sensitive agriculture and livestock productivity in Khyber Pakhtunkhwa.* Government of Khyber Pakhtunkhwa.
[79] NDMA. (2022). National Disaster Risk Profile – Khyber Pakhtunkhwa. National Disaster Management Authority, Pakistan.
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## Institutional and Community Adaptive Capacities

### Institutional Capacity

Karak's institutional landscape for climate adaptation comprises multiple actors, including the district administration, line departments, academic institutions, and civil society, each operating with varying degrees of capacity, coordination, and resource availability. The Deputy Commissioner (DC) leads emergency responses and disaster preparedness through active Disaster Risk Reduction (DRR) cells and the use of schools as flood shelters, demonstrating proactive management of immediate crises. The DC has repeatedly advocated for a "whole-of-government" approach to climate response, highlighting awareness at senior administrative levels. However, the district lacks a dedicated climate adaptation unit, a formal policy framework, or an earmarked budget for climate resilience. The absence of a district-level climate cell or coordination committee results in fragmented interventions, limited data sharing, and reactive planning.

Key line departments, including Rescue 1122, Civil Defence, Agriculture, Health, and Tehsil Municipal Administration (TMA), recognize the risks posed by climate hazards and have undertaken isolated initiatives, such as community drills, health outreach, and sector-specific infrastructure projects. Nonetheless, operational capacity is highly constrained. Rescue 1122 lacks personnel trained in flood or livestock rescue, the Health Department has no climate-focused training or mental health support, and municipal services face weak drainage, water scarcity, and low outreach. Departments rely entirely on delayed provincial allocations, without dedicated adaptation funding, and coordination between them is ad hoc, undermining integrated planning. Weak enforcement of environmental regulations, fragmented mandates, and the exclusion of Union and Tehsil Councils from planning further limit institutional effectiveness. Civil society engagement is minimal, with no active NGO-led climate adaptation projects in the past five years, leaving community-level capacity largely unsupported. Academic institutions, notably Khushal Khan Khattak University, offer emerging climate knowledge through higher education programs, but this has not translated into local policy influence or practical interventions. Overall, Karak's institutional capacity demonstrates pockets of technical knowledge and leadership but is constrained by systemic gaps in coordination, funding, staffing, and civil society engagement, which collectively limit proactive district-wide adaptation.

### Community Capacity

Communities in Karak act as the first line of defence against climate shocks, demonstrating resilience through traditional knowledge, mutual support, and adaptive practices, yet their capacities are heavily constrained by structural barriers. Residents have developed strategies to cope with recurrent droughts, flash floods, and heatwaves, including small-scale water storage, rudimentary water filtration, adjustments in sowing and harvesting schedules, cultivation of indigenous drought-tolerant seeds, and localized reforestation to restore ecosystem buffers. Strong social cohesion allows families and tribal jirgas to coordinate relief, mobilize volunteers, and manage resource distribution during emergencies, often compensating for weak institutional response. Livelihood diversification, such as engaging in transport work, small trade, or migration, alongside informal financial arrangements like pooled savings and borrowing, further supports households in coping with shocks.

However, these strategies remain largely reactive and insufficient to address long-term vulnerabilities. Many households repeatedly face loss of shelter, livestock, and food stores, particularly those living in mud (kacha) houses that are easily damaged by floods. Women bear disproportionate responsibilities for childcare, water collection, and household management, while youth have minimal involvement in local adaptation planning, reflecting broader cultural and gender-based exclusion. Knowledge and technical gaps, including limited access to climate-smart agricultural inputs, lack of extension services, and absence of insurance mechanisms for crops and livestock, further reduce adaptive potential. Indigenous and local coping knowledge is not systematically documented or integrated into official planning, while weak public awareness and delayed early warnings prevent communities from taking timely action. Despite these challenges,

Karak's communities exhibit considerable latent adaptive potential through social networks, traditional practices, and cooperative structures. Strengthening linkages with institutions, providing technical support, and ensuring inclusive participation can convert these informal coping mechanisms into sustainable resilience strategies.

### Infrastructure and Financial Capacity

Karak's physical infrastructure and financial resources remain insufficient to manage climate risks effectively, exacerbating the vulnerability of both communities and institutions. Early warning systems are minimal or non-existent; existing mechanisms rely on word-of-mouth, mosque loudspeakers, or informal WhatsApp groups, often providing alerts too late for households to safeguard lives, livestock, and assets. Flood protection infrastructure, including embankments, culverts, drainage systems, and water supply networks, is frequently damaged or poorly maintained, leaving communities highly exposed. Schools, health centres, and other public facilities often lack climate-proofing or backup systems, while many water filtration plants and irrigation schemes are non-functional, worsening water insecurity and health hazards. Chronic underfunding prevents repair, maintenance, and proactive infrastructure investments, and the absence of dedicated contingency funds leaves the district unprepared for extreme events.

Financially, Karak has no climate-tagged budget, and line departments rely heavily on delayed provincial Annual Development Programme allocations. The district also lacks technical capacity to access international climate funds such as the Green Climate Fund or Adaptation Fund. Corporate Social Responsibility contributions from extractive industries are largely symbolic, misaligned with community priorities, and lack transparent management, leaving water, health, and environmental needs unmet. Union and Tehsil Councils have minimal revenue-raising power or financial autonomy, further constraining grassroots adaptation. These gaps in infrastructure and finance, combined with fragmented institutional coordination and weak governance, prevent the district from implementing proactive, long-term adaptation measures, leaving both the population and critical services vulnerable to ongoing and intensifying climate hazards.

# 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 Karak 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 modelling 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 Karak 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 Centre (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 Karak DAP has been structured around a seven-step process. To date, the following steps have been completed: (i) preliminary data collection and stakeholder engagement; (ii) assessment of climate vulnerabilities and adaptive capacities; (iii) identification and prioritization of adaptation options; and (iv) costing of adaptation options and identification of financial sources. A Monitoring, Evaluation, and Learning (MEL) framework has also been proposed as part of the DAP to track progress and measure the effectiveness of adaptation measures. The remaining steps will focus on: (v) integration of adaptation measures into district development and budgeting frameworks; (vi) implementation of the MEL framework; 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 Karak 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 Karak, 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 Karak 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 Karak'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 of Karak arises from the district's heightened vulnerability to climate change and the urgent need to build local resilience through a comprehensive, evidence-based, and participatory framework. Located in the semi-arid southern region of Khyber Pakhtunkhwa, Karak faces multiple climate-induced hazards, including droughts, heatwaves, flash floods, and land degradation. The district's fragile ecosystems, dependence on rain-fed agriculture, and reliance on groundwater for both domestic and industrial use amplify its exposure to these hazards. The devastating impacts of recurrent droughts, heatwaves, and flooding events highlight the urgent need for adaptation to protect local livelihoods, agriculture, and water resources.

The DAP directly addresses these challenges by providing a structured, localized mechanism to identify, prioritize, and implement climate adaptation measures. While Pakistan's NAP and NDCs 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 just a theoretical goal but a tangible, locally-driven process that responds to Karak's specific vulnerabilities and capacities.

**First**, the DAP provides a strategic framework for reducing vulnerability and building resilience. By systematically assessing local hazards and adaptive capacities, as informed by the CRVA, the DAP supports evidence-based decision-making for the sectors most affected by climate change, including agriculture, water resources, health, and infrastructure. It translates complex scientific information into actionable strategies, empowering district institutions and communities to plan and respond more effectively to climate risks.

**Second**, the DAP ensures the mainstreaming of adaptation into district planning and governance systems. Historically, adaptation efforts in Karak have been fragmented, lacking integration into existing planning 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 integration will strengthen inter-departmental coordination and enhances vertical linkages between the district, provincial, and federal levels, creating a cohesive system for climate action.

**Third**, the DAP contributes to safeguarding and climate-proofing development gains. Karak's recurring exposure to climate extremes continues to undermine progress in agriculture, infrastructure, and public services. By integrating resilience principles into infrastructure design, water management, and land-use planning, the DAP helps protect past investments, minimize future losses, and ensure the sustainability of local development. This aligns with national priorities of fostering climate-resilient growth and reducing the economic burden of climate-related disasters.

**Fourth**, the DAP strengthens Karak's capacity to mobilize financial resources for adaptation. By providing a clear set of adaptation priorities, cost estimates, and implementation pathways, the DAP serves as an important step in attracting funding from domestic and international sources such as the Green Climate Fund (GCF), the Adaptation Fund, and the National Disaster Risk Management Fund (NDRMF). The DAP also explores innovative financing options, including public-private partnerships and climate-focused investments, to support local resilience initiatives.

**Fifth**, the DAP fosters collaboration, inclusivity, and knowledge co-production. Its preparation involved active engagement with local communities, line departments, civil society organizations, academia, and youth representatives, ensuring that diverse voices inform decision-making. This participatory approach enhances the legitimacy, ownership, and sustainability of the plan, combining scientific knowledge with traditional and indigenous practices that have historically helped local communities cope with environmental variability.

**Sixth**, the DAP promotes social equity and inclusion by integrating gender and youth perspectives across all adaptation priorities. Women, youth, and marginalized groups often bear the brunt of climate impacts but also hold vital knowledge for building community resilience. The DAP ensures their active participation in designing, implementing, and monitoring adaptation actions, advancing social justice and ensuring that no one is left 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, contributing to the national targets under the NDCs. At the global level, it supports the achievement of the Sustainable Development Goals (SDGs), particularly SDG 13 on Climate Action, while aligning with the Paris Agreement and the Sendai Framework for Disaster Risk Reduction (2015-2030).

In summary, the District Adaptation Plan for Karak 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 fragmented interventions to an integrated, multi-sectoral, and inclusive approach to climate action.

## Foundation

The foundation of the Karak 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 Karak 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 Karak 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)[87] commits Pakistan to reducing greenhouse gas emissions by 50% by 2030, conditional on international support, while placing strong emphasis on adaptation in

[87] https://unfccc.int/sites/default/files/2025-09/Pakistan_NDC3.0_24%20Sep.pdf

priority sectors such as agriculture, water, health, and disaster risk management. The National Climate Change Policy, first issued in 2012 and updated in 2021[88], 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)[89] 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)[90] and the KP Climate Change Action Plan (2022)[91]. 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)[92], the KP Forest Amendment Act (2022)[93], and the Khyber Pakhtunkhwa Environmental Protection Act (2014)[94] 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[95], aligns the province with the federal National Disaster Management Act of 2010[96] 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[97] complements these frameworks by emphasizing preparedness, contingency planning, and the mainstreaming of DRR across all development processes.

Taken together, these international commitments, national frameworks, and provincial policies create a strong enabling environment for the Karak 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 Karak 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.

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[88] https://mocc.gov.pk/SiteImage/Policy/NCCP%202021.pdf
[89] https://unfccc.int/sites/default/files/resource/National_Adaptation_Plan_Pakistan.pdf
[90] https://epakp.gov.pk/wp-content/uploads/2022/09/Khyber-Pakhtunkhwa-Climate-Change-Policy-2022.pdf
[91] https://epakp.gov.pk/wp-content/uploads/2022/09/Khyber-Pakhtunkhwa-Climate-Change-Action-Plan-August-2022-English.pdf
[92] https://kpcode.kp.gov.pk/uploads/The_Khyber_Pakhtunkhwa_Water_Act_2020_Act_No_XXV_of_2020.pdf
[93] 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
[94] https://kpcode.kp.gov.pk/uploads/THE_KHYBER_PAKHTUNKHWA_ENVIRONMENTAL_PROTECTION_ACT_2014.pdf
[95] https://www.pakp.gov.pk/act/the-national-disaster-management-khyber-pakhtunkhwa-amendment-act-2012/
[96] https://kpcode.kp.gov.pk/uploads/Federal_National_Disaster_Management_Act_2010.pdf
[97] https://knowledge.unv.org/sites/default/files/2022-05/National%20DRR%20policy%20Pakistan.pdf

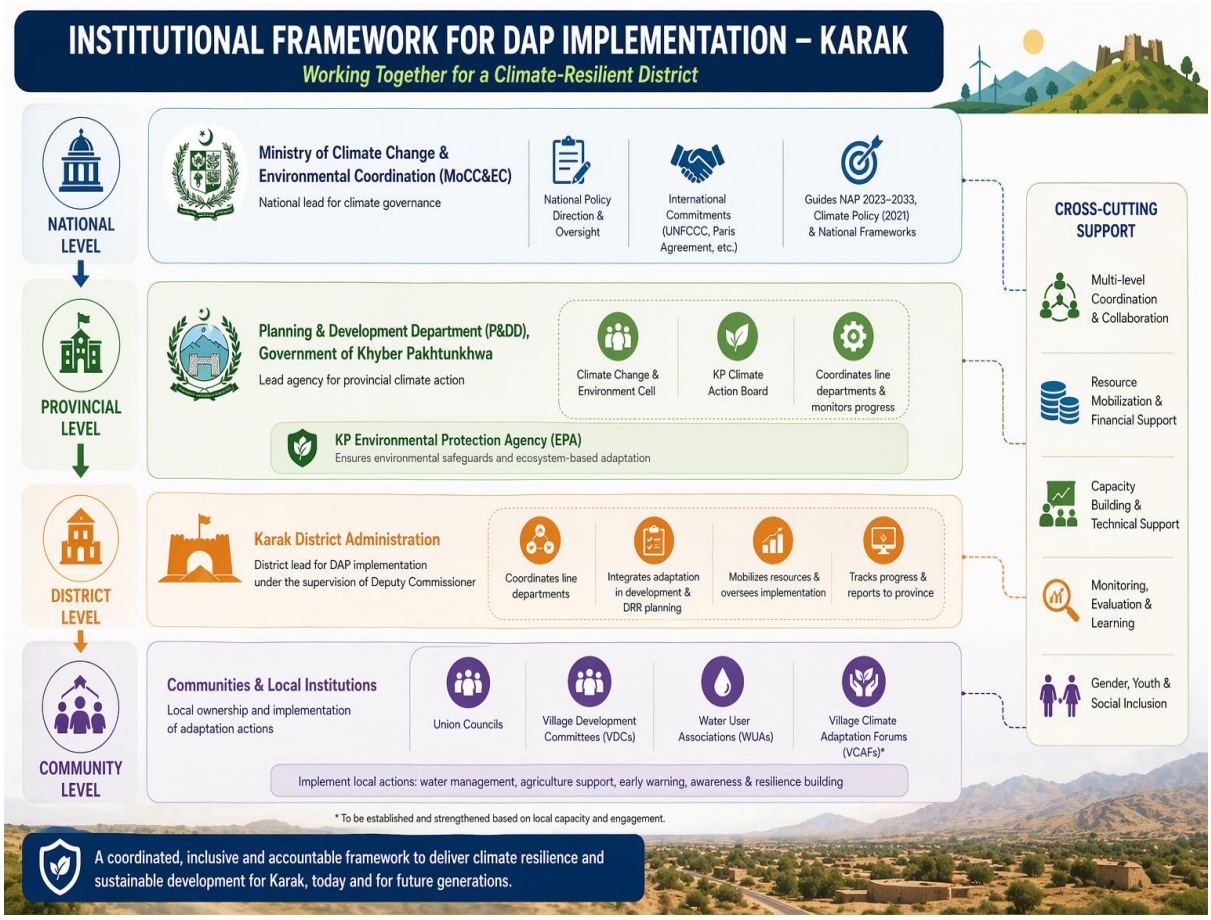


Figure 15: Institutional Framework for implementing DAP

### Institutional Framework

The institutional framework for the implementation of the Karak'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), 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.

At the district level, the Karak 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. However, the success of these efforts will depend on the current capacity, engagement, and operational status of these local entities, which may require strengthening and capacity-building to effectively implement adaptation measures.

## 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 Karak 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 Karak'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 improvements, and municipal services that can withstand climate shocks. In Karak, which relies on rain-fed agriculture and groundwater via tube wells and small dams, irrigation enhancements may include sustainable groundwater management, small-scale storage, and rainwater harvesting systems.
4. **Environmental Conservation and Biodiversity Protection**: Protect 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, the private sector, and local communities.
3. **Technology and Innovation**: Apply digital tools and context-appropriate irrigation enhancements, such as efficient water management practices and, where feasible, technologies like solar-powered pumps coupled with high-efficiency irrigation systems (e.g., drip or micro-sprinklers), to support sustainable water use and climate adaptation in Karak's semi-arid agricultural landscape.
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 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.

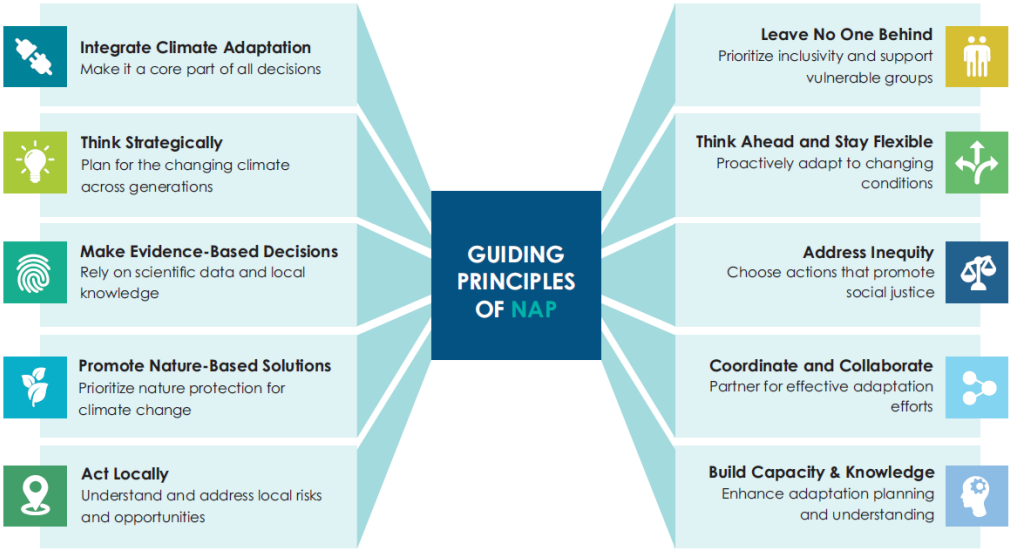


Figure 16: Guiding Principles for Pakistan's NAP

## Karak's DAP Preparation Process

The preparation of the DAP for Karak followed a structured, inclusive, and iterative process, anchored in the National 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 Karak unfolded as follows:

1. **Preliminary Data Collection and Stakeholder Engagement**: The district profile wascompiled 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 modelling, 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 analysed 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 Karak'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 in Karak played a pivotal role in shaping the DAP. The consultation process involved a broad spectrum of stakeholders, including government officials, local communities, NGOs, academia, and private sector representatives. Through a combination of Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and a multi-stakeholder workshop, critical insights were gathered, which directly informed the development of a context-specific, evidence-based adaptation strategy for Karak.

- **Shared Understanding of Climate Risks**

Stakeholders agreed regarding the primary climate hazards affecting Karak, particularly droughts, flash floods, and heatwaves. These climate events were seen as the most urgent threats to local livelihoods, agriculture, and infrastructure. A consensus emerged that Karak's vulnerability is compounded by the lack of sufficient water resources, poor drainage systems, and insufficient disaster resilience infrastructure. The impacts of industrial activities, especially oil, gas, and uranium mining, were also highlighted as exacerbating the district's environmental challenges.

- **Sectoral Prioritization**

The stakeholder consultations emphasized the urgent need to strengthen the resilience of several sectors:

— **Agriculture:** Local farmers and agriculture officers highlighted the need for improved water management practices, and soil conservation techniques to combat the worsening impacts of droughts and water scarcity.
— **Health:** Stakeholders from the health sector pointed to an increase in climate-sensitive diseases, particularly waterborne illnesses, respiratory diseases, and heat-related health issues. The lack of climate-adaptive infrastructure in healthcare facilities was also a key concern.
— **Water and Livelihoods:** Water scarcity emerged as a critical issue, with stakeholders stressing the need for better water governance and the construction of water storage systems such as small dams and check dams to ensure a stable water supply for both agriculture and domestic use.
— **Education:** The education sector raised concerns about the vulnerability of school buildings to climate-related disasters, with many schools prone to flooding and other climate hazards. The lack of climate-resilient infrastructure and the absence of climate change education in school curricula were seen as significant gaps.

- Integration of Local and Indigenous Knowledge

Local communities, especially elders and women's groups, shared traditional knowledge and coping strategies that have helped them adapt to environmental stress in the past. These included practices like crop rotation, water conservation methods, livestock behaviour observation, and cloud colour prediction for rainfall, such as the belief that brown clouds signal heavy rain. Additionally, community-based disaster response strategies were highlighted. This indigenous knowledge was integrated into the adaptation strategies to ensure that the proposed measures were culturally appropriate, effective, and widely accepted by the community.

- Identification of Adaptation Options

The stakeholder consultations produced a range of adaptation options, such as:

- **Infrastructure Resilience:** The need for flood-resilient infrastructure, including the construction of retaining walls, flood barriers, and better drainage systems, was prioritized.
- **Water Management:** Stakeholders agreed on the importance of implementing more efficient water management practices, such as rainwater harvesting and the introduction of water-efficient technologies.
- **Livelihood Diversification:** Measures to diversify livelihoods, particularly by promoting climate-smart agriculture and alternative income sources, were identified as essential to reduce dependency on rain-fed agriculture, which is highly vulnerable to climate change.

- **Strengthening Institutional Linkages**

One of the key outcomes of the stakeholder engagement process was the strengthening of institutional coordination. Local government departments, including the District Administration, Rescue 1122, and the Agriculture and Health Departments, acknowledged the need for a more coordinated approach to climate adaptation. Organizations like the Pakhtunkhwa Qoumi Jirga Pakistan, which has raised concerns about the environmental and health consequences of extractive industries, were identified as important partners in advocating for stronger environmental protection, community health, and restoration efforts. The consultations also highlighted the lack of inter-departmental coordination, with calls for a more unified approach to planning and executing climate adaptation strategies.

- **Community Ownership and Commitment**

The engagement process fostered a sense of ownership and commitment among local stakeholders. Both community leaders and government officials expressed their readiness to support the implementation of the DAP. There was a strong emphasis on community involvement in the monitoring and evaluation of adaptation actions to ensure sustainability. Several stakeholders also committed to mobilizing resources, both locally and through external channels, to support adaptation initiatives.

The stakeholder engagement process in Karak ensured that the District Adaptation Plan was not only informed by scientific data but also rooted in local realities, needs, and capacities. The process built trust, fostered local ownership, and laid the foundation for a collaborative, multi-stakeholder approach to climate resilience in the district. These outcomes will serve as a basis for implementing climate adaptation measures that are both effective and sustainable.

# 5. District Adaptation Priorities

## The Agriculture – Water Nexus

### Sectoral Context

Karak's semi-arid terrain, characterized by low and erratic rainfall, permeable soils, and reliance on shallow and deep groundwater, provides a fragile foundation for agricultural production. Chronic droughts, rising temperatures, and recurrent heatwaves have increasingly stressed crop and livestock systems, reducing soil moisture, impairing germination, and limiting fodder availability. Simultaneously, sudden flash floods and hill-torrent runoff during intense rainfall events exacerbate soil erosion, silt irrigation channels, and damage fields and livestock infrastructure. Groundwater, the primary source for irrigation and domestic use, is under severe pressure, with wells deepening over the past decade due to declining aquifer levels and rising contamination risks. These intersecting climatic and hydrological stresses constrain agricultural productivity, threaten food and water security, and heighten the vulnerability of smallholder and marginal households, making Karak's agrarian system highly sensitive to climate variability and extremes.

### Agriculture Food System

- The agricultural food system in Karak forms the backbone of the district's rural economy, directly supporting over 80% of households through rainfed and small-scale irrigated crop cultivation alongside livestock-based livelihoods. Agriculture and livestock collectively provide income, nutrition, and employment, making the sector crucial for local food security and socio-economic resilience[98] [99].
- Wheat, maize, and pulses dominate cropping patterns, covering approximately 65% of cultivated land, while vegetables and fodder crops occupy smaller areas. Despite semi-arid conditions, wheat yields average 1.8–2.2 t/ha, significantly below potential yields of 3.5–4.0 t/ha achievable under optimal irrigation and management practices [100]. Limited irrigation infrastructure, fragmented landholdings, and low mechanization restrict productivity and amplify vulnerability to climate shocks.
- Extreme climate events have repeatedly impacted production. According to the CRVA, prolonged droughts over the past decade caused crop failure in 45–50% of farming households, while localized flash floods affected approximately 2,350 hectares of arable land, washing away topsoil and reducing productive capacity. Heatwaves have also contributed to significant yield losses, with reported reductions of 20–25% in wheat and maize in the last five years [101]. These recurrent shocks exacerbate food insecurity and force households into debt cycles.
- Water scarcity is a persistent challenge for Karak's agricultural system. The climate is highly fluctuating, with hot summers and erratic rainfall patterns. The Thal zone receives less than 500 mm of rain annually, while the northeastern Tehsil Karak receives between 500 and 750 mm and groundwater remains the primary supplementary source for crops and livestock. Shallow aquifers (5–20 m) face microbial contamination in 30–35% of samples and elevated salinity levels in 20–25% of wells, while over-extraction during dry months reduces water availability during critical crop growth stages[102]. Industrial activities, particularly oil, gas, and uranium extraction, have further degraded water quality, affecting irrigation and livestock health.
- Livestock forms an integral component of the agricultural food system, providing milk, meat, draught power, and income. Approximately 72% of household's rear goats, sheep, cattle, or buffalo, but productivity remains low due to fodder scarcity, heat stress, limited veterinary

[98] https://cyberleninka.ru/article/n/water-scarcity-and-social-wellbeing-of-people-living-in-district-karak-khyber-pakhtunkhwa-pakistan
[99] https://dx.doi.org/10.17582/journal.sja/2023/39.2.545.551
[100] https://dx.doi.org/10.17582/journal.sja/2023/39.2.545.551
[101] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[102] https://dx.doi.org/10.17582/journal.sja/2023/39.2.545.551

services, and recurrent climate shocks. During the 2022 flash floods, at least 180 livestock were reported dead, while fodder losses affected nearly 1,500 households, underscoring the sector's vulnerability[103]. Women play a central role in livestock management, including feeding, milking, and care, but their workloads increase significantly during disasters.

- Rising demand for vegetables, dairy, and diversified nutrition has created additional pressure on smallholders. Weak market linkages, inadequate storage, and limited extension support reduce the ability to respond to these demands, leaving households susceptible to food insecurity, particularly during droughts and flash floods.
- The agricultural food system in Karak faces interlinked stresses from climate variability, water scarcity, soil degradation, and weak institutional support. Recurrent droughts, flash floods, heatwaves, and rising temperatures threaten both local livelihoods and household food security. These vulnerabilities highlight the urgent need for integrated, climate-resilient agricultural practices, water management technologies, and institutional interventions to strengthen adaptive capacity at both the household and community levels.

### Agriculture Land

- Karak district spans approximately 3,372 km², of which 75–78% consists of arid rangelands, rocky terrain, and scrublands[104] [105]. Cultivated areas are concentrated along seasonal streams and limited canal-irrigated tracts, making the district highly sensitive to precipitation variability.
- The soil is predominantly sandy loam to silty clay, with moderately alkaline pH (7.5–8.3) and low organic matter (<1.2%), limiting nutrient retention. Approximately 30–35% of cultivated plots experience surface crusting and shallow erosion during flash floods, while 25–30% of marginal lands show salinization due to poor drainage and high evapotranspiration under drought conditions[106] [107].
- Extreme climate events have caused significant land degradation. The 2010 and 2014 flash floods affected over 4,500 hectares of farmland, resulting in crop losses for 35–40% of households and topsoil erosion averaging 15–20 cm in vulnerable tracts[108].
- Prolonged droughts (2015–2017) reduced wheat and maize yields by 30–50%, with rangeland biomass declining 40–45%, limiting livestock fodder availability[109] [110].
- Limited irrigation infrastructure exacerbates land vulnerability, less than 10% of farmland benefits from tube wells or small-scale canal systems, while most areas rely entirely on rainfall. Over-extraction of groundwater in irrigated plots has contributed to declining water tables at ~2–3 m/year, compounding land stress and reducing cropping intensity[111].
- Natural vegetation and rangelands, historically dominated by Acacia modesta, *Olea ferruginea*, and *Prosopis juliflora*, have declined by 25–30% since 2000 due to overgrazing, fuelwood collection, and encroachment for informal agriculture[112]. This degradation diminishes ecosystem services such as soil stabilization, nutrient cycling, and microclimate regulation.

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[103] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[104] https://kpboit.gov.pk/karak-district/
[105] https://dx.doi.org/10.17582/journal.sja/2023/39.2.545.551
[106] https://socialsignsreview.com/index.php/12/article/view/67
[107] https://doi.org/10.1007/s11250-014-0702-6
[108] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[109] https://dx.doi.org/10.17582/journal.sja/2023/39.2.545.551
[110] https://cyberleninka.ru/article/n/water-scarcity-and-social-wellbeing-of-people-living-in-district-karak-khyber-pakhtunkhwa-pakistan
[111] https://cyberleninka.ru/article/n/water-scarcity-and-social-wellbeing-of-people-living-in-district-karak-khyber-pakhtunkhwa-pakistan
[112] https://doi.org/10.1007/s11250-014-0702-6

- Rapid expansion of small settlements and informal housing in valley bottoms has reduced cultivable land by 5–7% over the past decade, threatening local food security and increasing pressure on remaining arable areas[113].
- Karak's agricultural land system faces interlinked pressures from climate hazards, water scarcity, and unsustainable land use, underscoring the need for integrated land management, soil conservation techniques, and climate-adaptive cropping strategies to maintain productivity, livelihoods, and ecosystem services.

### Water Management for Irrigation

- Karak spans 6,846 km² (684,600 ha), of which only 22–25% is under cultivation, and less than 10–12% of this cultivated area receives any form of irrigation, making it one of KP's most water-stressed agricultural districts[114] [115].
- Irrigation infrastructure is extremely limited, with small distributaries connected to seasonal streams irrigating only 3,000–3,500 ha. Field consultations indicate that irrigation reliability has declined by 35–40% over the past decade due to sedimentation, unlined channels, and repeated flood damage.
- Groundwater is the dominant supplementary irrigation source, but extraction depths have increased to 280–450 ft, and in some parts even exceed 500 ft. Groundwater tables are declining by 2–3 meters annually, while water-quality issues such as salinity and fluoride contamination affect 27–33% of tested tube-well samples. [116]
- Rangelands, which cover 75–78% of Karak's area, play a critical role in water infiltration and groundwater recharge, yet rangeland degradation has reduced biomass by 40–45%[117] . This loss of vegetation accelerates runoff, increases flash flooding, and reduces usable irrigation water across farming communities.
- Governance challenges persist, including delayed desilting, weak coordination among irrigation and agriculture departments, absence of formal water-user associations, and unregulated groundwater pumping. These institutional gaps contribute to sowing-season water shortages, heightened water conflicts during droughts, and repeated irrigation failures during flood events.

### Livestock

- Livestock is central to rural livelihoods in Karak, providing food, income, employment, and a safety net during climate and economic shocks. [118] [119].
- Karak's estimated livestock population includes ~342,191 cattle, ~594,679 goats, ~100,347 sheep, ~5,374 buffaloes, ~3,102 camels, ~14,205 donkeys, ~278 horses, and ~784,745 poultry heads [120].
- Livestock productivity remains low, with average milk yield per cow reported at ~2 litres/day due to fodder shortages, water scarcity, overgrazed rangelands, and limited veterinary support[121] .

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[113] https://pakistanalmanac.com/kp-karak
[114] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[115] Government of Khyber Pakhtunkhwa. (2022). Agriculture Statistics of Khyber Pakhtunkhwa. Department of Agriculture, KP.
[116] Social Signs Review. (2023). Environmental Stress, Water Scarcity, and Livelihood Vulnerability in Karak District. Social Signs Research Initiative, Islamabad.
[117] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. International Journal of Innovations in Science & Technology, Special Issue, 43–58.
[118] Akhtar, K., Anees, R., Karim, T., Gul, S.U., Rehman, H.U., Ali, A., Wazir, M.I., Khan, F., & Achakzai, S.K. (2018). *Prevalence of tick infestation in cows of various regions of district Karak, Pakistan.* African Journal of Agricultural Research, DOI: 10.5897/AJAR12.2095
[119] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[120] SMEDA (2023). *District Profile Karak.* Small and Medium Enterprises Development Authority, Pakistan.
[121] Ibid.

- Tick infestation is widespread, affecting approximately 75% of cows and increasing vulnerability to disease and reduced milk production [122]. Only ~40% of Karak's rangeland plant species are palatable to livestock, with ~14% highly preferred, limiting fodder quality under climate stress [123].
- Women play a major role in livestock management, including feeding, milking, fodder collection, and small-scale processing, though gender-disaggregated data are limited[124].
- The livestock sector is highly exposed to climate hazards, including droughts, heatwaves, and floods. The 2022 floods caused the death of at least 40 animals and disrupted grazing and water supply [125].

### Farmer Level Challenges

- Farmers in Karak are highly dependent on rainfed (barani) agriculture and unregulated groundwater for irrigation, with ~87% of households relying on rainfall and ~67% using tube wells, making them extremely vulnerable to climate variability and droughts.[126] [127]
- Water scarcity is a persistent challenge: over-extraction of groundwater, drying wells, and declining water quality limit irrigation, affect crop yields, and force households to rely on distant water sources.[128]
- Flooding and hill torrents cause episodic damage to farmland, irrigation infrastructure, roads, and livestock pathways, while depositing silt that reduces soil fertility and creates drainage problems.[129]
- Soil degradation is widespread, including salinity, pH imbalance, nutrient deficiency, and formation of salty crusts, reducing productivity of major crops such as wheat, gram, bajra, and peanuts[130].
- Limited fodder and rangeland resources constrain livestock rearing only ~40% of plant species in Karak's grazing lands are palatable, and ~14% are highly preferred, which reduces supplementary income from livestock during drought or crop failure years.[131]
- Pest and disease pressures exacerbate losses; recurrent droughts and heatwaves increase vector-borne and waterborne diseases, while livestock are affected by tick infestations, lowering milk and meat productivity.[132]
- Farmers face institutional and resource limitations, including poor access to extension services, lack of training on efficient irrigation (e.g., drip, mulching), and inadequate disaster preparedness measures, which restrict resilience-building capacity.[133]
- Recurrent hazards and limited adaptive capacity drive indebtedness, reduced cropping intensity, distress migration, and increased labor burdens on women, who also take responsibility for recovery of households and livestock.[134]

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[122] Ibid.
[123] Rehman, H.U., et al. (2024). Assessment of Palatability and Grazing Preferences under Changing Climate: A Case Study of Plant Species in District Karak, Pakistan.
[124] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[125] Ibid.
[126] District Agriculture Extension Department, Karak. (2023). Agriculture Profile and Climate Risk Assessment, Karak District, Khyber Pakhtunkhwa, Pakistan.
[127] https://socialsignsreivew.com/index.php/12/article/view/67
[128] Ibid.
[129] Ibid.
[130] District Agriculture Extension Department, Karak. (2023). Agriculture Profile and Climate Risk Assessment, Karak District, Khyber Pakhtunkhwa, Pakistan.
[131] https://journal.50sea.com/index.php/IJIST/article/view/847
[132] Akhtar, K., Anees, R., Karim, T., Gul, S. U., Rehman, H. U., Ali, A., Wazir, M. I., Khan, F., & Achakzai, S. K. (2018). *Prevalence of tick infestation in cows of various regions of district Karak, Pakistan.* African Journal of Agricultural Research
[133] Field observations by the author during site visits to Karak, 14–25 July 2025.
[134] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)

### Impact of Climate Change

Agricultural systems in Karak, critical for rural livelihoods and regional food security, are increasingly exposed to climate-induced stressors, which amplify pre-existing structural vulnerabilities across soil, hydrological resources, livestock management, and farm-level production systems. The district is rich in natural resources, making it economically significant within the province.[135] Karak experiences extreme variations, with scorching summers reaching up to 44°C in June and cold winters with temperatures as low as 5°C in January. The district receives an annual average of 478 mm of rainfall, concentrated in monsoon months and winter spells, which often triggers flash floods in addition to prolonged droughts. Recent studies document significant shifts in the floristic composition of grazing lands, reducing fodder availability and threatening livestock-based livelihoods.[136] These climatic stresses have serious implications for agriculture, rangelands, and biodiversity, with recurring wildfires adding to ecological degradation.[137]

Climate change is exerting significant pressure on groundwater resources in District Karak, a region heavily reliant on aquifers for irrigation and domestic use. A study found that variations in rainfall, rising temperatures, and shifts in seasonal patterns explained approximately 73% of the observed decline in groundwater levels. [138]The decline in rainfall emerged as the most critical factor, with an odds-ratio of 6.08, indicating that reduced precipitation substantially increases the risk of aquifer depletion. Rising temperatures were also highly influential, with a coefficient of 4.19, reflecting the impact of higher evapotranspiration on groundwater availability. Furthermore, delays and shifts in seasonal rainfall timing had a significant effect (coefficient 1.67), emphasizing that not only the quantity but also the timing of rainfall is crucial for effective aquifer recharge. The authors conclude that these climate-induced stressors, combined with the absence of alternative surface water sources, place Karak's groundwater resources at high vulnerability, threatening both agricultural productivity and local livelihoods [139]

Between 2021 and 2023, Tehsil Karak experienced a mean maximum temperature of 32.35°C and a mean minimum of 17.02°C, indicative of its typically hot summers and mild to cold winters. The hottest months were June through August, with average maximum temperatures exceeding 40°C, while the coolest period occurred in December and January, with minimum temperatures ranging from 5–7°C. Average relative humidity was around 71.6%, varying between 60–78%, with the highest values observed in July and August during the monsoon season. Rainfall averaged 47.7 mm but was highly seasonal, peaking in July (125.7 mm) and August (107.2 mm) and remaining very low in months such as November (5.8 mm). Soil temperature averaged 18.6°C, with a range of 8–26°C throughout the year, while average wind speed remained relatively low at 4.1 km/h. These climatic patterns reflect a semi-arid environment strongly influenced by the monsoon, shaping the agricultural calendar, water resources, and rangeland productivity in the district.[140]

From a land use and land cover (LULC) perspective, satellite imagery and spatial analyses indicate that District Karak is predominantly covered by barren lands and rangelands, with limited tracts of cultivated and forested areas concentrated around populated valleys. According to pre-monsoon Landsat-8 (2023) imagery and supporting GIS-based classification, approximately 58.2% of the district is classified as barren or sparsely vegetated, 27.6% as rangeland and scrub vegetation, 12.1% as agricultural land, and 2.1% as built-up areas along the Indus Highway corridor and in urban

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[135] https://karak.kp.gov.pk/

[136] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. International Journal of Innovations in Science & Technology, Special Issue, 43–58.

[137] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.

[138] Khan, M. S., Khan, A., Ahmad, S., & Iqbal, M. (2023). Impact of climate change on the confined aquifers resources and factors responsible for decline and vulnerability of groundwater in District Karak. *Researchers Links*, 14(1), 1–12.

[139] Ibid.

[140] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)

centres such as Karak City, Banda Daud Shah, and Takht-e-Nasrati. Post-monsoon imagery for September 2023 revealed a modest increase in vegetation cover following seasonal rainfall, with temporary water accumulation observed in depressions and abandoned mining pits near Bahadar Khel and Jatta Ismail Khel.[141]

### Priority Adaptation Areas and Initiatives

Karak's agriculture, rangelands, and water resources are central to rural livelihoods and food security, but intensifying heatwaves, declining rainfall, groundwater depletion, and flash floods threaten productivity and resilience. Addressing these challenges requires integrated interventions across land management, irrigation, livestock, and food systems, coupled with strengthened farmer capacity and adaptive governance. The following objectives outline priority areas for climate-smart interventions aimed at sustaining productivity, safeguarding natural resources, and enhancing the resilience of Karak's agrarian systems.

### Objective 1: Restore Aquifer Recharge & Sustain Groundwater Balance

Karak's semi-arid and arid landscapes have experienced rapid land degradation due to soil erosion, overgrazing, and unsustainable mining activities. NDVI analysis shows 22–25% loss in vegetation cover over the past two decades, while soil-loss rates reach 15–25 t/ha per year, causing significant topsoil depletion. Crop yields in degraded areas drop up to 35% during drought years. Recurrent heatwaves exacerbate soil moisture deficits, reducing crop and fodder productivity. Restoration efforts should include afforestation and reforestation, soil and water conservation (terracing, check dams), and regenerative agriculture practices to rebuild fertility, reduce erosion, and improve drought resilience.

### Objective 2: Strengthen Water Availability and Drought Resilience

Karak is experiencing severe water scarcity, with groundwater tables declining by 2–3 meters annually. The depth of wells has increased to 280–450 feet. Historical droughts (2012, 2016, 2019, 2022) caused widespread crop failures and rangeland degradation. Flash floods further damage water infrastructure and reduce infiltration. Adaptive water management strategies should include small-scale rainwater harvesting, groundwater recharge structures, lining of canals, and the introduction of water-efficient irrigation systems (drip, sprinkler). Establishing local water user associations and early-warning systems will improve water allocation, reduce risk during dry periods, and enhance irrigation reliability.

### Objective 3: Enhance Climate Resilience of Livestock and Fodder Systems

Livestock is central to Karak's rural livelihoods, yet heatwaves, droughts, and fodder shortages have caused high mortality and productivity loss. Limited veterinary support and low availability of climate-resilient breeds further reduce livestock resilience. Interventions should focus on improving fodder production and storage, introducing heat- and drought-tolerant breeds, expanding vaccination and veterinary outreach, and providing targeted support for women-led livestock enterprises. These measures will secure income, maintain nutrition, and reduce vulnerability to climate extremes.

### Objective 4: Improve Farmer Knowledge, Risk Management, and Adaptive Practices

Farmers in Karak face small landholdings, limited mechanization, poor market access, and high exposure to climate extremes. Crop losses, asset depletion, and reliance on deep boreholes or tanker water reduce household resilience. Building adaptive capacity requires strengthening extension services, farmer field schools, ICT-based climate advisories, and access to climate-resilient inputs, credit, and crop insurance. Enhanced knowledge and preparedness will empower farmers to adopt timely adaptation measures, mitigate losses, and recover faster from shocks.

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[141] Ullah et al., 2022

**Objective 5: Promote Integrated Climate-Smart Food and Livelihood Systems**

Karak's agricultural productivity is constrained by high temperatures, low rainfall, soil degradation, and flash floods, resulting in cereal yield reductions of 15–25%. A climate-smart food system approach is needed to diversify crops (cereals, legumes, horticulture), link farmers to markets to reduce post-harvest losses, and integrate nutrition-sensitive practices. Embedding climate adaptation into local planning and agricultural policies will help secure long-term productivity, strengthen livelihoods, and reduce vulnerability to extreme weather and resource scarcity.

Table 3: Key Objectives and Initiatives for Agriculture-Water Nexus – Karak District

| No. | Objective & Initiative | Timeframe | Key Responsible Entity | Priority Vulnerable UCs / Tehsils |
|---|---|---|---|---|
| **Objective 1: Restore Aquifer Recharge & Sustain Groundwater Balance** | | | | |
| **1.1** | Implement afforestation and reforestation on degraded slopes across all tehsils, prioritizing high-vulnerability areas identified through CRVA, soil erosion risk, NDVI decline, and flood/runoff mapping. The process should begin with the collection of seeds from indigenous, drought-tolerant plant species, which will then be sown on vulnerable land to reduce soil erosion, stabilize slopes, enhance soil moisture retention, and improve ecosystem resilience. | Short (2026–2028) | KP Forest & Wildlife Dept.; Agriculture Dept.; District Admin.; LGRDD; NGOs; Soil & Water Conservation Department; P&DD KP (Climate Action Board) | District-wide |
| **1.2** | Promote climate-smart conservation agriculture through direct seeding of drought-tolerant wheat and millet varieties, retention of crop residues as mulch, and application of farmyard compost to restore soil organic carbon, improve moisture retention, and enhance resilience to drought and heat stress. | Medium (2029–2033) | Agriculture Dept.; KP Climate Change Cell; Research & Extension Services; P&DD KP; | Karak Tehsil, Banda Daud Shah and Sabir Abad (dam command and adjacent rainfed areas) |
| **1.3** | Strengthen and formalize rotational grazing and community-based rangeland management, building on existing traditional practices, to reduce overgrazing, restore degraded rangelands, and enhance post-flood ecosystem recovery. | Short–Medium (2026–2030) | District Admin; Livestock Dept.; NGOs | Takht-e-Nasrati, Banda Daud Shah |
| **Objective 2: Strengthen Water Availability and Drought Resilience** | | | | |
| **2.1** | Construct small-scale rainwater harvesting and groundwater recharge systems, including ponds, rooftop | Short (2026–2028) | Irrigation Dept.; Agriculture Dept.; Local NGOs | Banda Daud Shah (priority), Karak Tehsil, Sabir Abad |

| | | | | |
|---|---|---|---|---|
| | catchments, and recharge wells in high-runoff zones particularly Banda Daud Shah and Karak Tehsil. In Sabir Abad, develop small check dams and detention structures in monsoon-fed catchments to store seasonal flows, reduce flood peaks, and enhance groundwater recharge. Integrate these structures with community-based water management and conservation practices to improve water use efficiency and sustainability. | | | (monsoon-fed catchments) |
| **2.2** | Line existing irrigation channels and introduce water-efficient micro-irrigation systems (drip and sprinkler) across all tehsils of District Karak to reduce conveyance losses, improve irrigation efficiency, and enhance resilience to drought and heat stress. The intervention will be supported by climate-informed irrigation strategies, including crop-wise water scheduling, demand-based irrigation, and on-farm water management. | Medium (2029–2033) | KP Irrigation Dept.; KP Agriculture Dept.; KP | District-wide |
| **2.3** | Establish local water user associations and implement early-warning systems for drought/flood events. | Medium (2029–2033) | KP Climate Change Cell; District Admin.; Agriculture Department; Water Management Department; NGOs | All tehsils, with focus on Banda Daud Shah & Takht-e-Nasrati |
| **Objective 3: Enhance Climate Resilience of Livestock and Fodder Systems** | | | | |
| **3.1** | Introduce heat- and drought-tolerant, dual-purpose indigenous livestock breeds (e.g., Sahiwal and other climate-resilient local breeds) and strengthen climate-resilient fodder systems, including community fodder banks and silage storage, to reduce livestock mortality, stabilize production, and enhance resilience to drought and heat stress. | Short–Medium (2026–2030) | KP Livestock & Dairy Dev. Dept.; Agriculture Dept.; NGOs | District-wide |
| **3.2** | Expand veterinary outreach, preventive vaccination campaigns, and mobile animal health services to reduce climate-related livestock | Short (2026–2028) | Livestock & Dairy Dev. Board; KP Health Dept.; NGOs | All tehsils, focus on central Karak and Takht-e-Nasrati |

| | | | | |
|---|---|---|---|---|
| | mortality, particularly from heat stress, drought, and disease outbreaks. The intervention will prioritize remote and high-risk areas while ensuring district-wide coverage. | | | |
| **3.3** | Support women-led livestock enterprises with training and small grants for climate-resilient practices | Medium (2029–2033) | KP Women Dev. Dept.; Microfinance Banks; KP Livestock Board | Karak Tehsil (central), Banda Daud Shah |
| **Objective 4: Improve Farmer Knowledge, Risk Management, and Adaptive Practices** | | | | |
| **4.1** | Establish Farmer Field Schools (FFSs) and local demonstration plots for rainfed and tube-well irrigation systems to promote soil moisture management, mulching, drought-tolerant crop varieties, and hill torrent mitigation techniques, while strengthening farmer linkages with local markets to improve income stability and adoption of climate-resilient practices. | Short (2026–2028) | KP Agriculture Dept.; KP Climate Change Cell; NGOs | Karak Tehsil, Banda Daud Shah |
| **4.2** | Provide targeted training and technical support for small-scale water management, including recharge of shallow wells, micro-catchments, and water storage tanks; integrate early warning alerts for droughts and hill torrent floods. | Short–Medium (2026–2030) | LGRDD; Irrigation Dept.; NGOs | Banda Daud Shah, Takht-e-Nasrati, Karak Tehsil |
| **4.3** | Facilitate access to climate-resilient inputs, crop/livestock insurance, and microcredit tailored to rainfed farmers; establish mobile advisory services for pest and disease control during drought and heatwaves. | Medium (2029–2033) | Finance Dept.; Agriculture Dept.; Microfinance Banks; Livestock & Dairy Dev. Board | Karak Tehsil, Banda Daud Shah, Takht-e-Nasrati |
| **Objective 5: Promote Integrated Climate-Smart Food and Livelihood Systems** | | | | |
| **5.1** | Promote crop diversification with drought-tolerant cereals, legumes, and horticultural crops; establish small-scale community storage and solar-assisted cold storage for perishables; connect farmers to local and regional markets to reduce post-harvest losses. | Medium (2029–2033) | Agriculture Dept.; Market Authorities; P&DD KP; NGOs | Karak Tehsil, Banda Daud Shah |
| **5.2** | Implement pilot programs for sustainable rangeland management (rotational | Long-term (2033 onward) | P&DD KP; District Admin.; Agriculture | Banda Daud Shah, Karak Tehsil |

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|---|---|---|---|---|
| | grazing, fodder banks) and on-farm water conservation (rainwater harvesting ponds, micro-catchments); integrate lessons into district agricultural planning for broader scaling. | | Dept.; Forest & Wildlife Dept. | |
| **5.3** | Establish participatory monitoring and early-warning systems for crop yields, rangeland conditions, water availability, and climate hazards; train local communities in data collection and reporting to inform adaptive decision-making. | Long-term (2033 onward) | Finance Dept.; KP Climate Change Cell; Research Institutes; District Council; Agriculture Dept. | All tehsils, with focus on Banda Daud Shah and Karak Tehsil |

## Natural Capital

### Sectoral Context

Karak's natural capital, its rangelands, dryland agriculture, groundwater aquifers, and air quality, thus underpins local livelihoods but is increasingly threatened by over-grazing, land degradation, groundwater contamination (including radioactive elements), and rising particulate air pollution.

### Land and Ecosystems

- Karak District, situated in the southern region of Khyber Pakhtunkhwa, is characterized by its arid terrain, rugged salt ranges, and mineral-rich geology. The district covers an area of 3,372 km² with a population density of roughly 209.4 persons/km² (Census 2017). The land is predominantly "barani" (rain-fed), limiting intensive agriculture but supporting a unique ecosystem adapted to dryland conditions.[142]
- Despite its arid environment, Karak boasts significant biodiversity, with a 2017 survey recording 28 mammalian species. Key wildlife habitats are found around small dams like Khurum and Muhabbat Khel, which provide critical wetlands for both vertebrates and invertebrates. The district also supports diverse reptile populations, including 12 species and 6 amphibians, such as the Indian Spiny-tailed Lizard and Indian Monitor, which are well-adapted to the rocky, saline terrain. Vegetation in Karak consists mainly of dry sub-tropical thorn forests, with species like Zizyphus and Acacia modesta, which play a key role in supporting the local honey industry.[143] [144] [145] [146]
- Karak is geologically unique due to the presence of the Bahadurkhel Salt and Jatta Gypsum formations. The district sits on uranium-bearing deposits, and extensive mining of salt, gypsum, and hydrocarbons (oil/gas) has led to significant landscape scarring and soil erosion. Open-cast gypsum mining, in particular, has stripped away topsoil, making the area more vulnerable to wind and water erosion. Additionally, studies have shown that the Bahadurkhel Salt formation emits high levels of radon, with an average concentration of 1.8 Bq/L, significantly higher than the Jatta Gypsum formation, creating a natural radiological hazard in mining areas.[147] [148]

[142] https://kpboit.gov.pk/karak-district/
[143] Ibid.
[144] https://pdfs.semanticscholar.org/9f5b/480e63dfe8b3522a4828ba16ddba34fe8403.pdf
[145] https://www.entomoljournal.com/archives/?year=2017&vol=5&issue=1&ArticleId=1489
[146] https://researcherslinks.com/current-issues/Amphibians-and-Reptiles-Sheikh-Baddin-Prospects/20/3/3667/html
[147] https://www.cenresinjournals.com/wp-content/uploads/2020/02/Page-115-123-0625.pdf
[148] https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2022.1020028/full

- As part of the Billion Tree Tsunami initiative, Karak falls under the Central-Southern Forest Region-I, where afforestation efforts have focused on stabilizing soil in the arid landscape. While provincial forest cover increased from 20% to 26% (2014–2019), Karak's specific gains are often offset by the high survival challenges of saplings in its water-scarce environment.[149]

Water Resources

- Karak lacks perennial rivers and depends on deep aquifers and irregular rainfall, resulting in a delicate hydrological balance. A 2025 public health study revealed concerning levels of radioactive contamination in the district's drinking water, with the average uranium concentration in groundwater measured at 47.32 ± 23.8 µg/L, and 68.4% of samples exceeding the WHO's permissible limit of 30 µg/L. Contamination is notably higher in shallow aquifers (<60 m), commonly used by local communities. The study also found a strong correlation between this exposure and health issues, including kidney dysfunction, bone disorders, and liver diseases. Additionally, cancer risk assessments showed that 72% of the study sites surpassed acceptable lifetime cancer risk thresholds.[150]
- To reduce dependence on groundwater, the Khyber Pakhtunkhwa government has developed a network of small dams to capture flash flood water. Key infrastructure includes the Khurum Dam, Muhabbat Khel Dam, Makh Banda Dam, Latambar Dam, and Changhoz Dam. As of 2024, the Makh Banda and Latambar dams are nearing completion, with plans to irrigate an additional 34,000 acres of land, further enhancing the region's water management and agricultural potential.[151]

### Air Pollution

- Air quality in Karak is significantly impacted by its extractive industries, particularly oil and gas production. The region, home to major operations like the Nashpa Oil Field, experiences heavy metal accumulation in local vegetation, with research showing significant bioaccumulation in plants like *Calotropis procera*. These operations have also altered the local flora within a 1 km radius, indicating ongoing air quality stress. Additionally, the extraction process releases pollutants such as hydrogen sulfide ($H_2S$), volatile organic compounds (VOCs), and particulate matter, which are carried by the wind into nearby settlements, further degrading the air quality.[152] [153]
- Particulate matter (PM) and dust are major contributors to air pollution in Karak. The open-pit mining of gypsum and salt generates significant fugitive dust (PM10), which is linked to respiratory issues in nearby mining communities. Additionally, traditional brick kilns scattered throughout the district contribute to regional smog and elevated PM2.5 levels. While specific data for Karak is limited compared to larger cities like Peshawar, the presence of these kilns exacerbates local air quality concerns.[154]

### Climate Change Impacts

Karak is highly vulnerable to climate change due to its reliance on "barani" (rain-fed) agriculture and limited water storage capacity. The district is experiencing significant warming, with summer temperatures often exceeding 40°C. Scientific modeling indicates a strong correlation between rising temperatures and groundwater depletion. Rainfall is also becoming increasingly erratic; the Thal zone receives less than 500 mm of annual rainfall, while the northeastern tehsils receive 500–

[149] https://pide.org.pk/research/challenges-and-opportunities-of-the-ten-billion-tree-tsunami-project-tbttpp-a-case-study-of-the-ex-fata-pakistan/
[150] https://fmhr.net/index.php/fmhr/article/view/520
[151] https://www.dawn.com/news/1847810
[152] https://www.pulsus.com/scholarly-articles/response-of-plants-to-pollution-emitted-from-oil-and-gas-plant-with-special-reference-to-heavy-metals-accumulation.pdf
[153] https://pmc.ncbi.nlm.nih.gov/articles/PMC6344296/
[154] https://ntrs.nasa.gov/api/citations/20210026201/downloads/Bilal_Levy_RSE-D-21-01132R1.pdf

750 mm. Climate change has intensified this variability, leading to longer dry periods followed by intense flash floods that damage soil rather than replenishing aquifers.[155] [156]

Karak's agricultural sector is facing increasing stress due to climate change, particularly in its primary crops, wheat, maize, and gram, which are highly sensitive to shifting rainfall patterns. Delays in seasonal rains have been statistically linked to lower yields and greater reliance on groundwater pumping. With limited horticultural potential due to water scarcity, the rural economy remains heavily dependent on livestock and rain-fed cereals. Climate-induced droughts pose a direct threat to food security, affecting the 70% of the population engaged in subsistence farming.[157] [158]

While Karak does not face large riverine floods like other areas in Pakistan, the region is still exposed to multiple climate-related risks. Droughts and chronic water scarcity are the most pressing hazards, with decreasing rainfall and rising temperatures reducing soil moisture and groundwater recharge. [159] Flash floods, occurring in local nullahs and hill torrents after intense storms, erode already-degraded slopes and damage infrastructure, such as roads and irrigation systems. Additionally, the increased frequency of dust storms and wind erosion, particularly in areas with substantial vegetation loss, not only reduces air quality but also harms crops and seedlings.[160]

Heat extremes, consistent with broader national trends of more frequent and intense heatwaves, are likely to further reduce livestock productivity, stress dryland crops, and increase the demand for water and cooling. Regional analyses indicate that Pakistan is experiencing more intense monsoon events and catastrophic floods, such as those in 2022 and 2025, which disproportionately impact vulnerable provinces like Khyber Pakhtunkhwa. In Karak, this translates into even more unpredictable rainfall, with prolonged dry spells followed by intense downpours that accelerate soil erosion, gully formation, and the sedimentation of small dams and ponds.[161] [162]

Biodiversity in the district is also suffering, with changes in rangeland species composition as drought-tolerant but less palatable shrubs replace traditional forage species. The regeneration of native trees and shrubs, such as *Acacia spp.* and *Ziziphus nummularia*, has declined due to grazing, fuelwood collection, and moisture stress. [163] In summary, climate change is tightening the water-land-air nexus in Karak, where land degradation, contaminated and scarce groundwater, and increasing air pollution reinforce one another, exacerbating the region's vulnerability.

### Priority Adaptation Areas and Initiatives

Karak's natural capital, its rangelands, dryland agriculture, groundwater aquifers, and air quality, is essential for local livelihoods. However, these resources are under significant pressure due to overgrazing, land degradation, groundwater contamination, and air pollution. The impacts of climate change, including rising temperatures, erratic rainfall, and extreme weather events such as flash floods and droughts, are further exacerbating these stresses. Therefore, it is critical to implement adaptation actions that will protect and restore Karak's ecosystems, improve the quality of its natural resources, and enhance community resilience to environmental changes, ensuring long-term sustainability and livelihoods.

### Objective 1: Protect and Restore Ecosystems and Biodiversity

Karak's rangelands, shrublands, and fragmented forest patches, particularly in Takht-e-Nasrati and Banda Daud Shah, are experiencing severe degradation due to overgrazing, drought cycles, and

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[155] https://www.frontiersin.org/journals/water/articles/10.3389/frwa.2025.1540703/full
[156] https://researcherslinks.com/current-issues/Impact-Climate-Change-Confined-Aquifers-Resources/14/1/6322/html
[157] Ibid.
[158] https://kpboit.gov.pk/karak-district/
[159] https://weatherandclimate.com/pakistan/khyber-pakhtunkhwa/karak
[160] https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections
[161] https://www.pmd.gov.pk/reports/Extrme_Events_Scenario_Under_2C_Pakistan.pdf
[162] https://doi.org/10.1016/j.atmosres.2019.02.009
[163] http://dx.doi.org/10.30848/PJB2025-6(11)

fuelwood pressure, reducing biomass availability and increasing soil erosion, dust storms, and habitat loss. Strengthening ecosystem resilience requires restoring degraded rangelands using drought-tolerant species such as Acacia and Ziziphus, regenerating forests and wetlands to enhance carbon sequestration and biodiversity and establishing ecological corridors to connect remnant shrublands across micro-watersheds. Community stewardship will remain central, with local households engaged in reseeding, rotational grazing, and biodiversity monitoring to sustain ecosystem functions and protect livelihoods under increasing climate stress.

### Objective 2: Improve Water Resource Management and Quality

Water scarcity and poor groundwater quality pose some of the district's most urgent climate risks. With rising temperatures and declining recharge rates, strengthening water security requires constructing rainwater harvesting systems, small dams, and recharge wells to replenish aquifers, while expanding groundwater monitoring to track contamination, including uranium, to safeguard public health. Over the long term, promoting water-efficient irrigation, conservation practices in agriculture, and sustained community awareness will reduce pressure on groundwater resources and help ensure reliable, climate-resilient water availability for households, farmers, and emerging urban areas.

### Objective 3: Mitigate Industrial Pollution and Enhance Air Quality

Industrial and mining activities, particularly salt, gypsum, and oil extraction, are major contributors to air, soil, and water pollution in Karak, compounding health risks and environmental degradation under rising heat and drought stress. Strengthening pollution control will require stricter enforcement of environmental standards for mining operations, institutionalizing dust suppression and waste management measures, and establishing district-level air quality monitoring systems to track particulate matter and industrial emissions. In parallel, expanding urban green spaces and tree plantations will help moderate heat island effects, absorb pollutants, and improve the liveability of rapidly growing settlements.

### Objective 4: Strengthen Knowledge, Monitoring, and Governance for Natural Capital

Effective management of Karak's land, water, and air resources depends on stronger environmental monitoring systems, coordinated institutional action, and climate-informed governance. Establishing a District Environmental Information System (DEIS), piloted in Takht-e-Nasrati and urban Karak, will allow integrated tracking of land degradation, groundwater levels, air quality, and climate risks using GIS and remote sensing. Continuous training for DDMA, DRCC, and line departments will improve their capacity to interpret environmental data, incorporate natural capital considerations into planning, and design risk-informed development projects. Over the long term, mainstreaming climate-risk screening, natural-capital valuation, and climate-budget tagging into district planning and budgeting will institutionalize evidence-based adaptation and ensure that resources are directed toward the most vulnerable communities and ecosystems.

Table 4: Key Objectives and Initiatives for Natural Capital – Karak District

| No. | Objective & Initiative | Timeframe | Key Responsible Entity | Priority Vulnerable UCs / Tehsils |
|---|---|---|---|---|
| **Objective 1: Protect and Restore Ecosystems and Biodiversity** | | | | |
| **1.1** | Focus on rehabilitating degraded rangelands, implementing agroforestry systems using drought-tolerant species like Acacia and Ziziphus, and engaging local communities in soil and water conservation efforts. | Short (2026–2028) | Department of Forests, Local Government, Community-based Organizations | Takht-e-Nasrati |

| | | | | |
|---|---|---|---|---|
| **1.2** | Implement restoration projects for forests and wetlands, ensuring habitat preservation for key wildlife species and enhancing carbon sequestration. | Medium (2029–2033) | Department of Forests, Environmental NGOs, PDMA | Takht-e-Nasrati, Banda Daud Shah |
| **1.3** | Involve local communities in ecosystem restoration, biodiversity monitoring, and the creation of ecological corridors that link remnant shrublands and micro-watersheds. | Long-term (2033 onward) | Local Governance Bodies, Community-based Organizations, Environmental Agencies | Takht-e-Nasrati, Banda Daud Shah |
| **Objective 2: Improve Water Resource Management and Quality** | | | | |
| **2.1** | Construct rainwater harvesting systems, small dams, and recharge wells in areas with high groundwater stress, ensuring sustainable water availability. | Short (2026–2028) | Water Management Department, PDMA, District Administration | Siraj Khel, Shaheedan, Latamber (Takht-e-Nasrati) |
| **2.2** | Strengthen monitoring systems to assess groundwater contamination, especially uranium, and ensure public awareness of safe water sources. | Medium (2029–2033) | Environmental Protection Agency, PDMA, Local Authorities | Siraj Khel, Banda Daud Shah, Karak City |
| **2.3** | Support context-appropriate techniques such as rainwater harvesting structures, drip and micro-catchment irrigation, and soil moisture conservation measures in agriculture to enhance water use efficiency under arid conditions. Strengthen farmers' capacity through public awareness campaigns on managing scarce water resources and optimizing limited rainfall and groundwater for crop production.. | Long-term (2033 onward) | Local Government, Community Organizations, Water Management Department | District-wide |
| **Objective 3: Mitigate Industrial Pollution and Enhance Air Quality** | | | | |
| **3.1** | Regulate mining operations and implement stricter environmental regulations for mining operations, particularly salt, gypsum, and oil extraction, to minimize dust emissions, soil erosion, and contamination of air and water. | Short (2026–2028) | KP Mines & Minerals Department, PDMA, Local Government | Siraj Khel, Banda Daud Shah |
| **3.2** | Establish local air quality monitoring systems to track pollutants such as particulate matter, volatile organic compounds, and sulfur emissions, and engage communities in monitoring and reporting air quality issues. | Medium (2029–2033) | EPA, DDMA, PDMA, Community-based Organizations | Karak City, Mithakhel, Latamber |
| **3.3** | Develop urban green spaces such as parks and tree plantations to improve air quality and mitigate the effects of urban heat islands. | Long-term (2033 onward) | Urban Development Department, Local Authorities, PDMA | Karak City, Mithakhel |
| **Objective 4: Strengthen Knowledge, Monitoring, and Governance for Natural Capital** | | | | |

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| **4.1** | Establish a District Environmental Information System (DEIS). Develop an integrated GIS-based system for monitoring land degradation, groundwater levels, air quality, and other key environmental indicators. | Short (2026–2028) | EPA-KP, GIS/IT Units, Academia, P&DD KP | District-wide, piloting in Takht-e-Nasrati and urban Karak |
| **4.2** | Regularly train district departments, DDMA, and DRCC on environmental monitoring, data use, and risk-informed planning to better incorporate natural capital considerations into decision-making. | Short–Medium (2026–2033) | KP Climate Change Cell, District Admin., DDMA, P&DD KP | All three Tehsils (Karak, Banda Daud Shah, Takht-e-Nasrati) |
| **4.3** | Mainstream natural-capital valuation, climate-risk screening, and climate-budget tagging. Integrate these tools into district budgeting and project appraisal to prioritize adaptation investments, especially in sectors like agriculture, water, and infrastructure. | Long (2033 onward) | Finance Dept.; P&DD KP; District Administration | District-wide |

## Urban Resilience

### Sectoral Context

#### Urban Development

- Karak district remains overwhelmingly rural, with only around 7% of its 816,000 residents living in urban areas[164].The main urban center is Karak town (roughly 50–60,000 people), alongside smaller towns like Teri and Takht-e-Nasrati, which largely retain rural characteristics despite their urban status[165].
- Urban growth in Karak has been modest but unplanned; new housing and commercial areas have expanded haphazardly, often along main roads and near extraction sites, without formal land-use planning. This has led to scattered settlements that lack resilient infrastructure and are increasingly encroaching onto marginal lands.
- The absence of effective urban planning and land record systems results in poor land management, making it difficult to enforce zoning or protect open spaces. Unregulated sprawl, though on a smaller scale than in Pakistan's major cities, is a concern: as Karak's population gradually urbanizes, unchecked expansion could increase exposure to floods or other hazards in previously natural buffer areas.

#### Municipal Services

- In Karak city, the municipal authority (TMA) can only supply roughly one-third of the daily drinking water demand; the rest of the population must rely on private water tankers or distant wells[166]. Field assessments confirm that water insecurity is the district's most urgent challenge,

[164] https://www.citypopulation.de/en/pakistan/admin/khyber_pakhtunkhwa/610__karak/#:~:text=Urbanization%20,Urban%2058%2C065

[165] https://pakistanalmanac.com/kp-karak/#:~:text=Karak%20district%20is%20mostly%20a,Dust%20is%20the%20only%20pollutant

[166] https://www.dawn.com/news/623434/contaminated-water-for-karak-people#:~:text=The%20sources%20said%20that%20total,TMA%20tube%20wells%20are%20dysfunctional

with many households depending on expensive tanker water or on wells that often yield saline or polluted water[167].

- Laboratory tests have found that even the municipal tube-well water in Karak city contains unsafe levels of contaminants (excess minerals and pollutants), rendering it unfit for human consumption[168]. Residents unable to afford alternatives are thus consuming poor-quality water, leading to health risks. Sanitation infrastructure is similarly weak, there is no comprehensive sewerage system, and wastewater management is minimal.
- Most households use pit latrines or septic tanks, which risk contaminating groundwater during floods or overflows. Solid waste management is very limited: the TMA lacks equipment and funds for proper garbage collection, resorting to handcarts for waste disposal due to the absence of even a single garbage tractor[169]. As a result, waste is often dumped or burned in the open. These service gaps not only undermine living conditions but also exacerbate climate vulnerabilities; for instance, blocked drains and garbage can worsen urban flooding, and water scarcity will intensify during droughts.
- Frequent electricity outages add to the challenges, especially during heatwaves when demand for cooling soars but power supply is unreliable[170].

### Air Pollution

- Historically, with little industry, air pollution in Karak was thought to stem mainly from natural dust[171]. The district's dry, rugged terrain and unpaved roads indeed generate significant dust, which contributes to respiratory discomfort. However, in recent years, environmental stresses have intensified due to the boom in extractive industries. Karak sits atop rich deposits of oil, gas, uranium, and minerals, and the exploitation of these resources has introduced new pollution sources.
- Gas flaring and drilling operations emit pollutants into the air, while heavy vehicular traffic (trucks, tankers) servicing mines and oil wells produce exhaust and kick up dust. Mining and quarrying (for gypsum, coal, limestone, etc.) scar the landscape and create particulate pollution. The cumulative effect is deteriorating air quality: residents and health officials report rising incidences of respiratory illnesses and allergies in the vicinity of industrial sites.
- In parts of the district, unchecked extraction has also led to soil and water contamination, for example, in Takht-e-Nasrati tehsil, studies link uranium contamination in groundwater to one of Asia's largest uranium deposits being mined there. Tests of local water sources found uranium levels well above World Health Organization safe limits, posing severe health hazards.
- Likewise, oil and gas drilling has been associated with leakage of effluents into soil and waterways, and chemical runoff from these activities can degrade farmland. Deforestation is an added concern: woodlands and scrub that once stabilized soil and served as windbreaks have been cleared in some areas for industrial expansion or fuel, removing natural buffers against dust storms, flash floods, and erosion. Karak faces a double exposure: the district is grappling with both the environmental degradation from resource extraction and the broader impacts of climate change.
- These stresses compound each other, for instance, higher temperatures and wind can carry dust and pollutants further, and deforested hillsides are more prone to flood damage under heavy

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[167] https://www.dawn.com/news/623434/contaminated-water-for-karak-people#:~:text=They%20said%20that%2080%20per,evolve%20a%20strategy%20for%20collection
[168] https://www.dawn.com/news/623434/contaminated-water-for-karak-people#:~:text=They%20said%20that%2080%20per,evolve%20a%20strategy%20for%20collection
[169] https://www.dawn.com/news/623434/contaminated-water-for-karak-people#:~:text=He%20said%20that%20the%20government,used%20handcarts%20for%20the%20purpose
[170]https://sdpi.org/9892/blogs_detail#:~:text=sources%20of%20questionable%20quality%2C%20often,crop%20yields%20and%20livestock%20health
[171] https://pakistanalmanac.com/kp-karak/#:~:text=Karak%20district%20is%20mostly%20a,Dust%20is%20the%20only%20pollutant

rains. Improving air quality and managing environmental risks is now a growing priority, as these issues directly affect public health and the resilience of communities.

### Climate Change Impacts

Karak's climate is naturally arid and extreme, and climate change is amplifying these characteristics. Community surveys and local data indicate that heatwaves, droughts, and flash floods are increasing in both frequency and severity.[172] Summers are becoming longer and hotter, mirroring province-wide patterns of extended hot seasons and shorter, milder winters.[173] In recent years, daytime temperatures have regularly exceeded historical norms, heightening heat stress across the population. These rising temperatures pose serious health risks, such as heat exhaustion and dehydration, which are reportedly increasing, and place significant strain on infrastructure. Peak electricity demand for cooling during heatwaves far surpasses supply, causing frequent power outages at the most critical times.

Prolonged and more intense droughts have also been observed. Rainfall in Karak remains highly erratic, and multi-year averages indicate a declining trend that contributes to chronic water scarcity. Lengthening dry spells reduce surface water in ponds and small dams and lower groundwater levels in the wells that communities depend on. These drought conditions severely impact agriculture and livestock, rain-fed crop yields decline, grazing lands shrink, and fodder becomes scarce, while simultaneously worsening domestic water shortages in both urban and rural settlements.

Paradoxically, when rainfall does occur, it increasingly arrives in short, intense downpours. Such heavy rainfall events generate rapid runoff in the district's hilly terrain, causing flash floods in typically dry streams (rod kohi). These sudden flows can inundate low-lying settlements, damage roads, and destroy homes. A recent severe cloudburst that washed away houses in parts of Karak underscores the growing flood risk. Although Karak is not located on a riverine floodplain, these localized flash floods can be devastating, particularly in the absence of adequate drainage infrastructure.

Climate projections for Pakistan indicate that such extremes will likely intensify, as a warmer atmosphere holds more moisture, resulting in heavier rainfall when it occurs and longer dry periods in between. The Khyber Pakhtunkhwa climate policy also notes that rising surface temperatures are expected to exacerbate rainfall variability and flood hazards across the province, consistent with on-ground observations in Karak.[174] However, the district's ability to cope with these impacts is limited by scarce resources. Smaller urban centres like Karak often lag larger cities in terms of adaptation investments, technical capacity, and climate-resilient infrastructure. Without targeted intervention, climate change will place additional stress on Karak's urban systems: water shortages will worsen, heat and pollution will increasingly threaten public health, and unplanned urban expansion may expose more people to flood risk and other hazards. The need for urgent, well-funded climate adaptation efforts in the urban context is therefore critical to safeguard Karak's residents and economic resilience.

### Priority Adaptation Areas and Initiatives

#### Objective 1: Integrate climate resilience into urban planning and land-use management

Strengthening Karak's climate resilience begins with improved urban planning. Currently, unregulated expansion, such as construction in dry riverbeds and on unstable slopes, heightens exposure to heat, floods, and erosion. This objective focuses on embedding climate adaptation into how towns grow. Key priorities include developing a climate-sensitive land use plan, based on

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[172] https://sdpi.org/9892/blogs_detail#:~:text=challenge,crop%20yields%20and%20livestock%20health

[173] https://www.dawn.com/news/1707457#:~:text=The%20policy%20said%20KP%20had,change%2C%20which%20impacted%20agricultural%20output

[174] https://www.dawn.com/news/1707457#:~:text=It%20added%20that%20surface%20warming,humid%20forest

hazard mapping, to identify high-risk zones and regulate construction accordingly. Building codes should be updated to incorporate heat- and flood-resilient design features, and new public buildings must be sited with climate hazards in mind. Establishing an Urban Planning Unit within local government, trained in climate-informed development control, will ensure long-term climate projections guide approvals. Expanding green spaces and permeable areas, including large-scale tree planting with heat-tolerant species, will reduce heat islands and maintain natural drainage, with opportunities for partnering with local industries through CSR.

### Objective 2: Improve municipal service delivery for climate resilience

Urban resilience in Karak depends heavily on reliable water, sanitation, drainage, waste management, and energy systems, services already under strain and highly vulnerable to climate extremes. This objective aims to provide climate-proof essential municipal services. Priorities include strengthening water supply through new climate-resilient wells, rehabilitating damaged schemes, and installing rainwater harvesting on public buildings. To ensure water safety, community-scale filtration plants, especially in areas with contaminants like arsenic or uranium, should be deployed. Sanitation must be upgraded with flood-resilient designs, while improved drainage and stormwater channels are essential to manage flash floods. A structured waste collection and disposal system, supported by proper vehicles and designated sites, will curb open dumping and keep drains clear. Enhancing energy reliability by promoting solar systems with battery backup on key public facilities (e.g., pumping stations, health centers) will ensure service continuity during heatwaves and outages. Collectively, these actions strengthen the lifeline services that protect communities during climate shocks.

### Objective 3: Enhance environmental management and air quality to reduce climate-related health risks

Karak's environmental health is undermined by industrial emissions, dust, and declining water quality, all of which climate change intensifies. This objective target pollution control, restoration of degraded areas, and better monitoring. Key initiatives include enforcing strict emission and effluent standards on extractive industries, requiring pollution abatement technologies, and conducting regular inspections. Targeted reforestation around extraction zones and barren hills will stabilize soil, reduce dust, and rebuild natural buffers. Basic air quality monitoring in Karak town, paired with measures such as paving dusty roads, water-sprinkling during dry winds, and promoting cleaner household energy, will help reduce exposure to harmful pollutants. Protecting local water bodies through cleanup drives, regulation of waste disposal, and promoting groundwater recharge structures is equally critical. These actions collectively improve air and water quality, reduce health vulnerabilities, and enhance the resilience of both ecosystems and communities..

### Objective 4: Build local capacity, awareness, and governance for urban climate resilience

Effective climate resilience requires strong institutions, informed communities, and coordinated action. This objective focuses on building the human and governance systems needed to sustain adaptation efforts. Priority actions include training municipal and district officials in climate risk management, planning, and emergency response, and establishing a climate focal unit to coordinate with provincial agencies. Public awareness programs, through neighborhood meetings, trader groups, schools, and media, will promote heatwave safety, flood preparedness, and community participation. Strengthening early warning communication via SMS, radio, mosques, and social media, alongside activating disaster committees and preparing local shelters, will improve readiness. Community-based resilience groups that include women, youth, and elders should play an active role in planning and response. Coordination with local industries to direct CSR funding toward priority resilience needs (e.g., water filtration or emergency services) will further support implementation. By enhancing local capacity and engagement, Karak will be better equipped to sustain and scale the resilience measures outlined in the broader urban strategy.

Table 5: Key Objectives and Priority Initiatives for Urban Resilience – Karak District

| No. | Objective & Initiative | Timeframe | Key Responsible Entity | Priority Vulnerable UCs / Tehsils |
|---|---|---|---|---|
| **Objective 1: Integrate Climate Resilience into Urban Planning** | | | | |
| **1.1** | Develop climate risk maps and risk-informed land-use plans and enforce zoning regulations to restrict or prohibit new construction in high-risk areas based on approved risk zoning. Integrate these controls into district and tehsil-level land-use plans, building by-laws, and development approval processes. | Short (2026–2028) | KP Urban Policy Unit; District Administration; TMAs; P&DD KP | Karak, Banda Daud Shah, and Takht-e-Nasrati |
| **1.2** | Update and enforce building codes to improve flood, heat, and seismic resilience, and promote climate-smart building design in new construction. Ensure alignment with climate-resilient design standards for critical infrastructure, including roads and bridges, through coordination with relevant departments and integration of climate risk considerations into infrastructure planning and approval processes. | Short (2026–2028) | Local Government; Urban Planning.; C&W; Forest Department | Karak, Banda Daud Shah, and Takht-e-Nasrati |
| **1.3** | Establish urban green belts and permeable surfaces to counter heat islands and improve stormwater absorption. | Medium (2029–2033) | Revenue Dept.; District Admin.; TMAs; KP Urban Policy Unit; Forest Department | Peri-urban belts around Karak city and settlement fringes along major roads |
| **Objective 2: Strengthen Climate-Smart Municipal Services** | | | | |
| **2.1** | Rehabilitate and upgrade existing water supply systems, including tube wells, distribution networks, and filtration units, to reduce losses and improve reliability. Where critical gaps remain, undertake selective expansion through rainwater harvesting and climate-resilient supply options. Install and maintain filtration units to ensure safe drinking water in climate-vulnerable urban areas. | Short–Medium (2026–2033) | C&W Dept.; TMAs; LGRDD; KP Urban Policy Unit | Low-lying streets and markets in Karak city and town centres in Banda Daud Shah and Takht-e-Nasrati |
| **2.2** | Upgrade drainage and sewerage systems; build storm drains and flood retention ponds to manage flash floods. | Short (2026–2028) | TMAs; LGRDD; EPA-KP; Private-Sector Operators | Karak Tehsil and Banda Daud Shah |

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|---|---|---|---|---|
| **2.3** | Improve solid waste collection and disposal to prevent urban flooding and public health hazards. | Short–Medium (2026–2033) | PHED; TMAs; Energy Dept.; NGOs/Private Sector | Karak and Takht-e-Nasrati |
| **2.4** | Promote solar power backups for critical facilities (water pumps, clinics) to cope with load-shedding during climate extremes. | Short (2026–2028) | District Admin.; TMAs; PDMA KP; Pakistan Met Dept.; Rescue 1122 | Urban centres and main bazaars across all three tehsils |
| **Objective 3: Enhance Environmental Management & Air Quality** | | | | |
| **3.1** | Enforce environmental regulations on mining and drilling; monitor industrial emissions and effluents | Medium (2029–2033) | Forest Dept.; TMAs; Irrigation Dept.; District Admin. | Drainage corridors and transport corridors around Karak city, Gurguri, and Latamber |
| **3.2** | Reforest and rehabilitate degraded lands (especially around extractive sites) to restore natural flood buffers and reduce dust. | Short–Medium (2026–2033) | Forest Dept.; TMAs; Education Dept.; NGOs | Heat-stressed urban and peri-urban UCs of Karak Tehsil and town centres of Banda Daud Shah and Takht-e-Nasrati |
| **3.3** | Launch urban tree planting and green spaces to improve air quality and cooling. | Short (2026–2028) | C&W Dept.; TMAs; PHED; Academia | District-wide |
| **3.4** | Set up air quality monitoring and dust control measures (e.g. road watering, cleaner brick kiln technology). | Short–Medium (2026–2033) | EPA-KP; TMAs; C&W Dept; Environmental Labs/Academic Institutions | Karak city (especially areas near quarries, roadsides, and market zones), Gurguri, Latamber |
| **Objective 4: Build Local Capacity and Disaster Preparedness** | | | | |
| **4.1** | Train local officials in climate adaptation planning and emergency preparedness, including flood, heatwave, and drought response; and establish designated climate change focal persons within TMAs and the District Administration to coordinate preparedness, early warning response, and recovery actions. | Short–Medium (2026–2033) | TMAs; Finance Dept.; District Admin; Civil Défense; Rescue 1122 | District-wide |
| **4.2** | Conduct public awareness and preparedness campaigns on heatwaves, droughts, and floods through community drills, school-based education programs, and coordinated outreach. Establish public cooling and hydration | Medium (2029–2033) | P&DD KP; Finance Dept.; Donor Agencies | District-wide |

| | | | | |
|---|---|---|---|---|
| | points at high-exposure locations (e.g., roadside areas, transport nodes, markets) as part of heatwave awareness and response, while ensuring inter-departmental alignment for consistent messaging and implementation. | | | |
| **4.3** | Strengthen coordination with provincial agencies and private sector (CSR programs) to fund and implement local resilience projects. | Medium (2029–2033) | District Admin; KP Climate Change Cell; Chamber of Commerce; CSR wings of mining/energy companies | Takht-e-Nasrati and Banda Daud Shah (especially those affected by mining or lacking basic services) |

## Human Capital

### Sectoral Context

#### Health

- Healthcare facilities in the district are limited in number and capacity – there is one main District Headquarter Hospital in Karak town and a handful of smaller rural health centers, but many communities (especially in remote areas) lack easy access to medical services. Residents often travel to larger cities (Kohat, Peshawar) for specialized care, indicating gaps in local healthcare provision.
- Baseline health indicators reflect strains: water- and sanitation-related illnesses are common in Karak due to poor water quality and hygiene infrastructure. For instance, the prevalence of diarrheal diseases and gastroenteritis is noted to be high, especially in summer months, as many households consume microbiologically unsafe water [175].
- Environmental health issues are also acute, the district's exposure to industrial pollutants has introduced new health risks. A recent study revealed alarming toxic contamination in Karak's groundwater (linked with the uranium mining area), correlating with elevated rates of chronic conditions in the population[176].
- In communities using this groundwater, doctors have observed higher incidences of kidney dysfunction, bone disorders, and even cancers, illnesses previously uncommon in the region[177]. Respiratory ailments are another growing concern: clinics report that cases of asthma, bronchitis, and allergies have risen, likely due to dust and emissions from increased mining and vehicular traffic. Moreover, extreme heat events have already led to heat-related illnesses, local health workers recount treating heat exhaustion and dehydration cases during recent summer heatwaves.

#### Education

- The literacy rate in the Karak stands at roughly 60–65% (for ages 10+), which is an improvement from past decades but remains below the national average[178]. Schools are distributed across the

[175] https://www.dawn.com/news/623434/contaminated-water-for-karak-people#:~:text=KARAK%2C%20April%2023%3A%20Drinking%20water,TMA%29%20told%20this%20correspondent

[176] https://www.thefridaytimes.com/15-Sep-2025/how-karak-s-resource-wealth-became-a-crisis-for-water-health-and-climate

[177] Ibid.

[178] https://www.citypopulation.de/en/pakistan/admin/khyber_pakhtunkhwa/610__karak/#:~:text=Literacy%20,374%2C674%20no%20198%2C553

district, yet many rural localities have few middle or high schools, leading to long travel distances for students.

- There is also a gender gap, female literacy and school enrolment are lower than males, influenced by socio-cultural factors and school availability. From an infrastructure standpoint, many schools in Karak are basic and not equipped to handle climate extremes. A number of government schools operate in old or semi-open buildings with poor insulation; during peak summer, class environments become arduous due to lack of fans or cooling (especially when electricity is unreliable).
- In recent heatwaves, some schools have had to reduce outdoor activities or even shorten school hours for safety. Conversely, in winter, especially in Karak's hilly areas, inadequate heating can make classrooms uncomfortable, though winters are shortening.
- Another challenge is the physical vulnerability of educational infrastructure to extreme weather. Flash floods and heavy rains have on occasion, damaged school buildings or access roads. For example, a sudden flood in 2025 destroyed or severely damaged several homes and affected facilities in parts of Banda Daud Shah and Takht-e-Nasrati tehsils, such events disrupt schooling as buildings may be repurposed as shelters or become inaccessible.
- School emergency preparedness is nascent: most schools do not have formal disaster drills or contingency plans. Additionally, the education curriculum currently has limited content on climate change or local environmental management, meaning students and teachers may not be fully aware of the risks or adaptive practices.
- High rates of student absenteeism are noted during extreme weather, e.g. on very hot days or during heavy rainfall, attendance drops, and illnesses like heatstroke or waterborne diseases keep children at home. Thus, while education is critical for long-term resilience, the sector itself in Karak is vulnerable to climate variability and needs targeted support to ensure safe learning environments and continuity in the face of disruptions.

### Labor and Economic Productivity

- The livelihoods of people in Karak are closely tied to climate-sensitive sectors and are undergoing shifts. A large portion of the population engages in agriculture and livestock rearing, mostly at a subsistence level. Karak falls in a dry agro-ecological zone; farming here relies on sparse rainfall and rudimentary rod-kohi (hill torrent) irrigation. Major crops include wheat, sorghum, millet, and gram, but yields are generally low due to water scarcity and poor soil fertility[179].
- In recent years, farmers have observed declining agricultural productivity, prolonged dry spells and erratic rain have led to repeated crop failures. The district's agriculture is quite literally drying up: reduced rainfall, degrading soils, and groundwater depletion are causing many to abandon or scale back farming[180].
- Livestock (goats, sheep, cattle) are an important asset for rural households, providing food security and income, yet drought and heat stress have affected animal health and fodder availability, sometimes leading to distress sales of herds.
- Beyond farming, Karak has a unique livelihood dimension with its natural resource industries. The discovery and extraction of oil, gas, and minerals (like salt, gypsum, uranium) in Karak have created jobs, but mostly skilled or outsourced ones, many local people lack the training to take on technical roles in these industries, so employment benefits have been limited. Some locals find work as labourers or drivers for the extraction companies, but these jobs can be temporary and come with health risks (exposure to dust, heat, and hazardous conditions).
- Traditional skills and products also contribute to livelihoods: for instance, Karak is famous for its high-quality honey production, an activity well-suited to its flora. Beekeeping has provided

[179] https://pakistanalmanac.com/kp-karak/#:~:text=Generally%2C%20the%20area%20belongs%20to,then%20used%20for%20irrigation%20purposes

[180] https://www.thefridaytimes.com/15-Sep-2025/how-karak-s-resource-wealth-became-a-crisis-for-water-health-and-climate

income for some households and is being promoted as a climate-resilient livelihood (bees can forage on sparse vegetation like phulai acacia, and honey has strong market demand).181 Additionally, many families depend on remittances; several working-age men seek employment in cities like Dubai, Karachi or elsewhere, sending money back home, a coping strategy due in part to limited local opportunities. The labour profile thus spans from agrarian work to service jobs and migration. It's important to note that a majority of Karak's workforce is informal, with low wages and little social protection.

- Women's labour, often in home-based livestock rearing or fetching water, has also intensified as water sources dry up (women and girls spend more time and effort to secure water, affecting their health and time for education or other work). Without diversified and climate-resilient income sources, many households remain highly vulnerable to climate shocks that can wipe out crops, kill livestock, or halt work. Strengthening livelihoods against climate impacts is thus a critical need for Karak's human capital development.

### Climate Change Impacts

Climate change is undermining human capital in Karak by intensifying risks across health, education, and livelihoods. Rising temperatures and longer summers have led to more frequent heat-related illnesses, with outdoor workers and schoolchildren particularly affected during recurring heatwaves. Water scarcity during droughts reduces hygiene and nutrition, increasing diarrheal and respiratory diseases, while post-rainfall pooling and warmer conditions are expanding the threat of malaria and dengue.[182] Flash floods further cause injuries, contaminate drinking water, and heighten disease outbreaks, while the psychological stress of crop loss and economic insecurity is increasingly visible, especially among farmers and youth. Education is also being disrupted: extreme heat reduces attendance and concentration in schools lacking cooling, while flash floods and heavy rains result in closures and lost instructional days. Economic pressures during droughts or after crop failures force some families to withdraw children from school, with girls often disproportionately affected due to added domestic burdens such as water collection.[183]

Livelihoods are equally strained as erratic rainfall and extreme heat reduce crop yields, shorten agricultural work seasons, and push farm labourers into seasonal migration. Outdoor workers across other sectors lose income when extreme heat makes afternoon work unsafe, mirroring ILO projections that heat stress will significantly reduce global working hours by 2030.[184] Climate extremes also damage infrastructure, livestock, and irrigation systems, compounding economic losses. With water availability declining across KP, assessments warn of increased forced migration, a trend already emerging in parts of Karak as wells dry and farming becomes less viable. Even workers in sectors like mining face new safety hazards, including deeper excavation and risks from sudden rainfall flooding. Overall, without adaptation, climate change threatens to erode health, education, and economic stability in Karak, weakening the district's long-term human development trajectory.[185]

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[181] https://pakistanalmanac.com/kp-karak/#:~:text=One%20of%20the%20most%20famous,1

[182] https://www.emro.who.int/pak/pakistan-news/who-and-pakistan-warn-climate-change-is-worsening-malaria-amid-2-million-annual-cases.html#:~:text=Climate%20change%20and%20associated%20impacts,access%20limitations%20in%20Sindh%20province

[183] https://unfccc.int/sites/default/files/resource/National_Adaptation_Plan_Pakistan.pdf#:~:text=processes,is%20crucial%20to%20analyse%20climate

[184] https://www.dawn.com/news/1491635#:~:text=as%20Europe%20sweltered%20in%20record,temperatures

[185] https://www.dawn.com/news/1707457#:~:text=Regarding%20water%20situation%2C%20it%20said,security%20and%20agriculture%20in%20KP

### Priority Adaptation Areas and Initiatives

#### Objective 1: Strengthen health systems and community health resilience against climate impact

Karak's health system must embed climate risk into service planning, infrastructure design, and disease surveillance. This includes climate-resilient retrofitting of BHUs and hospitals (e.g. elevated plinths, solar backup, improved ventilation), integration of early warning systems for heatwaves and disease outbreaks, and routine monitoring of climate-sensitive indicators like heat illness and diarrheal spikes. Local health staff should be trained in climate-linked health management and risk communication. Targeted outreach, including safe water access in uranium-contaminated zones and sanitation improvements, is essential to reduce health vulnerabilities and improve community resilience.

#### Objective 2: Enhancing Community Resilience and Emergency Preparedness

Ensuring educational continuity under climate stress requires investment in resilient school infrastructure (flood-resistant design, passive cooling, and energy backups), as well as school-level disaster preparedness. Heat and flood protocols should be formalized through drills, teacher training, and adjustment of schedules. Schools should serve as hubs for awareness on WASH, climate safety, and local environmental action. During disaster-induced closures, alternate learning channels (radio, mobile, take-home kits) must be deployed to prevent prolonged disruption, especially for vulnerable students.

#### Objective 3: Building Workforce Capacities and Green-Livelihood Transition

Diversifying income sources and upskilling Karak's workforce is critical to withstand climate shocks. Scaling up climate-smart agriculture (drought-resilient crops, efficient irrigation, improved livestock care) and introducing vocational training in green sectors (solar tech, resilient construction, food processing) can build economic resilience. Honey production, beekeeping, and other value chains suited to Karak's ecology should be supported through microfinance and market access. Occupational safety measures, heat-protection protocols, and financial safety nets (e.g. insurance or cash-for-work schemes) are essential to protect outdoor workers from productivity losses linked to extreme heat and climate volatility.

Table 6: Key Objectives and Initiatives for Human Capital - Karak District

| No. | Objective & Initiative | Timeframe | Key Responsible Entity | Priority Vulnerable UCs / Tehsils |
|---|---|---|---|---|
| **Objective 1: Strengthen Health Systems and Community Health Resilience Against Climate Impacts** | | | | |
| **1.1** | Retrofit BHUs and RHCs with elevated plinths, solar backup, improved WASH and ventilation | Short to Medium (2026–2033) | Health Dept KP; Local Govt Dept | Takht-e-Nasrati, Sheenghar, Latamber |
| **1.2** | Establish early warning and response system for heat and disease outbreaks | Short–Medium (2026–2030) | DHO; PDMA KP Rescue 1122 | Karak City, Gurguri, Mithakhel |
| **1.3** | Train LHWs and frontline staff on climate-linked diseases and risk communication | Short (2026–2028) | Provincial Training Institutes; Health Dept | District-wide with focus on remote UCs |
| **Objective 2: Climate-Proof the Education Sector to Safeguard Learning and School Infrastructure** | | | | |
| **2.1** | Upgrade schools with heat-tolerant infrastructure and | Medium (2029–2033) | Education Dept KP; C&W Dept | Banda Daud Shah, Ahmad Abad, Tappi |

| | | | | |
|---|---|---|---|---|
| | develop climate safety protocols | | | |
| **2.2** | Establish learning continuity options via radio/WhatsApp for flood or heat closures | Short (2026–2028) | Education Dept; NGOs | Flood-prone and low-connectivity UCs |
| **2.3** | Integrate climate and DRR awareness into school curricula and clubs. | Short (2026–2028) | Education Dept; SDMA | District-wide |
| **Objective 3: Enhance Livelihood Resilience and Adaptive Skills for a Climate-Impacted Workforce** | | | | |
| **3.1** | Train youth and women in green skills (solar, beekeeping, food processing) | Medium (2029–2033) | TEVTA KP; Social Welfare Dept | Karak City, remote rural UCs |
| **3.2** | Provide microfinance and grants for resilient livelihoods (solar pumps, agribusiness) | Short (2026–2028) | SME Development Authority; Microfinance Institutions | Female-led households, drought-affected zones |
| **3.3** | Develop occupational safety and heat-protection standards for outdoor workers | Short (2026–2028) | Labour Dept; Municipal Admin | Construction, agriculture, and mining areas |

## Cross-Cutting Areas

## Disaster Risk Management

### Sectoral Context

#### Disaster Risk Landscape

- Karak faces a high level of multi-hazard exposure, particularly to floods, flash floods, heatwaves, earthquakes, droughts, and dust storms. The district's topography, with steep slopes and dry riverbeds, increases its vulnerability to flash floods during monsoon rains and from hill torrents.
- Karak is particularly prone to floods, especially during the monsoon season, when hill torrents cause flash flooding. Although it was spared from the catastrophic 2022 floods that devastated nearby regions, the district remains vulnerable due to unpredictable rainfall patterns and soil erosion.[186] [187]
- The district is experiencing rising temperatures, with summer heatwaves becoming more intense. In recent years, temperatures have surpassed 45°C, and heatwaves in 2024 and 2025 were particularly severe, contributing to hundreds of heat-related deaths. Projections suggest that the region will see a significant increase in the number of hot days over the coming decades, intensifying the impact on human health and agriculture.[188] [189]
- Karak is facing chronic water scarcity, exacerbated by erratic rainfall and decreasing groundwater levels. The Thal zone of the district receives less than 500 millimeters of rainfall annually, and the combined effects of climate change, temperature increases, and reduced rainfall have led to a decline in groundwater resources. This has serious implications for agriculture, drinking water supplies, and overall livelihoods.[190]

[186] https://www.redcross.org.uk/stories/disasters-and-emergencies/world/climate-change-and-pakistan-flooding-affecting-millions
[187] CRVA. (2025). Climate Risk and Vulnerability Assessment (CRVA) of Karak District. Sustainable Development Policy Institute (SDPI)
[188] Ibid.
[189] https://www.adb.org/sites/default/files/linked-documents/56151-001-cca.pdf
[190] https://www.frontiersin.org/journals/water/articles/10.3389/frwa.2025.1540703/full

- A significant public health threat in Karak is lead contamination in drinking water, with levels far exceeding the World Health Organization's permissible limits. Recent studies show alarming concentrations of lead in groundwater, with health risks particularly severe for children. This contamination poses a critical need for intervention to safeguard public health.[191]

### 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 the NDMA at the federal level.[192]
- Legal frameworks guiding disaster management include the National Disaster Management Act (2010), Khyber Pakhtunkhwa DRM Policy (2018), and the National Disaster Management Plan (NDMP) 2012-2022.
- Operational challenges include weak early warning systems, inadequate disaster preparedness infrastructure, and limited capacity at the district level, with many districts, including Karak, lacking updated disaster management plans.[193] [194]
- There is insufficient integration of disaster risk reduction with climate change adaptation and development planning, limiting effective community engagement and response capabilities.
- Resource gaps, such as lack of training, logistics support, and IT-based disaster management systems, hinder effective DRM implementation in Karak.[195]

### Climate Change Impacts

Climate change is having a profound impact on Karak, with rising temperatures and increasingly erratic rainfall patterns contributing to a growing vulnerability. The district is projected to experience a temperature increase of 0.85°C to 0.94°C between 2020 and 2039, leading to more frequent and intense heatwaves. These extreme temperatures are placing significant strain on Karak's already limited emergency health systems and response capacity. Alongside the temperature rise, precipitation patterns are becoming more unpredictable, with heavier rainfall events expected to occur more frequently.[196] [197]

In addition to rising temperatures, Karak is facing severe water stress, exacerbated by declining groundwater levels, which are essential for agriculture, drinking water, and daily living. Erratic rainfall patterns and delayed seasonal weather are contributing to the steady depletion of the district's groundwater resources, heightening water scarcity, especially in agriculture. These areas often lack the infrastructure and resources to effectively mitigate the impacts of these hazards. The district's dependence on rain-fed agriculture and its semi-arid conditions, combined with overexploitation of water resources and soil degradation, are exacerbating the threat to food security and economic stability. With the increasing frequency of extreme weather events, Karak faces an urgent need for adaptive measures, including improved water governance, climate-resilient agricultural practices, and better disaster preparedness strategies to mitigate future climate risks.[198] [199]

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[191] Ibid.
[192] PDMA KP. Monsoon Contingency Plan 2022 and Annual Reports.
[193] https://dialogue.earth/en/climate/pakistan-needs-effective-early-warning-system-to-fight-floods/
[194] https://thedocs.worldbank.org/en/doc/585851542124456386-0310022018/original/IdressMasudLessonsFromPakistan.pdf
[195] https://agp.gov.pk/SiteImage/Policy/Special Study on Preparedness of PDMA,KPK 2016-17 Report 2018-19-converted.pdf
[196] https://www.adb.org/sites/default/files/linked-documents/56151-001-cca.pdf
[197] https://epakp.gov.pk/wp-content/uploads/2022/09/Khyber-Pakhtunkhwa-Climate-Change-Action-Plan-August-2022-English.pdf
[198] Field observations conducted by the author during site visits to Karak, 14–25 July 2025.
[199] https://documents1.worldbank.org/curated/en/669421468188348522/pdf/68358-v2-disaster-risk-urban-poor-final-Box393223B-PUBLIC.pdf

### Priority Adaptation Areas and Actions

#### Objective 1: Enhancing Early Warning Systems and Disaster Preparedness

Effective early warning systems (EWS) are crucial to mitigate the impacts of disasters in Karak. The increasing frequency of flash floods, heatwaves, and droughts necessitates the development of an efficient EWS that leverages technology, community networks, and traditional knowledge. The objective is to ensure timely and accurate warnings for vulnerable communities, allowing them to take precautionary measures and reduce loss of life and property.

#### Objective 2: Strengthening Disaster Response and Recovery Mechanisms

Karak's capacity to respond to and recover from disasters is essential for building long-term resilience. Immediate, efficient, and coordinated responses during disasters, coupled with climate-resilient recovery efforts, can help communities rebound faster and better. This objective aims to establish frameworks for quick disaster response and long-term recovery, focusing on strengthening local capacities and creating climate-resilient infrastructure that can withstand future hazards.

#### Objective 3: Strengthening Institutional Coordination and Capacity

A robust DRM system requires coordination across various government and community stakeholders. Strengthening institutional capacities at the district level ensures effective implementation of disaster management initiatives. This objective seeks to foster collaboration among district agencies and improve their technical skills, enabling them to handle climate-induced disasters and reduce vulnerability across the district.

#### Objective 4: Improving Disaster Risk Financing and Resource Mobilization

Securing adequate financing for disaster risk management activities is key to long-term resilience. This objective focuses on establishing mechanisms for mobilizing resources, including through local government funds, private sector contributions, and climate finance. With a dedicated disaster resilience fund, Karak can ensure that necessary investments in DRM are made, even in times of crisis.

#### Objective 5: Enhancing Public Awareness and Community Participation

Disaster risk management cannot succeed without the active participation of local communities. Raising awareness about climate risks, preparedness strategies, and disaster response protocols is critical for building local resilience. This objective aims to empower communities, particularly vulnerable groups, with the knowledge and tools they need to respond to climate-induced hazards.

Table 7: Key Objectives and Initiatives for Disaster Risk Management - Karak District

| No. | Objective & Initiative | Timeframe | Key Responsible Entity | Priority Vulnerable UCs / Tehsils |
|---|---|---|---|---|
| **Objective 1: Enhancing Early Warning Systems and Disaster Preparedness** | | | | |
| **1.1** | Establish and maintain district-wide early warning systems using GIS and mobile alerts. | Short (2026–2028) | PDMA; Telecom Authorities; District Administration; PDMA KP; Pakistan Meteorological Department; Irrigation Dept | Siraj Khel, Shaheedan, Latamber (Takht-e-Nasrati) |
| **1.2** | Integrate context-specific local knowledge and indigenous coping mechanisms into formal disaster risk management strategies, | Medium (2029–2033) | PDMA; DDMA; Local Governance Bodies, NGOs | Takht-e-Nasrati, Banda Daud Shah |

| | | | | |
|---|---|---|---|---|
| | tailored to dominant hazards (floods, droughts, heatwaves) and local socio-ecological conditions. Document, validate, and incorporate these practices into PDMA/DDMA contingency plans, standard operating procedures, and community-based preparedness frameworks. | | | |
| **1.3** | Train local communities in disaster response and preparedness, focusing on women and youth. | Short (2026–2028) | Local Government, Youth Affairs Department, Women's Development Department | Banda Daud Shah, Karak City |
| **Objective 2: Strengthening Disaster Response and Recovery Mechanisms** | | | | |
| **2.1** | Develop and implement a District Disaster Response and Recovery Plan (DDRRP). | Short (2026–2028) | PDMA; DDMA; District Administration; Civil Defence; Rescue 1122 | Takht-e-Nasrati, Banda Daud Shah |
| **2.2** | Establish a District Emergency Fund to support immediate needs post-disaster. | Medium (2029–2033) | District Administration; Private Companies; OGDCL | Takht-e-Nasrati, Banda Daud Shah |
| **2.3** | Introduce climate-resilient recovery policies focusing on eco-friendly infrastructure. | Long-term (2033 onward) | Local Government; KP Urban Policy Unit; District Administration | Karak City, Takht-e-Nasrati |
| **Objective 3: Strengthening Institutional Coordination and Capacity** | | | | |
| **3.1** | Establish a District Disaster Management Coordination Committee (DDMCC). | Short (2026–2028) | PDMA; District Administration; Civil Defence; Rescue 1122; P&DD KP | Takht-e-Nasrati, Banda Daud Shah |
| **3.2** | Build technical capacity for disaster risk analysis, climate risk management, and emergency logistics. | Medium (2029–2033) | PDMA; NDMA; Local Government | Karak City, Banda Daud Shah |
| **Objective 4: Improving Disaster Risk Financing and Resource Mobilization** | | | | |
| **4.1** | Develop a District Climate Resilience Fund (DCRF) with contributions from CSR and climate finance. | Medium (2029–2033) | District Admin; Finance Dept.; PDMA KP; CSR Committees | Takht-e-Nasrati, Banda Daud Shah |
| **4.2** | Integrate disaster risk screening into district development plans to ensure adaptive investments. | Short (2026–2028) | P&DD KP, District Administration | Karak City, Takht-e-Nasrati |
| **Objective 5: Enhancing Public Awareness and Community Participation** | | | | |
| **5.1** | Conduct public awareness campaigns on climate risks and disaster preparedness. | Short (2026–2028) | PDMA, Local Government, Women's Development Department | Banda Daud Shah, Takht-e-Nasrati |
| **5.2** | Establish community-level DRM committees to engage local populations in disaster planning. | Medium (2029–2033) | Local Government; CSOs; NGOs | Takht-e-Nasrati, Karak City |

## Gender, Youth, and Social Inclusion

### Sectoral Context

Karak District, located in southern Khyber Pakhtunkhwa, is predominantly rural, with 92.9% of the population residing in villages and small towns around Karak City and Teri[200]. The economy relies heavily on agriculture (mostly rain-fed/barani), livestock grazing on increasingly degraded rangelands, and extractive industries, including oil, gas, salt, gypsum, limestone, and coal.[201] [202] Extractive and agricultural practices exacerbate environmental degradation, soil erosion, and social inequalities.[203] The district experiences a semi-arid climate with high inter-annual rainfall variability (average 478 mm), scorching summers up to 44°C, and cold winters down to 5°C[204]. These geographic and environmental constraints limit crop productivity and heighten vulnerability to climate shocks. The KP Gender Parity Report 2025 indicates that districts like Karak are emblematic of broader provincial challenges, including low female labour force participation, limited access to formal employment, and gendered roles in rural and extractive-sector economies.[205] These structural inequalities intersect with climate vulnerability to shape who can benefit from development initiatives.

### Gender

- Karak District has a total population of 815,878, comprising 421,292 males, 394,575 females, and 11 transgender individuals[206]. This reflects a slightly male-skewed population, with a gender ratio of approximately 107 males per 100 females. Significant gender inequalities exist, particularly in literacy, labour participation, and access to resources. The overall literacy rate is 65.36%, with male literacy at 84.12% and female literacy at only 45.6%.[207]
- Female labour force participation is below 20%, largely confined to unpaid agricultural and livestock activities, while socio-cultural norms limit women's mobility, decision-making, and access to credit or land[208] [209]. Climate change exacerbates these inequalities: women bear disproportionate burdens from prolonged droughts, water scarcity, and household responsibilities, often walking long distances to collect water during dry periods. Extreme heat and recurrent droughts increase physical strain and health risks for women, while limiting their ability to engage in economic activities[210]. These intersecting factors highlight urgent needs for gender-responsive climate adaptation and social protection interventions.
- 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'.[211]
- Low literacy and limited skills restrict women's access to formal employment, entrepreneurship, and financial resources, perpetuating cycles of poverty and dependency.

### Youth

- Youth (10–19 years) constitute 183,458 individuals in Karak District, with 98,249 males, 85,207 females, and 2 transgender persons, representing a substantial portion of the population.[212] The

[200] CityPopulation. (2023). Karak District population data.
[201] Ullah, S., Ullah, T., Sarim, F. M., Hadi, F., Sultan, A., Zada, S., & Manan, F. (2024). Assessment of palatability and grazing preferences under changing climate: A case study of plant species in District Karak, Pakistan. International Journal of Innovations in Science & Technology, Special Issue, 43–58.
[202] Field observations by the author during site visits to Karak, 14–25 July 2025.
[203] https://karak.kp.gov.pk
[204] Ullah et al., 2024
[205] https://cmkp.gov.pk/ParityReport2025
[206] CityPopulation. (2023). Karak District population data.
[207] Ibid.
[208] Ullah et al., 2024
[209] Field observations by the author during site visits to Karak, 14–25 July 2025.
[210] https://cmkp.gov.pk/ParityReport2025
[211] UNDP. (2021). *Human Development Report Pakistan 2021: Gender and Development*
[212] CityPopulation. (2023). Karak District population data.

working-age group (15–64 years) makes up 55% of the population, signalling potential for a demographic dividend if proper education, skill development, and employment opportunities are provided.

- Educational attainment among youth remains uneven, with female youth experiencing lower literacy and school completion rates.[213] Employment opportunities are limited, primarily to agriculture, livestock, and informal labor. Erratic rainfall, droughts, and extreme heat events reduce agricultural employment, forcing many youths into temporary migration or low-paid informal work[214]. Climate change disrupts educational pathways and vocational skill development, particularly for rural youth, as households prioritize immediate livelihood survival over schooling[215]. This combination of limited opportunities and environmental stress increases vulnerability and reduces future economic prospects for young men and women alike.

### Social Inclusion

- Social inclusion in Karak is constrained for marginalized groups, including persons with disabilities, the elderly, and linguistic minorities. Rural settlement patterns and poor infrastructure limit mobility and access to services, while early warning systems, health facilities, and social protection programs often fail to reach these populations[216].
- The population is highly homogeneous linguistically (99.78% Pashto speakers), which fosters cohesion but can marginalize non-Pashto speaking minorities in governance and development planning[217]. Climate hazards, including droughts, heatwaves, and water scarcity, disproportionately impact these groups due to physical vulnerability, lack of adaptive resources, and limited access to information. Groundwater contamination from mining and oil extraction further threatens health and well-being, highlighting the need for inclusive, climate-resilient social protection measures.[218]

### Impact of Climate Change

Climate change in Karak District has profound implications for women, youth, and socially marginalized groups, shaping both their daily lives and long-term resilience. Women, who already face low labour force participation (less than 20%) and limited access to education (female literacy 45.6% compared to 84.1% for men), are disproportionately affected by climate-induced shocks such as droughts, heatwaves, and water scarcity[219]. Prolonged dry spells increase the time and physical burden of water collection, while recurrent heat events disrupt household work and limit women's capacity to engage in income-generating activities. Social norms restricting mobility and access to credit, land, and training further compound women's vulnerability, undermining both their economic independence and adaptive capacity. [220]

Youth, who comprise a substantial portion of Karak's population (183,458 individuals aged 10–19), face compounded educational and livelihood challenges under climate stress[221]. Erratic rainfall, droughts, and rangeland degradation reduce agricultural and livestock employment opportunities, forcing many young men and women into temporary migration or low-paid informal labour. [222] Disruptions to schooling, coupled with limited vocational and skill development programs,

[213] Ibid.
[214] Field observations by the author during site visits to Karak, 14–25 July 2025.
[215] https://cmkp.gov.pk/ParityReport2025
[216] Ullah et al., 2024
[217] CityPopulation. (2023). Karak District population data.
[218] Field observations by the author during site visits to Karak, 14–25 July 2025.
[219] CityPopulation. (2023). Karak District population data.
[220] Field observations by the author during site visits to Karak, 14–25 July 2025.
[221] CityPopulation. (2023). Karak District population data.
[222] Ullah et al., 2024

constrain long-term employment prospects and contribute to eco-anxiety, as youth confront uncertainty about future livelihoods, income security, and environmental sustainability. [223]

Socially marginalized groups, including persons with disabilities, the elderly, and minority households, face further inequities in access to resources, public services, and early warning systems. Groundwater contamination from mining and extractive industries, combined with limited healthcare and inaccessible infrastructure, heightens health risks and limits adaptive responses. [224]. Women-headed households and families in remote rural settlements are particularly disadvantaged, experiencing greater difficulty in securing relief and recovery assistance during climate shocks.

While adaptive social protection mechanisms exist in Pakistan, such as the Benazir Income Support Programme (BISP) and Ehsaas Emergency Cash, integration with climate adaptation efforts in Karak remains weak[225] . Programs provide immediate financial relief but generally lack built-in features for climate resilience, such as support for drought-resistant crops, livestock insurance, or skill-building for climate-resilient livelihoods. NGO-led initiatives, including community disaster preparedness and small-scale irrigation projects, have begun addressing climate risks, but they are not systematically aligned with social protection systems, limiting sustainability and reach.

The compounded effects of limited educational and livelihood opportunities, inequitable access to resources, and weak integration of social protection with climate adaptation highlight that climate change in Karak is not only an environmental crisis but also a deeply social one. Addressing these challenges requires gender-responsive, youth-focused, and socially inclusive strategies that integrate climate-adaptive social protection to ensure that vulnerable communities are not left behind.

### Priority Adaptation Areas and Initiatives

#### Objective 1: Enhance Women's Adaptive Capacity and Access to Climate-Resilient Livelihoods

In Karak, women face multiple intersecting vulnerabilities, limited literacy (45.6%), low labour force participation (<20%), and cultural restrictions on mobility, which are especially critical during climate shocks such as heatwaves, droughts, and floods. For example, women are often unable to physically access financial assistance from social protection programs like BISP or Ehsaas during extreme heat due to social norms and household responsibilities. This objective focuses on developing locally accessible climate-resilient livelihood programs, including home-based microenterprises, community savings groups, and small-scale climate-smart agriculture, coupled with literacy, awareness, and financial training initiatives. Mobile cash disbursement systems or community facilitators can be used to overcome mobility restrictions, ensuring women can benefit from adaptive social protection even under extreme climatic conditions.

#### Objective 2: Build Climate-Resilient Skills and Opportunities for Youth

Youth in Karak (over 183,000 aged 10–19) face disrupted education and limited employment opportunities due to droughts, flash floods, and heatwaves that reduce agricultural and livestock productivity. These climate events force many young people into temporary migration or informal, low-paid labour, while limiting access to schools and vocational training centres. This objective seeks to create youth-centred programs for climate-adaptive skills, including drought-tolerant farming techniques, flood-resilient infrastructure labour, renewable energy, and eco-tourism projects. Local youth hubs, mobile training units, and mentorship schemes can ensure continuity of education and skill-building despite climate shocks.

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[223] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit
[224] https://karak.kp.gov.pk/
[225] CMKP. (2025). Khyber Pakhtunkhwa Gender Parity Report 2025. Chief Minister Khyber Pakhtunkhwa's Monitoring and Evaluation Unit

### Objective 3: Strengthen Climate-Sensitive Social Protection for Marginalized Groups

Existing social protection programs often fail to reach the most vulnerable in Karak due to climate shocks and social norms. During heatwaves or floods, women-headed households, the elderly, and disabled persons may be unable to physically collect cash or aid. This objective emphasizes climate-triggered social protection, including mobile cash transfers, automated drought/flood relief triggers, and inclusive access mechanisms for women, the elderly, and persons with disabilities. Ensuring social protection delivery systems account for mobility, cultural restrictions, and extreme climatic events will reduce inequality and enhance resilience.

### Objective 4: Promote Community-Led Climate Justice and Inclusive Adaptation

Climate change in Karak reinforces social inequities and eco-anxiety, particularly among youth, women, and socially marginalized households. Women and youth often have limited participation in disaster planning or resource management due to cultural norms, further marginalizing them during climate events. This objective focuses on community-based adaptation initiatives that include participatory resource management, awareness campaigns, eco-tourism, and green livelihood projects. Prioritizing the voices of women, youth, and marginalized groups in planning and implementation ensures climate justice, equitable access to benefits, and strengthened collective adaptive capacity.

Table 8: Key Objectives and Initiatives for Gender, Youth, and Social Inclusion – Karak District

| No. | Objective & Initiative | Timeframe | Key Responsible Entity | Priority Vulnerable UCs / Tehsils |
|---|---|---|---|---|
| **Objective 1: Enhance Women's Adaptive Capacity and Access to Climate-Resilient Livelihoods** | | | | |
| **1.1** | Establish community-based women's livelihood groups for climate-smart kitchen gardening, poultry, small livestock, handicrafts, and ICT-based microenterprises, complemented by mobile microfinance and conditional cash support during heatwaves or droughts, to strengthen household incomes and enhance local economic resilience under climate stress. | Short (2026–2028) | Social Welfare Dept.; Agriculture Dept.; NRSP/SRSP; Local NGOs | Karak City, Banda Daud Shah, Teri, Takht-e-Nasrati |
| **1.2** | Conduct women-focused financial literacy, climate-resilience, and adaptive skills training at local community centers to overcome mobility and social constraints. | Medium (2029–2033) | Education Dept.; Local NGOs; Women Development Dept. | Karak City, Teri, Banda Daud Shah |
| **1.3** | Deploy mobile cash disbursement units for social protection programs (BISP/Ehsaas) during heatwaves to ensure women can access support safely. | Short (2026–2028) | Social Welfare Dept.; BISP; DDMA | Takht-e-Nasrati, Banda Daud Shah, Teri |
| **Objective 2 Build Climate-Resilient Skills and Opportunities for Youth** | | | | |
| **2.1** | Establish Youth Climate Resilience Hubs offering training in drought-tolerant agriculture, livestock management, renewable energy, and eco-tourism. | Medium (2029–2033) | TEVTA KP; Youth Affairs Dept.; Agriculture Dept.; Local NGOs | Karak City, Banda Daud Shah, Takht-e-Nasrati |

| | | | | |
|---|---|---|---|---|
| **2.2** | Implement mobile learning and mentoring programs to reduce disruption in education and skill-building during heatwaves or droughts. | Medium (2029–2033) | DDMA; Local Universities; Youth Affairs Dept.; NGOs | Karak City, Teri, Banda Daud Shah |
| | | | | |
| **Objective 3: Strengthen Climate-Sensitive Social Protection for Marginalized Groups** | | | | |
| **3.1** | Establish heatwave and drought-triggered emergency cash support. | Short (2026–2028) | BISP; Social Welfare Dept.; DDMA | Teri, Takht-e-Nasrati, Banda Daud Shah |
| **3.2** | Introduce micro-insurance for crop loss, livestock loss, and small women-led businesses. | Medium (2029–2033) | State Bank; Insurance Companies; Livestock Dept. | Takht-e-Nasrati, Teri, Banda Daud Shah |
| **3.3** | Deploy mobile maternal and child health services during climate emergencies. | Short (2026–2028) | Health Dept.; Population Welfare Dept.; PRCS | Karak City, Teri, Takht-e-Nasrati |
| **Objective 4: Promote Community-Led Climate Justice and Awareness** | | | | |
| **4.1** | Launch community-based climate education programs in schools, madrassas, and women's community spaces. | Short (2026–2028) | Education Dept.; DDMA; Youth Affairs Dept.; NGOs | Karak City, Teri, Banda Daud Shah |
| **4.2** | Establish psychosocial support services for women, youth, and the elderly in disaster-prone UCs to address eco-anxiety and mental health stress. | Short (2026–2028) | Health Dept.; Social Welfare Dept.; NGOs | Karak City, Takht-e-Nasrati, Teri |
| **4.3** | Develop green entrepreneurship programs for youth, including eco-tourism, solar energy kiosks, and sustainable handicrafts. | Medium (2029–2033) | SMEDA; Youth Affairs Dept.; Local Chambers; NGOs | Banda Daud Shah, Karak City, Takht-e-Nasrati |

# 6. Costing and Financing

## Detailed costing of prioritized adaptation measures

The DAP for Karak translates identified climate priorities into a structured investment framework comprising 74 adaptation initiatives across 25 strategic objectives, with a total estimated financing requirement of PKR 6.833 billion (USD 24.40 million) for phased implementation. Cost estimates have been developed using an activity-based costing approach, drawing on unit cost norms of relevant government line departments, recent PC-I and PC-II benchmarks, prevailing market rates, and cost references from comparable infrastructure and resilience projects implemented in similar hazard-prone contexts.

The proposed investment allocation is closely aligned with the district's climate risk profile and sectoral vulnerability patterns identified through the CRVA. The largest share of financing is directed towards Disaster Risk Management (PKR 1.885 billion) and Urban Resilience (PKR 1.385 billion), together accounting for approximately 48% of the total investment envelope, reflecting Karak's high exposure to droughts, floods, erosion, climate-induced infrastructure stress, and growing urban service deficits. Significant allocations are also made to Natural Capital (PKR 1.190 billion) and the Agriculture–Water Nexus (PKR 0.923 billion) to address land degradation, water scarcity, and climate-sensitive livelihoods. Investments in Human Capital (PKR 0.741 billion) and Gender, Youth and Social Inclusion (PKR 0.709 billion) underscore the DAP's emphasis on strengthening adaptive capacity, social resilience, and inclusive development outcomes alongside physical risk reduction.

The 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 (such as drainage systems, resilient infrastructure, and flood protection) and non-structural enablers (including 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 | 15 | 923 | 3.30 |
| **2** | Urban Resilience | 4 | 14 | 1385 | 4.95 |
| **3** | Natural Capital | 4 | 12 | 1190 | 4.25 |
| **4** | Human Capital | 3 | 9 | 741 | 2.65 |
| **5** | Disaster Risk Management | 5 | 12 | 1885 | 6.73 |
| **6** | Gender, Youth and Social Inclusion | 4 | 12 | 709 | 2.53 |
| | Total | 25 | 74 | 6833 | 24.40 |

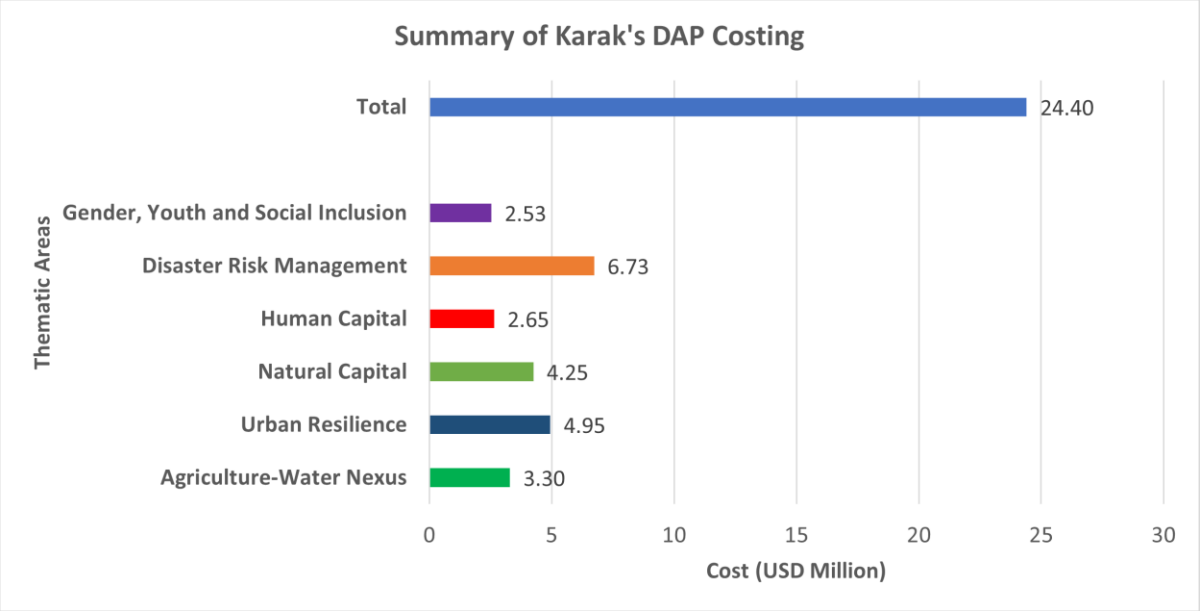


Figure 17: Summary of Karak's DAP Costing

The district of Karak will adopt a phased implementation approach, with priority initiatives geographically anchored in high-vulnerability UCs identified in the CRVA and sequenced according to available fiscal space. This costing framework, therefore, not only quantifies resource requirements but also ensures alignment with the annual ADP cycles, climate finance mobilization, and future public investment planning. In line with this approach, initiatives will be prioritized based on their potential to mitigate the most pressing climate risks, with funding allocation adjusted accordingly to maximize impact. The phased strategy will also enable continuous monitoring and adaptation to be evolving climate risks and resource availability. The full initiative-wise costing breakdown, including detailed cost estimations for each of the priority actions, is provided separately in ***Error! Reference source not found.***.

## Potential sources of finance

Financing Karak's adaptation priorities will require a multi-layered approach, combining domestic public resources, development partner support, private sector contributions, and international climate finance. Given Karak's unique resource profile, which includes significant oil, gas, and mineral extraction, alongside the growing pressures of climate change, there are several potential sources of funding for the district's adaptation initiatives.

### 1. Domestic Public Finance

Karak can leverage district-level budget mechanisms to secure dedicated and predictable financing for its climate adaptation initiatives. Building on Khyber Pakhtunkhwa's provincial Climate Budget Tagging (CBT) framework, the district can institutionalize a dedicated budget line or sub-program within the District Annual Development Programme (ADP), titled "Climate Resilience and Adaptation.[226] This will help capture all expenditures related to drought mitigation, groundwater recharge, slope stabilization, erosion control, and early warning systems.

Initial allocations can be modest, sourced from reallocated or underutilized district funds, but should progressively increase based on measurable outcomes such as enhanced water security, functional early warning systems, and the maintenance of small-scale flood and drought infrastructure. Additionally, climate tagging at the district level will improve reporting to provincial

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

and national climate finance systems, making the district eligible for co-financing from the Green Climate Fund (GCF), the Adaptation Fund (AF), and provincial resilience programs.

### 2. Utilization of Royalties and CSR Funds from Oil, Gas, and Mining Sectors

Karak generates substantial royalty revenues from its oil and gas production, particularly from operations in Nashpa, Banda Daud Shah, Bahadar Khel, and Teri, as well as from mining operations producing gypsum, salt, and coal. These royalties, along with Corporate Social Responsibility (CSR) contributions mandated by national and provincial extractive industry frameworks, represent a critical yet underutilized source of local climate adaptation finance.

A portion of the oil, gas, and mineral royalties should be earmarked for district-level climate and environmental development, following a "Local Benefit-Sharing Model."[227] Furthermore, oil and gas operators like OGDCL and MOL should be engaged through the District Adaptation Steering Committee to align their CSR portfolios with priority adaptation actions, such as funding solar-powered water supply systems, rangeland rehabilitation, mine-site restoration, and health services for heat-stressed communities. Mining companies, particularly those extracting gypsum and salt in Bahadar Khel and Takht-e-Nasrati, should contribute annually to a District Environmental and Community Development Fund (DECDF), which can co-finance adaptation projects like reforestation, erosion control, slope stabilization, and safe water infrastructure.

### 3. Pooled Adaptation and Resilience Fund

A District Pooled Adaptation and Resilience Fund (PARF) should be established under the District Adaptation Steering Committee, pooling resources from various sources, including district climate-tagged budget allocations, royalties and CSR funds from oil, gas, and mining operations, provincial resilience grants, and contributions from donor agencies. This fund can finance both structural interventions (such as check dams, embankment reinforcement, and reforestation) and soft measures (such as awareness campaigns, training, and early-warning system maintenance). The fund will operate with transparent criteria and a scoring matrix to prioritize investments based on vulnerability, and quarterly public reporting and audits will ensure transparency and accountability.

### 4. Climate Finance Facilitation Cell

In alignment with the KP P&D's Climate Change Cell, Karak should establish a similar focal point or unit to facilitate climate finance.[228] This unit would support the preparation of bankable proposals (PC-1s), monitor project execution, liaise with provincial departments and donor agencies, and track disbursements. The facilitation cell will play a key role in improving access to both domestic and international climate finance and ensuring that Karak's adaptation priorities are funded efficiently.

### 5. Leveraging Existing Funding Programs

Adaptation projects in Karak can benefit from several national and provincial funding and technical support programs. For example, the National Flood Protection Plan-IV (NFPP-IV) and Flood Protection Sector Project (FPSP-III) can support flood and erosion control infrastructure, while the KP Green Growth Initiative can fund rangeland rehabilitation and afforestationAdditionally, UNDP's Climate Promise and GCF Readiness Programs offer technical assistance for climate finance tracking, proposal formulation, and performance monitoring. Together, these programs, combined with royalties and CSR contributions, create a hybrid financing model blending public, private, and development finance for Karak's long-term resilience.

## Opportunities for innovative financing

Beyond conventional funding sources, Karak can explore innovative financing mechanisms to expand its resource base, reduce fiscal pressures, and enhance the sustainability of adaptation

[227] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/171511468331214139
[228] https://pndkp.gov.pk/2023/07/18/establishment-of-climate-change-pd-department-kp

interventions. These mechanisms offer new avenues for addressing the district's adaptation challenges and could provide substantial financial support for long-term climate resilience efforts.

Issuing district-level green or blue bonds, including Shariah-compliant sukuk, could attract private sector investment for climate-resilient infrastructure, water management, and ecosystem-based projects. These bonds represent an innovative financing tool, enabling Karak to fund large-scale adaptation infrastructure while encouraging private sector participation. Similarly, debt-for-climate or nature swaps could convert external debt obligations into financing for high-priority adaptation interventions, such as natural capital restoration, flood mitigation, and sustainable land management initiatives.

Payment for Ecosystem Services (PES) programs could generate sustainable revenue streams for adaptation projects by focusing on forest conservation, watershed management, and wetland protection. These programs not only deliver co-benefits like biodiversity conservation and flood risk reduction but also engage local communities in the sustainable management of ecosystems, ensuring long-term environmental resilience while generating financial returns.

Climate risk insurance products, such as coverage for vulnerable households and farmers, can mitigate the economic impacts of climate-related disasters like floods, droughts, and extreme weather events. Contingent credit facilities could provide immediate post-disaster funding, enable quicker recovery and reducing long-term fiscal burdens. Blended finance, combining concessional finance, development partner grants, and private sector investment, can also be utilized to reduce risks and attract capital for large-scale adaptation interventions. By pooling resources from different sources, blended finance can enable Karak to fund capital-intensive projects that might otherwise be difficult to finance.

Results-based financing (RBF) mechanisms tie disbursements to measurable adaptation outcomes, enhancing accountability and ensuring that adaptation interventions deliver their intended results. This approach incentivizes progress and ensures financial resources are used efficiently. Additionally, Karak could participate in carbon markets and generate climate credits by implementing projects that reduce greenhouse gas emissions, such as reforestation or sustainable land management. These credits could then be sold to generate revenue for adaptation projects, providing another important source of financing.

By tapping into these innovative financing mechanisms, Karak can significantly enhance its financial capacity to address climate impacts and ensure the sustainability of its adaptation projects, thereby building long-term resilience for the district.

# 7. Implementation Plan and Roll-Out

The implementation of Karak's DAP will follow the principles outlined in the National Adaptation Plan, utilizing a whole-of-government approach to prioritize targeted actions, effective operational planning, resource mobilization, and continuous learning. While the NAP sets the national direction, the Karak DAP defines district-level delivery pathways through the existing line departments, district coordination mechanisms, and annual budget cycles.

## Implementation Plan

The implementation of Karak's DAP will operationalize identified adaptation priorities through phased, coordinated actions across the district's thematic sectors. This plan will serve as the roadmap for translating adaptation priorities into measurable outcomes, with clear institutional responsibilities, stakeholder involvement, and sustainable financing mechanisms. The implementation strategy will be guided by five core 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 is a central component of Karak's climate adaptation strategy, addressing the district's reliance on agriculture and vulnerability to water scarcity and flooding. The implementation of key initiatives will be conducted in phases, starting with immediate actions in the short term (2026–2028) and progressing into medium and long-term strategies.

In the short term, initiatives will focus on restoring aquifer recharge and sustaining groundwater balance. This includes afforestation and reforestation on degraded slopes to reduce soil erosion and improve moisture retention. The KP Forest & Wildlife Department, Agriculture Department, and District Administration will lead these efforts, with a focus on Banda Daud Shah and Karak Tehsil. Additionally, drought-tolerant crop varieties and conservation practices, such as direct seeding and farmyard compost addition, will be introduced to restore soil organic carbon, managed by the Agriculture Department and supported by KP Climate Change Cell.

In the medium term (2029–2033), the focus will shift towards scaling water-efficient practices, including micro-irrigation systems like drip and sprinkler irrigation. WUAs will be formed, and a focus will be placed on establishing early-warning systems for droughts and floods. These actions will primarily target Karak Tehsil and Takht-e-Nasrati. Efforts will also include the promotion of rotational grazing and sustainable rangeland management practices, with local community involvement in land restoration efforts.

In the long term (2033+), the district will institutionalize water governance mechanisms, integrating digital agro-advisory systems into the District Management Information System (MIS). This will help monitor and manage water usage, improving agricultural productivity, water efficiency, and resilience for smallholder farmers.

Natural Capital

Restoring and preserving Karak's natural ecosystems is critical for reducing the district's vulnerability to climate-induced hazards, such as floods and land degradation. Initial actions (2026–2028) will focus on rehabilitating rangelands and implementing agroforestry systems using drought-tolerant species, such as Acacia and Ziziphus. These activities will be led by the Department of Forests, in collaboration with local communities and NGOs, especially in the Takht-e-Nasrati region.

From 2029–2033, Karak will focus on enhancing water resource management through the construction of small dams and rainwater harvesting systems in areas with high groundwater stress, such as Siraj Khel and Shaheedan in Takht-e-Nasrati. The Water Management Department will oversee these activities. Efforts to mitigate industrial pollution, such as regulating mining operations, will also be implemented to reduce soil contamination and improve air quality, particularly in Karak City and surrounding areas.

By 2033+, the district will create a District Environmental Information System (DEIS) to monitor land degradation, groundwater levels, and air quality. This will be integrated with existing monitoring systems to improve natural resource management and help prioritize future adaptation investments.

### Urban Resilience

The district's urban resilience efforts will be critical in addressing the challenges posed by rapid urbanization, inadequate drainage, and increasing climate variability. Short-term actions (2026–2028) will focus on integrating climate resilience criteria into urban planning and building codes, particularly in flood-prone areas such as Karak City, Banda Daud Shah, and Takht-e-Nasrati. These initiatives will include mapping urban flood zones and promoting climate-smart designs in new construction.

Medium-term initiatives (2029–2033) will focus on upgrading drainage systems and retrofitting high-risk infrastructure to ensure greater resilience. Urban greening efforts, such as tree planting and the development of green corridors, will also be prioritized to combat urban heat islands and improve air quality. A District Infrastructure and Urban Resilience Unit will be established by 2033 to institutionalize climate risk screening in all urban development projects.

### Human Capital

Strengthening human capital is vital for Karak's climate resilience, focusing on health, education, and livelihood systems. In the short term (2026–2028), the District Health Department will focus on retrofitting Basic Health Units (BHUs) and Rural Health Centres (RHCs) with elevated plinths and solar power, ensuring climate-resilient health services in vulnerable areas such as Takht-e-Nasrati and Latamber. The Education Department will also integrate climate change awareness into school curricula, reaching students across Karak Tehsil, Banda Daud Shah, and Takht-e-Nasrati.

In the medium term (2029–2033), the focus will shift towards expanding vocational training programs and providing green skills training for youth and women in climate-sensitive sectors. Microfinance programs will support climate-resilient businesses, and solar energy solutions will be deployed in public buildings. By 2033+, the district will launch a Climate Scholarship and Innovation Fund to support youth research on climate adaptation, further enhancing human capital and fostering a culture of climate resilience.

### Disaster Risk Management (DRM)

Disaster Risk Management (DRM) will focus on enhancing the district's capacity to prepare for, respond to, and recover from climate-induced disasters. In the short term (2026–2028), Karak will develop and maintain district-wide early warning systems, including mobile alerts and GIS mapping of flood-prone areas. PDMA, Rescue 1122, and the District Administration will play key roles, especially in Siraj Khel, Shaheedan, and Latamber.

From 2029–2033, DRM efforts will focus on strengthening response systems, including the establishment of a District Disaster Response and Recovery Plan (DDRRP) and a District Emergency Fund for immediate post-disaster needs. Training programs will be implemented to prepare local communities, especially women and youth, for disaster response. By 2033+, Karak will focus on integrating climate-resilient recovery policies into urban development, ensuring long-term sustainable recovery from climate events.

### Gender, Youth, and Social Inclusion

Gender, youth, and social inclusion are essential components of Karak's adaptation strategy. The Social Welfare Department will establish community-based livelihood groups for women, focusing on climate-smart practices such as kitchen gardening and small livestock management. These efforts will be prioritized in areas like Karak City, Banda Daud Shah, and Teri in the short term (2026–2028). The Women's Development Department will also conduct financial literacy and climate-resilience training programs.

In the medium term (2029–2033), Youth Climate Resilience Hubs will be established to offer training in climate-smart agriculture, eco-tourism, and renewable energy. Micro-insurance schemes will be introduced to protect women and marginalized groups from crop loss, livestock death, and business disruption during climate emergencies. By 2033+, the district will institutionalize gender-responsive indicators within its M&E framework, ensuring that adaptation outcomes are measured through an inclusion lens. This will help empower women, youth, and marginalized groups to become active agents of resilience.

### 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, and 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 Karak's DAP requires efficient mobilization, allocation, and management of resources. The 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 ADPs of relevant departments to ensure 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, will coordinate 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 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.

Karak can also tap into its resource base through the Utilization of Royalties and CSR Funds from Oil, Gas, and Mining Sectors. The district generates significant royalty revenues from oil, gas, and mining activities, particularly from operations in Nashpa, Banda Daud Shah, Bahadar Khel, and Teri. These royalties, along with Corporate Social Responsibility (CSR) contributions mandated by national and provincial frameworks, represent a critical source of local climate adaptation finance. A portion of these royalties should be earmarked for district-level climate and environmental development through a Local Benefit-Sharing Model, ensuring that the local communities benefit directly from the extractive activities in their areas. The District Adaptation Steering Committee will engage oil and gas operators, like OGDCL and MOL, to align their CSR portfolios with adaptation priorities, such as funding solar-powered water systems, rangeland rehabilitation, and restoration of mine sites. Mining companies should also contribute to a District Environmental and Community Development Fund (DECDF), co-financing projects like reforestation, erosion control, and safe water infrastructure.

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, labour 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, Karak can mobilize the resources necessary to implement its adaptation priorities effectively and sustainably.

## Integration of adaptation priorities into District Development Plans & budget cycles

For the effective implementation of Karak's DAP, identified adaptation priorities must be fully integrated into the district's development planning and financial management processes. By integrating adaptation into the 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 for 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, Karak 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 Karak's DAP

Monitoring & Evaluation (M&E) is a core pillar for the effective implementation of Karak's DAP. 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, Karak will be able to track shifts in hazard profiles, exposure, and vulnerability, and incorporate updated evidence into decision-making, prioritization, and resource allocation. The M&E process will ensure that district-level actions are aligned with national and provincial frameworks, contributing meaningfully to provincial and national climate accountability and supporting harmonized tracking across development and climate reporting processes.

### M&E Framework

Karak's DAP 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 (e.g., integration, financing, and implementation milestones) and outcome indicators (e.g., changes in exposure, risk, and vulnerability). These indicators will be practical, relying on existing data sources such as 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 the 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

M&E indicators lie at the core of an effective system, driving action, highlighting areas needing additional efforts, and promoting climate-smart approaches. Well-defined indicators will ensure relevance and practicality based on data availability, time, and resource requirements. A collaborative process will be undertaken to establish these indicators, involving stakeholders from district-level agencies, line departments, technical experts, and community representatives. This participatory process will ensure the selected indicators align with sectoral priorities and capture the desired outcomes. Once identified, these indicators will undergo a piloting phase to filter out redundant ones and address any gaps.

The M&E indicators for Karak's DAP will include both critical and supporting actions. Regular assessments by the District Administration and line departments will evaluate the preparedness of relevant organizations, including service providers, community committees, and policymakers. The selected indicators will cover both process and outcome aspects:

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

The following table outlines the proposed M&E indicators for tracking the progress and outcomes of the DAP interventions in Karak. These indicators are designed to monitor both process milestones and outcome impacts, ensuring that adaptation actions are effectively implemented and their results are measurable.

| Indicator Type | Indicator | Description |
|---|---|---|
| **Process Indicators** | Integration of adaptation priorities into workplans | Tracks whether adaptation priorities are integrated into departmental workplans and budgets. |
| | Resource Allocation | Monitors the allocation and utilization of resources (financial and human) for implementing adaptation actions. |
| | Capacity-building activities completed | Tracks the number of training sessions, workshops, and capacity-building activities conducted. |
| | Policy adoption | Monitors the adoption of climate adaptation policies at the district level. |
| | Community engagement | Measures the extent of community participation in adaptation activities, including local committees and NGOs. |
| **Outcome Indicators** | Reduction in water scarcity | Measures the reduction in water scarcity due to rainwater harvesting, groundwater recharge, and water management. |
| | Agricultural resilience improvement | Tracks the adoption of drought-tolerant crops and water-efficient irrigation methods. |
| | Reduction in health impacts | Assesses the reduction in climate-related health issues (respiratory, gastrointestinal, skin diseases) after interventions. |
| | Increase in soil moisture retention | Measures improvements in soil moisture retention due to afforestation, reforestation, and sustainable agriculture practices. |
| | Reduction in flood vulnerability | Tracks the reduction in flood risks due to improved water management systems like check dams and ponds. |
| | Increase in groundwater recharge | Measures improvements in groundwater recharge due to rainwater harvesting systems and soil conservation practices. |
| | Livestock mortality reduction | Monitors the reduction in livestock mortality due to heat stress, drought, and disease outbreaks. |
| | Improvement in economic stability | Measures improvements in income stability and livelihood diversification due to climate-resilient agricultural and livelihood practices. |
| | Reduction in ecosystem degradation | Tracks the restoration of degraded ecosystems, such as rangelands, through afforestation and soil conservation efforts. |

To ensure comprehensive progress tracking, a combination of quantitative and qualitative measures will be used. Quantitative data will provide insights into the results of sectoral adaptation strategies, while qualitative data will provide a narrative context, capturing community perceptions, inclusivity, and social impact.

The log-frame structures for each sector will be collaboratively established, led by the Deputy Commissioner (DC) and the District Disaster Management Authority (DDMA). These structures will be rooted in the theory of change for each sector, with defined indicators, baselines, targets, time periods, and data sources. This approach will ensure a cohesive and strategic M&E process 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)

These established data sources will enhance the timeliness and effectiveness of the M&E process. A comprehensive District M&E Plan will be developed within six months of DAP initiation. This plan will outline clear guidance on data collection, compilation, and synthesis, standardizing data collection methods, defining timelines for periodic evaluations, and clarifying roles and responsibilities.

### Supporting M&E Implementation

To support the M&E process, capacity-building programs will be developed based on the training needs assessment of district officers. These programs will aim to promote a shared understanding of M&E concepts, frameworks, and tools, enabling stakeholders to apply evidence-based approaches to track adaptation progress. Tailored training modules will be provided to district officials, line departments, and implementing partners, ensuring that they 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, ensuring that officials remain informed about evolving methodologies, technologies, and reporting requirements under the KP Climate Action Plan, NAP, and NDCs. This will empower officials and institutions to integrate new knowledge, adaptive management practices, and emerging climate intelligence into planning and implementation cycles.

Technology and Digital Tools will play a central role in Karak's 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. Data collection protocols, verification, and metadata documentation will be standardized to ensure transparency and compatibility with provincial and national climate monitoring systems.

To strengthen evidence generation, research institutions and universities will be engaged to address existing knowledge gaps on local climate vulnerabilities, adaptation effectiveness, and socio-economic impacts. 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 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 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 Karak's 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 M&E system will guide continuous improvement, strengthen coordination with provincial and national adaptation frameworks, and ensure that Karak remains on a sustainable, climate-resilient development pathway.

## Communication and outreach strategy

An effective communication and outreach strategy is essential for ensuring the successful implementation, ownership, and sustainability of Karak's District Adaptation Plan (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. Key stakeholders will include governmental agencies such as district line departments (Agriculture, Irrigation, Forest, Health, Education, C&W, PHED), the DDMA, and the DC Office; provincial and national agencies including KP P&DD Climate Cell, PDMA, KP Environmental Protection Agency, and MoCC&EC; community-based entities like Village Development Committees (VDCs), Water User Associations (WUAs), farmer cooperatives, women's groups, and youth organizations; civil society and NGOs working on livelihoods, natural resource management, and climate awareness; academia and research institutions providing data, analysis, and capacity-building support; and the private sector and media for outreach and advocacy.

This stakeholder mapping will guide the design of targeted communication messages and the selection of appropriate outreach channels, ensuring 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, 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; and 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. These will include print and digital materials such as policy briefs, newsletters, brochures, posters, and infographics summarizing adaptation progress; community-based platforms, such as VDCs, WUAs, farmer field schools, and women's collectives, for local-level communication; knowledge products including success stories, case studies, and local innovations, documented and disseminated to inform future adaptation; workshops and consultations, such as regular multi-stakeholder dialogues, capacity-building events, and learning exchanges; and web and data platforms, including 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.