



# CLIMATE RISK PROFILE

## KHYBER PAKHTUNKHWA

## PROLOGUE

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Coordinator to the Prime  
Minister  
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As we stand at the precipice of climate uncertainty, Pakistan faces an urgent call to action. The recent floods, droughts, and other extreme weather events are stark reminders of the far-reaching consequences of climate change. These challenges not only threaten our environment but also pose significant economic and social risks to our nation.

In this critical juncture, it is imperative that we equip ourselves with the necessary tools to confront the impending climate crisis. The Climate Risk Profile of KP, presented here, serves as a vital resource in our endeavour to understand and mitigate the impacts of climate change in the local context. Developed through rigorous research and analysis, this profile offers valuable insights into projected climate parameters and their implications for various sectors across KP.

I commend the efforts of the German government and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) for their unwavering support in advancing climate resilience in Pakistan. Their commitment to strengthening climate knowledge, fostering organizational development, and facilitating political change processes is commendable. Through collaborative initiatives and cross-sectoral approaches, we strive to harness the potential of mitigation and adaptation measures, paving the way for sustainable development in alignment with the Paris Climate Agreement and Agenda 2030.

The Climate Risk Profile of KP, mainly/principally developed by Global Climate-Change Impact Studies Centre (GCISC), serves as a cornerstone in our collective efforts to build a resilient and sustainable future. It provides a comprehensive overview of climate risks and opportunities, empowering decision-makers at all levels to make informed choices. Moreover, it lays the foundation for further research and refinement, facilitating adaptive planning and proactive measures to address evolving climate challenges.

As we embark on this journey towards climate resilience, let us embrace the spirit of collaboration and innovation. Together, we can navigate the complexities of climate change and forge a path towards a brighter, more sustainable tomorrow.

## FOREWORD

**Shahid Zaman**  
**Secretary,**  
Secretary for Climate Change,  
Forests, Environment &  
Wildlife, Government of  
Khyber Pakhtunkhwa

It is with great pleasure and a sense of responsibility that I introduce the Climate Risk Profile of KP. As the custodian of environmental stewardship in the province, it is incumbent upon us to understand and address the multifaceted challenges posed by climate change.

KP, as one of the most populous and agriculturally productive regions of Pakistan, is particularly vulnerable to the impacts of climate variability and change. From extreme weather events to shifting precipitation patterns, the manifestations of climate change are increasingly evident in our daily lives.

The Climate Risk Profile of KP represents a significant milestone in our ongoing efforts to enhance climate resilience and sustainability. Developed in collaboration with esteemed partners such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German development Cooperation, this profile provides a comprehensive assessment of projected climate parameters and their implications for KP environment, economy, and society.

I extend my sincere appreciation especially to GCISC and to all those involved in the creation of this invaluable resource. Their dedication and expertise have ensured the accuracy and relevance of the information presented herein. By offering a nuanced understanding of climate risks and opportunities, this profile equips policymakers, planners, and stakeholders with the insights needed to formulate effective strategies and interventions.

As we navigate the complex terrain of climate change, it is essential that we adopt a proactive and collaborative approach. The Climate Risk Profile of KP serves as a catalyst for informed decision-making and coordinated action, fostering resilience and sustainability across our province.

I encourage all stakeholders to utilize this profile as a guiding tool in our collective efforts to build a climate-resilient KP. Together, let us embrace the challenges and opportunities presented by climate change, forging a path towards a greener, more prosperous future for generations to come.

## FOREWORD

**Wolfgang Hesse**

Cluster Coordinator  
Energy Climate Change and  
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Khyber Pakhtunkhwa (KP) stands at the frontline of Pakistan's escalating climate crisis. Rising temperatures, shifting rainfall patterns, accelerated glacial melt, and the increasing frequency of extreme weather events are transforming the province's landscapes and placing mounting pressure on its communities, ecosystems, and infrastructure. The urgency to act has never been greater, as climate risks in KP continue to intensify and intersect with existing socio-economic vulnerabilities.

As the Coordinator of the Energy, Climate Change & Just Transition Cluster at GIZ Pakistan, it is my privilege to introduce the Climate Risk Profile for Khyber Pakhtunkhwa. This document is the result of extensive research, collaboration, and technical expertise contributed by a wide range of partners and stakeholders. It reflects a shared commitment to improving our understanding of the province's evolving climate risks and to identifying practical pathways for building resilience and supporting effective adaptation measures.

KP's diverse geography, ranging from high mountain ranges and fertile valleys to river basins and forested areas, makes it particularly vulnerable to climate-induced hazards such as floods, droughts, landslides, and glacial lake outburst floods (GLOFs). These hazards threaten agricultural productivity, disrupt water availability, endanger public health, damage critical infrastructure, and undermine ecosystem integrity. Their impacts also deepen existing social and economic vulnerabilities, particularly among communities whose livelihoods depend heavily on natural resources.

This Climate Risk Profile provides a comprehensive overview of current climate trends, projected future scenarios, and their implications for key sectors and vulnerable groups in KP. By offering a robust evidence base, it aims to inform policy and planning processes, guide investment in climate adaptation, and catalyze coordinated action at provincial and local levels.

I hope that this profile will serve as a valuable resource for policymakers, practitioners, researchers, and development partners working to strengthen climate resilience in KP. Collective and sustained action will be essential to safeguard livelihoods, ecosystems, and development gains in the face of a changing climate.



## PREFACE

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In a world increasingly defined by the impacts of climate change, understanding the unique risks and vulnerabilities faced by nations is paramount. Pakistan, with its diverse geography, complex socio-economic landscape, and growing population, stands at the forefront of this global challenge. The need for a comprehensive understanding of Pakistan's climate risk profile has never been more urgent.

This study report on the climate risk profile of KP represents a culmination of rigorous research, data analysis, and stakeholder engagement aimed at unravelling the intricacies of climate vulnerability within the country. Developed through collaboration between experts from diversified fields of research, this report endeavors to provide a holistic perspective on the multifaceted risks posed by climate change across various sectors and regions of Pakistan.

Through detailed examination and analysis, this report sheds light on the evolving climate patterns, extreme weather events, and their cascading impacts on agriculture, water resources, infrastructure, human health, and ecosystems. Moreover, it delves into the socio-economic implications of climate risks, highlighting disparities, vulnerabilities, and adaptive capacities within different segments of society.

While the findings presented in this report may paint a sobering picture of the challenges ahead, they also serve as a clarion call for action. By identifying key risk factors, hotspots, and priority areas for intervention, this report aims to inform evidence-based policymaking, foster resilience-building efforts, and catalyse transformative actions towards a more climate-resilient future for KP, Pakistan.

As we navigate the complexities of climate change, let this report serve as a guiding beacon, illuminating pathways for sustainable development, adaptation, and mitigation. Together, let us embark on a journey of collective action, collaboration, and innovation to safeguard our planet and ensure a prosperous tomorrow for all.

## EXECUTIVE SUMMARY

According to the Global Climate Risk Index, Pakistan is currently the eighth most climate-affected country in the world. Pakistan contributes little to global CO<sub>2</sub> emissions (0.75% with just under 3% of the world's population) but is one of the countries most affected by the impacts of climate change. Pakistan is particularly vulnerable to flash floods, heavy monsoon rains, cyclones, droughts, and heatwaves due to extreme weather events. Melting glaciers in the Himalayas threaten flooding in the short to medium term and droughts in the long term. Extreme weather events already cause an average economic loss of almost EUR 3 billion per year. If Pakistan does not take measures to adapt to climate change, more than 21,000,000 people, or 10% of the country's population, could face additional poverty by 2050. At the same time, the technical and financial capacity to adapt to the adverse effects of climate change remains very low. Heatwaves in rapidly and unsustainably growing cities, as well as extreme weather events and natural disasters, particularly affect the poor population dependent on local livelihoods and natural resources.

In Pakistan, water resources, agriculture, infrastructure, ecosystems, biodiversity, and public health are all vulnerable to the impacts of climate change. The country's Climate Change Policy, National Adaptation Plan, and Nationally Determined Contributions (NDCs) prioritize adaptation efforts in these sectors, particularly focusing on agriculture and energy due to their significant emissions. This sub-national climate risk profile meticulously utilizes the latest CMIP6 climate change scenarios tailored to KP's unique context. It encompasses critical climate extreme indicators across various spatial and temporal scales. Importantly, this sub-national profile supplements existing national-level climate risk assessments conducted by reputable organizations such as PIK, the World Bank, and the Asian Development Bank, which mainly relied on CMIP5 IPCC climate change scenarios.

This sub-national profile offers an overview of projected climate change trends and their related impacts on various sectors within KP, Pakistan, by the end of the 21st century. Pakistan, by the end of the 21st century.

Developed under the Strengthening Climate Adaptation and Resilience (SAR) project, the assessment utilizes Representative Concentration Pathways (RCPs) and Shared Socio-economic Pathways (SSPs) to model plausible futures. Specifically, it explores RCP-SSP 2.4.5 (a moderate-emission scenario leading to approximately 2.7°C of warming) and RCP-SSP 5.8.5 (a high-emission, less likely scenario resulting in approximately 4°C of warming above pre-industrial levels).

KP's unique topography, heavy dependence on agriculture and water resources from the Hindu Kush Himalaya (HKH) region, and socio-economic vulnerabilities make it highly sensitive to climate variability and long-term change. Projections under the high-emission scenario indicate seasonal temperature increases exceeding 5.5°C during summer in northern KP and over 4.5°C during winter across the province by 2100. Precipitation patterns show marked spatial and seasonal variability, with summer rainfall increasing by over 110 mm in southern KP under RCP-SSP 5.8.5. These changes are expected to affect hydrology, crop yields, food security, health systems, and infrastructure.

Importantly, this profile integrates findings from a dedicated gender study to better understand how climate impacts are experienced differently across social groups. The study, also conducted under the SAR project, analyzed gender-related vulnerabilities through a three-tiered approach: macro-level policy review, institutional analysis, and community-level consultations. It revealed that women in KP face significant barriers in accessing climate-resilient technologies, financial resources, and institutional support, due to entrenched cultural norms and limited participation in decision-making.

By aligning climate projections with gender-sensitive insights, the profile enhances its relevance for inclusive adaptation planning. It underscores the importance of integrating gender-disaggregated data, promoting women's leadership in resilience-building, and tailoring adaptation strategies to meet the needs of vulnerable populations. This evidence-based approach equips policymakers, practitioners, and stakeholders with the tools necessary to develop equitable and robust responses to climate risks in KP.

## PROVINCIAL CONTEXT

Khyber Pakhtunkhwa, situated in the northwestern region of Pakistan, is one of the country's four provinces. Although it is the smallest province geographically, it ranks third in population, with approximately 35 million residents, comprising about 15% of the nation's population. Economically, KP contributes significantly, accounting for 10.5% of Pakistan's total economy.



The rugged terrain of KP, compounded by the integration of the Merged Areas, has intensified the vulnerability of its rural population. Particularly in the Merged Areas and remote regions, internally displaced individuals and those who recently returned face heightened risks from climate hazards and consequent food insecurity. As of August 2020, 1.18 million people, constituting 23% of the Merged Areas' population, are grappling with crisis and emergency-level food insecurity due to prolonged conflict, which has disrupted food and livestock production, infrastructure, and markets. Concurrently, the province's population is growing at a rate of about 2.4%, underscoring the urgency of ensuring agricultural self-sufficiency. The province witnesses significant out-migration, primarily of young males seeking better economic prospects elsewhere, leaving the responsibility of farm management to female family members. The province's economy is diversified, with key sectors including forestry, mining, agriculture, and manufacturing. Agriculture, particularly focused on major crops like wheat, maize, tobacco, rice, sugar beets, and various fruits and vegetables, is a vital component. To support these economic activities, a reliable transportation network is essential.

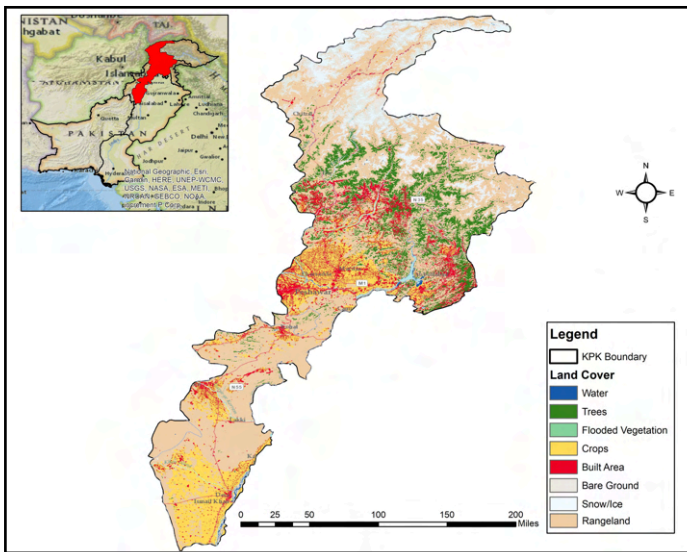
KP heavily relies on road transport, serving as a crucial transit corridor to Afghanistan through the Khyber Pass. The province boasts a well-developed road infrastructure, including a network of over 15,000 kilometres of classified paved roads. The capital of the province Peshawar extends northward along the Kabul River. It contains about half of the province's total population even though it covers one-tenth of the total covered area by the KP. In the west of Peshawar, the iconic Khyber Pass is an easy route between Afghanistan and the Indian subcontinent. Peshawar's climate is warm and temperate.

KP consists of mountain ranges, undulating submontane areas, and plains surrounded by hills. The mountain ranges generally run in the north-south which is the south of the River Kabul. It divides the KP from east to west. The Hindu Kush region in the North is known for its exotic beauty. The highest peak of the northern Hindu Kush is the Tirich Mir. The rugged basins of the Panjkora, Swat, and Kandia rivers lie in the south of the Hindu raj.

## TOPOGRAPHY AND ENVIRONMENT

Geographically, the province of KP is divided into two zones, the northern zone, and the southern zone. The northern zone scopes from the Hindu Kush to the borders of the Peshawar basin. The climate of the northern zone is snowy and cold with heavy rainfall in winter. It has pleasant summers with moderate rainfall excluding the capital Peshawar which is hot in summer. The southern zone ranges from Peshawar to the Derajat basin. It has hot summers with relatively cold winters with minimal rainfall.

The climate of the province varies with elevation. The mountain ranges encounter cold winters and cool summers, whereas the temperature rises towards the south. Precipitation of the province is fluctuating; roughly it averages about 16 mm annually. The most active duration for the precipitation occurs from January to April. The mountain slope in the north is known for oak and pine. The area is also filled with immense grasslands.



*Figure 1: Location of Khyber Pakhtunkhwa Province in Pakistan (Source: Land Cover Atlas of Pakistan, The Khyber Pakhtunkhwa Province)*

The climate in the province exhibits significant variation based on elevation. Mountainous regions experience cold winters and mild summers, whereas temperatures tend to rise towards the southern areas. Precipitation levels fluctuate across the province, averaging around 16 inches annually. The period from January to April typically sees the most significant rainfall. The northern mountain slopes are characterized by dense oak and pine forests, as well as expansive grasslands. Peshawar receives notable rainfall throughout the year, with even the driest months experiencing some precipitation. The average temperature in Peshawar is 22.3°C (72.1°F), with annual precipitation ranging from 817 mm to 32.2 inches.

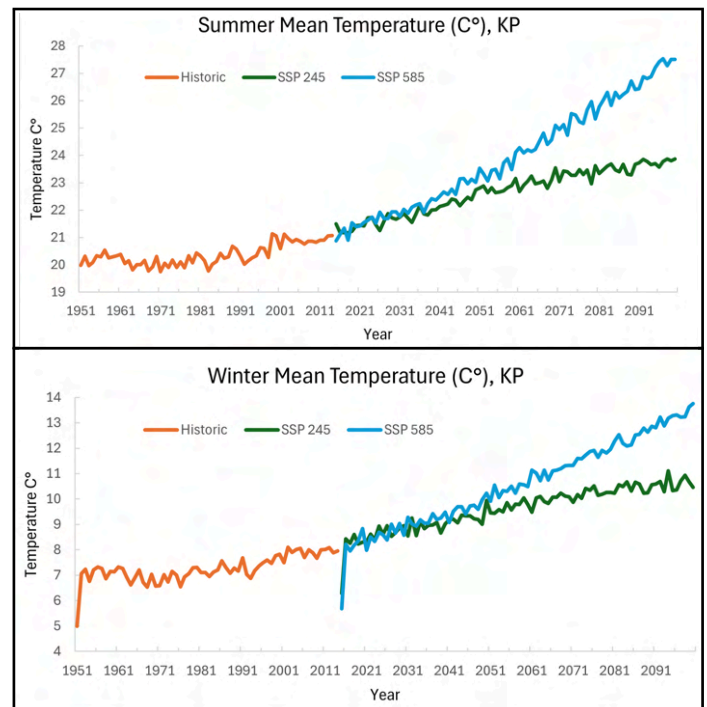


## PROJECTED CLIMATE CHANGES

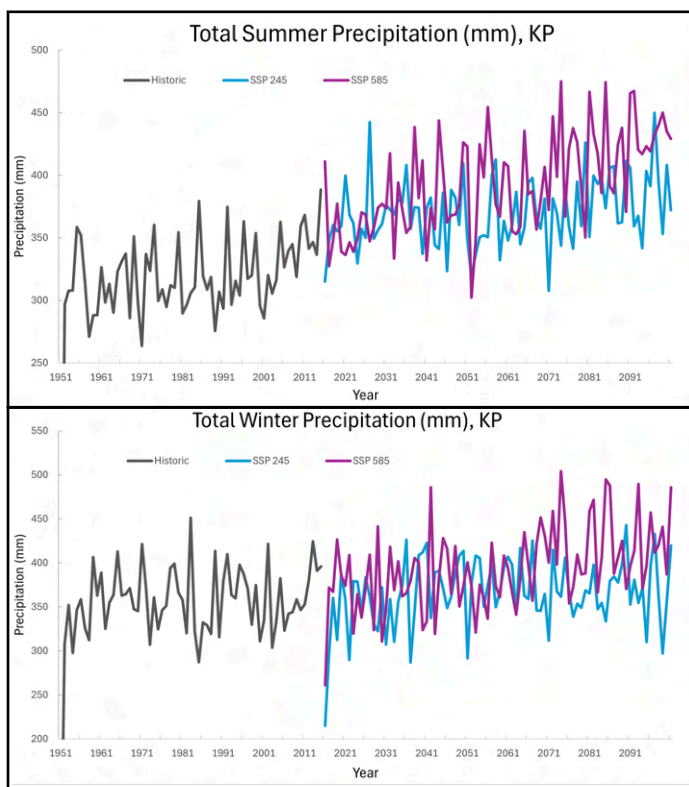
### Temperature

Projections for seasonal temperatures in KP province indicate notable upward trends under both emission scenarios, with more pronounced increases anticipated during winter months. Particularly, the most substantial rise in average temperature is forecasted for the summer season, exceeding 6 degrees Celsius in the latter half of the century (2061-2100) under the RCP-SSP585 scenarios.

Conversely, in the northern parts of Pakistan, including KP and adjoining areas, the figure suggests a comparatively lower but still notable range of temperature changes, varying from 1 degree Celsius to 3.8 degrees Celsius. While these increases are relatively less extreme compared to the southwestern regions, they still carry implications for local ecosystems, water resources, and socio-economic activities.



**Figure 02: Future changes in the temporal distribution of Summer and Winter temperatures ( $T_{mean}$  °C) of KP province during the 150 years from 1950–2100**



**Figure 03: Future changes in the temporal distribution of Summer and Winter precipitation (mm) of KP province during 150 years from 1950–2100**

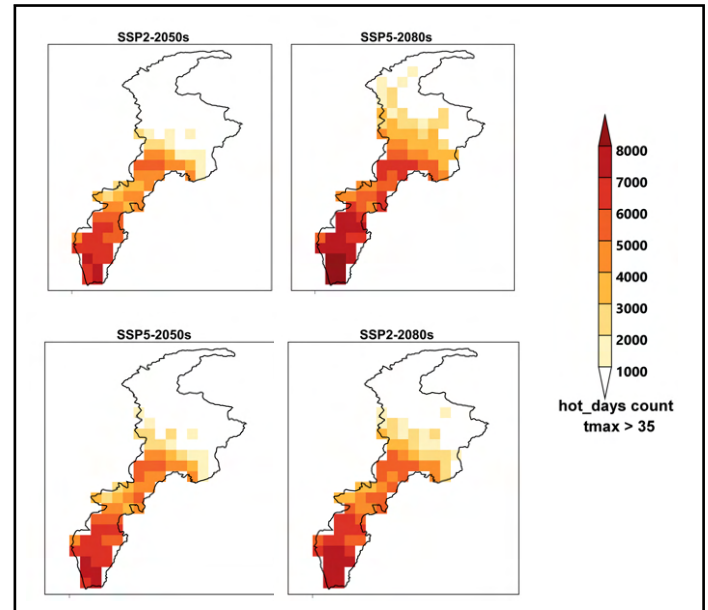
### Precipitation

Figure 03 shows analysis of seasonal precipitation patterns in KP reveals notable trends for the future periods F1 (2021-2060) and F2 (2061-2100) under RCP-SSP 245 and 585 emission scenarios. Spatial maps depicting precipitation distribution during the summer and winter seasons demonstrate distinct patterns across the province. In the summer season, characterized by monsoon rainfall, higher precipitation levels ranging from 10 mm to over 100+ mm are observed, particularly in the northeastern regions of KP. This heightened precipitation. In contrast, winter precipitation analysis towards the future indicates a substantial increase in precipitation levels during the Kharif season towards the end of the century, with a more pronounced rise under the RCP-SSP 585 emission scenario

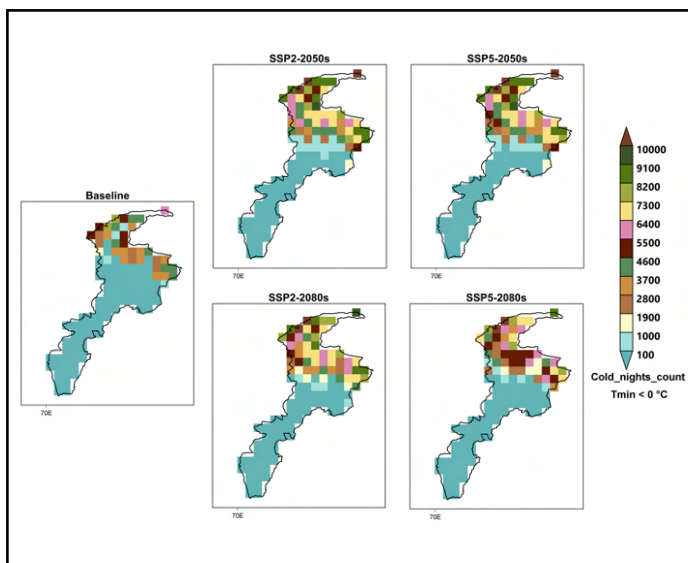
## PROJECTED CLIMATE CHANGES

### Hot days

As temperatures continue to increase, the frequency of extremely hot days; defined as days with a daily maximum temperature exceeding 35°C is expected to rise significantly across KP, particularly in central and southern parts. Spatial maps in Figure 04, using daily maximum temperatures for the control period (1974–2014) and future periods F1 (2021–2060) and F2 (2061–2100) under RCP-SSP 245 and RCP-SSP 585, reveal a higher number of hot days in southern KP. The hilly and mountainous terrain experiences fewer hot days due to its cooler microclimate. The increasing temperatures projected under RCP-SSP 585 are clearly reflected in the hot day distribution. The spatial analysis provides crucial insights into changing climate dynamics, comparing frequency and intensity of hot days across scenarios and timeframes, highlighting regional variations and impacts of climate change on temperature extremes in KP.



*Figure 04: Future changes in the spatial distribution of hot days of KP province during F1 (2021–2060) and F2 (2061–2100) under two emission scenarios i.e., RCP-SSP 245 and RCP-SSP 585*



*Figure 05: Future changes in the spatial distribution of cold nights of KP province during the control period 1974–2014 and F1 (2021–2060) and F2 (2061–2100) under two emission scenarios i.e., RCP-SSP 245 and RCP-SSP 585*

### Cold Nights

Cold nights are defined as days when the daily minimum temperature falls below 0°C within a five-day window centered on each calendar day of a 40-year climate reference period. Figure 05 shows that the historical period to the late century, cold nights remain relatively low in the lower parts of KP, fewer than 1,000. However, in the upper parts of KP, the count surpasses 10,000, indicating a substantial rise at higher elevations. The maps highlight significant spatial variability across the region, reflecting diverse climatic conditions. This increase may impact multiple sectors: agriculture may require changes in crop selection and cultivation, and the health sector may face higher cold-related illness cases. Recognizing these trends and regional differences is critical for climate change adaptation and resilience-building efforts in KP.

## Growing Degree Days

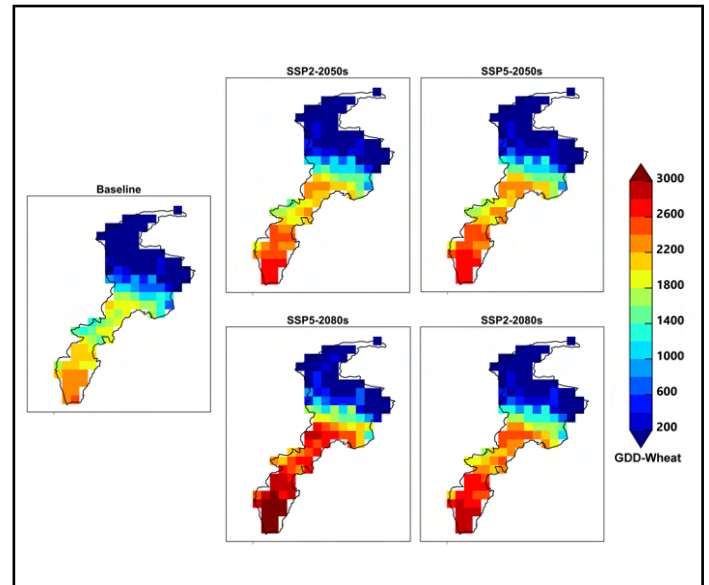
The growing degree days (GDD) is considered an important parameter determining the crop growth and development under different temperature regimes (Kalra et al., 2008; Kingra & Kaur, 2012; Meena & Rao, 2013). It assumes a direct and linear relationship between growth and temperature (Nuttonson, 1955). The crops sown on the recommended time have a higher heat requirement than those of later sown crops. This happens because of the lower temperatures during the early vegetative growth stages and comparatively higher temperatures at the time of reproductive stage (Khichar & Niwas, 2007)

In the realm of climate change, the Growing Degree Day (GDD) index plays a pivotal role by aiding in several key agricultural aspects. Firstly, it assists in estimating the growth stages of crops, providing valuable insights into their development. Additionally, it helps assess the suitability of a region for the production of specific crops, guiding farmers in selecting the most appropriate varieties for their local conditions. Moreover, the GDD index aids in predicting crucial milestones such as crop maturity stage, enabling farmers to plan their harvests effectively. Furthermore, it facilitates determining the optimal timing for fertilizer or pesticide application, optimizing resource utilization and minimizing environmental impact.

Lastly, the GDD index serves as a valuable tool in estimating the heat stress experienced by crops, allowing farmers to implement mitigation measures and safeguard their yields against adverse weather conditions.

Accumulated Growing Degree Days (GDD) were calculated using a base temperature of 5°C with the help of the following:

$$GDD_k = \sum_{n=1}^D \max\{(T_{MAXnk} + T_{MINnk} - B), 0\}$$



*Figure 06: Spatial distribution of Growing Degree Days (GDD) over KP during the baseline period (1974-2014) and F1 (2021-2060) and F2 (2061-2100) under two emission scenarios (RCP-SSP 245 and RCP-SSP 585).*

## SECTOR SPECIFIC CLIMATE RISK ASSESSMENT

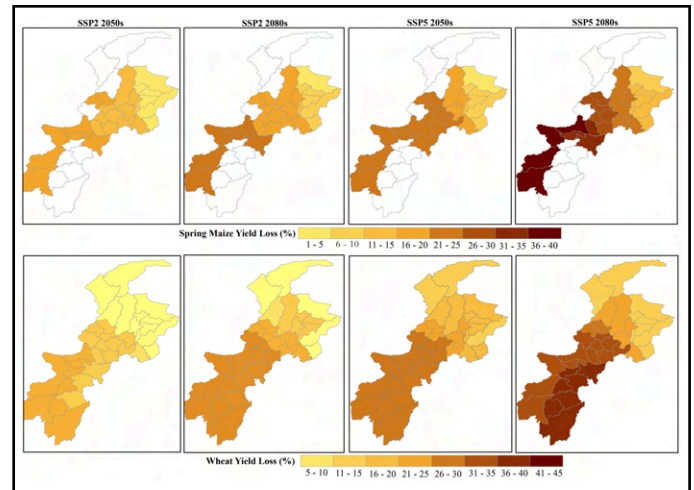
### Agriculture

Climate change has profound impacts on agriculture in Pakistan, particularly in relation to water resources (Azmat et al. 2021). One of the most significant effects is the alteration in precipitation patterns and temperature over mountainous regions (Ahmad et al. 2022). Consequently, rainfall has become irregular and unpredictable, disrupting the traditional agricultural calendar. Farmers often face challenges with sowing and harvesting as rains come either too early or too late, potentially damaging crop yield (Azmat et al. 2019 and 2021). The increased frequency and intensity of extreme weather events such as floods and droughts further exacerbate the situation. These events can destroy crops, wash away topsoil, and disrupt irrigation infrastructure, making agricultural activities highly uncertain.

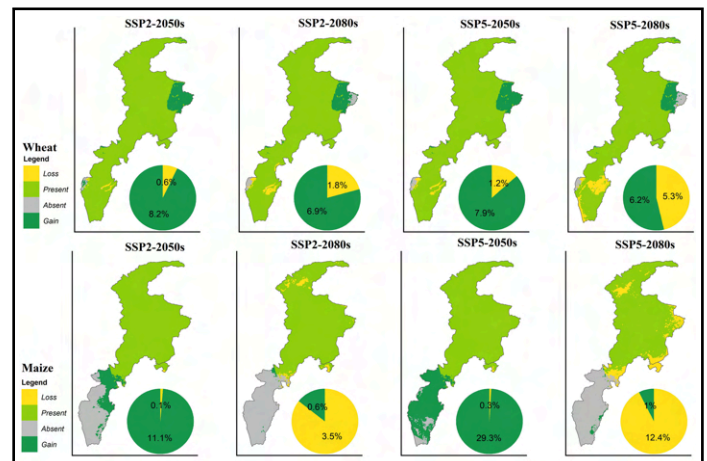
Pakistan's agriculture system heavily depends on glacial meltwater from the Hindukush, Karakoram, and Himalayas. These glaciers feed the rivers, particularly the Indus River and its tributaries like the Kabul River, which are the lifelines of agriculture in Punjab and KP. Rising global temperatures are accelerating glacial melt, which initially increases water flow (Jamal et al., 2023; Lutz et al., 2014) but eventually leads to reduced glacial volume (Bajracharya et al., 2019), and decreased water availability during crucial growing seasons (Azmat et al., 2020). Reduced surface water flow forces reliance on groundwater, which is being rapidly depleted (Hassan and Hassan, 2017). Over-extraction lowers the water table and increases salinity, rendering water unsuitable for irrigation.

Climate change also directly impacts crop yields. Higher temperatures result in heat stress, significantly reducing productivity (Ahmad et al. 2023; Abbas, 2022; Gul et al., 2022; Jan et al., 2021). Staple crops such as wheat and rice are particularly vulnerable. Warmer conditions also support the proliferation of pests and diseases, which can devastate crops. Reduced water availability, irregular rainfall, and increased pest pressures create a challenging environment. Figure 07 shows, changes in optimal temperatures are projected to drastically reduce the yields of spring maize and wheat. By the end of the 21st century, spring maize yields are expected to decline by 40% under SSP 2080s, again following a north-to-south

Both maize and wheat yields are expected to decline under SSP2 and SSP5 due to current agronomic and water management practices.



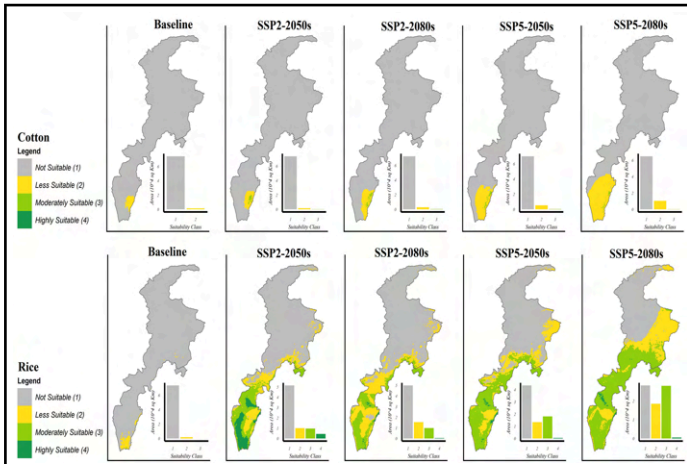
**Figure 07: Potential loss of wheat and maize crops for climate change scenarios**



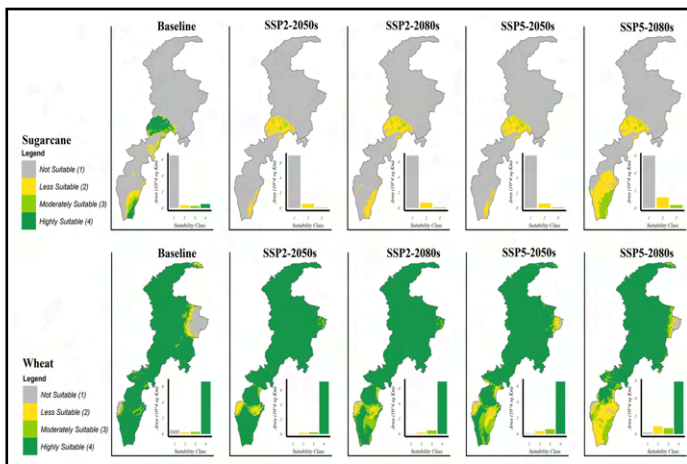
**Figure 08: State of wheat and maize cropping area under climate change scenarios.**

Figure 08 shows potential changes in major crop areas in KP. KP is projected to lose 0.6% and 1.8% of its wheat area under SSP2 during the 2050s and 2080s, respectively, with a maximum decline of 5.2% under SSP5 by the 2080s. Some regions may gain wheat area by 8.2% and 6.9% under SSP2 in the 2050s and 2080s. Gains under SSP5 are lower due to higher temperatures. For spring maize, a gain of 11.1% and 29.3% is projected under SSP2 and SSP5 during the 2050s, but a significant loss is expected by the 2080s. Spring maize could potentially vanish from KP under SSP5 (Syed et al., 2022).





**Figure 09: Suitability level of cotton and rice for climate change scenarios**

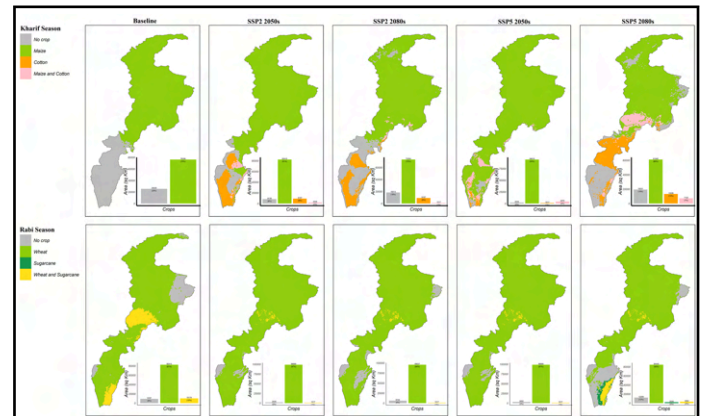


**Figure 10: Suitability level of sugarcane and wheat for climate change scenarios.**

Figure 09 illustrates the suitability levels for wheat, and sugarcane. KP is currently unsuitable for cotton cultivation. However, southern KP is expected to develop less to moderately suitable areas for cotton. A small part of southern KP currently has less suitable conditions for rice, but this area is expected to increase, shifting to moderately and highly suitable conditions under SSP2 and SSP5 in the 2050s and 2080s. A large area in southern KP is projected to become moderately suitable for rice. Figure 10 shows suitability changes for wheat and sugarcane. Rising temperatures are expected to shift highly suitable sugarcane regions to moderately and less suitable areas. Moderately suitable regions for sugarcane may shrink and become confined to southern KP. Most suitable areas for maize are projected to vanish. For wheat, suitability is expected to remain stable with a slight decrease in southern regions, and a slight gain in northern areas.

Figure 11 illustrates cropping suitability for Kharif and Rabi crops. Climate change is altering cropping

zones, patterns, and intensity in KP. Under baseline conditions, wheat and sugarcane (Rabi) and maize (Kharif) dominate. By mid-century, cotton is expected to expand into maize areas, creating mixed cotton-maize zones. Late-century scenarios show both cotton and maize covering large areas of KP. Wheat and sugarcane areas are projected to decline, with their cropping zone boundaries becoming more distinct and shifting southward.



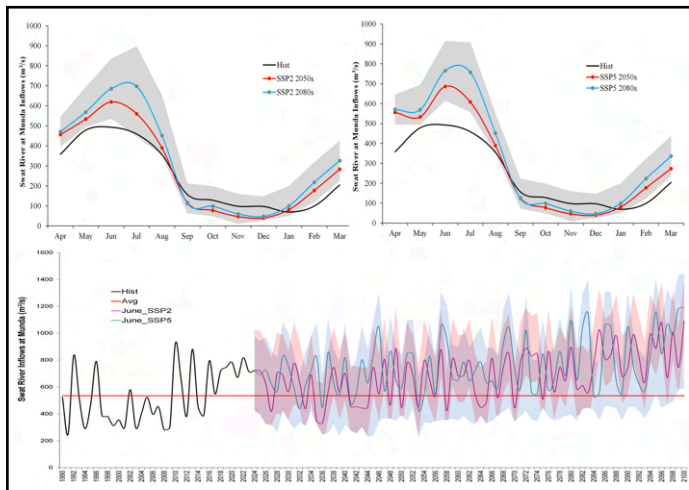
**Figure 11: Potential cropping zones of Kharif and Rabi crops for climate change scenarios.**

In KP's Rabi season, wheat dominates, with 81% area suitable. By 2050s, wheat suitability may rise to 97% under SSP2 and SSP5, reducing wheat-sugarcane areas. By 2080s, wheat suitability may drop to 94% under SSP2 and 83% under SSP5, with unsuitable land increasing. In Kharif, 75% of KP is suitable for maize. By 2050s, maize suitability could rise to 81% under SSP2 and 93% under SSP5. Cotton suitability may also increase, while unsuitable land decreases to 8% under SSP2 and 2% under SSP5.

The Gender Analysis indicates that KP Agriculture Policy (2015-2025) recognizes gender roles. However, it overlooks women's increased workload in water collection under climate change. As primary managers of household water, women need gender-sensitive training in conservation and leadership roles in decisions on water access and flood management. Improving community access to clean water must acknowledge their critical role in provision. However, the lack of gender-disaggregated data, monitoring systems, and KPIs weakens responsive planning. The analysis recommends integrating gender-sensitive frameworks, robust data systems, gender budgeting, and inclusive decision-making for effective climate adaptation.

## Water Resources

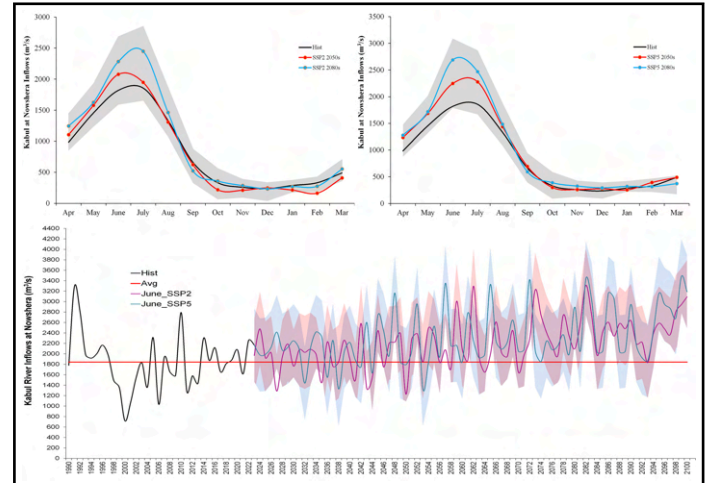
The agriculture sector in KP, Pakistan, is significantly threatened by climate change. Altered precipitation patterns, including irregular and unpredictable rainfall, present major challenges by disrupting sowing and harvesting cycles and leading to both floods and droughts. Rising temperatures exacerbate water scarcity by accelerating glacial melt, initially increasing water flow but ultimately reducing long-term water availability as glaciers shrink (Ahmad et al. 2022; Biemans et al. 2019). This strain on water resources is compounded by the depletion of groundwater, which becomes increasingly saline and less suitable for irrigation. Agriculture in most regions of KP relies heavily on rainfall, but the province's rivers and irrigation systems play a crucial role. The Tarbela Dam on the Indus River supports an extensive network of canals, irrigating key agricultural areas like Peshawar, Mardan, and Swabi. This regulated water supply enhances crop yields and supports livelihoods. The dam's ability to store and release water mitigates the effects of erratic rainfall and droughts. However, even a small change in river flow can disturb peak water availability, leading to significant losses in yield or agricultural areas.



**Figure 12: changes in Swat River's monthly inflows and during month of July (peak month) under climate change scenarios**

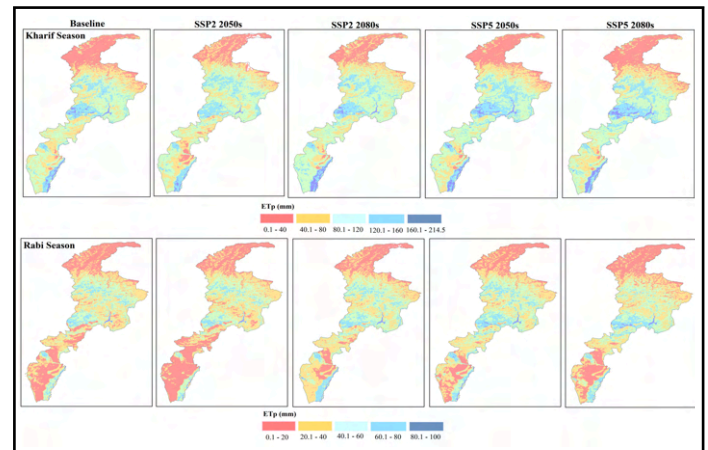
Figure 12 illustrates changes in River flows in Swat under changing climate scenarios. Peak flows in July and August are increasing abruptly under SSP2, with a shift from August to July under SSP5.

A long-term increase in July flows indicates extensive glacier melt during peak summer months, posing challenges to the current water management system.



**Figure 13: change in Kabul River's monthly inflows (Indus River) and during the month of July (peak month) under climate change scenarios**

Figure 13 shows increased summer flows, particularly in June and July, under SSP2 and SSP5, mainly due to early seasonal snowmelt and glacier melt. This could alter downstream water delivery and storage, impacting agriculture during dry seasons.



**Figure 14: Change in Potential Evapotranspiration under future scenarios**

Evapotranspiration (ETp), shown in Figure 14, is projected to increase across KP, especially in the south. Higher ETp indicates greater crop water requirements, reduced soil moisture reliability, and serious challenges for agricultural water

management under future climate change scenarios.

The Gender Analysis of climate risks in water indicates that the KP Water Act 2020 is gender-blind. The absence of gender-disaggregated data, monitoring systems, and KPIs reduces the effective gender-responsive planning. Gender issues remain fragmented and secondary, and the cultural barriers have been neglected. The analysis recommends urgent action for integrating gender-sensitive frameworks, robust data systems, gender budgeting, and inclusive decision-making.

## Health

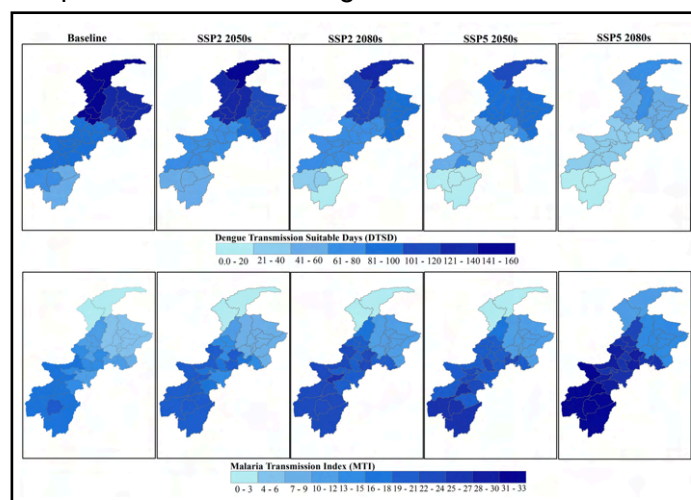
Climate change significantly impacts the health sector in KP, Pakistan, posing severe risks to the well-being of its population. The region experiences an increased frequency and intensity of waterborne diseases, such as cholera and diarrhea, due to the contamination of water sources. Shifting climate patterns affect the spread of vector-borne diseases like malaria and dengue, as warmer and wetter conditions provide ideal breeding grounds for mosquitoes (Campbell-Lendrum et al., 2015). Several studies have reported that climate change significantly impacts the spread and intensity of dengue viruses, primarily through its influence on the habitat and behavior of *Aedes* mosquitoes, the primary vectors of the disease (Huber et al., 2018; Mordecai et al., 2017). Pakistan, being one of the most vulnerable countries to climate change, faces significant impacts on the intensity and spread of dengue outbreaks.

The number of dengue transmission suitable days (DTSD) is a key metric for assessing the spread of dengue. For KP, temperature data from CMIP6 under SSP2 and SSP5 scenarios was used to identify dengue hotspots using DTSD values.

These hotspots were interpolated for adjoining districts of KP. The analysis revealed that the density of cases is potentially higher in the northern (colder) part of KP, while dengue cases are declining in the southern part. Overall, dengue cases are inversely proportional to temperature rise; as temperatures increase, dengue cases will decline.

Figure 14 shows that dengue cases will be minimal by the end of the 21st century under the SSP5 scenario, with a higher number of cases in the mid-

century under SSP2. High-altitude regions are more vulnerable compared to low-altitude or plain regions, demonstrating a clear inverse relationship between temperature rise and dengue cases.



*Figure 15: climate change impact on dengue transmission in KP Province under future scenarios.*

Conversely, malaria is an extremely climate-sensitive tropical disease. Rainfall, temperature, and humidity increase the duration of larvae development, shorten parasite incubation, prolong mosquito survival, and provide swampy habitats, increasing mosquitoes and their bites, thus increasing malaria risk. Malaria is moderately endemic in Pakistan, but its transmission is unstable. Erratic patterns due to climate change can be assessed using the Malaria Transmission Index (MTI).

The MTI values in Figure 15 show a direct relationship between climate change and malaria spread, with increasing MTI from north to south. MTI is significantly increasing over time under SSP2 and SSP5 during the 2050s and 2080s. Even small temperature shifts cause concern: a 0.5°C rise can lead to a 30–100% increase in mosquito abundance - “biological amplification” (Pascual et al., 2006).

The number of dengue transmission suitable days (DTSD) is a key metric for assessing the spread of dengue. For KP, temperature data from CMIP6 under SSP2 and SSP5 scenarios was used to identify dengue hotspots using DTSD values. These hotspots were interpolated for adjoining districts of KP. The analysis revealed that the density of cases is potentially higher in the northern (colder) part of KP, while dengue cases are declining in the southern part. Overall, dengue cases are inversely proportional to temperature rise; as temperatures



increase, dengue cases will decline.

The gender analysis shows that climate change impacts health, leading to increased frequency of waterborne diseases, malaria, dengue, and heat-related illnesses. Women reported worsened health outcomes and increased caregiving responsibilities for the sick due to climate change impacts. The analysis recommends to prioritizing access to healthcare and sanitation as part of climate resilience efforts, recognizing the specific health vulnerabilities and caregiving roles of women and girls.

## Ecosystem

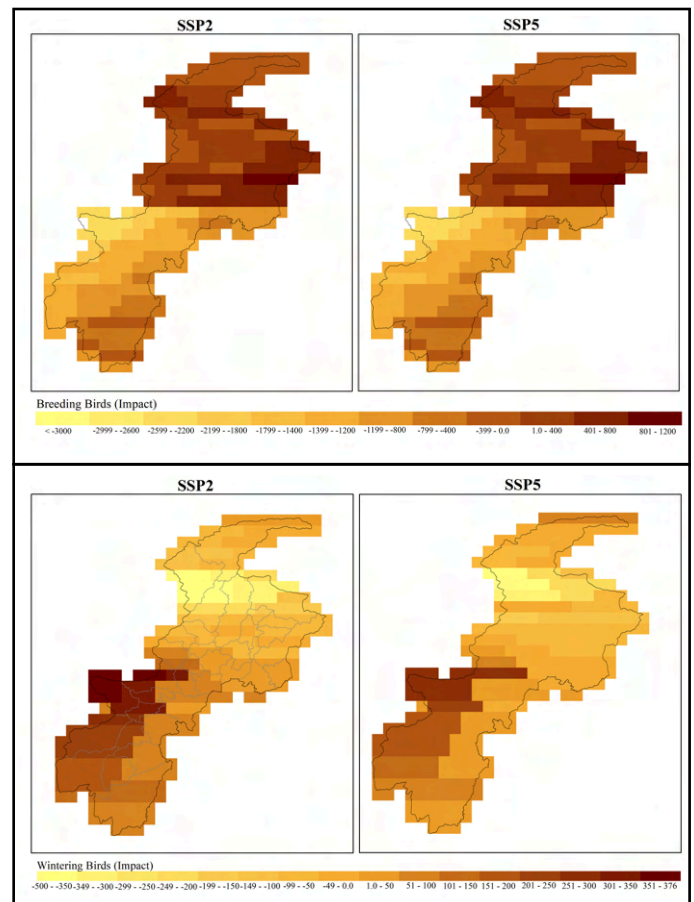
Climate change is causing a global redistribution of plant and animal species, leading to the formation of new ecosystems and ecological communities, which will have significant impacts on human society. Although the geographical ranges of species are dynamic and fluctuate over time, climate change is driving a universal shift in the distribution of life on Earth. For birds, the primary response to warmer and drier conditions caused by climate change is often a shift in location to maintain preferred environmental conditions. At the cooler edges of their distributions, species are moving towards more favorable conditions. Conversely, their range limits are contracting at the warmer edges. This contraction occurs where environmental conditions, such as temperatures, precipitation, and rainfed croplands, have become unfavorable.

Climate change poses significant threats to the ecosystem of KP, Pakistan, a region known for its diverse landscapes and rich biodiversity. Rising temperatures and altered precipitation patterns can lead to habitat loss and shifts in species distributions, particularly affecting endemic and endangered species in the mountainous areas. The increased frequency and intensity of extreme weather events, such as floods and droughts, exacerbate soil erosion, disrupt agricultural practices, and reduce water availability, impacting both terrestrial and aquatic ecosystems.

Figure 16 depicts the impacts on breeding birds in the KP province under climate change scenarios (SSP2 and SSP5). The impact values for breeding birds' range between -3000 to 1200, with negative severity over the southern part of KP and positive

severity over the northern part. Moreover, the most northern, high-altitude regions of KP show mid-range impact values.

Under SSP2, estimated losses for a future extreme flood include 0.26 million people, 215 settlements, 68 bridges, 6 health units, 75 communication towers, 33 schools, and 42 roads. Under SSP5, the damage could reach 2.04 million people, 1703 settlements, 526 bridges, 116 health units, 1410 towers, 698 schools, and 129 roads .



**Figure 16: Combined impact of the projected changes on breeding birds and wintering birds due to significant drivers in KP, under RCP2.6 and RCP6.0.**

Most climate change impact models on ecosystems primarily focus on natural losses without accounting for the additional factors contributed by human activities, such as infrastructure development, rapid urbanization, and deforestation. Forest carbon stocks in KP in the context of climate change mitigation and reported that due to extensive deforestation, approximately 96% of trees are immature (young) with only 4% being mature trees. This has resulted in a decrease in carbon stock in



KP from 144.71 million tons to 127.6 million tons. In contrast, Punjab Province has only 4% forest cover with limited carbon stock capacity.

## Infrastructure

The primary causes of floods in Pakistan are intense and prolonged monsoon rains, glacial melt from northern regions, deforestation, poor water management, and unplanned urbanization. Climate change intensifies these factors, making provinces like KP more vulnerable to frequent and severe floods. KP's infrastructure is particularly impacted by extreme rainfall and rapid glacier melt, causing events like the devastating floods of 2010 and 2022 (Azmat et al., 2018; Azmat et al., 2020).

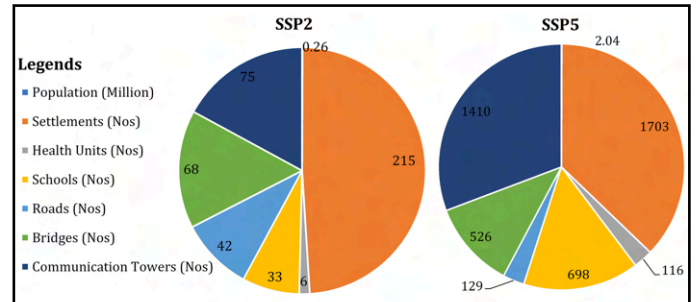
High temperatures accelerate glacier melt, contributing to riverine and flash floods, glacier lake outburst floods (GLOFs), and damage to infrastructure such as roads and bridges (Tomalka, 2022). The 2010 flood, triggered by a 4-day monsoon spell combined with snow and glacier melt, caused massive flash floods in the eastern Hindu Kush and Suliman foothills. It severely damaged agriculture, roads, canals, houses, and electricity infrastructure. In Muzaffargarh district alone, losses amounted to USD 783,997 (Shakeel et al., 2019). In Sindh, 57% of cropland was affected, with estimated crop losses of 88% for cotton (3.1 million bales), 80% for rice (1.8 million tons), and 61% for sugarcane (10.5 million tons) during the 2022 floods (Qamer et al., 2023).

In 2022, unprecedented rainfall during boreal summer displaced over 30 million people in Pakistan (Hong et al., 2023). This event exemplifies climate change-induced sequential rainfall (Nanditha et al., 2023).

Figure 17 highlights the infrastructure at risk; settlements, bridges, roads, health units, and schools, under SSP2 and SSP5 climate scenarios. Future periods, especially late-century, may witness floods more severe than in 2010 and 2022. Peak river flows during summer at Munda, Nowshera (Kabul River), and Tarbela Dam are projected to rise significantly (Figures 21–22), leading to substantial infrastructure damage in Punjab and KP.

Moreover, In boreal summer of 2022, Pakistan experienced extremely high rainfall, resulting in severe flooding and displacing over 30 million people (Hong et al., 2023). At the same time, heatwaves persisted over central China and Europe. Considering

this the 2022 flood, is a true example of climate change induced highly intensive sequential rainfall in Pakistan (Nanditha et al., 2023). The 2022 Pakistan flood event was an intensified manifestation of the 2010 Pakistan flood event, which was also caused by compounding factors, but occurred in a more pronounced upward trend in both tropics and extra tropics.



**Figure 17: Infrastructure loss due to floods in KP under SSP2 and SSP5 scenarios.**

This disaster has demonstrated what this vulnerability looks like for the people of Pakistan, particularly in Punjab and Sindh. The total damage of KP and Punjab were 935 million USD and 515 million USD, respectively. Figure 29 shows the climate change induced extreme rainfall impacted the large area of Pakistan during 2022 flood. The right panel of Figure 16 shows the population and crop lands impacted due to 2022 flood in Sindh province.

The gender analysis denotes that women often lead household-level efforts for disaster preparedness, such as reinforcing homes before monsoons. The climate changes including flood significantly impact infrastructure, which exacerbates vulnerabilities, particularly for women who face increased household burdens, face safety and security related issues after shifting from their houses to relief camps. The analysis recommends incorporating women's perspectives and leadership in decisions regarding infrastructure investments, including flood management systems; supporting initiatives like reinforcing homes before monsoons, recognizing the direct benefits to households and addressing vulnerabilities exacerbated by climate impacts.

## GENDER ANALYSIS OF CLIMATE RISKS IN THE SELECTED SECTORS: Key Findings & Recommendations

### Macro Level: Policies and legal frameworks

The KP Climate Change Policy 2022 and Action Plan acknowledge the gendered impacts of climate change but lack actionable strategies or concrete implementation mechanisms to address these impacts effectively. The KP Agriculture Policy (2015-2025) recognizes the gender roles affected by male outmigration but does not address the specific vulnerabilities that women face as a result. The KP Water Act 2020 is entirely gender-blind, failing to consider the differential impacts of water governance on men and women and missing critical opportunities to improve gender equity in the sector. The KP Urban Development Plan 2022-2030 attempts to promote women-friendly spaces in urban planning but lacks clarity on how these spaces will be implemented and monitored. The KP CC Action Plan includes some gender measures but does not align these with the overall objectives or operational strategies of the policy, which diminishes their potential impact. The KP Agriculture Policy's provision of a 10% recruitment quota for women similarly lacks supporting mechanisms to ensure this target is met in practice. The KP Water Act 2020 consistently neglects gender-sensitive objectives and demonstrates significant gaps in addressing intersectional vulnerabilities, particularly the specific needs of rural women. Gender-disaggregated data collection frameworks are absent across most policies, with the KP Urban Development Plan briefly suggesting their inclusion without providing an actionable roadmap. The KP Water Act 2020 fails to mention gender disaggregated data altogether, creating substantial evidence gaps for policymakers. Policies like the KP Agriculture Policy and CC Action Plan recognize the importance of women's access to technology and resources but do not address the systemic and cultural barriers that prevent women from actually benefiting from these resources. The Urban Development Plan emphasizes the need for improved mobility and women-friendly public spaces but does not provide mechanisms to dismantle the structural challenges limiting women's physical access. The KP Water Act lacks provisions for ensuring women's equitable access to water-related resources. While the concept of equitable participation appears in some policies, such as the KP Urban Development Plan, other key frameworks

like the KP CC Action Plan and the KP Agriculture Policy lack structured and enforceable mechanisms to institutionalize women's involvement in climate governance. Monitoring frameworks across policies do not include gender-specific Key Performance Indicators

(KPIs) or audit mechanisms to measure progress on gender inclusion. While the Urban Development Plan references some gender-segregated statistics related to transport, broader gender-responsive monitoring is missing. The Water Act fails to include gender impact assessments altogether. Although the KP CC Policy and Action Plan incorporate disaster planning components, they lack a gender-sensitive approach in their response and recovery strategies. Neither the KP Agriculture Policy nor the KP Water Act mentions disaster risk reduction (DRR), ignoring women's specific needs in building resilience to climate-induced disasters. Gender-responsive budgeting frameworks are completely absent across all the reviewed policies, which limits the ability to effectively allocate resources to close gender gaps. While KP's policies demonstrate varying degrees of gender inclusion, critical gaps persist across most frameworks, especially in the KP Water Act, which consistently fails to incorporate gender-sensitive provisions.

### Macro Level Recommendations

KP's climate-related policies must urgently integrate gender-sensitive frameworks with clear, actionable strategies. Gender-disaggregated data collection systems should be institutionalized and regularly updated to inform evidence-based policymaking. Gender-specific KPIs must be developed to track and measure progress effectively, and gender-responsive budgeting must be adopted to ensure resources are allocated to address gender disparities. Disaster risk reduction strategies must incorporate a gender lens, focusing on women's specific needs during emergency preparedness, response, and recovery. There is also a need for clear mechanisms that guarantee women's participation in climate governance and policy implementation processes. Policies should address the structural barriers that limit women's access to resources and ensure

equitable participation in decision-making at all levels.

### Meso Level: Institutions and Organizations

The meso-level analysis focuses on the institutional capacity of organizations responsible for climate adaptation and disaster risk management in KP. Key Informant Interviews (KIs) with stakeholders across government and allied sectors revealed that gender considerations in KP's climate policies remain fragmented and often treated as secondary priorities. Stakeholders consistently noted that gender integration remains ad hoc, with no sustained, province-wide strategies in place. While the Gender Action Plan, developed with support from IUCN, shows initial promise, its implementation faces significant barriers due to chronic underfunding, insufficient gender-specific data, and persistent socio-cultural norms that limit women's mobility and participation. Stakeholders from the Agriculture Research and Environment sectors pointed to targeted initiatives like kitchen gardening and the promotion of solar-powered tools for household energy as efforts to support women's economic roles. However, they emphasized that these interventions remain isolated, with limited scalability and poor institutional backing. Cultural norms were repeatedly highlighted as major obstacles to women's participation in decision-making spaces, such as Jirgas, which restrict women's ability to influence climate adaptation strategies at the community level. Programs like PDMA's evacuation route designs and the inclusion of women in Community-Based Disaster Risk Management (CBDRM) initiatives were acknowledged as positive examples, but they are not embedded in institutional practices and are not routinely implemented. Stakeholders noted that the absence of gender-disaggregated data continues to undermine evidence-based policymaking. Weak coordination between provincial departments and limited inter-sectoral collaboration further restrict the integration of Climate Risk Assessments (CRAs) into policy design. Most respondents agreed that CRAs are significantly underutilized within KP's policy frameworks. Hazard mapping and vulnerability assessments, where they exist, do not follow standardized methodologies and are often limited to agriculture and disaster sectors, leaving critical sectors like health, urban planning,

and energy without sufficient risk-informed planning. The lack of multi-sectoral integration limits the comprehensive application of CRAs, reducing their potential to inform adaptive strategies. Barriers to effective CRA integration include limited training for policymakers on advanced tools like GIS-based modelling, outdated gender and climate data, and poor collaboration with external partners, including academia and NGOs. Some localized climate vulnerability assessments conducted by PDMA and international collaborations with organizations like IUCN demonstrate potential for improved CRA application. However, these efforts are isolated, lack scalability, and are not institutionally sustained. Stakeholders overwhelmingly acknowledged that inclusive CRA development is rare, with minimal community engagement and limited participation of marginalized groups. Academic collaborations in agriculture and water management have generated valuable insights, but the disconnect between research and policymaking limits their practical uptake.

### Meso Level Recommendations

There is a critical need to strengthen cross-sectoral collaboration for comprehensive CRA integration across all sectors, including health, energy, and urban planning. Provincial departments must build their technical capacity to use advanced CRA tools and develop gender-sensitive analysis methodologies. Establishing a centralized, gender-disaggregated data repository would significantly improve evidence-based decision-making. Institutional frameworks must be adjusted to guarantee women's participation in climate decision-making processes. Gender mainstreaming should be formalized within all relevant institutions through clear guidelines, monitoring systems, and capacity-building initiatives. Scalable, localized CRA practices should be developed and embedded into regular institutional workflows to ensure long-term sustainability. Partnerships with academic and international organizations should be leveraged to create locally relevant, gender-sensitive CRA models.

## Micro Level: Community

At the community level, focus group discussions (FGDs) with 34 women and 19 men from farming communities in Pubbi, Nowshehra, provided valuable insights into climate change perceptions, impacts, and adaptive responses. Both men and women reported significant weather changes over the past five years, including

more frequent heatwaves, irregular rainfall, and flash floods. Women emphasized the increasing length of dry spells and the occurrence of sudden, heavy rains that disrupt farming schedules. Men focused on the reduction of timely rainfall and the growing intensity of heat, which directly impact crop production. These climate shifts have severely affected daily life. Participants reported repeated crop failures, a rise in livestock diseases, and growing water scarcity, all of which have compounded financial and social pressures. Women face heightened caregiving burdens, often managing household water use and attending to sick family members and livestock. Men face escalating economic stress, with many forced to migrate due to declining agricultural productivity and shrinking livelihood opportunities. The instability of farming-based livelihoods is a common challenge, with farmers struggling to cope with repeated losses and increasing costs of agricultural inputs. Women have assumed greater responsibility for farming and household management in the absence of migrating male family members. Participants also noted the deteriorating quality of wheat, with women specifically pointing out that the grains have become smaller and less palatable, leading families to divert them to cattle feed while purchasing higher-quality wheat for household consumption. The consensus across all FGDs was that climate change is no longer a distant concern—it is a pressing daily challenge that is reshaping lives, livelihoods, and household dynamics. Vulnerabilities have deepened, particularly among the elderly and children, who face increasing health risks exacerbated by limited access to healthcare and mobility constraints.

Gender roles are shifting, with women now managing household finances, overseeing farming operations, and taking on additional caregiving responsibilities, significantly increasing their workload. Women face considerable barriers in accessing agricultural tools, financial services, and

training programs due to cultural restrictions and , limited mobility. Without targeted interventions these structural inequalities will continue to disproportionately burden women while men navigate increasingly uncertain economic landscapes. Community-level adaptation strategies include diversifying crops, conserving water, and investing in improved infrastructure. However, adaptation decision-making is largely male dominated. Most women reported that men make key adaptation decisions, with 27 out of 34 women confirming that men lead these processes. Six women mentioned joint decision-making, while only one woman reported that women were the primary decision-makers. Interestingly, all 15 men claimed that adaptation decisions were made jointly with women. This perception gap highlights the need for more inclusive decision-making processes that actively incorporate women's voices and priorities. When asked about their key adaptation needs, women emphasized financial support, agricultural training, and improved access to clean water, sanitation, and healthcare as critical priorities. Their focus was on securing resources that would alleviate daily hardships and enable more effective adaptation. Men prioritized financial assistance, improved water management systems, and training in sustainable farming techniques as essential for stabilizing their agricultural practices and recovering economically. Both groups recognized the urgency of adapting to climate challenges, although their priorities reflected their distinct roles within the household and community.

## Micro Level Recommendations:

Community-level resilience can be significantly strengthened by delivering localized, gender-sensitive training on sustainable agriculture, water conservation, and livestock management. Women must be provided with better access to financial services, agricultural tools, and extension programs, and the cultural and logistical barriers that restrict their participation must be actively addressed. Community-driven adaptation plans should incorporate women's perspectives and ensure their involvement in decision-making processes. Local authorities should facilitate inclusive platforms for joint decision-making, increasing women's leadership in climate resilience planning. Infrastructure investments, such as flood



management systems and water access points, should prioritize the needs of women and vulnerable groups. Targeted support that addresses both men's and women's adaptation priorities will help build equitable and sustainable community resilience in the face of accelerating climate impacts.

**Table: A: Assessment of Policies and Action Plans from gender lens: Using Color-coding Indicators for KP"**

| Policy Document                   | Acknowledging Gendered Impact | Gender-Sensitive Policy Objectives | Assessing Gender Intersectionality | Gender-disaggregated Data | Access to Resources | Role in Decisions Making and Governance | Gender Sensitive Monitoring Indicators /Audit | Inclusion of Gender in DRR | Gender-Sensitive Budgeting |
|-----------------------------------|-------------------------------|------------------------------------|------------------------------------|---------------------------|---------------------|-----------------------------------------|-----------------------------------------------|----------------------------|----------------------------|
| KP CC Policy 2022                 |                               |                                    |                                    |                           |                     |                                         |                                               |                            |                            |
| KP CC Action Plan (2022)          |                               |                                    |                                    |                           |                     |                                         |                                               |                            |                            |
| KP Agriculture Policy (2015-2025) |                               |                                    |                                    |                           |                     |                                         |                                               |                            |                            |
| KP Water Act 2020                 |                               |                                    |                                    |                           |                     |                                         |                                               |                            |                            |
| KP Urban Dev. 2022-2030           |                               |                                    |                                    |                           |                     |                                         |                                               |                            |                            |

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## List of Abbreviations

|              |                                                                  |                      |                                                           |
|--------------|------------------------------------------------------------------|----------------------|-----------------------------------------------------------|
| <b>BMZ</b>   | German Federal Ministry for Economic Cooperation and Development | <b>MoCC &amp; EC</b> | Ministry of Climate Change and Environmental Coordination |
| <b>KP</b>    | Khyber Pakhtunkhwa                                               | <b>RCPs</b>          | Representative Concentration Pathways                     |
| <b>CRP</b>   | Climate Risk Profile                                             | <b>SSPs</b>          | Shared Socioeconomic Pathways                             |
| <b>CMIP</b>  | Coupled Model Intercomparison Project                            | <b>LULUCF</b>        | Land use, Land-Use Change and Forestry                    |
| <b>IPCC</b>  | Intergovernmental Panel on Climate Change                        | <b>Mm</b>            | Millimeters                                               |
| <b>FAO</b>   | Food and Agriculture Organization                                | <b>PET</b>           | Potential Evapotranspiration                              |
| <b>GCMs</b>  | Global Climate Models                                            | <b>PRECIP</b>        | Precipitation                                             |
| <b>GDD</b>   | Growing Degree Day                                               | <b>TAVG</b>          | Average Temperature                                       |
| <b>GDP</b>   | Gross Domestic Product                                           | <b>TMAX</b>          | Maximum Temperature                                       |
| <b>INDCs</b> | Intended Nationally Determined Contributions                     | <b>TMEAN</b>         | Mean Temperature                                          |
| <b>GHGs</b>  | Greenhouse Gases                                                 | <b>TMIN</b>          | Minimum Temperature                                       |
| <b>GIZ</b>   | Gesellschaft für Internationale Zusammenarbeit                   | <b>TX10P</b>         | 10th percentile of TX (Cold Days)                         |
| <b>GLOFs</b> | Glacial Lake Outburst Floods                                     | <b>TX99P</b>         | 99th percentile of TX (Warm Days)                         |



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