Research Article

Climate Change is Real and Relevant for Sustainable Development, An Empirical Evidence on Scenarios from North-West Pakistan

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Abstract | This study is based on empirical data on temperature and rainfall change from Khyber Pakhtunkhwa region of North-West Pakistan to illustrate that climate change is no longer theoretical. It is real and becoming self-evident. Climate assessment 1981-2010 and future scenario 2010-2040 for KP noted little shifts in the annual average rainfall. However seasonal shifts are rather significant. In all the districts, spring and summer rains are showing an increasing trend whereas fall and winter rains are continuously declining. This shows that spring and summer are becoming wetter and fall and winter are becoming dryer till 2040. Nearly two-third or more of the total rains are received during spring and monsoon. In decadal scenario, it is likely that annual average precipitation will continue to increase till 2030 and start declining during 2030-2040 in all the seasons. The temperature scenarios also present a noticeable change. An average increase in temperature in KP is 1.8^{0}C during 2010-2040. In the Northern districts (mountain areas) it is the 1.9^{0}C closely followed by Central with 1.8^{0}C and the South 1.6^{0}C (where South is already a heat surplus zone). These trends are crucial in terms of disasters with likelihood of spring / monsoon floods and winter drought.

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Introduction

The 5th assessment report of the United Nations' Intergovernmental Panel on Climate Change (IPCC) led the world community to believe that greenhouse gases are the leading cause of the rising global temperature and by the year 2100 global temperature will have risen from 1.1 to 6.4 degrees Celsius (IPCC, 2014). This assessment and several other expert reports suggested that our planet is getting warmer, our ice caps are melting and threats of floods continue to rise impacting vulnerable people and challenging institutional capacities to respond especially in developing countries (Adger, 2003; Kortman et al., 2007; Agrawal et al., 2008; Agrawal and Perrin, 2009; Nizami et al., 2010; Yu et al., 2013; Croft, 2015; Ali et al., 2016, 2017). Scientists also believe that climate change is not only global and is no more limited to Carbon science, it has regional and local biological production impacts and economic, social, political and scientific consequences.

Globally, Pakistan is included in the list of most vulnerable countries to climate change impact (Kreft and Eckstein, 2014). The impacts of climate change are already threatening the security of livelihoods and assets in Pakistan. These threats, based on knowledge about changing climate trends and land suitability,

can be transformed into opportunities. Pakistan is ecologically diverse and the 6th most populated country in the world (Agrawal 2018). The country has a predominantly agrarian economy contributing to over 21% of GDP and employing 45% of total labour force and major export income (GOP, 2010). Climate change exacerbated by human practices, poses an additional pressure on crucial and limited resources such as water and land. The most critical climate change factor is the aridity combined with the dependence on a single river system the Indus which supports the biggest irrigation system of the world (GoP, 2015; Chaudhry, 2017). Several national studies have identified the effects of climate change on water and that such effects differ across different regions (Tubiello and Fischer, 2006; Nelson et al., 2009; Orlowsky et al., 2017). Water and agriculture are highly sensitive to climatic conditions and are directly affected by climate change. Water and agriculture have a reciprocal relationship.

However, there is still a sense of disbelief among some of the world leaders and people who view these assessments more theoretical than real. Public scepticism about climate change is reported decreasing in some parts of the world (Semenza et al., 2008; Wouter et al., 2011). While low climate awareness is reported in south Asia (Zaheer and Colom, 2013) and less coverage by media in Pakistan (Sharif and Medvecky, 2018) despite the fact that farmers in some areas recognise climate change impacting farming systems (Abid et al., 2015). During a recent conference on climate change in Pakistan some participants said that there is no statistical credible evidence for rising temperatures and melting glaciers in Pakistan and that the 2010 devastating floods were triggered by the use of technology developed by the High-frequency Active Auroral Research Programme (HAARP) and not due to rise in temperature due to climate change. Such perception take root in the absence of empirical evidence as studies on climate change are seldom available for Pakistan. Any available studies related to climate change focus on qualitative analysis taking farmer's perceptions (Akmal et al., 2014) and farmers experiences (Abid et al., 2015). Some studies bring empirical evidence on rising temperatures and shifting rainfall patterns but for smaller areas (Hanif et al., 2017) which cannot be taken as evidence for changing climate for the country or even for a province.

Taking empirical evidence for Khyber Pakhtunkhwa (KP) province in the north-west in Pakistan, this study contributes to the on-going discussion on climate change. This study uses detailed climate baseline for KP revealing highly useful evidence to argue that climate is changing and cannot be ignored in designing development planning especially for climate sensitive sectors.

The study area

Khyber Pakhtunkhwa (KP) is one of the four administrative provinces of Pakistan located in the north-western region of the country with diversity of terrain causing substantial seasonal variations. The province comprises of diverse landscape with agricultural plains, drylands and mountains. This diversity is an opportunity but at the same time increases exposure to vulnerability due to climate variability and change. A large area of KP comprises highlands which are highly vulnerable to climate variability and change (Ali et al., 2014) and rich in water resources playing an important role in the regional hydrological cycle (Grumbine et al., 2015). The province has two major climatic systems; the monsoon to the east and the Mediterranean towards the west with dry and semi-dry climate (Akmal et al., 2014).

KP has demonstrated strong indicators of vulnerability to climate change due to their diversity of agroecology and landforms but also because of changing regime in temperature and precipitation, inevitably significant for agriculture (Nizami et al., 2010). These shifting trends are significantly impacting farming in KP. Climate variability and change manifest themselves in increased frequency of hazards and positive or negative influence on crops performance. Fortunately, in KP this realization already prevails among various stakeholders including farmers on ground. However, many of them do not have a proper response capacity to these changes.

Materials and Methods

This study benefits from climate assessment (climate scenarios) for some districts conducted by the Climate Change Centre at the University of Agriculture Peshawar and Helvetas Swiss Intercooperation in collaboration with Pakistan Meteorological Department (Hussain et al., 2013; Hanif and Ali, 2014; Hanif and Hussain, 2015; Hanif et al., 2015a, b, c; Hanif, 2017). Using meteorology data from

Pakistan Meteorological Department from all existing weather stations different models were applied to prepare missing scenarios for reaming districts. A set of emission scenarios termed as "Representative Concentration Pathways (RCPs)" under Coupled Model Inter-comparison Project 5 (CMIP5) and IPCC Fifth Assessment Report-AR5 (IPCC, 2014) based on new set of emissions is available for downscaling to prepare local climate scenarios. For this study, the climate projections have been made using the newly developed representative concentration pathways (RCPs) under the CMIP5 and appropriate statistical downscaling. The CMIP5 ensemble mean climate and is closer to observed climate and therefore current work is based on CMIP5 model output. In CMIP5, four RCP scenarios: RCP2.6, RCP4.5, RCP6.0 and RCP8.5, which represent pathways of radioactive forcing, have been used (Schmidt and Andreas, 2014). RCP2.6 pathways has been used for computation of rainfall and temperature scenarios of the districts for the next three decades.

Under RCP2.6 scenario, greenhouse gas emissions and emissions of air pollutants are reduced substantially over time by 2100. CMIP5 models are generally of higher resolution and are available at common spatial scale of 0.5×0.5 degree resolution. The CMIP5 model data is freely available for research purpose to scientific community. The CMIP5 model data is available for different forcing factors. Only CO2 emission data based on RCP2.6 has been used in the present work to develop the climate scenarios. In this work, only two variables rainfall and temperature were required. The baseline data (1981-2010) of temperature and precipitation were computed with the support of available real time observational climate data available with the PMD's weather stations in KP. The grid point models' data (0.25x0.25 resolution) of Climate Research Centre (CRU) was used for temperature and Global Precipitation Climatology Centre (GPCC) data for precipitation. The data were simulated on decadal basis. The results were bias corrected with climate of the region. Statistical downscaling was used to run the precipitation and temperature scenarios for the study areas. Finally, the projected scenarios for each decade have been compared with the base-line period (1981-2010) to understand the rate of change of climate variables. The decadal CMIP5 scenario runs for the study areas have been developed using only one ensemble mean of CMIP5 models. The scenarios provide multi-model temperature and precipitation projections at seasonal scale for the period 2011-2040.

The rainfall and temperature scenarios for each district have been tabulated at the end of this paper for the future reference and use by scientific and development community.

Results

Rainfall trends in KP based on climate scenarios

As a result of this study, KP province is classified into three rainfall zones based on annual average rainfall received (Table 1), namely Low (less than 600mm), Medium (less than 1000mm) and High (above 1000mm). This rainfall situation in KP is given in the Figure 1 with low, medium and high rainfall zones. Table 1 presents the districts included in the rainfall zones for further reference of the readers.

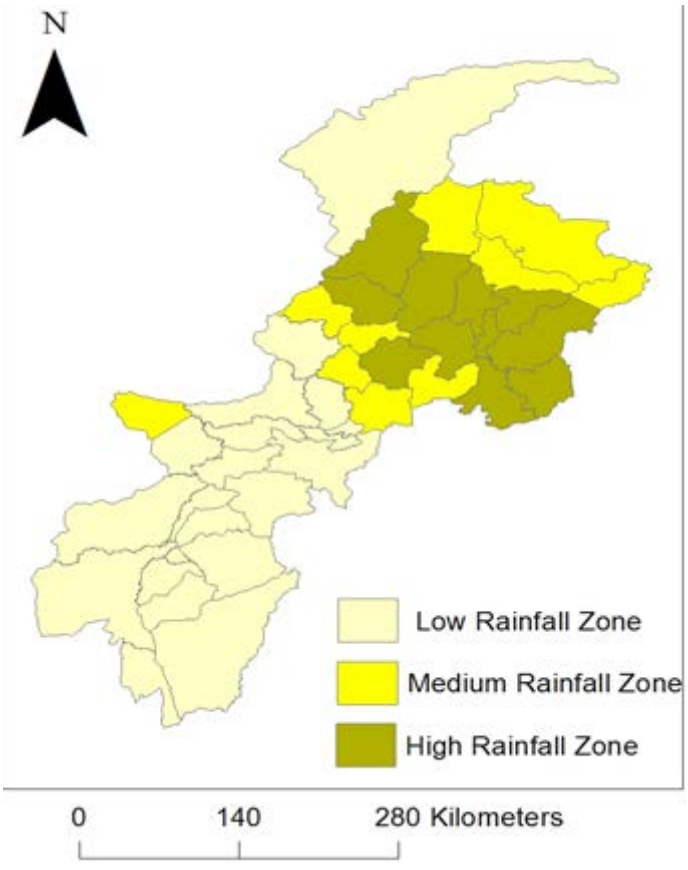

Figure 1: *Overall situation of annual rainfall of KP, FATA at present (2018).*

Table 2 shows that there will be little shifts in terms of districts receiving lower or higher rainfall. However, the main feature of KP's rainfall is the seasonal variation and shifts. The table provides likely scenario of rainfall shifts till 2040 within and across the three rainfall regions.

Table 1: *Rainfall classification in Khyber Pakhtunkhwa by quantity (mm).*

Low rainfall region	Medium rainfall region	High rainfall region
<600mm	600-1000mm	>1000mm
Districts Peshawar, Charsadda, Khyber, Kohat, Hangu, Kurram (lower), Karak Bannu, Lakki Marwat, FR DI Khan, DI Khan Tank, Chitral, Mohmand, Orakzai, North and South Waziristan	Districts Swat, Malakand, Kurram (upper), Nowshehra, Mardan, Swabi, Bajaur, Kohistan, Mansehra (North), Shangla.	Districts Swat (Lower), Buner, Dir (Lower and Upper), Haripur, Kala Dhaka, Abbottabad, Mansehra (South), Battagram.

Table 2: *Rainfall prevalence shift 2010-2040.*

2010	2040
49% districts fall in Low rainfall zone	46% districts fall in Low rainfall zone
28% districts fall in Medium rainfall zone	26% districts fall in Medium rainfall zone
23% districts fall in High rainfall zone	28% districts fall in High rainfall zone

Considering rainfall and temperature, the months of the year have been identified into four seasons as follows:
Winter: December, January and February
Spring: March, April, May
Summer: June, July, August, September
Fall: October, November

The following sections detail the study results in terms of rainfall occurrence in low, medium and high rainfall zones by seasons.

Rainfall trends in low rainfall region

Figure 2 shows that the annual average rainfall in KP will increase by 4% by 2040 in low rainfall zone. Rains are expected to increase till 2030 and then decline in the next decade. Winter and autumn rains are expected to continuously decline till 2040 (13% and 29% reduction by 2040). The spring and summer rains are expected to increase till 2030 and then declining (increase of 13% and 16% by 2040). District Charsadda is expected to receive more rains and will shift to medium rainfall zone from low rainfall zone by the year 2020.

According to Figure 3, between 68-75% rainfall is received during Spring and Summer with an increasing trend till 2040. Whereas 21-26% rain is received in Winter with a declining trend till 2040. The remaining 4-6% rain is received during Fall, also with a declining trend.

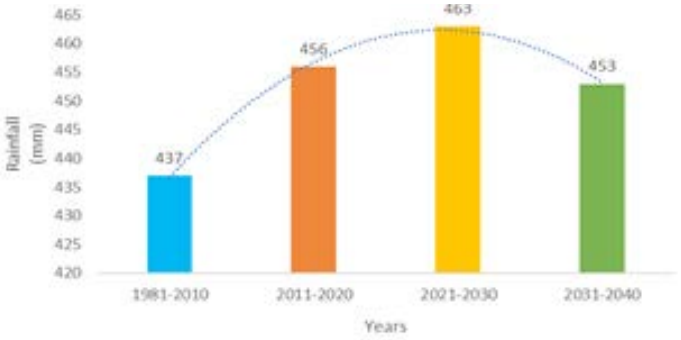

Figure 2: *Low rainfall region <600mm.*

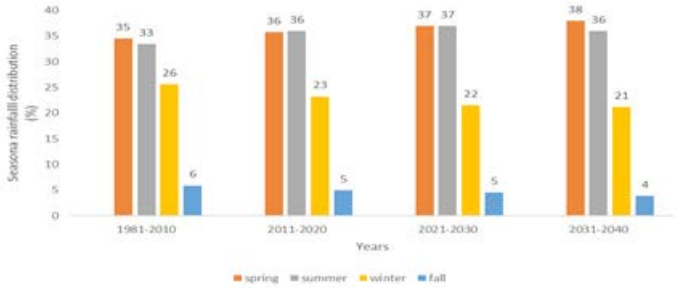

Figure 3: *Seasonal percentage- Low rainfall region.*

Rainfall trends in medium rainfall region

As shown in Figure 4, the annual average rainfall in this region seems to increase till 2030 and then slightly decline (overall increase of 6% only by 2040). The Winter and Fall rains are expected to decline till 2040 (14% and 25% reduction by 2040). The Spring rainfall is expected to continuously increase till 2040, with an overall expected increase by 18%.

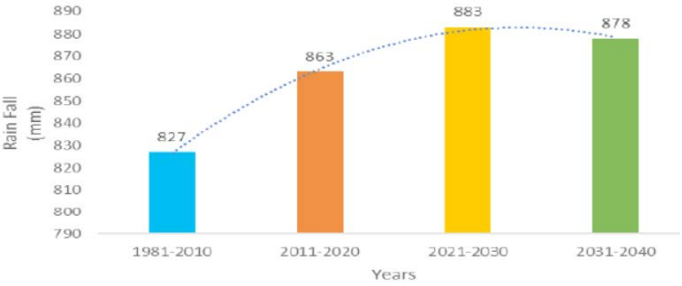

Figure 4: *Medium rainfall region (600-1000 mm).*

According to Figure 5, the Summer rainfall is expected to increase till 2030 and then expected to slightly decline. An overall increase of 16%. Districts Mardan and Shangla are expected to shift to High rainfall zone from Medium rainfall zone by 2020. Between 72-79% rainfall is received during Spring and Summer which is expected to increase. Whereas

22-27% rain is received in Winter which is expected to further decline. The remaining rainfall is received during Fall (5-6%) which is also expected to decline.

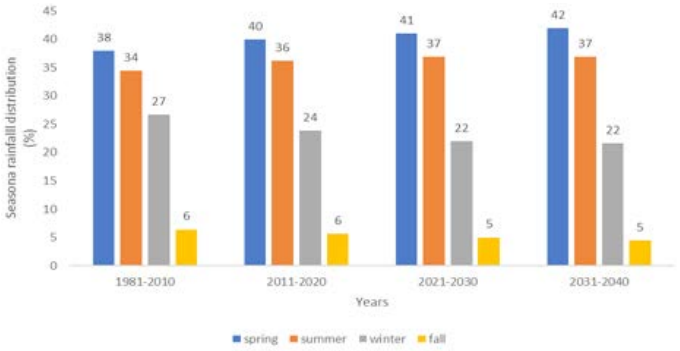

Figure 5: *Seasonal percentage- Mediam rainfall region.*

Rainfall trends in high rainfall zone

For the high rainfall zone, as shown in Figure 6, the annual average rainfall seems to increase till 2030 and then slightly decline (overall increase of 5% only by 2040). The Winter and fall rains are expected to continuously declining till 2040 (respectively between 14% and 19% reduction by 2040). The Spring and Summer rains are expected to continuously increasing till 2040, with an overall increase by 16-17%.

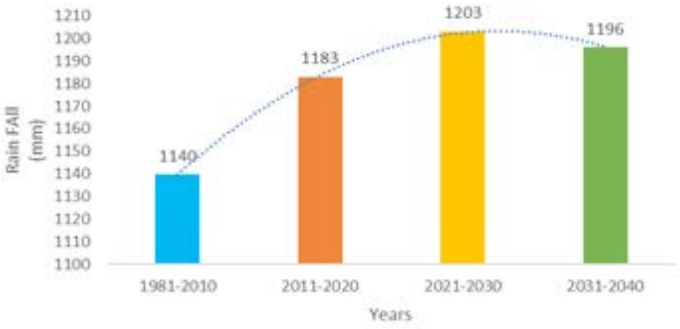

Figure 6: *High rainfall region >1000 mm.*

As shown in Figure 7, between 71-76% rainfall is received during Spring and Summer with an increasing trend. Whereas 19-22% rain is received in Winter with a declining trend. The remaining 5-7% rain is received during Fall with a declining trend till 2040.

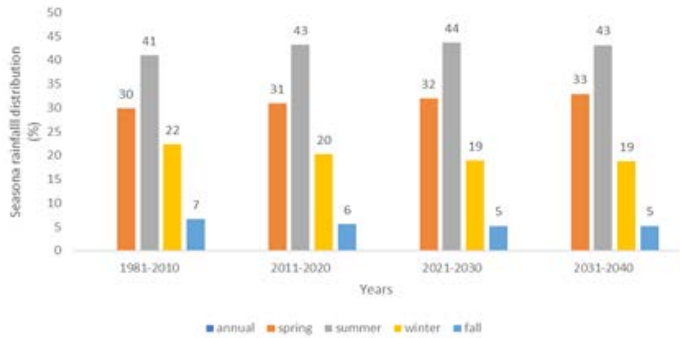

Figure 7: *Seasonal percentage- High rainfall region.*

In summary the overall proportion of participation is reducing for KP during Fall and Winter and increasing in Spring and Summer. This means that the KP has to take highly effective measures for storage and rainwater harvesting to avoid sole dependence on canal water received from rivers or on groundwater. Both of these resources are expected to diminish due to reducing rainfall in the long run and increasing temperature.

Snow concentration in future

In high altitude region, most of the precipitation is received in the form of snow. The climate assessment suggests that the snow maxima is shifting towards spring.

Figure 8 shows an overall pattern of cryosphere in Hindukudh-Karakoram-Himalaya regions in Pakistan. Temporal and spatial distribution of snow in KP, Gilgit-Baltistan (GB) and Azad Jammu and Kashmir (AJK) followed almost uniform overlay, but the amount may be different in terms of elevation, aspect and orientation of the landscapes. Since the winter snow producing systems move from the west to the east therefore snow cover over western mountainous slopes was higher than the eastern exposed sides. In general, the frequency and amount of snow occurrence gradually decreased in the valleys with the passage of time over the last two decades and now minimal snow can be found in meteorological observations up to 2500m high locations in GB, KP and AJK (Rasool, 2015).

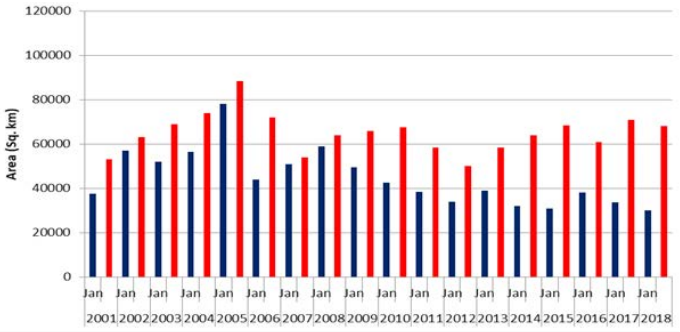

Figure 8: *Snow concentration in future in Pakistan (Rasool, G., 2015).*

Temperature trends and scenarios

Temperature scenarios developed in this study for three geographical regions (Central, South and North).

Central Region: Mardan, Swabi, Nowshera, Mohmand, Peshawar, Khyber, Charsadda.

South Region: Bannu, Lakki Marwat, Karak, FR

D.I khan, D.I khan, Orakzai, Kurram, Hangu, Kohat, Tank, North and South Waziristan.

North Region: Buner, Lower Dir, Upper Dir, Chitral, Abbottabad, Mansehra, Shangla, Bajaur, Haripur, Swat, Malakand, Battagram, Kohistan, Kala Dhaka in KP for the period 1981–2040 indicate a highly noticeable change.

Temperature trends central region

Data in Figure 9 indicate the following temperature trends for the central region. In general temperature in this region is increasing with some seasonal variation. Details of temperature scenarios for all four seasons is as follows:

- Annual Average temperature will increase by 1.8°C
- Annually nights are warming up by 1.5°C and days by 2.0°C
- Winter Average minimum temperature will increase by 0.9°C
- Winter Average maximum temperature will increase by 1.4°C
- Spring Average minimum temperature will increase by 1.3°C
- Spring Average maximum temperature will increase by 2.1°C
- Summer Average minimum temperature will increase by 1.3°C
- Summer Average maximum temperature will increase by 1.7°C
- Fall Average minimum temperature will increase by 1.7°C
- Fall Average maximum temperature will increase by 2.0°C

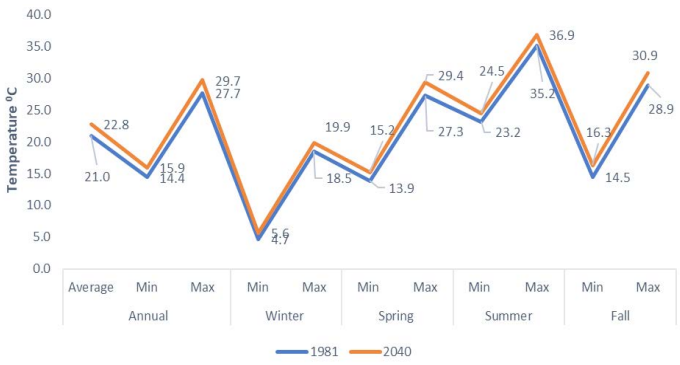

Figure 9: *Annual and seasonal temperature trends 1981-2040 (Central region).*

Temperature trends South region

Data in Figure 10 indicate that minimum and maximum temperature in the South regions is expected to increase in all seasons. Details of temperature scenarios for all four seasons is as follows:

- Annual Average temperature will increase by 1.6°C
- Annually nights are warming up by 1.2°C whereas days are warming by 1.7°C
- Winter Average minimum temperature will increase by 0.7°C
- Winter Average maximum temperature will increase by 1.4°C
- Spring Average minimum temperature will increase by 1.3°C
- Spring Average maximum temperature will increase by 2.2°C
- Summer Average minimum temperature will increase by 1.1°C
- Summer Average maximum temperature will increase by 1.6°C
- Fall Average minimum temperature will increase by 1.8°C
- Fall Average maximum temperature will increase by 2.0°C.

Figure 10: *Annual and seasonal temperature trends 1981-2040 (South region).*

Temperature trends north region

Temperature trends as shown in Figure 11 indicates that temperature in all seasons is increasing except for average winter temperature which indicates a decreasing trend. Temperature trends for all four seasons is given below:

- Annual Average temperature will increase by 1.9°C
- Annually nights are warming by 1.5°C whereas nights are warming by 2.3°C
- Winter Average minimum temperature will hardly increase from the baseline (0.1°C).
- Winter Average maximum temperature will increase by 1.9°C
- Spring Average minimum temperature will increase by 1.4°C
- Spring Average maximum temperature will increase by 2.4°C

- Summer Average minimum temperature will increase by 1.6°C
- Summer Average maximum temperature will increase by 2.3°C
- Fall Average minimum temperature will increase by 1.9°C
- Fall Average maximum temperature will increase by 2.0°C

Figure 11: *Annual and seasonal temperature trends 1981-2040 (North region).*

Implications of rising temperature and changing rain temperature

The above data show that in all seasons day and night temperatures are increasing. Night temperatures are increasing at a lower rate when compared to days which are warming faster. Overall, an average increase in temperature in the North (mountains) is the highest closely followed by Centre and the South where South is already a heat surplus zone. Implication of increased temperature and changing rainfall patterns are discusses in the following sub sections.

GLOF and flood implication

For the past ten years, climate change induced disasters have taken momentum in the valley, particularly the floods caused by glacial lakes. These glacial lake outburst floods (GLOF) occur when the ice walls containing the reservoir fail, sending entire lakes down to inhabited areas below. During such emergencies, there is severe loss of lives and physical assets (UNDP, 2017). According to the study results, the rise in both maximum and minimum temperatures in spring may have more disaster implications in the North. Most dangerous glaciers may need to be identified for potential damage assessment and for critical observation to raise early warning for GLOF risks. Spring temperature is increasing with a very high rate followed by summer. The temperature trends in the North are crucial due to glacial activity and when this combines with late occurrence of snowfall, the likelihood of disasters becomes very high. Regulating water flow in the North together with effective Disaster Risk Reduction (DRR) measures to avoid heavy overflows and downpour of rain must be placed on a high priority using all biological and structural means.

The rainfall data documented in earlier sections were analysed for Central, South and North KP to explore implications for various sectors. Summary of this analysis is provided in Table 3.

Implication for farming

The increased temperatures coupled with changing rainfall patterns will have implications for farming and agriculture production which are discussed in the sub sections for low, medium and high rainfall regions.

Implications in low rainfall regions: Low rainfall region will face drastic water scarcity constraints during Fall and winter. Fall and early Winter is crucial period for wheat sowing. In rainfed areas wheat cultivation will be severely affected. High priority must be given to these districts in financial planning for developing water storage through small dams and high efficiency irrigation system for crops.

a. There is a high need in this region to work with farmers to adopt water efficient crop management methods as well as ways and means to predict and manage drought impacts. Strong measures to conserve summer moisture may help withstanding dry spell during Fall.
b. Historically a risk of intense rain with heavy showers with hailstorm are expected in late spring when wheat harvesting is expected.

Implication Medium rainfall region: Fall will receive water scarcity like situation and special measures, such as summer moisture conservation may help addressing acute shortage of water depending for crops.

a. Horticulture in this region will be severely affected due to intense rains during flowering and fruit maturity periods.
b. This region stands at a medium risk for flash floods and landslides in hilly areas such as flash floods and landslides.
c. Historically, a risk of intense rain is expected in spring when wheat harvesting is expected.
d. Coupled with higher temperature, humidity factor can rise in this region during spring and rather extended summer.
e. Mardan and Shangla are shifting to high rainfall

zone, which may be an opportunity as well as disaster implication requiring structural and non-structural preparedness.

Implication High rainfall zone: Horticulture will be severely affected due to intense rains during flowering and fruiting stages.

a. This region however stands at a medium risk for flash floods and landslides in hilly areas such as flash floods and landslides.
b. Historically a risk of intense rain with heavy showers are expected in spring when wheat harvesting is expected.
c. Coupled with higher temperature, humidity factor can rise in this region during spring and rather extended summer.
d. Snowfall trend in this region shows an increasing shift of snow maxima towards spring. However, exceptionally this region may also experience unprecedented early snow fall events.

Conclusions and Recommendations

Evidence from KP illustrates trends from 1981 to 2020 and projections till 2040 that temperature and rainfall changes are taking place. For those who may not attribute such dynamics to climate change, our argument is that there is no harm in not believing in climate change if this can help eliminate the risks of floods and other hydro-climatic challenges. However, since disaster and frequent unusual events continue to occur at a scale that cannot be attributed to anthropogenic factors alone, the main attribution goes to global dynamic such as climate change. Climate change is a real issue that needs to be recognized for taking timely context specific action for adapting to the challenges.

Changes noticed in KP are likely to affect water and agriculture directly since these are highly sensitive to climatic conditions in a reciprocal relationship. Therefore, it is important to recognize and understand climate trends for longer term planning and preparedness. The following conclusions and recommendations emerge from the analysis of climate trends in KP.

In all the three rainfall zones of KP (low, medium, high), the annual average rainfall is increasing till 2030 and then declining in 2031-2040 by 4-6%. Among districts, Charsadda is eventually shifting to medium Rainfall zone from Low rainfall zone with an overall increase of 8% rainfall. Mardan and Shangla are shifting to High rainfall zone from Medium with an increase of 7-18% rainfall. Fall and Winter rainfall are drastically declining. Winter rainfalls reduce by 11-14% till 2014. Spring rains are consistently increasing between 13-20%. Summer rains are also increasing in all the regions from 13-17% till 2030 and then declining. Only 4-6% of total annual rain is received during Fall for all decades. Between 21-26% rain is received during winter with a declining trend. The remaining rain is received during spring and summer in equal distribution.

These shifts need to be taken into the account in adaptation planning and DRM measures in these districts. In our assessment, the shift of rainfall in the three districts will have important implications for agriculture:

- Positive implication in the shape of more water and relatively increased temperatures in high altitude areas may help double cropping
- Negative implications due to untimely rainfall e.g.,

a. More rains during the blossom season, and the risk of increased runoff.
b. Risk of drought due to water scarcity, requiring mitigation measures (including drought resistant varieties and water productivity) in low rainfall zone.
c. Need to consistent and large-scale efforts for improved water productivity in agriculture, especially in medium and low rainfall zones.
d. Measures for disaster risk reduction, soil protection and flood risk mitigation in high rainfall zone.
e. It is important to note that spring and summer rainfalls may cause risks to crops (e.g. Wheat at harvesting stage may be at a high risk) and human lives (floods).
f. Fall and winter rainfall situation poses a severe threat of drought, especially in low rainfall zones.

The study recommends; regulating water flow in the North together with effective DRR measures to avoid heavy overflows and downpour of rain (which is also increasing in the North during spring and summer) must be placed on a high priority using all biological and structural means. Financial investment priorities may range from small dams to rainwater harvesting. It is important that these shifts are recognized and interpreted for defining impact on agriculture and plausible measures (e.g. change of cropping pattern,

Table 3: *Disaster risk implication of rainfall and temperature changes.*

Region	Precipitation trends	Temperature trends	Disaster risks
Central KP	Average Increase: 9% Winter: Decline by 17% Spring: Increase by 22% Summer: Increase by 24% Fall: Decline by 33%	Annual average increase by 1.8°C Winter nights will be warmer by 0.9°C Winter days warmer by 1.4°C Spring nights warmer by 0.8°C Spring days warmer by 1.3°C Summer nights warmer by 2.1°C Summer days warmer by 1.3°C Fall nights warmer by 1.8°C Fall days warmer by 2.0°C	Torrential rains towards the end of spring Likelihood of flash floods in spring and summer River overflows in low lying areas during early summer due to snow melting in higher watersheds Frequent frost will be observed during dry and cold winters
South KP	Average Increase: 1% Winter: Decline by 19% Spring: Increase by 14% Summer: Increase by 17% Fall: Decline by 32%	Annual average increase by 1.6°C Winter nights warmer by 0.7°C Winter days warmer by 1.4°C Spring nights warmer by 1.3°C Spring days warmer by 2.2°C Summer nights warmer by 1.1°C Summer days warmer by 1.6°C Fall nights warmer by 1.8°C Fall days warmer by 2.0°C	Dry spell in fall/ winter Torrential rainfall towards the end in spring Some of the Southern districts are at high risk of floods
North KP	Average Increase: 4% Winter: Decline by 8% Spring: Increase by 14% Summer: Increase by 7% Fall: Decline by 17%	Annual average increase by 1.9°C Winter nights unchanged (0.1°C) Winter days warmer by 1.9°C Spring nights warmer by 1.4°C Spring days warmer by 2.4°C Summer nights warmer by 1.6°C Summer days warmer by 2.3°C Fall nights warmer by 1.9°C Fall days warmer by 2.0°C	Flash floods in spring and summer due to intense rains Coupled with increased temperature, GLOF and avalanches are highly likely in high mountain regions beside river overflooding in spring / summer

technology, varieties etc.). Without this, the country will continue to lose its economic returns and farmers will lose their livelihoods and food security. A massive training programme for agriculture planners, extension workers as well as farmers is necessary to provide or implement relevant advice to adapt to the change caused by changing rainfall and temperature regimes.

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Data reference tables

Tables 4, 5, 6, 7, 8 and 9 are given at the end of the article.

Novelty Statement

Future temperature and precipitation scenarios with particular reference to climate change ranging up to 2040 and covering whole KP including erstwhile FATA is unique piece of research that will help future plan-ning and development in the region.

Author's Contribution

Arjumand Nizami: Review of literature, methodology, climate data analysis and trends
Jawad Ali: Methodology analysis of climate change implications and interpretation
Muhammad Zulfiqar: Overall review, conclusions and recommendations

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Table 4: *Rainfall data and scenario Khyber Pakhtunkhwa (low rainfall region).*

Low rainfall zone (<600mm per annum)							
Districts	**Base**	**Projected**	**% change from**	**Projected**	**% change from**	**Projected**	**% change from**
	1981-2010	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Peshawar	507.9	547	7.7%	555.2	9.3%	554.5	9.2%
Kohat	575.2	618.4	7.5%	638.5	11.0%	632.8	10.0%
Hangu	522.5	533.5	2.1%	542.8	3.9%	543.1	3.9%
Charsadda	580.1	618.5	6.6%	631.4	8.8%	628.8	8.4%
Khyber	505.6	517	2.3%	523.6	3.6%	507.2	0.3%
Kurram Lower	493.1	509.5	3.3%	518.8	5.2%	519.7	5.4%
Bannu	476	492.7	3.5%	497.4	4.5%	480.8	1.0%
Lakki Marwat	440.4	453.6	3.0%	462.4	5.0%	449.2	2.0%
Karak North	455.5	482.5	5.9%	491.5	7.9%	488.2	7.2%
South Chitral	457.5	490.3	7.2%	504.5	10.3%	471.5	3.1%
Orakzai	480.4	490.4	2.1%	493.1	2.6%	480	-0.1%
North Waziristan	405.3	419	3.4%	411.5	1.5%	387.1	-4.5%

Tank	390.5	413.2	5.8%	421.4	7.9%	416.1	6.6%
FR D.I. khan	294.5	311.4	5.7%	317	7.6%	305.5	3.7%
North Chitral	352.2	345.5	-1.9%	360.7	2.4%	355.8	1.0%
Mohmand	309.8	326.4	5.4%	342.8	10.7%	355.8	14.8%
South Waziristan	387.6	402.5	3.8%	390	0.6%	358	-7.6%
D.I khan	319.3	335.7	5.1%	345.2	8.1%	336.6	5.4%
Karak South	345.4	363.8	5.3%	355.8	3.0%	337	-2.4%
	343	357	4%	362	6%	352	3%

Table 5: *Rainfall data and scenario Khyber Pakhtunkhwa (Medium rainfall region).*

Medium rainfall zone (600-1000mm per annum)							
Districts	**Base**	**Projected**	**% change from**	**Projected**	**% change from**	**Projected**	**% changefrom**
	1981-2010	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Swat Upper	838.3	871.5	4.0%	881.5	5.2%	851	1.5%
Malakand	862.1	880.3	2.1%	899.4	4.3%	908.4	5.4%
Kurram Upper	636.4	664.7	4.4%	678	6.5%	681.7	7.1%
Nowshera	720.3	803.2	11.5%	846.4	17.5%	850	18.0%
Mardan	944.8	1062.9	12.5%	1124.3	19.0%	1114.9	18.0%
Shangla	988.5	1033	4.5%	1057.7	7.0%	1062.6	7.5%
Swabi	744	784.7	5.5%	820.7	10.3%	820.2	10.2%
Bajaur	684.3	693.1	1.3%	705	3.0%	711.6	4.0%
Kohistan Upper	795.1	785.1	-1.3%	777.8	-2.2%	765.9	-3.7%
Mansehra North	905	920.6	1.7%	928.7	2.6%	917.7	1.4%
Kohistan Upper	980.6	994.8	1.4%	997	1.7%	976.2	-0.4%
	827	863	4%	883	7%	878	6%

Table 6: *Rainfall data and scenario Khyber Pakhtunkhwa (High rainfall region).*

High rainfall zone (>1000 mm per annum)							
Districts	**Base**	**Projected**	**% change from**	**Projected**	**% change from**	**Projected**	**% change from**
	1981-2010	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Kala Dhaka	1085.2	1102.5	1.6%	1121.3	3.3%	1114.4	2.7%
Swat Lower	1060	1168.8	10.3%	1205	13.7%	1225	15.6%
Battagram	1006.5	1016.7	1.0%	1027.7	2.1%	1026.8	2.0%
Buner	1044.1	1085.9	4.0%	1106.7	6.0%	1112	6.5%
Lower Dir	1016.2	1037.3	2.1%	1060.1	4.3%	1045	2.8%
Abbottabad	1324.7	1379	4.1%	1401.4	5.8%	1400.5	5.7%
Mansehra South	1229	1278.2	4.0%	1308.9	6.5%	1308.9	6.5%
Haripur	1065.8	1111.9	4.3%	1155.2	8.4%	1133	6.3%
Dir Upper	1425.8	1465.6	2.8%	1441.5	1.1%	1395.5	-2.1%
	1140	1183	4%	1203	6%	1196	5%

Table 7: *Temperature data and scenario Khyber Pakhtunkhwa (North region).*

Temperature (°C)	**Base**	**Projected**	**% change from**	**Projected**	**% change from**	**Projected**	**% change from**
Upper Dir	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	14.6	15.4	5.5	15.8	8.2	16	9.6
Minimum	6.7	7.6	13.4	7.9	17.9	8	19.4
Maximum	22.4	23	2.7	23.5	4.9	23.8	6.3

Winter							
Average	5.7	6.3	10.5	6.7	17.5	6.9	21.1
Minimum	-1.4	-1.5	7.1	-1.7	21.4	-1.7	21.4
Maximum	12.8	14.2	10.9	15.2	18.8	15.4	20.3
Spring							
Average	14.9	15.7	5.4	16.3	9.4	16.7	12.1
Minimum	7.1	7.7	8.5	8.1	0.7	8.3	16.9
Maximum	22.8	23.8	4.4	24.6	7.9	25.2	10.5
Summer							
Average	23.7	24.5	3.4	25.1	5.9	25.5	7.6
Minimum	16.4	17	3.7	17.5	6.7	18	9.8
Maximum	31	32	3.2	32.7	5.5	32.8	5.8
Fall							
Average	13.7	14.6	6.6	15.3	11.7	15.6	13.9
Minimum	4.6	5.6	21.7	6.4	39.1	6.8	47.8
Maximum	22.8	23.6	3.5	24.2	6.1	24.4	7
Lower Dir	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	17.6	18.4	4.5	18.8	6.8	19	8.0
Minimum	10.7	11.6	8.4	11.9	11.2	12	12.1
Maximum	24.5	25.1	2.4	25.6	4.5	25.9	5.7
Winter							
Average	8.3	8.9	7.2	9.3	12.0	9.5	14.5
Minimum	1.2	1.1	-8.3	0.9	-25.0	0.9	-25.0
Maximum	14.8	16.2	9.5	17.2	16.2	17.4	17.6
Spring							
Average	19	19.8	4.2	20.4	7.4	20.8	9.5
Minimum	12.4	13	4.8	13.4	8.1	13.6	9.7
Maximum	25.7	26.7	3.9	27.5	7.0	28.1	9.3
Summer							
Average	26.9	27.7	3.0	28.3	5.2	28.7	6.7
Minimum	20.3	20.9	3.0	21.4	5.4	21.9	7.9
Maximum	33.4	34.4	3.0	35.1	5.1	35.2	5.4
Fall							
Average	16.8	17.7	5.4	18.4	9.5	18.7	11.3
Minimum	8.7	9.7	11.5	10.5	20.7	10.9	25.3
Maximum	24.3	25.1	3.3	25.7	5.8	25.9	6.6
Buner	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	21.6	22.5	4.2	23.1	6.9	23.3	7.9
Minimum	14.7	15.5	5.4	16.0	8.8	16.1	9.5
Maximum	28.4	29.4	3.5	30.1	6.0	30.4	7.0
Winter							
Average	11.7	12.1	3.4	12.4	6.0	12.4	6.0
Minimum	4.8	4.7	-2.1	4.5	-6.3	4.4	-8.3
Maximum	18.4	19.3	4.9	20.1	9.2	20.2	9.8
Spring							
Average	22.3	23.3	4.5	24.0	7.6	24.4	9.4
Minimum	15.3	16.1	5.2	16.5	7.8	16.7	9.2
Maximum	29.3	30.5	4.1	31.5	7.5	32.3	10.2
Summer							
Average	29.5	30.8	4.4	31.6	7.1	32.0	8.5
Minimum	23.4	24.2	3.4	24.6	5.1	24.8	6.0
Maximum	35.6	37.4	5.1	38.6	8.4	39.2	10.1
Fall							
Average	19.7	20.8	5.6	21.5	9.1	22.0	11.7

Minimum	11.5	12.1	5.2	12.5	8.7	12.7	10.4
Maximum	27.8	29.4	5.8	30.4	9.4	31.2	12.2
Haripur	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	21.3	22.4	5.1	23.2	8.8	23.6	10.7
Minimum	14.3	15.1	6.0	15.7	10.2	15.9	11.6
Maximum	28.4	29.8	5.0	30.8	8.5	31.4	10.6
Winter							
Average	11.1	11.9	7.2	12.3	10.8	12.5	12.6
Minimum	4.7	5.3	12.8	5.5	17.0	5.6	19.1
Maximum	17.4	18.4	5.7	19.0	9.2	19.3	10.9
Spring							
Average	22.4	24.2	8.0	25.2	12.5	25.6	14.3
Minimum	14.8	16.4	10.8	17.2	16.2	17.4	17.6
Maximum	30.0	32.0	6.7	33.2	10.7	33.8	12.7
Summer							
Average	29.2	30.6	4.8	31.6	8.2	32.2	10.3
Minimum	22.8	24.0	5.3	24.8	8.8	25.2	10.5
Maximum	35.5	37.1	4.5	38.3	7.9	39.1	10.1
Fall							
Average	20.0	21.2	6.0	21.8	9.0	22.2	11.0
Minimum	11.6	12.4	6.9	12.8	10.3	13.0	12.1
Maximum	28.3	29.9	5.5	30.7	8.3	31.3	10.4
Mansehra	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	17.3	18.3	5.8	19.0	9.8	19.5	12.7
Minimum	11.4	12.2	7.0	12.8	12.3	13.2	15.8
Maximum	23.2	24.4	5.2	25.2	8.6	25.8	11.2
Winter							
Average	8.3	8.9	7.2	9.3	12.0	9.5	14.5
Minimum	2.7	2.6	-3.7	2.4	-11.1	2.4	-11.1
Maximum	13.9	15.3	10.1	16.3	17.3	16.5	18.7
Spring							
Average	17.8	18.6	4.5	19.2	7.9	19.6	10.1
Minimum	11.8	12.4	5.1	12.8	8.5	13.0	10.2
Maximum	23.8	24.8	4.2	25.6	7.6	26.2	10.1
Summer							
Average	24.3	25.1	3.3	25.7	5.8	26.1	7.4
Minimum	18.8	19.4	3.2	19.9	5.9	20.2	7.4
Maximum	29.9	30.9	3.3	31.6	5.7	32.1	7.4
Fall							
Average	15.9	16.8	5.7	17.5	10.1	17.8	11.9
Minimum	8.7	9.7	11.5	10.5	20.7	10.9	25.3
Maximum	23.1	23.9	3.5	24.5	6.1	24.7	6.9
Bajaur	1981-2010	2011-2020	Base	2021-2030	Base	2031-2040	Base
Annual							
Average	19.7	20.7	5.1	21.4	8.6	21.9	11.2
Minimum	13.0	13.8	6.2	14.4	10.8	14.8	13.8
Maximum	26.5	27.7	4.5	28.5	7.5	29.1	9.8
Winter							
Average	10.1	10.7	5.9	11.1	9.9	11.3	11.9
Minimum	3.5	3.4	-2.9	3.3	-5.7	3.3	-5.7
Maximum	16.7	18.1	8.4	18.9	13.2	19.1	14.4
Spring							
Average	21.0	21.8	3.8	22.4	6.7	22.8	8.6
Minimum	14.3	14.9	4.2	15.3	7.0	15.5	8.4

Maximum	27.6	28.6	3.6	29.4	6.5	30.0	8.7
Summer							
Average	28.9	29.7	2.8	30.3	4.8	30.7	6.2
Minimum	22.8	23.4	2.6	23.9	4.8	24.2	6.1
Maximum	35.1	36.1	2.8	36.8	4.8	37.3	6.3
Fall							
Average	18.8	19.7	4.8	20.4	8.5	20.7	10.1
Minimum	11.2	12.2	8.9	13.0	16.1	13.4	19.6
Maximum	26.4	27.2	3.0	27.8	5.3	28.0	6.1
Abbottabad	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	16.8	17.6	4.8	18.2	8.3	18.6	10.7
Minimum	10.4	11.0	5.8	11.4	9.6	11.6	11.5
Maximum	23.1	24.1	4.3	24.9	7.8	25.5	10.4
Winter							
Average	8.0	8.6	7.5	9.0	12.5	9.2	15.0
Minimum	-1.8	-1.6	-11.1	-1.4	-22.2	-1.3	-27.8
Maximum	14.2	15.2	7.0	15.8	11.3	16.1	13.4
Spring							
Average	17.0	17.8	4.7	18.4	8.2	18.8	10.6
Minimum	10.5	11.1	5.7	11.5	9.5	11.7	11.4
Maximum	23.6	24.6	4.2	25.4	7.6	26.0	10.2
Summer							
Average	23.8	24.6	3.4	25.2	5.9	25.6	7.6
Minimum	18.1	18.7	3.3	19.2	6.1	19.5	7.7
Maximum	29.5	30.5	3.4	31.2	5.8	31.7	7.5
Fall							
Average	15.5	16.4	5.8	17.4	10.3	17.4	12.3
Minimum	8.1	9.1	12.3	9.9	22.2	10.3	27.2
Maximum	22.9	23.7	3.5	24.3	6.1	24.5	7.0
Chitral South	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	16.1	17	5.6	17.7	9.9	18	11.8
Minimum	8.5	9.1	7.1	9.7	14.1	9.9	16.5
Maximum	23.8	25	5.0	25.8	8.4	26.2	10.1
Winter							
Average	7.3	7.9	8.2	8.3	13.7	8.5	16.4
Minimum	0.7	0.9	28.6	1.1	57.1	1.2	71.4
Maximum	13.9	14.9	7.2	15.5	11.5	15.8	13.7
Spring							
Average	10.8	11.6	7.4	12.2	13.0	12.6	16.7
Minimum	4.5	5.1	13.3	5.5	22.2	5.7	26.7
Maximum	17.2	18.2	5.8	19	10.5	19.6	14.0
Summer							
Average	24.7	25.5	3.2	26.1	5.7	26.5	7.3
Minimum	16.1	16.7	3.7	17.2	6.8	17.5	8.7
Maximum	33.3	34.3	3.0	35	5.1	35.5	6.6
Fall							
Average	21.6	22.5	4.2	23.2	7.4	23.5	8.8
Minimum	12.6	13.6	7.9	14.4	14.3	14.8	17.5
Maximum	30.7	31.5	2.6	32.1	4.6	32.3	5.2
Chitral North	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	15.1	16.0	6.0	16.7	10.6	17.0	12.6
Minimum	7.9	8.5	7.6	9.1	15.2	9.3	17.7
Maximum	22.2	23.4	5.4	24.2	9.0	24.6	10.8

Winter							
Average	6.6	7.2	9.1	7.6	15.2	7.8	18.2
Minimum	0.4	0.6	50.0	0.8	100.0	0.9	125.0
Maximum	12.7	13.7	7.9	14.3	12.6	14.6	15.0
Spring							
Average	9.8	10.6	8.2	11.2	14.3	11.6	18.4
Minimum	3.5	4.1	17.1	4.5	28.6	4.7	34.3
Maximum	16.0	17.0	6.3	17.8	11.3	18.4	15.0
Summer							
Average	23.2	24.0	3.4	24.6	6.0	25.0	7.8
Minimum	14.3	14.9	4.2	15.4	7.7	15.7	9.8
Maximum	32.0	33.0	3.1	33.7	5.3	34.2	6.9
Fall							
Average	20.7	21.6	4.3	22.3	7.7	22.6	9.2
Minimum	11.8	12.8	8.5	13.6	15.3	14.0	18.6
Maximum	29.5	30.3	2.7	30.9	4.7	31.1	5.4
Swat Lower	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	19.2	20.3	5.7	21.1	9.9	21.5	12.0
Minimum	12.0	12.8	6.7	13.4	11.7	13.6	13.3
Maximum	26.3	27.7	5.3	28.7	9.1	29.3	11.4
Winter							
Average	10.5	11.3	7.6	11.7	11.4	11.9	13.3
Minimum	3.6	4.0	11.1	4.2	16.7	4.2	16.7
Maximum	17.4	18.6	6.9	19.2	10.3	19.5	12.1
Spring							
Average	16.8	18.6	10.7	19.6	16.7	20.0	19.0
Minimum	9.9	11.5	16.2	12.3	24.2	12.5	26.3
Maximum	23.8	25.8	8.4	27.0	13.4	27.6	16.0
Summer							
Average	27.2	28.6	5.1	29.6	8.8	30.2	11.0
Minimum	20.1	21.3	6.0	22.1	10.0	22.5	11.9
Maximum	34.2	35.8	4.7	37.0	8.2	37.8	10.5
Fall							
Average	22.2	23.5	5.9	24.1	8.6	24.5	10.4
Minimum	14.5	15.3	5.5	15.7	8.3	15.7	8.3
Maximum	30.0	31.6	5.3	32.4	8.0	33.2	10.7
Malakand	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	15.5	16.3	5.2	17.1	10.3	17.5	12.9
Minimum	7.7	8.3	7.8	8.9	15.6	9.1	18.2
Maximum	23.2	24.2	4.3	25.2	8.6	25.8	11.2
Winter							
Average	7.2	7.8	8.3	8.1	12.5	8.3	15.3
Minimum	-0.5	-0.3	-40.0	-0.2	-60.0	-0.2	-60.0
Maximum	14.9	15.9	6.7	16.3	9.4	16.5	10.7
Spring							
Average	12.6	13.0	3.2	13.2	4.8	13.3	5.6
Minimum	5.3	5.5	3.8	5.9	11.3	6.1	15.1
Maximum	19.9	20.5	3.0	21.3	7.0	21.9	10.1
Summer							
Average	23.3	23.8	2.1	24.4	4.7	24.8	6.4
Minimum	15.9	16.3	2.5	16.8	5.7	17.1	7.5
Maximum	30.8	31.4	1.9	32.1	4.2	32.6	5.8
Fall							
Average	18.9	19.8	4.8	20.5	8.5	21.0	11.1

Minimum	10.4	11.0	5.8	11.6	11.5	11.9	14.4
Maximum	27.4	28.6	4.4	29.4	7.3	30.1	9.9
Kohistan Lower	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	19.5	20.5	5.1	21.3	9.2	21.7	11.3
Minimum	12.3	12.9	4.9	13.5	9.8	13.7	11.4
Maximum	26.7	28.1	5.2	29.1	9.0	29.7	11.2
Winter							
Average	10.7	11.1	3.7	11.4	6.5	11.6	8.4
Minimum	3.6	3.5	-2.8	3.4	-5.6	3.4	-5.6
Maximum	17.8	18.6	4.5	19.3	8.4	19.5	9.6
Spring							
Average	17.2	17.6	2.3	17.8	3.5	17.9	4.1
Minimum	10.2	10.8	5.9	11.2	9.8	11.4	11.8
Maximum	24.2	25.2	4.1	26.0	7.4	26.6	9.9
Summer							
Average	27.5	28.3	2.9	28.9	5.1	29.3	6.5
Minimum	20.4	21.0	2.9	21.5	5.4	21.8	6.9
Maximum	34.7	35.7	2.9	36.4	4.9	36.9	6.3
Fall							
Average	22.8	23.7	3.9	24.4	7.0	24.7	8.3
Minimum	15.3	16.3	6.5	17.1	11.8	17.5	14.4
Maximum	29.7	30.5	2.7	31.1	4.7	31.3	5.4
Kohistan Upper	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	18.9	19.7	4.2	20.3	7.4	20.5	8.5
Minimum	11.8	12.4	5.1	12.8	8.5	12.8	8.5
Maximum	26.1	27.3	4.6	28.1	7.7	28.5	9.2
Winter							
Average	10.2	10.6	3.9	10.9	6.9	11.1	8.8
Minimum	3.3	3.2	-3.0	3.1	-6.1	3.1	-6.1
Maximum	17.2	18.0	4.7	18.7	8.7	18.9	9.9
Spring							
Average	16.7	17.1	2.4	17.3	3.6	17.4	4.2
Minimum	9.8	10.4	6.1	10.8	10.2	11.0	12.2
Maximum	23.5	24.5	4.3	25.3	7.7	25.9	10.2
Summer							
Average	27.0	27.8	3.0	28.4	5.2	28.8	6.7
Minimum	19.9	20.5	3.0	21.0	5.5	21.3	7.0
Maximum	34.0	35.0	2.9	35.7	5.0	36.2	6.5
Fall							
Average	21.9	22.8	4.1	23.5	7.3	23.8	8.7
Minimum	14.1	15.1	7.1	15.9	12.8	16.3	15.6
Maximum	29.7	30.5	2.7	31.1	4.7	31.3	5.4
Kala Dhaka	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	18.3	19.1	4.4	19.7	7.7	20.1	9.8
Minimum	11.8	12.7	7.6	13.5	14.4	14.0	18.6
Maximum	24.9	25.5	2.4	25.9	4.0	26.2	5.2
Winter							
Average	10.2	10.8	5.9	11.2	9.8	11.4	11.8
Minimum	3.6	4.4	22.2	5.0	38.9	5.3	47.2
Maximum	16.7	17.1	2.4	17.3	3.6	17.4	4.2
Spring							
Average	16.3	16.7	2.5	17.1	4.9	17.3	6.1
Minimum	10.1	10.3	2.0	10.5	4.0	10.6	5.0

Maximum	22.5	23.1	2.7	23.7	5.3	24.0	6.7
Summer							
Average	25.9	26.5	2.3	26.9	3.9	27.1	4.6
Minimum	19.7	20.4	3.6	20.9	6.1	21.2	7.6
Maximum	32.0	32.5	1.6	32.8	2.5	32.9	2.8
Fall							
Average	21.0	21.9	4.3	22.6	7.6	22.9	9.0
Minimum	13.7	14.7	7.3	15.5	13.1	15.9	16.1
Maximum	28.3	29.1	2.8	29.7	4.9	29.9	5.7
Battagram	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	18.7	19.5	4.3	20.1	7.5	20.5	9.6
Minimum	12.2	13.1	7.4	13.9	13.9	14.4	18.0
Maximum	25.3	25.9	2.4	26.3	4.0	26.6	5.1
Winter		**19.5**					
Average	10.6	10.7	0.9	11.0	3.8	11.1	4.7
Minimum	4.1	4.0	-2.4	3.8	-7.3	3.6	-12.2
Maximum	17.0	17.3	1.8	17.8	4.7	18.3	7.6
Spring		**10.7**					
Average	16.7	17.1	2.4	17.3	3.6	17.4	4.2
Minimum	10.5	11.1	5.7	11.4	8.6	11.5	9.5
Maximum	22.9	23.1	0.9	23.2	1.3	23.3	1.7
Summer		**17.1**					
Average	26.2	26.8	2.3	27.2	3.8	27.4	4.6
Minimum	20.0	20.7	3.5	21.2	6.0	21.5	7.5
Maximum	32.4	32.9	1.5	33.2	2.5	33.3	2.8
Fall		**26.8**					
Average	21.6	22.5	4.2	23.2	7.4	23.5	8.8
Minimum	14.3	15.3	7.0	16.1	12.6	16.5	15.4
Maximum	28.9	29.7	2.8	30.3	4.8	30.5	5.5
Shangla	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	15.7	16.5	5.1	16.9	7.6	17.1	8.9
Minimum	9.4	10.3	9.6	10.6	12.8	10.7	13.8
Maximum	22.1	22.7	2.7	23.2	5.0	23.5	6.3
Winter							
Average	6.5	7.1	9.2	7.5	15.4	7.7	18.5
Minimum	0.6	0.5	-16.7	0.3	-50.0	0.3	-50.0
Maximum	12.3	13.7	11.4	14.7	19.5	14.9	21.1
Spring							
Average	15.7	16.5	5.1	17.1	8.9	17.5	11.5
Minimum	9.4	10	6.4	10.4	10.6	10.6	12.8
Maximum	22	23	4.5	23.8	8.2	24.4	10.9
Summer							
Average	23.4	24.2	3.4	24.8	6.0	25.2	7.7
Minimum	17.3	17.9	3.5	18.4	6.4	18.9	9.2
Maximum	29.4	30.4	3.4	31.1	5.8	31.2	6.1
Fall							
Average	14.5	15.4	6.2	16.1	11.0	16.4	13.1
Minimum	7	8	14.3	8.8	25.7	9.2	31.4
Maximum	21.9	22.7	3.7	23.3	6.4	23.5	7.3
Swat Upper	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	16.7	17.5	4.8	18.1	8.4	18.5	10.8
Minimum	9.8	10.4	6.1	10.8	10.2	11	12.2
Maximum	23.5	24.5	4.3	25.3	7.7	25.9	10.2

Winter							
Average	7.2	7.5	4.2	7.7	6.9	7.9	9.7
Minimum	0.8	0.6	-25.0	0.5	-37.5	0.6	-25.0
Maximum	13.6	14.4	5.9	14.9	9.6	15.2	11.8
Spring							
Average	15.1	16.3	7.9	17.3	14.6	17.9	18.5
Minimum	7.7	8.7	13.0	9.5	23.4	9.9	28.6
Maximum	22.5	23.9	6.2	25.1	11.6	25.9	15.1
Summer							
Average	25	26	4.0	26.8	7.2	27.4	9.6
Minimum	18.2	19	4.4	19.6	7.7	20	9.9
Maximum	31.9	33.1	3.8	34.1	6.9	34.9	9.4
Fall							
Average	19.6	20.4	4.1	21	7.1	21.4	9.2
Minimum	12.5	13.1	4.8	13.5	8.0	13.7	9.6
Maximum	26.6	27.6	3.8	28.4	6.8	29	9.0

Table 8: *Temperature data and scenario Khyber Pakhtunkhwa (Central region).*

Temperature (°C)	**Base**	**Projected**	**% change from**	**Projected**	**% change from**	**Projected**	**% change from**
Swabi	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	20.9	21.7	3.8	22.3	6.6	22.5	7.6
Minimum	13.9	14.5	4.0	15.0	7.8	15.1	8.5
Maximum	27.9	28.9	3.6	29.6	6.1	29.9	7.2
Winter							
Average	11.8	12.4	5.4	12.7	8.0	12.7	8.0
Minimum	4.9	5.6	13.6	6.0	21.7	5.9	19.7
Maximum	18.6	19.1	2.7	19.3	3.8	19.4	4.3
Spring							
Average	22.5	23.3	3.4	24.0	6.5	24.4	8.4
Minimum	15.6	16.4	5.1	17.1	9.6	17.4	11.5
Maximum	29.5	30.5	3.5	31.5	6.9	32.0	8.6
Summer							
Average	29.7	30.2	1.8	30.5	2.8	30.7	3.5
Minimum	23.5	23.9	1.6	24.3	3.3	24.4	3.7
Maximum	35.5	36.1	1.7	36.3	2.3	36.6	3.1
Fall							
Average	19.7	20.4	3.7	20.9	6.2	21.1	7.2
Minimum	11.6	12.2	4.8	12.5	7.4	12.6	8.2
Maximum	27.7	28.5	2.9	29.2	5.4	29.5	6.5
Mohmand	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	13.1	13.9	6.1	14.5	10.7	14.9	13.7
Minimum	7.4	8.1	9.5	8.5	14.9	8.7	17.6
Maximum	18.9	19.8	4.8	20.6	9.0	21.2	12.2
Winter							
Average	4.3	4.9	14.0	5.3	23.3	5.5	27.9
Minimum	-1.4	-1.5	7.1	-1.7	21.4	-1.7	21.4
Maximum	9.9	11.3	14.1	12.3	24.2	12.5	26.3

Spring							
Average	13.7	14.5	5.8	15.1	10.2	15.5	13.1
Minimum	8.0	8.6	7.5	9.0	12.5	9.2	15.0
Maximum	19.4	20.4	5.2	21.2	9.3	21.8	12.4
Summer							
Average	21.6	22.4	3.7	23.0	6.5	23.4	8.3
Minimum	16.2	16.8	3.7	17.3	6.8	17.6	8.6
Maximum	26.9	27.9	3.7	28.6	6.3	29.1	8.2
Fall							
Average	13.0	13.9	6.9	14.6	12.3	14.9	14.6
Minimum	6.6	7.6	15.2	8.4	27.3	8.8	33.3
Maximum	19.3	20.1	4.1	20.7	7.3	20.9	8.3
Mardan	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	22.3	23.3	4.5	24.6	10.3	24.8	11.2
Minimum	15.4	15.8	2.6	16.4	6.5	16.6	7.8
Maximum	29.1	30.7	5.5	32.7	12.4	33.0	13.4
Winter							
Average	12.0	12.6	5.0	13.4	11.7	13.6	13.3
Minimum	5.0	5.4	8.0	5.6	12.0	5.6	12.0
Maximum	18.8	19.8	5.3	21.0	11.7	21.5	14.4
Spring							
Average	22.9	23.9	4.4	25.2	10.0	25.6	11.8
Minimum	16.0	16.2	1.3	16.6	3.8	16.8	5.0
Maximum	29.8	31.6	6.0	33.8	13.4	34.4	15.4
Summer							
Average	30.5	31.8	4.3	32.6	6.9	33.0	8.2
Minimum	24.4	24.8	1.6	25.4	4.1	25.6	4.9
Maximum	36.7	38.9	6.0	40.7	10.9	41.3	12.5
Fall							
Average	20.3	21.4	5.4	22.8	12.3	23.0	13.3
Minimum	12.3	12.9	4.9	13.7	11.4	14.2	15.4
Maximum	28.3	29.9	5.7	31.9	12.7	32.4	14.5
Nowshera	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	21.9	22.7	3.7	23.3	6.4	23.5	7.3
Minimum	15.1	15.7	4.0	16.2	7.3	16.3	7.9
Maximum	28.7	29.7	3.5	30.4	5.9	30.7	7.0
Winter							
Average	12.0	12.6	5.0	12.9	7.5	12.9	7.5
Minimum	4.9	5.6	14.3	6.0	22.4	5.9	20.4
Maximum	18.9	19.4	2.6	19.6	3.7	19.7	4.2
Spring							
Average	22.7	23.5	3.5	24.2	6.6	24.6	8.4
Minimum	15.7	16.5	5.1	17.2	9.6	17.5	11.5
Maximum	29.6	30.6	3.4	31.6	6.8	32.1	8.4
Summer							

Average	29.8	30.3	1.7	30.6	2.7	30.8	3.4
Minimum	23.9	24.3	1.7	24.7	3.3	24.8	3.8
Maximum	35.6	36.2	1.7	36.4	2.2	36.7	3.1
Fall							
Average	20.0	20.7	3.5	21.2	6.0	21.4	7.0
Minimum	12.2	12.8	4.9	13.1	7.4	13.2	8.2
Maximum	27.9	28.7	2.9	29.4	5.4	29.7	6.5
Peshawar	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.1	23.9	3.5%	24.5	6.1%	24.9	7.8
Minimum	16.4	17.3	5.5%	18.1	10.4%	18.6	13.4
Maximum	29.9	30.5	2.0%	30.9	3.3%	31.2	4.3
Winter							
Average	13.9	14.5	4.3%	14.9	7.2%	15.1	8.6
Minimum	6.7	7.5	11.9%	8.1	20.9%	8.4	25.4
Maximum	21.2	21.6	1.9%	21.8	2.8%	21.9	3.3
Spring							
Average	20.9	21.3	1.9%	21.7	3.8%	21.8	4.3
Minimum	14.3	14.9	4.2%	15.5	8.4%	15.6	9.1
Maximum	27.5	27.7	0.7%	27.9	1.5%	28.0	1.8
Summer							
Average	31.3	31.9	1.9%	32.3	3.2%	32.5	3.8
Minimum	25	25.7	2.8%	26.2	4.8%	26.5	6.0
Maximum	37.6	38.1	1.3%	38.4	2.1%	38.5	2.4
Fall							
Average	26.4	27.3	3.4%	28.0	6.1%	28.3	7.2
Minimum	19.7	20.7	5.1%	21.5	9.1%	21.9	11.2
Maximum	33.2	34.0	2.4%	34.6	4.2%	34.8	4.8
Khyber	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.2	24.0	3.4	24.4	5.2	24.6	6.0
Minimum	16.4	17.3	5.5	17.6	7.3	17.7	7.9
Maximum	29.9	30.5	2.0	31.0	3.7	31.3	4.7
Winter							
Average	13.9	14.3	2.9	14.6	5.0	14.8	6.5
Minimum	6.6	6.8	3.0	7.0	6.1	7.1	7.6
Maximum	21.2	21.8	2.8	22.2	4.7	22.5	6.1
Spring							
Average	21.2	22.0	3.8	22.6	6.6	22.8	7.5
Minimum	14.4	15.0	4.2	15.4	6.9	15.5	7.6
Maximum	27.9	28.9	3.6	29.7	6.5	30.0	7.5
Summer							
Average	31.2	31.8	1.9	32.2	3.2	32.4	3.8
Minimum	25.0	25.7	2.8	26.2	4.8	26.5	6.0
Maximum	37.5	38.0	1.3	38.3	2.1	38.4	2.4
Fall							
Average	26.5	27.4	3.4	28.1	6.0	28.4	7.2

Minimum	19.8	20.8	5.1	21.6	9.1	22.0	11.1
Maximum	33.2	34.0	2.4	34.6	4.2	34.8	4.8
Charsadda (^{0}C)	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	22.6	23.4	3.5	24.0	6.2	24.4	8.0
Minimum	15.9	16.8	5.7	17.6	10.7	18.1	13.8
Maximum	29.4	30.0	2.0	30.4	3.4	30.7	4.4
Winter							
Average	13.5	14.1	4.4	14.5	7.4	14.7	8.9
Minimum	6.2	7.0	12.9	7.6	22.6	7.9	27.4
Maximum	20.8	21.2	1.9	21.4	2.9	21.5	3.4
Spring							
Average	20.3	20.7	2.0	20.9	3.0	21.0	3.4
Minimum	13.6	14.2	4.4	14.5	6.6	14.6	7.4
Maximum	27.1	27.3	0.7	27.4	1.1	27.5	1.5
Summer							
Average	30.7	31.3	2.0	31.7	3.3	31.9	3.9
Minimum	24.6	25.3	2.8	25.8	4.9	26.1	6.1
Maximum	36.8	37.3	1.4	37.6	2.2	37.7	2.4
Fall							
Average	26.0	26.9	3.5	27.6	6.2	27.9	7.3
Minimum	19.2	20.2	5.2	21.0	9.4	21.4	11.5
Maximum	32.8	33.6	2.4	34.2	4.3	34.4	4.9

Table 9: *Temperature data and scenario Khyber Pakhtunkhwa (South region).*

Temperature (°C)	**Base**	**Projected**	**% change from**	**Projected**	**% change from**	**Projected**	**% change from**
Karak south	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.0	23.8	3.7	24.4	6.3	24.6	7.1
Minimum	16.0	16.6	4.0	17.1	7.1	17.2	7.8
Maximum	30.0	31.0	3.5	31.7	5.8	32.0	6.8
Winter							
Average	12.0	12.6	5.3	12.9	7.8	12.9	7.8
Minimum	4.8	5.5	15.3	5.9	23.7	5.8	21.6
Maximum	19.2	19.7	2.6	19.9	26.9	20	3.0
Spring							
Average	24.1	24.9	3.3	25.6	6.2%	26	7.9
Minimum	17	17.8	4.7	18.5	8.8%	18.8	10.6
Maximum	31.1	32.1	3.2	33.1	6.4%	33.6	8.0
Summer							
Average	32.2	32.7	1.6	33	2.5%	33.2	3.1
Minimum	25.9	26.3	1.5	26.7	3.1%	26.8	3.5
Maximum	38.5	39.1	1.6	39.3	2.1%	39.6	2.9
Fall							
Average	23.6	24.3	3.0	24.8	5.1%	25	5.9
Minimum	16.2	16.8	3.7	17.1	5.6%	17.2	6.2
Maximum	31.1	31.9	2.6	32.6	4.8%	32.9	5.8
Bannu	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							

Average	20.6	21.7	5.3	22.5	9.2	23.0	11.7
Minimum	13.9	14.6	5.0	15.2	9.4	15.6	12.2
Maximum	27.4	28.8	5.1	29.8	8.8	30.4	10.9
Winter							
Average	10.0	10.6	6.0	11.4	14.0	11.8	18.0
Minimum	3.1	3.6	16.1	3.8	22.6	3.8	22.6
Maximum	16.8	17.5	4.2	18.9	12.5	19.7	17.3
Spring							
Average	21.4	22.5	5.1	23.3	8.9	24.0	12.1
Minimum	14.5	14.9	2.8	15.5	6.9	15.7	8.3
Maximum	28.3	30.1	6.4	31.5	11.3	32.0	13.1
Summer							
Average	29.0	30.5	5.2	31.5	8.6	32.1	10.7
Minimum	22.8	23.2	1.8	23.8	4.4	24.2	6.1
Maximum	35.1	37.5	6.8	39.0	11.1	40.0	14.0
Fall							
Average	18.8	19.7	4.8	20.2	7.4	20.4	8.5
Minimum	11.2	11.8	5.4	12.2	8.9	12.2	8.9
Maximum	26.4	27.4	3.8	28.2	9.9	28.6	8.3
Lakki Marwat	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.4	24.5	4.7	25.3	8.1	25.7	9.8
Minimum	16.4	17.2	4.9	17.8	8.5	18.0	9.8
Maximum	30.4	31.8	4.6	32.8	7.9	33.4	9.9
Winter							
Average	12.9	13.7	6.2	14.1	9.3	14.3	10.9
Minimum	5.4	6.0	11.1	6.2	14.8	6.3	16.7
Maximum	20.2	21.2	5.0	21.8	7.9	22.1	9.4
Spring							
Average	24.7	26.5	7.3	27.5	11.3	27.9	13.0
Minimum	17.5	19.1	9.1	19.9	13.7	20.1	14.9
Maximum	31.8	33.2	4.4	35.0	10.1	35.6	11.9
Summer							
Average	31.4	32.8	4.5	33.8	7.6	34.4	9.6
Minimum	25.3	26.5	4.7	27.3	3.9	27.7	9.5
Maximum	37.4	39.0	4.3	40.2	7.5	41.0	9.6
Fall							
Average	21.5	22.7	5.6	23.3	8.4	23.7	10.2
Minimum	13.5	14.3	5.9	14.7	8.9	14.9	10.4
Maximum	29.5	31.1	5.4	31.9	8.1	32.5	10.2
FR. D.I khan	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	18.9	19.5	3.2	19.9	5.3	20.1	6.3
Minimum	12.2	12.6	3.3	12.9	5.7	13	6.6
Maximum	25.6	26.4	3.1	26.9	5.1	27.2	6.2
Winter							
Average	7.8	8.4	7.7	8.7	11.5	8.7	11.5

Minimum	1.2	1.9	58.3	2.3	91.7	2.2	83.3
Maximum	14.4	14.9	3.5	15.1	4.9	15.2	5.6
Spring							
Average	19.7	20.1	2.0	20.3	3.0	20.5	4.1
Minimum	13.1	13.6	3.8	13.9	6.1	13.9	6.1
Maximum	26.3	26.6	1.1	26.7	1.5	27.1	3.0
Summer							
Average	28.4	28.9	1.8	29.2	2.8	29.4	3.5
Minimum	22.1	22.5	1.8	22.9	3.6	23	4.1
Maximum	34.7	35.3	1.7	35.5	2.3	35.8	3.2
Fall							
Average	19.7	20.6	4.6	21.3	8.1	21.7	10.2
Minimum	12.5	13.1	4.8	13.7	9.6	14	12.0
Maximum	27	28.2	4.4	29	7.4	29.5	9.3
D.I khan	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	24.2	24.8	2.5	25.2	4.1	25.4	5.0
Minimum	16.9	17.3	2.4	17.6	4.1	17.7	4.7
Maximum	31.5	32.3	2.5	32.8	4.1	33.1	5.1
Winter							
Average	15.2	15.8	3.9	16.1	5.9	16.1	5.9
Minimum	7	7.7	10.0	8.1	15.7	8	14.3
Maximum	23.4	23.9	2.1	24.1	3.0	24.2	3.4
Spring							
Average	20.1	20.5	2.0	20.7	3.0	20.9	4.0
Minimum	12.8	13.3	3.9	13.6	6.2	13.6	6.2
Maximum	27.4	27.7	1.1	27.8	1.5	28.2	2.9
Summer							
Average	32.4	32.9	1.5	33.2	2.5	33.4	3.1
Minimum	25.4	25.8	1.6	26.2	3.1	26.3	3.5
Maximum	39.5	40.1	1.5	40.3	2.0	40.6	2.8
Fall							
Average	29	29.9	3.1	30.6	5.5	31	6.9
Minimum	22.3	22.9	2.7	23.5	5.4	23.8	6.7
Maximum	35.6	36.8	3.4	37.6	5.6	38.1	7.0
Karak North	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	20.3	20.9	3.0	21.3	4.9	21.5	5.9
Minimum	13.7	14.1	2.9	14.4	5.1	14.5	5.8
Maximum	26.9	27.7	3.0	28.2	4.8	28.5	5.9
Winter							
Average	10	10.6	6.0	10.9	9.0	10.9	9.0
Minimum	3.3	4	21.2	4.4	33.3	4.3	30.3
Maximum	16.8	17.3	3.0	17.5	4.2	17.6	4.8
Spring							
Average	20.9	21.5	2.9	22	5.3	22.4	7.2
Minimum	14.3	14.8	3.5	15.1	5.6	15.4	7.7

Maximum	27.5	28.2	2.5	28.9	5.1	29.4	6.9
Summer							
Average	29.1	29.6	1.7	29.9	2.7	30.1	3.4
Minimum	23.3	23.7	1.7	24.1	3.4	24.2	3.9
Maximum	35	35.6	1.7	35.8	2.3	36.1	3.1
Fall							
Average	21.3	22	3.3	22.5	5.6	22.7	6.6
Minimum	14.3	14.9	4.2	15.2	6.3	15.3	7.0
Maximum	28.2	29	2.8	29.7	5.3	30	6.4
Orakzai	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.0	23.8	3.5	24.2	5.2	24.4	6.1
Minimum	16.5	17.4	5.5	17.7	7.3	17.8	7.9
Maximum	29.5	30.1	2.0	30.6	3.7	30.9	4.7
Winter							
Average	13.9	14.3	2.9	14.6	5.0	14.8	6.5
Minimum	7.3	7.5	2.7	7.7	5.5	7.8	6.8
Maximum	20.5	21.1	2.9	21.5	4.9	21.8	6.3
Spring							
Average	20.9	21.7	3.8	22.3	6.7	22.5	7.7
Minimum	14.5	15.1	4.1	15.5	6.9	15.6	7.6
Maximum	27.2	28.2	3.7	29.0	6.6	29.3	7.7
Summer							
Average	30.8	31.4	1.9	31.8	3.2	32.0	3.9
Minimum	24.4	25.1	2.9	25.6	4.9	25.9	6.1
Maximum	37.3	37.8	1.3	38.1	2.1	38.2	2.4
Fall							
Average	26.4	27.3	3.4	28.0	6.1	28.3	7.2
Minimum	20.0	21.0	5.0	21.8	9.0	22.2	11.0
Maximum	32.9	33.7	2.4	34.3	4.3	34.5	4.9
Kurram	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	13.5	14.3	5.9	15.1	11.9	15.5	14.8
Minimum	7.6	8.2	7.9	8.8	15.8	9.0	18.4
Maximum	19.3	20.3	5.2	21.3	10.4	21.9	13.5
Winter							
Average	6.1	6.5	6.6	6.8	11.5	7.0	14.8
Minimum	-1.2	-0.8	-33.3	-0.6	-50.0	-0.6	-50.0
Maximum	13.5	13.9	3.0	14.3	5.9	14.5	7.4
Spring							
Average	7.1	7.7	8.5	7.9	11.3	8.0	12.7
Minimum	5.0	5.6	12.0	6.0	20.0	6.2	24.0
Maximum	9.2	10.2	10.9	11.0	19.6	11.6	26.1
Summer							
Average	22.5	23.1	2.7	23.7	5.3	24.1	7.1
Minimum	15.7	16.3	3.8	16.8	7.0	17.1	8.9
Maximum	29.3	30.3	3.4	31.0	5.8	31.5	7.5

Fall							
Average	18.2	19.1	4.9	19.8	8.8	20.3	11.5
Minimum	11.0	11.8	7.3	12.4	12.7	12.7	15.5
Maximum	25.3	26.3	4.0	27.1	7.1	27.8	9.9
Hangu	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.5	24.3	3.4	24.7	5.1	24.9	6.0
Minimum	17.1	18.0	5.3	18.3	7.0	18.4	7.6
Maximum	30.0	30.6	2.0	31.1	3.7	31.4	4.7
Winter							
Average	14.4	15.0	4.2	15.5	7.6	15.6	8.3
Minimum	7.9	8.3	5.1	8.6	8.9	8.6	8.9
Maximum	21.0	21.8	3.8	22.5	7.1	22.7	8.1
Spring							
Average	21.3	22.1	3.8	22.7	6.6	23.1	8.5
Minimum	14.9	15.5	4.0	15.9	6.7	16.1	8.1
Maximum	27.8	28.8	3.6	29.6	6.5	30.2	8.6
Summer							
Average	31.5	32.1	1.9	32.5	3.2	32.7	3.8
Minimum	25.1	25.6	2.0	25.9	3.2	26.0	3.6
Maximum	38.0	38.7	1.8	39.2	3.2	39.5	3.9
Fall							
Average	26.8	27.7	3.4	28.4	6.0	28.7	7.1
Minimum	20.4	21.4	4.9	22.2	8.8	22.6	10.8
Maximum	33.3	34.1	2.4	34.7	4.2	34.9	4.8
Kohat	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	24.6	25.4	3.3	25.8	4.9	26.0	5.7
Minimum	17.7	18.6	5.1	18.9	6.8	19.0	7.3
Maximum	31.5	32.1	1.9	32.6	3.5	32.9	4.4
Winter							
Average	15.1	15.7	4.0	16.2	7.3	16.3	7.9
Minimum	7.7	8.1	5.2	8.4	9.1	8.4	9.1
Maximum	22.5	23.3	3.6	24.0	6.7	24.2	7.6
Spring							
Average	23.1	23.9	3.5	24.5	6.1	24.9	7.8
Minimum	16.1	16.7	3.7	17.1	6.2	17.3	7.5
Maximum	30.2	31.2	3.3	32.0	6.0	32.6	7.9
Summer							
Average	32.5	33.1	1.8	33.5	3.1	33.7	3.7
Minimum	26.1	26.8	2.7	27.3	4.6	27.6	5.7
Maximum	39.0	39.5	1.3	39.8	2.1	39.9	2.3
Fall							
Average	27.6	28.5	3.3	29.2	5.8	29.5	6.9
Minimum	20.8	21.8	4.8	22.6	8.7	23.0	10.6
Maximum	34.4	35.2	2.3	35.8	4.1	36.0	4.7
Tank	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**

Annual							
Average	26.0	26.8	3.1	27.2	4.6	27.4	5.4
Minimum	19.1	20.0	4.7	20.3	6.3	20.4	6.8
Maximum	32.9	33.5	1.8	34.0	3.3	34.3	4.3
Winter							
Average	16.5	17.1	3.6	17.6	6.7	17.7	7.3
Minimum	9.1	9.7	6.6	10.1	11.0	10.1	11.0
Maximum	23.9	24.7	3.3	25.4	6.3	25.6	7.1
Spring							
Average	24.5	25.1	2.4	25.5	4.1	25.9	5.7
Minimum	17.5	18.0	2.9	18.3	4.6	18.6	6.3
Maximum	31.6	32.3	2.2	32.8	3.8	33.3	5.4
Summer							
Average	33.9	34.5	1.8	34.9	2.9	35.1	3.5
Minimum	27.5	28.0	1.8	28.3	2.9	28.4	3.3
Maximum	40.4	41.1	1.7	41.6	3.0	41.9	3.7
Fall							
Average	29.0	29.9	3.1	30.6	5.5	30.9	6.6
Minimum	22.2	23.2	4.5	24.0	8.1	24.4	9.9
Maximum	35.8	36.6	2.2	37.2	3.9	37.4	4.5
Waziristan North	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	24.1	24.9	3.3	25.3	5.0	25.5	5.8
Minimum	17.0	17.9	5.3	18.2	7.1	18.3	7.6
Maximum	31.1	31.7	1.9	32.2	3.5	32.5	4.5
Winter							
Average	14.4	15.0	4.2	15.2	5.6	15.3	6.3
Minimum	6.8	7.2	5.9	7.3	7.4	7.3	7.4
Maximum	22.0	22.8	3.6	23.1	5.0	23.3	5.9
Spring							
Average	22.7	23.5	3.5	24.1	6.2	24.5	7.9
Minimum	15.6	16.2	3.8	16.6	6.4	16.9	8.3
Maximum	29.9	30.9	3.3	31.7	6.0	32.2	7.7
Summer							
Average	32.2	32.8	1.9	33.2	3.1	33.4	3.7
Minimum	25.6	26.1	2.0	26.4	3.1	26.5	3.5
Maximum	38.7	39.4	1.8	39.9	3.1	40.2	3.9
Fall							
Average	26.9	27.8	3.3	28.5	5.9	28.8	7.1
Minimum	19.9	20.9	5.0	21.7	9.0	22.1	11.1
Maximum	34.0	34.8	2.4	35.4	4.1	35.6	4.7
Waziristan South	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	24.7	25.5	3.2	25.9	4.9	26.1	5.7
Minimum	17.4	18.3	5.2	18.6	6.9	18.7	7.5
Maximum	31.9	32.5	1.9	33.0	3.4	33.3	4.4
Winter							

Average	15.2	15.8	3.9	16.3	7.2	16.7	9.9
Minimum	7.2	7.7	6.9	8.1	12.5	8.4	16.7
Maximum	23.2	23.9	3.0	24.5	5.6	25.0	7.8
Spring							
Average	23.1	23.9	3.5	24.5	6.1	24.7	6.9
Minimum	15.8	16.4	3.8	16.8	6.3	16.9	7.0
Maximum	30.5	31.5	3.3	32.3	5.9	32.6	6.9
Summer							
Average	32.6	33.2	1.8	33.6	3.1	33.8	3.7
Minimum	26.2	26.7	1.9	27.0	3.1	27.1	3.4
Maximum	39.1	39.8	1.8	40.3	3.1	40.6	3.8
Fall							
Average	27.7	28.6	3.2	29.3	5.8	29.6	6.9
Minimum	20.6	21.6	4.9	22.4	8.7	22.8	10.7
Maximum	34.9	35.7	2.3	36.3	4.0	36.5	4.6
Lower / South Kurram	**1981-2010**	**2011-2020**	**Base**	**2021-2030**	**Base**	**2031-2040**	**Base**
Annual							
Average	23.5	24.3	3.4	24.7	5.1	24.9	6.0
Minimum	17.1	18.0	5.3	18.3	7.0	18.4	7.6
Maximum	30.0	30.6	2.0	31.1	3.7	31.4	4.7
Winter							
Average	14.4	15.0	4.2	15.5	7.6	15.6	8.3
Minimum	7.9	8.3	5.1	8.6	8.9	8.6	8.9
Maximum	21.0	21.8	3.8	22.5	7.1	22.7	8.1
Spring							
Average	21.3	22.1	3.8	22.7	6.6	23.1	8.5
Minimum	14.9	15.5	4.0	15.9	6.7	16.1	8.1
Maximum	27.8	28.8	3.6	29.6	6.5	30.2	8.6
Summer							
Average	31.5	32.1	1.9	32.5	3.2	32.7	3.8
Minimum	25.1	25.6	2.0	25.9	3.2	26.0	3.6
Maximum	38.0	38.7	1.8	39.2	3.2	39.5	3.9
Fall							
Average	26.8	27.7	3.4	28.4	6.0	28.7	7.1
Minimum	20.4	21.4	4.9	22.2	8.8	22.6	10.8
Maximum	33.3	34.1	2.4	34.7	4.2	34.9	4.8