ENVIRONMENTAL IMPACT OF CLIMATE CHANGE IN PAKISTAN

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ABSTRACT

Climate change results in the increase or decrease in temperature and rainfall. These have significant impact on environment – impinge agricultural crop yields, affect human health, cause changes to forests and other ecosystems, and even impact our energy supply. Climate change is a global phenomenon and its impact can be observed on Pakistan's economy and environment. This paper contains details concerning the climate change and environmental impacts. It takes into account current and projected key vulnerabilities, prospects for adaptation, and the relationships between climate change mitigation and environment. The purpose of the study is to devise national policies and incentive systems combined with national level capacity-building programs to encourage demand-oriented conservation technologies. Recommendations are also made to abate the climate change related issues in country.

1. INTRODUCTION

Despite many complexities, scientific evidence clearly points to the fact that the world is warming up. In fact, each of the last three decades has been successively warmer than those preceding [1]. The Greenland and Antarctic ice and glaciers have continued shrinking over the last two decades. The sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia. Global warming is due to human activity and increasing emission levels of greenhouse gases in the atmosphere. The concentrations of greenhouse gases (GHGs) in the atmosphere – carbon dioxide, methane, and nitrous oxide – have increased by 40% since pre-industrial times. These emissions are from fossil fuel use and land use change [2, 3]. Global surface temperature change for the end of the 21st century is likely to exceed 1.5°C, and there are evidences for growing human influence on global warming and changes in some climate extremes [1, 4].

Various events related to climate change have raised interest in understanding the role of global warming in driving the extreme weather. Climate models have been improved over the years. These models can now reproduce observed continental-scale surface temperature patterns and warming trends over several decades [5-12]. Measured data and modeling studies of temperature change, climate feedbacks and changes in the Earth's energy budget, all provide confirmation of the magnitude of global warming. If emissions of greenhouse gases continue, it may cause further warming and bring changes in all components of the climate system. This may have serious consequences if left unabated. For limiting climate change, substantial and sustained reduction in greenhouse gas emissions is essential.

Even though Pakistan's contribution to the total GHG emissions is among the lowest in the world, it is still among the countries that are most vulnerable to the susceptibilities of climate change. The very low technical and financial capacity to adapt to the adverse impacts of climate change further adds to the complexity of the issue. In Pakistan, climate change has constantly manifested itself through extreme events, such as the unprecedented floods, droughts (as shown in Figure-1), storms and glacial lake outbursts, etc. The economic and social losses for each of these have been in millions. In the recent floods alone, 20 million people have been affected. This outbalances the three major in securities of the country, namely water, food and energy. Over the years, Pakistan made sporadic efforts for climate change mitigation and adaptation, but a concerted

Figure-1: A glimpse of Drought and Floods in Pakistan

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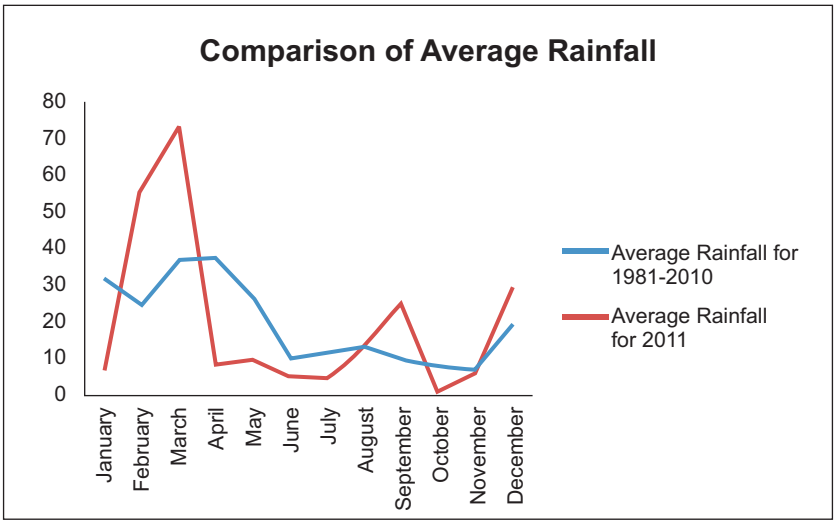

Figure-2: Comparison of Average Rainfall at Skardu (1981-2010 and 2011)

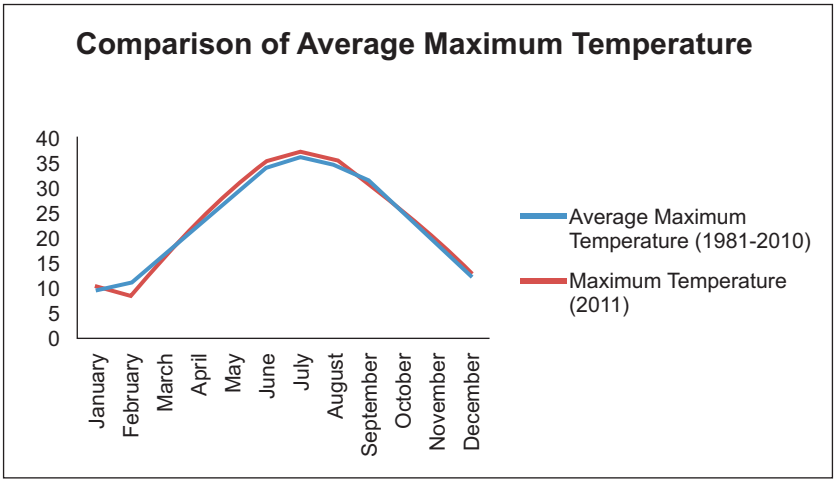

Figure-3: Comparison of Average Maximum temperature at Skardu (1981-2010 and 2011)

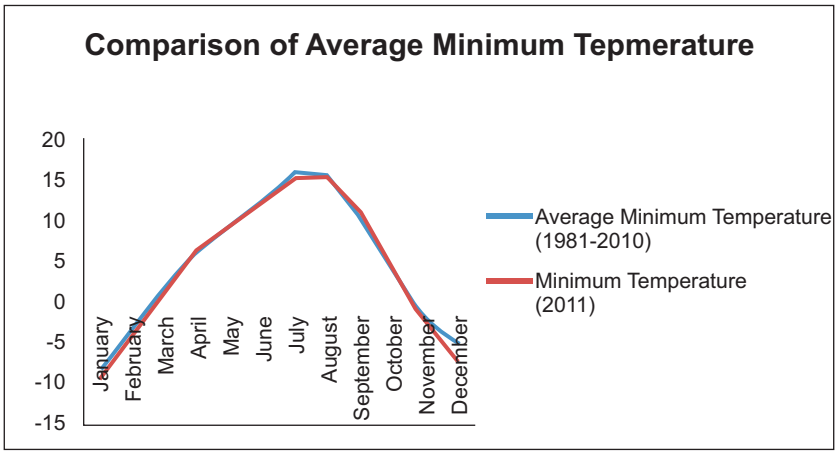

Figure-4: Comparison of Average Minimum temperature at Skardu (1981-2010 and 2011)

policy and strategy framework does not exist. At the same time a cohesive program to combat the issue on ground is also absent.

Pakistan is situated in slightly north of the Tropic of Cancer. North of Pakistan is the junction of three world famous mountain ranges, namely Himalayas, Karakoram and Hindu Kush, which possess third largest mass of ice after the Earth's polar regions. There are more than 5000 glaciers in Pakistan's territory having huge volume of water in frozen form that could sustain the country's water supplies through melting. Winter snowfall tends to sustain the melt mass of ice from glaciers, but the balance is disturbed due to increased heat.

For this study, data from four meteorological stations in different cities of Pakistan, i.e., Skardu, Chitral, Islamabad, and Lahore, were analyzed. The selection of northern part of Pakistan for study purposes was due to the importance of the region, which has glaciers and ice-capped mountains. There was higher average rainfall, as well as great variation in temperature in summer and winter. It was observed that these variations in temperature and rainfall cause changes in the environment. Weather patterns get erratic, which may result in flooding of rivers, damage crops, property, human lives, as well as the ecosystem. Therefore, it is very necessary to adopt measures for mitigating the effects of climate change.

2. PURPOSE OF THE STUDY

The following points indicate the purpose of the study:

a. Devising national policies and incentive systems, coupled with national level capacity-building programs to encourage demand-oriented conservation technologies.
b. Identifying comparative advantages in agriculture and agro-based industries in the light of changing climate scenarios at national, regional and global levels.
c. Integrating environment and development in the "Social Action" or other programs that strengthen regional cooperation and networking for joint actions.

3. DATA ANALYSIS

Beside temperature, rainfall is a very important factor in the climate change because it is a source for ground-water and relative humidity. The amount of rainfall greatly affects the vegetation. Rainwater is also stored in dams and is used to generate electricity as well as for irrigation purposes. Changes in rainfall and other forms of precipitation will be one of the most critical factors determining the overall impact of climate change. Rainfall is much more difficult to predict than temperature. Data analyses of rainfall, maximum and minimum monthly temperatures were made for this study, having a comparison of mean monthly values for the period 1981-2010 with the mean monthly values for 2011.

3.1 Weather Pattern of Skardu

Monthly average maximum temperature, minimum temperature and rainfall (Figure-2) at Skardu were analyzed. This analysis suggested that there was a significant variation in the rainfall.

According to the data (Figure-2), the average rainfall in the month of January for the period 1981-2010 was 31.4 mm, while the maximum rainfall was observed in the months of April (37.2 mm). On the contrary, in 2011, rainfall of 6.5 mm was observed in the month of January, while the maximum rainfall was observed in the month of March (73.0 mm). This variation reflected rapid weather change (w.r.t. rainfall) uneven behaviour and in irregular patterns, which may have serious consequences for the climate, environment and human life.

As depicted in the average maximum temperature data of Skardu (Figure-3), the temperature values did not show too much variation between the maximum temperature values of 2011 and the average maximum values for the period 1981-2010. However, a slight difference was observed in the maximum temperature for the month of February.

The average minimum temperature of Skardu in 2011 (Figure-4), did not show too much variation compared to average minimum temperatures for the period 1981-2010. A slight difference was noted for the months of June and December.

3.2 Weather Pattern of Chitral

Analyses of Chitral's monthly average maximum temperature, minimum temperature and rainfall (Figures 5, 6 and 7), showed a variation between rainfall in 2011 and the average rainfall from 1981 to 2010. This anomalous behavior tends to affect climate adversely which has marked effects on the ecosystem.

In Figure-5, the anomaly is seen in the average

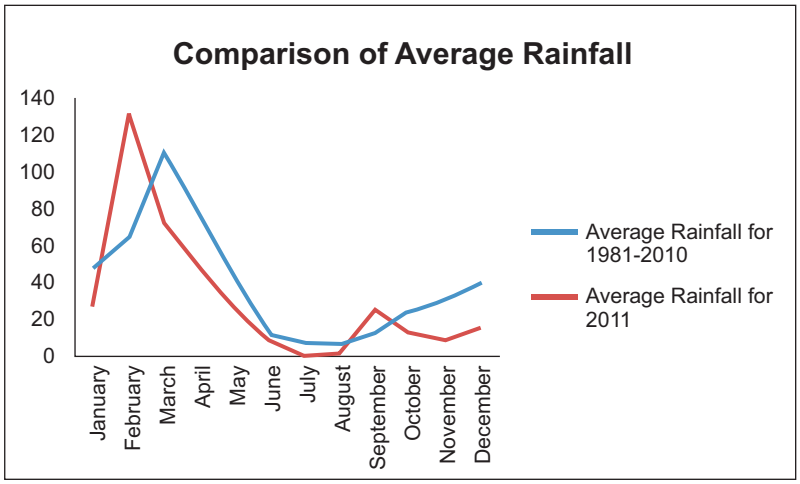

Figure-5: Comparison of average rainfall at Chitral (1981-2010 and 2011)

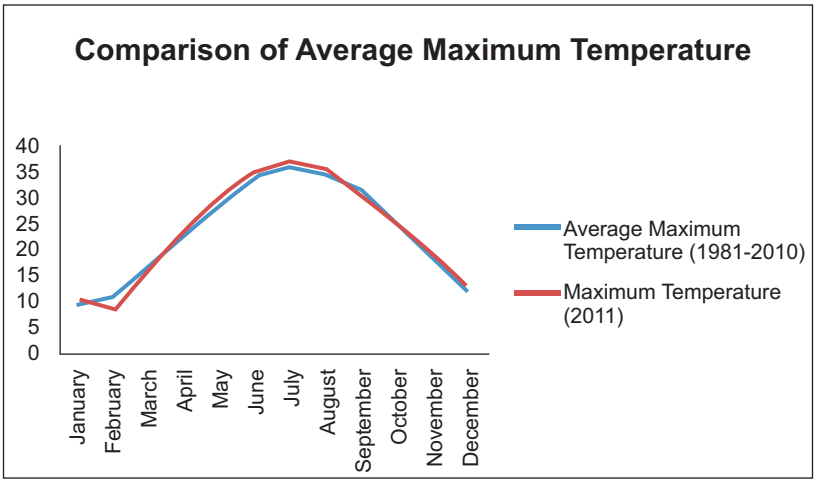

Figure-6: Comparison of Average Maximum temperature at Chitral (1981-2010 and 2011)

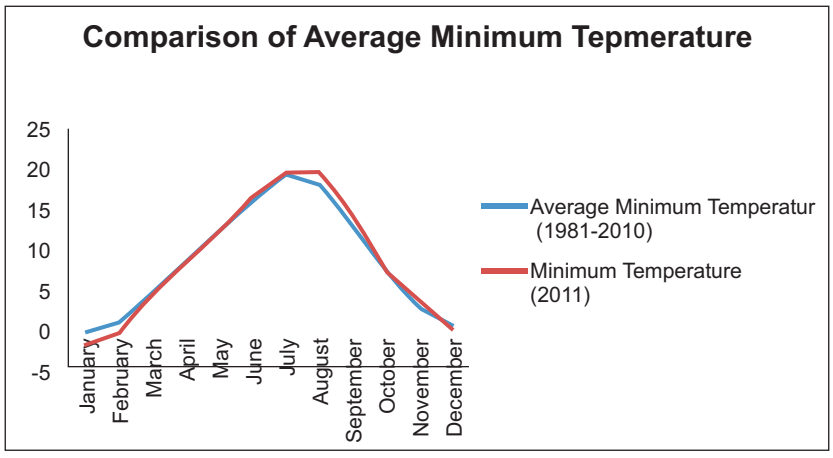

Figure-7: Comparison of Average Minimum temperature at Chitral (1981-2010 and 2011)

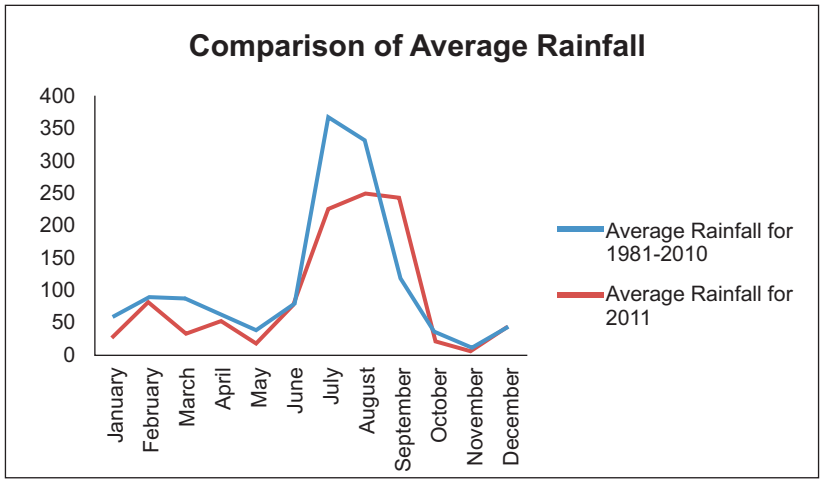

Figure-8: Comparison of average rainfall at Islamabad (1981-2010 and 2011)

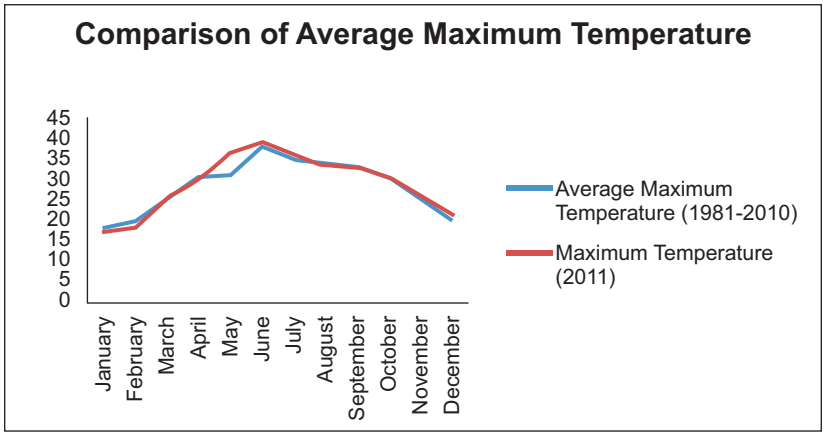

Figure-9: Comparison of Average Maximum temperature at Islamabad (1981-2010 and 2011)

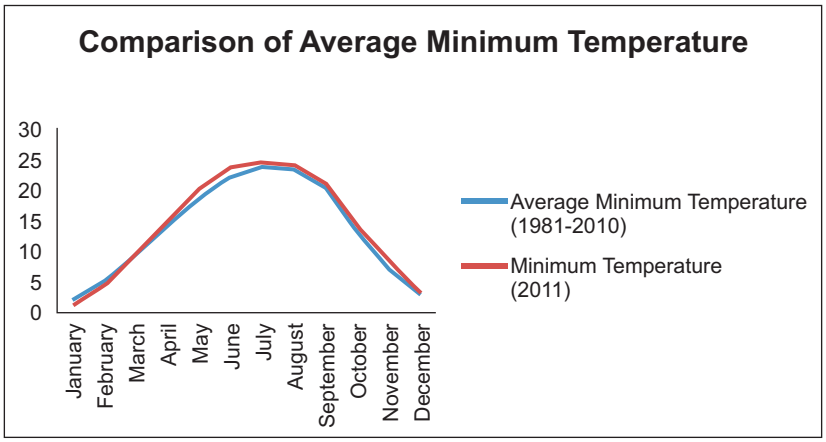

Figure-10: Comparison of Average Minimum temperature at Islamabad (1981-2010 and 2011)

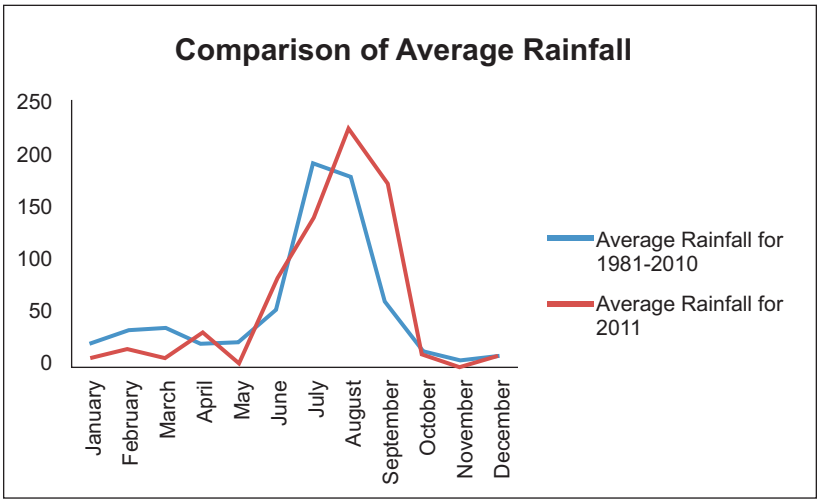

Figure-11: Comparison of average rainfall at Lahore (1981-2010 and 2011)

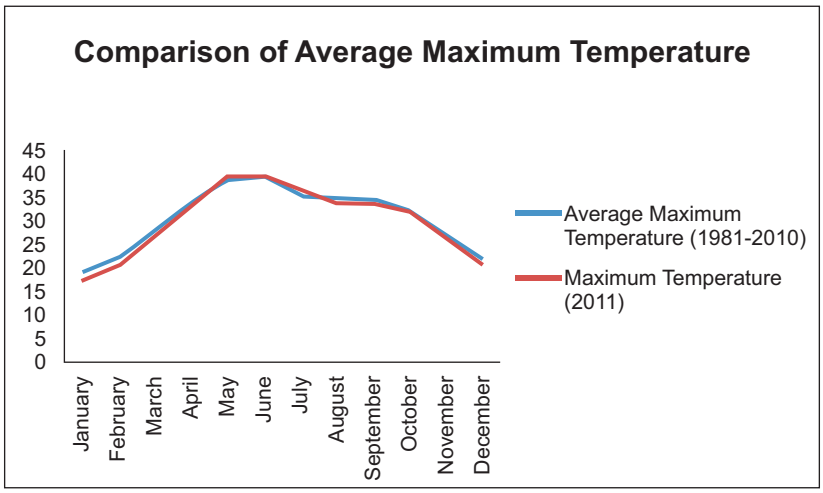

Figure-12: Comparison of Average Maximum temperature at Lahore (1981-2010 and 2011)

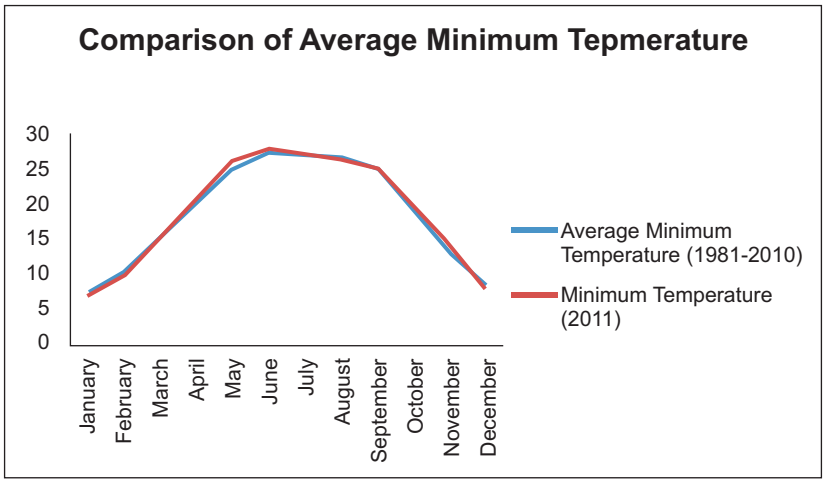

Figure-13: Comparison of Average Minimum temperature at Lahore (1981-2010 and 2011)

monthly rainfall for January 2011 (27.5 mm), while the maximum rainfall was observed in February 2011 (113.2 mm). On the other hand, average rainfall in the month January for the period 1981-2010 was 47.7 mm and the maximum rainfall was observed in the month of March (110.9 mm).This variation reflect the rapidly changing weather pattern in an uneven and irregular fashion, which has the potential to create problems for human beings, the local climate and the environment. The average maximum temperature (Figure-6) does not show too much variation between the average maximum temperature for the period 1981-2010 and the year 2011. However a slight deviation was observed in the month of February.

The minimum temperature of 2011 (Figure-7) did not show too much variation either with the average minimum temperature, however a slight difference was noted for the months of January and August.

3.3 Weather Pattern of Islamabad

The analysis of monthly average monthly rainfall, average maximum temperatures, and average minimum temperatures (Figure 8, 9, 10) showed a rapid variation in the rainfall pattern. As rainfall is a major climatic factor in the local weather pattern, this anomaly disturbs not only the climate but also all other systems, like level of water flow in rivers, flooding, water level in dams, which is further associated with the generation of electricity and irrigation.

3.4 Weather Pattern of Lahore

An analysis of average rainfall data of the year 2011 (Figure-11) suggested anomaly in rainfall pattern for January (<10 mm) and maximum average rainfall (226.0 mm) in the month of August. When compared to the average rainfall of the period 1981 to 2010, the average rainfall in January was 24.0 mm and the maximum rainfall was observed in the month of July (192.0 mm). This variation reflected that weather has rapidly changed in the past years in an uneven and irregular pattern, which poses risks to climate and human life.

An analysis of monthly Average Maximum temperature (Figure-12), suggested below average maximum temperatures during 2011, other than the months of January to February and August to October, where the average maximum temperature in 2011 exceeded the average temperature of the period 1981-2010. Widespread significant changes in extreme high temperature events were not observed.

Figure-13 shows variation between the average minimum temperatures of two time spans, i.e. Average minimum temperatures for the period 1981-2010 as compared to average minimum temperatures for the year 2011. In 2011, a slight increase was observed in average minimum temperature, especially from April to June and October to November. However no particular difference was observed in the temperature values taken throughout the remaining year.

Temperature extremes were found to exhibit no significant trend in inter-annual variability. There was a trend of few extremely low minimum temperature events in several widely-separated areas and there was some indication of a decrease in day-to-day temperature variability in recent decades.

4. CONCLUSIONS

The study data presented a picture of the thermal regime in main towns and cities of the northern areas, as well as upper Punjab, which is likely to prevail during the period 2011-2030.The upward peaks in the graphs indicated extreme wet years when flooding conditions prevail in different parts of the country. Despite flood patterns not recurring, their frequency seemed to be increasing over time. The area impacted by floods was not found to be as extensive as the drought hit areas, and the temperature was not found highly variable as compared to other weather parameter like rainfall, over monthly, yearly and decadal scales. An accurate prediction of the expected temperatures can help provide ample time for planning contingencies for both farmers and policy makers.

There is a general consensus in the output of most of the climate models that the average maximum temperatures in Islamabad and Lahore will increase by about 3°C during the next hundred years, which is about 1°C less than that in the northern areas of Pakistan. The pattern of temperature change is similar throughout the country. During the first half of the century, the increase in temperatures was about 1°C, whereas in second half it has been projected at 3°C. Such a rise and fall in temperature can usher complex changes in regional ecosystems.

Rainfall is a highly variable climatic parameter over time and space. Future projections of rainfall for central and upper climatic zones of the country have been presented (Figures 2, 5, 8 and 11), which indicate large inter-decadal variations. Climatic models project the future rainfall pattern in such a way that the

amounts of rainfall in the first half of the century are likely to increase, whereas in the second half, it will follow a sharp decline with highly variable occurrences. The decade of 2040s is expected to be a largely drought affected period.

5. RECOMMENDATIONS

Action plans to mitigate possible effects of climate change with practical measures in the short, medium and long-term are recommended. Such plans should focus on: assessing and creating an inventory of water resources; disaster-risk reduction; and adaptation to climate change. Mitigation measures should cater to key environmental concerns, including deforestation and reduction of GHG emissions from energy sector. Another important recommendation may be to enhance water-storage capacity by constructing dams at various suitable locations in the northern areas of Pakistan.

It is also recommended that the provincial governments come up with long-term policy measures to address the intensity of extreme weather events, as well as erratic monsoon patterns in coordination with the Federal Government.

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