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Climate Change in Khyber Pakhtunkhwa

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Abstract
Khyber Pakhtunkhwa (KP) is a northwestern province of Pakistan most vulnerable to climate change and its consequences since it is diverse in topography with the Himalayas and dry plains. This essay will review the different aspects of climate change in KP such as agricultural productivity, health of the population, infrastructure susceptibility and socio-economic impact. It also evaluates the response of governance in the province critically, as a response in terms of policy structure, adaptation strategies and current challenges and future potential in terms of enhancing climate resilience. With the knowledge of the local and global drivers of climate change, the paper seeks to impart knowledge to the policy makers and citizens that what is necessary is a set of sustainable interventions in the environment to lessen the vulnerability and increase resilience

1. Introduction

Khyber Pakhtunkhwa (KP) is a region in the north-western part of Pakistan, which is represented by a variety of landscapes, such as the fertile basin of Peshawar, mountains, such as Hindu Kush range, and the arid plain. The province is experiencing a climate that is changing fast and rainfall patterns are also becoming less predictable, temperatures are rising and the number of extreme weather events is also on the rise. This transformation influences drastically the agriculture, health of the population, infrastructure, and stability of the social-economic state. The shifting climate makes prevailing issues such as poverty, food security, and availability of water worse. Climate change has turned out to be one of the most serious and complicated questions of the modern world and it has a destructive impact on the environment, economy, and society. The world is experiencing an exaggerated rate of increase in temperatures and this has caused extreme changes in weather patterns as well as natural habitats. Climate change is a universal phenomenon but its consequences are not universal. Indeed, the effects are higher in some of these areas especially the vulnerable ones, which are already affected by geographical position and social-economic subjects. Khyber Pakhtunkhwa (KP) being a province in the north-western region of Pakistan is an obvious evidence of such vulnerability. The province of Khyber Pakhtunkhwa is typified by the varied geography made up of lofty mountains of the Hindu Kush and Himalayas at one end of the spectrum and fertile plains of the Indus River at the other. This geographical variation predisposes the province to be very sensitive to changes in the environment besides being rich with natural resources. Climate change in KP has taken different

forms, including changes in precipitation patterns, temperature increase, unpredictable rainfall and an escalation of extreme weather incidences such as floods, droughts and heatwaves among others. Such modifications have led to major impacts not only on the agriculture, water resources as well as the health of the people and also on the biodiversity, making the journey towards sustainable development rather complicated in the region.

The province economy is founded on agriculture and it is an industry very sensitive to weather conditions, especially rainfall. Variation in amount of rainfall and higher incidences of droughts have had devastating effects on crop production posing threats to food security and livelihoods. The water supply of the region that depends on the glacier snowmelt and rainfall to a great extent is getting under pressure. The abruptly retreating glaciers in the Hindu Kush and the neighboring mountainous areas are contributing to reduced supply of fresh water which is compounding water shortage among the rural as well as the urban communities. This reduced water supply has great concerns, not only in irrigation but also in the aspect of drinking water, sanitation and energy generation. Besides, the diversity of life in Khyber Pakhtunkhwa, especially in the forested areas, is being threatened by the escalating temperature and other changing ecosystems. The once prevalent species that existed within the natural habitats within the state of the province are currently experiencing new challenges thus posing questions on the sustainability of the ecological balance in KP in the long run. The area is also highly vulnerable to the negative effects of natural calamities, like floods and landslides which are more important and aggravating with changing climate, particularly during monsoon season. The fact that these changes to the environment are costing so much to people is also very alarming. Climate change affects the communities in vulnerable areas, especially the ones in rural and remote sections of the province, the most. The changing climate tends to expose such populations to the dangers of displacement, health risks, and economic insecurity since most of them are ill equipped to face the new environment. These communities are extremely challenged as the number of extreme weather events occurrence and severity grows.

Against this background, this research paper seeks to discuss the effects of climate change on Khyber Pakhtunkhwa especially the socio-economic vulnerability of the province and the efficiency of current mitigation and adaptation approaches. This research will entail a close examination of the climatic trends in the regions, implications of these trends on agriculture, water resources and the health of its citizens, and the contribution of the government policies and international cooperation in coping with these challenges. In addition, the paper will discuss the possibility of renewable energy, sustainable farming and community-based adaptation techniques as mechanisms of enhancing a resilience to climate change in KP. Finally, this paper aims to inform the current body of knowledge on climate change in Pakistan by shedding light on the risks Khyber Pakhtunkhwa is particularly exposed to as well as provide some feasible recommendations to policy makers, development agencies, and locals to reduce the consequences of such risks and adapt to the changing climate. This study will target unique regional weaknesses and opportunities to guide not only regional but also national climate change action plan and sustainable development efforts.

2. Climate Change Impacts in Khyber Pakhtunkhwa

2.1 Agriculture

The Khyber Pakhtunkhwa economy is dominated by agriculture and most people rely on it to earn their livelihoods. Climate change is however posing a threat to this sector in a number of ways. Altered temperature patterns, rain patterns, and the occurrence of extreme weather conditions like floods and droughts have resulted in poor crop production which poses a threat to food security within the region. The International Maize and Wheat Improvement Center

(CIMMYT) further asserts that climate change has transformed the seasons of planting crops, making the older plant varieties less feasible and costing farmers their money. In its reaction, farmers are adopting drought-resistant crops and hybridized crops including drought-resistant wheat and new varieties of rice. Yet, the ability of farmers to meet these changes is restricted by their economic condition and the absence of the access to the modern agricultural technology (CIMMYT, 2022). Increased water scarcity has also been caused by erratic rainfall patterns and rising number of droughts, which directly influence irrigation intensive agricultural activities, such as those in the Mardan district, Swat and in Charsadda (Khan et al., 2020). This further contributes to food insecurity and KP has seen the reduction in the crop yields of wheat and maize by 20 percent in the past decade. 2.2 Health Climate change has major effects on the health care system of Khyber Pakhtunkhwa. Unstable rain and increased temperatures have worsened the predicament of diseases that are transmitted by vectors such as malaria, dengue, and other mosquito-transmitted diseases. It is estimated that the climate change may result in malaria cases growing by 3040 percent and waterborne diseases such as cholera and typhoid by 1020 percent by 2050 (Gavi, 2022).

The increased flooding that is likely to happen because of the severe monsoons has led to massive displacement resulting in more deaths related to waterborne diseases since there is a lack of proper sanitation and clean water sources. The province is ill prepared to handle these challenges because the health infrastructure in KP is already strained. Also, health hazard associated with heatwaves is projected to rise in the future decades, and KP is likely to face a 25 percent rise in heatwaves by 2050 (Khan et al., 2020).

2.3 Infrastructure and Urban Areas

The infrastructure of KP is quite susceptible to climatic changes, especially extreme weather conditions like floods, landslides and earthquakes. In recent years, the province has experienced excessive rain which has led to massive damages of roads, bridges, houses etc. It resulted in a lot of damage in 2023 with reports coming in of significant damages across the districts of Lakki Marwat, Karak, and Bannu, where flooding displaced thousands of families (Wikipedia, 2023a). The vulnerability of transportation infrastructure in the province of KP, a critical pillar of trade with the neighboring Afghanistan, was demonstrated by a landslide at the Torkham border crossing in 2023 (Wikipedia, 2023b). Besides direct losses to the weather incidents, there are also water shortages occasioned by climate change that are threatening access to potable water, especially in cities such as Peshawar, which have experienced fast urbanization hence the stressed water supply systems.

2.4 Social-Economic Consequences

Climate change has been critical to the socio-economic of KP especially among the marginalized communities. Climate-based disturbances on the economy take their toll on rural communities, which rely on agriculture. A large number of the population is directly or indirectly engaged in agricultural activities and the low agricultural yield as a result of droughts, floods, and soil erosion have contributed towards poverty in the rural regions (Dawn, 2023). Flooding displacement is also on the increase. KP has more than 1.8 million individuals at risk of displacement due to floods, which only increases pressure on the local government to support displaced people by offering new housing, healthcare, and employment opportunities (Dawn, 2023). This situation is augmented by the already present poverty levels where an estimated 35 percent of KP population is below the poverty line (Khan et al., 2020).

3. Government Response and Policy Framework

3.1 Climate Change Policy 2022

In 2022, Khyber Pakhtunkhwa provincial government prepared the Climate Change Policy that identifies multiple mitigation and adaptation strategies in several sectors. The policy will focus on the weaknesses in agriculture, energy, water, health and urban development. It also provides certain actions in disaster risk reduction and adaptation considering the urgency of becoming resilient to climate change (Khyber Pakhtunkhwa Environmental Protection Agency [EPAKP], 2022). A sustainable agricultural practice is one of the most important emphasis of the policy such as how it can develop crops that have a greater drought resistance and irrigation which can be more efficient as to the use of water. It also aims at enhancing healthcare infrastructure to reduce the effects of the health risks that are associated with climatic changes, which include malaria and dengue (EPAKP, 2022).

3.2 Climate Change Action Plan

Together with the policy, the Climate Change Action Plan offers a comprehensive plan of action to be taken towards the realisation of these strategies. It describes major initiatives, sources of finance and schedules to install climate-resistant infrastructure, better farming techniques and more effective disaster preparedness systems (EPAKP, 2022). Moreover, the action plan focuses on capacity-building initiatives to increase knowledge and skills of the local population, policy makers and institutions to respond to climate challenges. It is also stipulated in this plan that early warning systems on natural disasters shall be developed, which can reduce the effect of floods and heatwaves (EPAKP, 2022).

3.3 Climate and Health Adaptation Plan

In the acknowledgement of the intersection of climate and health, KP introduced Climate and Health Adaptation Plan, which aims at strengthening health systems. The objective of this plan includes developing adaptive capacity among the healthcare sector through enhancing accessibility to healthcare facilities, disease surveillance, and the fight against waterborne diseases (Tribune, 2023). As per the plan, the economic cost of climate-related health challenges is projected to reach Rs 5,541 billion by 2030 unless the situation changes. To curb this, the strategy includes measures that will embrace climate-resistant health infrastructure and integrate climate change into health policy and planning (Tribune, 2023).

4. Challenges in Implementation

Although there are very elaborate policies, there are a number of challenges that prevent implementation of effective measures of climate change adaptation: Resource Limitation: Limited financial and human resources have made it hard to carry out massive adaptive climate projects in the province. This involves the poor funding of the rural development projects and infrastructure modernization. Coordination Problems: The coordination process between the levels of governments (federal, provincial, and local) and among the different stakeholders such as NGOs, community-based organizations, and the players in the private sector lacks. Lack of Awareness: A good number of the populace in KP lack full awareness of the long term dangers of climate change. Such ignorance is a barrier to the implementation of climate-resilient activities, particularly in rural settings where the methods of traditional agriculture continue to prevail (Khan et al., 2020).

5. Opportunities for Climate Resilience

Nonetheless, KP offers a great number of possibilities in terms of climate resilience development: Community-Based Adaptation: Locally-based communities especially in the rural settings can be influential in adaptation to climate change through practices such as sustainable farming, disaster management and water savings. Public-Private Partnerships: To increase the

mobilization of resources in climate projects, there can be a collaborative partnership between the government, the private sector and international donors leading to improved access to technology and expertise. Education and Capacity Building: Diversification of climatic change-related problems in the province can be achieved through investment in education activities and training activities of communities, policymakers, and healthcare workers.

4. Mitigation Strategies for Climate Change in Khyber Pakhtunkhwa

Mitigation measures play an essential role in mitigating the consequences of climate change by dealing with the cause of this phenomenon namely, the emission of greenhouse gases. In the Khyber Pakhtunkhwa (KP), some of the mitigation strategies are being offered and even enacted to minimize carbon footprints in various sectors. These include:

4.1 Renewable Energy Development

KP enjoys great prospects in terms of renewable energy such as hydroelectric, wind, and solar energy. To de-emphasize reliance on fossil fuels, the provincial government has launched some projects that aim at exploiting these resources. The Dargai Wind Power Project, located in the Malakand Division, is an example of a project that would use the wind potential in the area in order to produce renewable energy (Energy and Power Development Department, KP, 2022). On the same note, there should be promotion of solar panels especially in the rural settings to offer decentralized power to off grid communities and minimize the energy usage in non-renewable energy sources.

4.2 Carbon Sequestration in Forests

The conservation and growth of the forests of KP can provide a very essential carbon sink, which can mitigate climatic change effects. The provincial government with the help of NGOs has created afforestation schemes, one of which is the Billion Tree Tsunami scheme which aims to plant a billion trees throughout the province. The project not only assists to sequester carbon di-oxide, but also counter the soil erosion, boost the biodiversity and eco-tourism.

4.3 Sustainable Agricultural Practices

Promoting sustainable farming in KP is important in reducing climate change because the farming sector is a major contributor to climate change caused by unfriendly farming activities. Practices like zero tillage, crop rotation and organic farming are advocated to increase the fertility of soil and limit the emissions that come along with conventional agriculture. Further, the government is offering incentives to farmers to use climate-resistant types of crops that need less water and are resistant to pests and diseases.

4.4 Waste Management and Circular Economy

KP is also paying more attention to the plans regarding waste management to cut the emissions of the landfills and to develop waste disposal systems. KP can considerably decrease its carbon footprint by switching to the circular economy in which waste is kept to a minimum and materials are recycled. The major programs are recycling, composting, and transformation of organic wastes to biogas to generate energy.

5. Adaptation Strategies for Climate Change in Khyber Pakhtunkhwa

The mitigation activities are aimed at minimizing the causes of the climate change, whereas the adaptation measures strive to assist the communities and the ecosystem to withstand the unavoidable effects. Some adaptation measures are being imparted and recommended to assist in the adaptation of people both in the towns and the countryside due to the changing climate in KP.

5.1 Climate-Resilient Infrastructure

KP has made one of the priorities to build climate resilient infrastructure. The government is also concentrating on retrofitting the existing infrastructure and the building of new structures, roads

and bridges that are resistant to extreme weather conditions like floods and heat waves. As a case in point, the building of flood-proof roads in areas of frequent floods such as Nowshera and Charsadda has minimized destruction on monsoon seasons. Also, the management of storm water is being worked on at the urban and most especially in Peshawar to avoid the floods caused by the high rainfall.

5.2 Water Management and Conservation

The water shortage is a significant problem in KP due to low rain and high temperature. To deal with this, the government is emphasizing on effective management and conservation of water. The reservoirs are under construction and the existing ones are being rehabilitated like Warsak Dam in order to store water both to use in agriculture and to use at home. Furthermore, to increase water supply to farms, rainwater harvesting and introduction of effective irrigation systems are very important in rural regions.

5.3 Disaster Risk Reduction and Early Warning Systems

Natural disasters in form of floods, landslides and drought that affected KP have been increasing because of climate change. One of the main adaptation strategies has been the creation of the early warning systems against floods and other natural disasters. As an example, installation of automatic weather stations and flood forecasting systems to ensure that local authorities are able to provide timely alerts before occurrence of flooding hence preventing loss of life and properties. The government is also improving on the disaster response mechanisms and disaster prone areas are training the communities.

5.4 Public Health and Climate Change

Health sector in KP is also adapting to circumvent health risks caused by climate change. Provincial government is laying emphasis on enhancing both health systems in order to face the rising rates of waterborne and vector-borne diseases. This involves improving the health facilities to treat the diseases that are climate related like malaria and cholera and offer vaccines to vulnerable groups. There is also integration of climate-sensitive health policies into local health programs to lessen the burden of diseases that is worsened by climatic changes.

6. Role of International Organizations in Climate Resilience

International organistries are very important in enhancing the climate resilient activities of Khyber Pakhtunkhwa. These agencies will offer finance, technical support, and knowledge-sharing opportunities that can enable the province to address the issues of climate change.

6.1 United Nations Development Programme (UNDP)

Key areas that the UNDP has facilitated in KP regarding its climate change adaptation projects include disaster risk management and sustainable development. The UNDP through different projects including the so called project of Strengthening Resilience to Climate Change in KP has assisted local communities to have a climate proof practice in water management and agriculture.

6.2 Asian Development Bank (ADB)

ADB has been able to fund the construction of climate resilient infrastructure in KP including flood protection wall and drought resistance irrigation systems. The bank is also assisting the provincial government to come up with the policies which incorporate mitigation and adaptation policies of climate change into regional development plans.

6.3 World Bank

Along with its government, the World Bank has collaborated with KP to strengthen their climate change adaptation with its program called, Climate Adaptation and Resilience. The program is aimed at incorporating climate aspects in the development of infrastructure and urban planning, and also enhancing the governance of natural resource.

6.4 Non-Governmental Organizations (NGOs)

NGOs both local and international also play important role in climate change in KP. The World Wide Fund for Nature (WWF) Pakistan, the Sustainable Development Policy Institute (SDPI), and ActionAid are some organizations that have been extensively engaged in sensitization, community based adaptation initiatives, and sensitizing the government to have improved policies on climate.

7. Case Studies of Successful Climate Resilience Projects in KP

There are a number of climate resilience interventions that have demonstrated their effectiveness in Khyber Pakhtunkhwa, thus demonstrating the potential of positive change, even against such dire climate impact. The case studies prove the success of the local adaptation activities and the importance of the community engagement in climate resilience strategies.

7.1 The Billion Tree Tsunami

The Billion Tree Tsunami is one of the most popular and successful initiatives in KP, which was launched in 2015. The initiative was expected to restore the forests and fight soil erosion by planting one billion of the trees throughout the province. The project not only assisted in sequestrating the carbon dioxide but also provided local people with job opportunities and increased biodiversity. This initiative has been successful and has attracted international attention and also has been adopted in other parts of Pakistan.

7.2 Community-Based Water Management in Swat

Communities in Swat Valley have also been able to carry out the successful implementation of water conservation and management. The farmers of the area have embraced the use of drip irrigation which has cut on the amount of water used by up to 50 percent leading to better agricultural productivity and saving of this scarce water resource. This self-help project has enhanced food security, livelihoods and natural water conservation in a drought-prone region.

7.3 Flood Resilience in Charsadda

Over a number of flood prone districts, a flood resilience project has been established such that flood barriers have been built and a flood-resistant house has been established in Charsadda. The effect of seasonal floods has been greatly mitigated by these measures as lives and property have been protected. The participation of community in the planning and upkeep of flooding defenses has made the project very successful.

8. Stakeholder Engagement and Community Participation

The involvement of stakeholders on all levels is an essential factor of the success of climate change adaptation and mitigation projects. In Khyber Pakhtunkhwa, the government, the local communities, and the private sector are required to collaborate to develop climate resilience.

8.1 Role of Local Communities

Communities exist within the locality and they are vital in the adaptation to the changing climate. As decision-making processes are engaged in and the adaptation projects are owned by communities, it allows them to determine that solutions are more specific to the local needs and have the chance to be more sustainable long-term. Water management and reforestation, local disaster preparedness are some of the community-based programs that have been effective in providing local resilience in KP.

8.2 Public-Private Partnerships

Private sector can also play a decisive role in driving climate action. The synergy of the skills, resources and innovativeness available in the public and private sectors through the public-private partnership can be used to carry out large-scale projects. The collaboration of the government, NGOs, and businesses in KP has played a critical role in initiating winds of renewable energy production, enhancement of infrastructure, and development of sustainable agriculture.

8.3 Role of Academia and Research Institutions

There is also the role of academia and research institutions in responding to climate change. Colleges in KP are also doing the research work of climate impact, and measurement, including the research going on in the University of Peshawar and the Agriculture University. These institutions give government policies direction and lead people in local communities on the most effective adaption practices through the information and evidence they provide.

9. The Future of Climate Change in Khyber Pakhtunkhwa

In the future, Khyber Pakhtunkhwa is going to experience more intense problems because of climate change. Nevertheless, under the adequate strategy, KP can alleviate some of the most dramatic effects and adjust to the new reality. The further evolution of the province will be associated with the necessity to invest in climate resilience, sustainable development, and involving all the layers of the population.

6. Conclusion

Climate change poses a serious challenge to Khyber Pakhtunkhwa because it affects agriculture, health, infrastructure and social-economic stability. Nevertheless, through the policies of pro-action, strategic planning, and partnerships, the province can become resilient and adjust to the changing environment. Future of the environment of KP and its people can be secured with ongoing work of climate adaptation, and the involvement of the population in this process, as well as successful mobilization of resources. Effects of climate change in Khyber Pakhtunkhwa (KP) have increasingly been felt and they have had their toll on the province such that the environment is not the only casualty but the socio-economic welfare of the people is also at stake as well. Increasing climate, altering rainfall patterns, receding glaciers, and occurrence of extreme weather events pose a challenge to the region that is already struggling with existing vulnerabilities based on geographical setting, existing economic set-up, as well as socio-political factors. In agricultural sector to water resources, health to biodiversity, all these hot changes in climate are striking the main sectors in the province and it is evident that the impact of global warming is no longer in the future but it is already being experienced nowadays. The results of the study demonstrate that effects of climate change on KP are broad and multi-fold. The water shortage in the province which is the mainstay of its economy is coupled with the unpredictable weather patterns that result in red-one crop yield and reduced water sources especially due to glaciers melting. This has disturbed the ecosystem of the area and the flora and fauna has been threatened because the rich biodiversity of the province is highly threatened by loss of habitat and changed environment. Also, the clan-induced problems are hitting the most vulnerable, especially people in rural and remote places, who are ill equipped with resources and infrastructure to cope.However, all these challenges are not lost. The province also has a great potential of coming up with some climate adaptation strategies that can be used to ease the effects of climate change. Renewable sources of energy, e.g. hydro, solar, and wind power, offer a significant possibility to eliminate overreliance on fossil fuels and minimize the number of greenhouse gases. Moreover, increased efforts in terms of sustainable land farming, enhanced water management regimes, and preservation of natural ecosystems may also have an immense contribution to enhancing the resilience of the region against the effects of climate change. The contribution of the government policies, international cooperation, and the work of the communities cannot be overestimated to make sure that the province can move towards the more sustainable and climate-resistant future.Khyber Pakhtunkhwa has already moved in the direction of climate action in the following ways by adopting different policies to deal with the effects of climate change. But stronger and coordinated action is necessary to deal with the intricacies of the climate crisis. This is not merely limited to considerations of short-term aid to

those in greatest need but it must concentrate on strategies developed to ensure long-term adaptation and resilience. It is important to maintain a balance between development and the environment in maintaining a secure future of the people of the province. To sum up, the case of Khyber Pakhtunkhwa and its experience with climate change proves how the climate crisis is not only global but calls for a united effort to change the situation. Challenges are extraordinary, yet one can trace the way out with innovative ideas, teamwork, and the efforts of local, national, and international players. The outcomes of this study highlight the significance of further investment into climate resilience and sustainable development to safeguard natural resources, economy, or the well-being of the population of the province. KP needs to ensure that its communities are flexible, strong, and proactive in the challenges that lie ahead of them; in this light, there is need to address issues relating to climate change as it progresses. Adapting to the impact of climate change and ensuring sustainable practices, the province of Khyber Pakhtunkhwa can be on its way to a climate resilient future of future generations.

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