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CLIMATE CHANGE IN PAKISTAN: CHALLENGES FOR SUSTAINABILITY AND HUMAN DEVELOPMENT

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Abstract

Climate change has emerged as one of the most critical global challenges of the 21st century, with profound implications for environmental sustainability, economic stability, and human development. Pakistan, as a developing and predominantly agrarian economy, is among the most climate-vulnerable countries in the world. The nation faces rising temperatures, erratic rainfall, glacial melt, and frequent extreme weather events such as floods, droughts all of which have significant repercussions for food security, water resources, health, and livelihoods. The agricultural sector, which employs a large portion of the population, is particularly threatened. This study seeks to explore the institutional challenges and opportunities for addressing climate change in Pakistan, investigate the environmental issues contributing to climate change, promote resource conservation and analyze the role of the international community in mitigating the effects of climate change.

Key words: Climate Change, Agrarian, Global Challenges, Economy, Environmental Issues

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INTRODUCTION

Climate change as a long-term changed of the global or regional climate patterns, such as a significant change in temperature, precipitation, or wind that generally occurs over many decades or longer. It was mostly related to the growth in greenhouse gas emissions, mainly carbon dioxide, methane and nitrous oxide that reinforce the greenhouse effect. Over time the concept has changed due to scientific advances which highlight the jagged relationship between natural and human processes. The United Nations Framework Convention on Climate Change defines climate change as natural (climate variability) and caused by human activities (UNFCCC, 2022).

It was when the planet started warming at a steady pace. However, with the mid-20th century research abilities to attribute the climate change to carbon dioxide as well as other greenhouse gases received scientific recognition. It is the Global climate changes of the 21st century that highlighted significant alterations of global weather and temperature regimes which constituted a defining challenge. The factors responsible for these changes were derived from natural and more significantly anthropogenic activities such as industrialization, deforestation and burning of fossil fuels. It had profound environmental, economic and social implications, depressing biodiversity and threatening the livelihoods of human populations around the world (IPCC, 2023). By bringing this challenge into focus, nations around the globe had recognized its far-reaching ramifications and progressive implications for every sector of human development. Global climate change has a history, tracing its timeline back to the time when fossil fuels were previously burned on a large scale by the Industrial Revolution, and thus unprecedentedly large quantities of gases have been released into the atmosphere (Zaidi, 2021).

Global climate change has rapidly gained attention, showcasing alarming trends and patterns of rising average global temperatures; increasing frequency of extreme weather events; and accelerating sea level rise. The global temperatures increased by about 1.1°C from preindustrial times according to the IPCC's Sixth Assessment Report (2023) which found that the last decade was the warmest on record. Consequently, at the poles, polar ice caps and glaciers had melted at unprecedented rates and had elevated sea levels and put coastal communities around the globe on notice (World Meteorological Organization, 2023). One of the most important challenges for humanity in the 21st century has been identified as global climate change, or a widening of the Gulf of Mexico, that has far reached effects on the ecosystems, economies and societies all around the globe.

CLIMATE CHANGES AND ITS IMPACTS ON PAKISTAN

Pakistan is an important agricultural economy; another component in the economy is dependent on agriculture for raw materials. Rabi crop in Pakistan is Wheat. This accounts for 38% of the arable land used for grain production. In 2008-09, the share of wheat in GDP growth was estimated at 2.8%. According to the Food and Agriculture Organization (2010), Pakistan is ranked 6th in terms of wheat production. The average wheat yield in Pakistan was 2504.58 kg per hectare (Ashfaq et al, 2011).

Pakistan is a small contributor to global greenhouse gas emissions and has been one of the most vulnerable countries to the consequences of climate change. Geographic, socio-economic and environmental factors with a matchless combination of such vulnerability to climate related disasters made the country unusually responsible to the influence of climate related disasters. Climate change in Pakistan has been profound and multifaceted affecting everything from unpredictable weather patterns to new health risks.

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For example, constrained and intensified by limited resources and institutional capacity efforts to mitigate and adapt to these challenges have been limited (World Bank, 2023).

The location and vulnerability of Pakistan to climate change comes from being confined (geographically) and depending (economically) on the climate sensitive sectors of agriculture and water resources. Changes in the monsoon system, significant temperature increases, and an increase in the frequency of extreme weather events, such as floods, droughts and heat waves have been seen in the country (German watch, 2022). Pakistan's challenges rank among the top ten countries most affected by climate related disasters in the last two decades due to fragile infrastructure and limited adaptive capacity. The floods of 2022 were the latest to declare the serious consequences of unchecked climate vulnerability (UNDP Pakistan 2023).

Climate change in Pakistan has highly damaging and alarming environmental impacts. The country's water resources are threatened due to rise in temperature and the melting of glaciers in Himalayan and Karakoram ranges. The risk of glacial lake outburst floods increases (FAO, 2022). Weak natural ecosystem, intensified degradation, deforestation, desertification, etc reduced biodiversity and destroying agriculture's productivity. Moreover, the rainfall is also unpredictable and prolonged droughts have disturbed the balance of natural ecosystem. It has been impacting network effects on agriculture and water supply (World Meteorological Organization, 2023).

Different studies have been conducted in Pakistan to measure and document the impact of climatic changes in Pakistan on crop cultivation and production as well. The results were quite alarming because crop production directly involved with the financial wellbeing of the farmers and the country as well. In central Punjab, multiple modeling approaches to determine the effects that climate change will have on wheat productivity. Declines were found in staple crops including rice, wheat, maize and barley, and production of a suite of other crops has decreased as well. It highlighted that crop productivity has been directly reduced by changing climatic patterns, including increased temperatures and changed precipitation. However, wheat production is sensitive to both heat stress and water scarcity and the impact on that is particularly concerning. The results of the research suggest that if no adaptation strategies are applied, food security in this region could suffer serious losses to yields because of continued climate change. The study recommends local and national policy interventions aimed at increasing adaptive capacity, including better irrigation and heat-resistant crop varieties (Munir et al, 2022).

It was found that melting glaciers in the Himalayas were reducing river flows, which was then affecting irrigation in agriculture dependent areas. The research also focused on the necessity to develop improved water management policies and water efficient agricultural practices to address these challenges. Climate changes have a direct adverse impact on the socio-economic status of the rural communities. The research has found that the frequency of extreme weather events, like floods and droughts, is disproportionally felt by those particularly vulnerable. It sought more climate-resilient infrastructure to support communities hit by the economic and social impacts of climate change, and a strengthening of safety nets at the social level.

The objective of the research is to answer questions, what is the impact of environmental issues such as pollution and waste on climate change in Pakistan? And assess the impact of climate change because Pakistan is agrarian country and geographically location of Pakistan makes it vulnerable to change in climate. Greenhouse gases become cause of climate changes these gases are Carbon di oxide, Nitrogen oxide

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and Methane. These gases increase the temperature of the earth, the rapid increase of global warming reduced the yield of wheat. Secondary data were used to estimate a different model for the effects of climate change. Yield data were collected from AMIS (Agricultural Marketing Information Service). The results showed that the climatic variability has a large effect on wheat productivity, and the economic variable has a small effect. Climate change and food security in Pakistan, extreme weather events (flood and heat wave) affected agricultural production and food price volatility. They believed that rural poverty, and especially low-income households, can be impacted by climate induced food insecurity. The study suggested addressing this by stepping up investments in climate friendly agriculture and disaster risk management (Zahid et. Al, 2020).

The socioeconomic implications of climate induced variation in wheat productivity on smallholder farmers in Punjab. The authors also found that small farmers rely most heavily on traditional farming practices and have limited access to adaptive resources; while small farmers are disproportionately vulnerable to yield fluctuations resulting from climate change. Not only do reduced wheat yields threaten their income, but they add to food insecurity and poverty as well. These farmers, however, face multiple barriers to adapting to climate change, including limited financial resources, absence of knowledge of the appropriate climate smart agricultural practices and limited access to modern technology, the research finds. The study urges policy measures aimed for smallholder farmers to improve cash to guard resources access, skill in sustainable agricultural methods and stronger infrastructure to face climate stemming challenges (Ahmad & Hussain, 2023)

STATEMENT OF PROBLEM

Global climate change has become one of the most pressing challenges of the 21st century, posing significant risks to both the environment and human development. In Pakistan, climate change impacts are already evident in the form of rising temperatures, erratic rainfall patterns, and the increasing frequency of extreme weather events such as floods and droughts (Ali, et al., 2020). Pakistan, being an agrarian economy is highly vulnerable to these climatic changes which significantly affect its agricultural productivity, water resources and overall economic stability (Shah et al., 2019). Consequently, the implications of climate change in Pakistan not only threaten environmental sustainability but also exacerbate existing social and economic inequalities.

RELATIONSHIP BETWEEN CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

Climate change and the issue of sustainable development were closely related to one another and having enormous effects on one another. Climate change has increasingly been recognized as one of the most pressing challenges for the achievement of sustainable development since it has disrupted economic, social systems, ecosystems and political relationships. On the other hand, unsustainable development practices have cumulatively accelerated climate change by establishing a vicious cycle that hinder progress worldwide (IPCC, 2023). In tackling climate change, the challenges must be addressed in a multidisciplinary way such as mitigation, adaptation and sustainable practice must be integrated into development strategies (UNDP, 2023). Climate change is an increasingly recognized area of critical research in relation to the relationship between climate change and sustainable development. United Nations Sustainable Development Goals (SDGs) emphasizes that social, economic and environmental sustainability requires to contend with climate change.

Climate change has an impact on sustainable development such as higher temperatures

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and the changed pattern of precipitation that are destroying agricultural productivity, biodiversity and economic stability. Climate change was also a major factor in goals such as zero hunger, good health, clean water, and affordable energy and the study, it argued, as they were all directly affected by climate change. They suggested urgent international support for implementing climate adaptation strategies and integrated economic development program.

The importance of climate action for sustainable development is recognized by acknowledged report of the Intergovernmental Panel on Climate Change (IPCC, 2021). It shows that climate change heightens poverty and inequality, denying people basic access to food, water and energy critical to sustainable development. IPCC emphasized for the integrated policies on socio-economic development and the environmental protection.

ENVIRONMENTAL DEGRADATION; AN ANALYSIS

Environmental degradation caused by improper waste disposal and industrial pollution has detrimental effects on the quality of air, water, and soil, further aggravating the adverse impacts of climate change (Ali et al., 2020). Investigating the impact of pollution and waste on climate change will shed light on the critical areas that require immediate policy intervention to protect the environment.

Another critical aspect of addressing climate change in Pakistan is the conservation of natural resources. Overexploitation of resources such as water, forests, and land has resulted in a depletion of the country's natural capital. This unsustainable use of resources not only reduces the resilience of ecosystems but also hinders the country's long-term development prospects (Khan & Samillah, 2015). Promoting the conservation of natural resources and adopting green practices can mitigate the adverse effects of climate change, improve resource efficiency, and ensure environmental sustainability for future generations.

It is also analyzed that the relationship between urban areas' vulnerability to climate risks such as flooding, heat waves and the drive to make cities more sustainable in Pakistan. This study found that exposing the city to climate related disasters is increased by urbanization without climate resilience. To mitigate climate risks and support sustainable development, climate adaptation measures, e.g. green infrastructure, urban planning, and social inclusivity must be integrated in the making of sustainable cities (Doyle et al, 2020)

The reduction of vulnerabilities also relied on community-based adaptation approaches such as building flood resistant infrastructure and early warning systems (ADB, 2023). However, despite these efforts, concerted financial resources were lacking as were weak governance structures and lack of technical expertise in these regions to ensure effective implementation of adaptation measures (World Resources Institute, 2022).

Pakistan's agricultural sector vulnerability to climate change through assessments of irregular rainfall coupled with temperature surges. The research showed that crop production received strong negative impact across Pakistan's central and northern territories. They proposed that sustainable agricultural practices must incorporate water saving approaches together with crop variety diversification to build climate resiliency in agriculture systems.

ROLE OF ENVIRONMENTAL SUSTAINABILITY IN DEVELOPMENT

Environmental sustainability played a pivotal part in achieving sustainable development by ensuring the responsible management of natural resources and ecosystems. It focused on addressing key environmental challenges, including deforestation, water scarcity and

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pollution, which directly impacted economic and social stability. An important step to environmental sustainability is made by investing in renewable energy, conservation, climate resiliency initiatives and infrastructure. Although in regions susceptible to climate changed and placing too much emphasis on compensation risk limiting efforts, given limited resources and institutional weaknesses (FAO, 2023). Integrated approaches that aligned environmental sustainability with broader developmental priorities were needed and that addressed these barriers.

PAKISTAN'S EFFORTS TO COMBAT CLIMATE CHANGE

Pakistan's efforts to combat climate change need to be supported by the international community. The country's vulnerability to climate change necessitates global cooperation in the form of financial aid, technology transfer, and capacity- building programs. The international community has made several commitments under frameworks such as the Paris Agreement to assist developing countries in their climate change mitigation and adaptation efforts (United Nations Framework Convention on Climate Change [UNFCCC], 2015). However, the effectiveness of these contributions remains debatable, and there is a need for a thorough examination of how these external interventions can be better aligned with Pakistan's national climate goals as well as the international climate agreement and especially the Paris agreement, to explain how the global mitigation effort is being propelled. The developing countries adaptation strategies centered on enhancing resilience to climate impacts through sustainable agriculture improved water management and disaster risk reduction.

ROLE OF INTERNATIONAL COMMUNITY

The international community is in mitigating its effects. International agreements, climate financing, and technological collaborations were analyzed to determine their impact on Pakistan's climate adaptation and mitigation strategies, such as the Paris Agreement, and their influence on Pakistan's climate policies. It explored how developed nations contributed to climate change mitigation through carbon reduction commitments, financial aid, and the transfer of clean energy technologies. Additionally, international support in terms of funding, research, and technological transfer was explored to identify potential areas where Pakistan could benefit from global partnerships. The research highlighted the significance of collective global efforts in combating climate change and recommended strategies for enhancing Pakistan's participation in international climate initiatives.

CONCLUSION

The results suggest that timely implementation of these strategies may be able to substantially mitigate yield losses during extreme weather events such as heat waves and droughts. Early sowing dates and heat tolerant varieties can save wheat crops from the most damaging stages of heat stress, the authors argue. Therefore, irrigation systems can also be optimized by, for instance, moving from the large systems of flood irrigation to systems that use drip irrigation, to conserve water while still maintaining crop production. Climate change must be integrated into the global economic agenda. The findings indicate that an investment to reduce carbon emissions is economically feasible over the long term even if there are initial financial expenses. Stern makes clear that global cooperation in emissions reduction is vital and markets that hinder reductions in GHG emissions (e.g. carbon pricing, carbon markets, carbon taxes) are needed to incentivize it.

To mitigate the effects of climate change, the study advances the need for climate resilient agricultural practices including the use of drought resistant varieties, the improvement of

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irrigation system and better crop management practices. The research also calls for concerted efforts of both the government and of research institutes to also support farmers to adopt such adaptive strategies.

The key recommendations include enhancing climate resilience, raising climate finance, adopting gender sensitive policies as well as ensuring that adaptation measures are inclusive of vulnerable communities. Given the growing impacts of climate change on these, meeting the global sustainable development agenda will depend on tackling these challenges.

RECOMMENDATIONS

1. One of the major barriers to mitigating the effects of climate change in Pakistan is the insufficient awareness about its causes and consequences. Many stakeholders including policymakers, local communities, and industries, remain uninformed about the severity of climate risks and the urgent need for adaptation and mitigation strategies.
2. The institutional capacity to address these challenges remains weak and the country lacks a coordinated response to climate change. This research aims to address this gap by emphasizing the importance of enhancing institutional capacity and promoting public awareness on climate change issues.
3. Pakistan is also grappling with severe environmental problems, including pollution and waste management. These issues, compounded by rapid urbanization and industrialization, contribute significantly to the acceleration of climate change.
4. Government support in the form of subsidies for heat resistant seeds, access to modern irrigation technologies and financial support for farmers to make changes in sustainable practices are necessary.
5. Awareness of climate variability, coupled with adaptation strategies will reduce the yield gap and increase wheat production in Pakistan' agriculture sector.

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