

Impact Assessment of Global Warming on the Economy of Pakistan

From 2010 to 2022 Proposing Policy Recommendations for Future Resilience

 Junaid Khan¹



Copyright © 2024 Author(s)

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Suggested Citation:

Khan, J. (2024). Impact Assessment of Global Warming on the Economy of Pakistan: From 2010 to 2022 Proposing Policy Recommendations for Future Resilience. *Journal of Pakistan Administration*. 45(2). 172–195.

Received: August 6, 2024/ Accepted: November 21, 2024/ Published: December 30, 2024.

Abstract

Global warming is the biggest challenge faced by mankind in the current century. Green House Gases have significantly contributed towards the rising global temperatures. While, all countries of the world are affected by the resulting climate changes, Pakistan faces an existential threat. Ironically, Pakistan produces less than 1% of global emissions of GHG yet it is facing the extreme brunt of climate changes. As a developing country, Pakistan is predominantly an agrarian economy with 22% sectoral share in GDP of the national economy. Global warming has caused adverse impacts on the economy owing due to a plethora of issues and challenges. These include temperature variance, food insecurity, energy deficiency, agriculture degradation etc.

The significant temperature variances caused by global warming have led to severe heatwaves and cold spells in Pakistan. These extreme weather conditions disrupt normal life and threatens the agricultural sector of Pakistan, causing crop failures and food insecurities. Furthermore, the unusual temperature variations have led to rising incidence of vector-borne diseases compromising health security. Additionally, global warming has

¹ Provincial Management Services, Khyber Paktwankhawan, Government of Pakistan
e-mail: khan.j@gmail.com

exacerbated water scarcity issues, leading to conflicts over water resources and posing threats to national security. The agriculture and industrial sectors are grappling with these challenges, facing issues such as changing weather patterns, resource scarcity, and increased operational costs due to the need for climate change mitigation measures.

The economic security of the country needs comprehensive investment in climate adaptation and climate resilience measures. All relevant stakeholders must work together to mitigate the adverse impacts of Global Warming and promote sustainable economic development.

Keywords: *Global Warming, Climate Change, Disaster Risk Management, Resilience, Disaster Mitigation.*

1. Introduction

Global warming is a major challenge of the 21st century, with alarming economic implications for nations across the globe. Global warming is the increase in temperature of the surface of Earth over a long period. It is mainly triggered by Green House Gas emissions, posing threats to developing and third-world economies. Uncontrolled emissions of Green House Gases due to robust industrialization since the renaissance resulted in higher temperatures, ozone depletion and severe climate changes. The consequences of Global Warming include accelerated melting of polar ice and the corresponding rise in the sea levels. It is pertinent to say that global warming benefits some industrialized nations in terms of long-term production activities, such as Canada's prairies, where snow melting has positive impact on its agriculture and livestock, but on the other hand, it constricts water resources for developing nations like Pakistan, affecting economically critical sectors including agriculture productivity, ecology, fisheries, and human health.

Climate change is the long-term changes in the average weather patterns of different regions of the Earth. These climatic changes are driven by anthropogenic activities such as the combustion of fossil fuels and industrial productions which release Green House Gases into air. These gases trap heat from sun rays, leading to a gradual warming of temperature of the surface of Earth. Climate change is causing temperatures to fluctuate, changes in rain patterns, stronger sun rays, rise in sea water levels and severe weather patterns that critically affect human health, agriculture, forests, and land. The recent human interventions in the global ecosystem such as artificial rains are further worsening the overall balance of nature by polarizing the natural resources to certain regions artificially. Globally, around 971 million people live in places where climate change risks are severe. Countries that are not well developed cannot undertake any remedial actions due to their meager resources and



dwindling economies, often succumbing to recession. Pakistan is consistently ranking in the top ten most vulnerable countries of the world where climate change has played havoc over the past two decades. As a result, the country has endured disastrous effects due to calamitous weather events such as long-term droughts and floods majorly caused by the global warming phenomenon.

Pakistan has suffered prolonged droughts and severe floods that has resultantly destroyed lives, livelihoods, and valuable assets on enormous scale. The changing climatic patterns is clear evidence that the global warming predictions and its consequences are correct. The world weather crisis has caused major floods in Pakistan in the years 2010 and 2022.

According to the “World Climate Research Program and World Meteorological Organization (WMO)” these events are bound to reoccur in the same region with increased frequency and greater severity. They have concluded that the events of floods in Pakistan fits well with the patterns which have been predicted by the global warming scientists. While it is generally asserted that a considerably longer duration of time is required to establish a link between global warming and flood occurrences in Pakistan, climate scientists are expecting more of the same with greater intensity. The floods of 2010 and 2022 cannot be termed as individual events even though both have been reported as separate occurrences. According to experts of global warming, these events occur because of global warming and changing climatic patterns.

According to Ministry of Water and Power, Pakistan has suffered more than US\$ 60 billion as flood damages since over past seven decades. The 2010 floods alone resulted into financial losses worth more than US\$ 10 billion with a loss of life of more than 2000 people, 17,533 villages and 160,000 square km of area affected.

According to the Planning Ministry of Pakistan, the recent floods in the year 2022 have further strengthened the fact that Pakistan is facing an existential threat to Global Warming. It was a catastrophic mix of heavy rainfall which surpassed the average by 190 % coupled with intense low-pressure system developed due to severe heatwaves of the summer season and glacial lake-bursts. More than 1/3rd of Pakistan was under water for an extended period, affecting 33 million people with 8 million displaced. More than 8 million people have been pushed into poverty, Pakistan is still finding it difficult to mobilize assistance from foreign countries, donors and development partners.

The 2022 flood caused colossal damages to various sectors of Pakistan economy. According to the Post Disaster Needs Assessment (PDNA) report of the World Bank, flood damages have been estimated to be more than US\$14.9

billion with total economic losses amounting to over US\$ 15.2 billion. Housing and human settlements were the worst hit across Pakistan. More than 90 districts of the country were hit by the calamity, resulting in 0.78 million fully damaged and 1.27 million partially damaged houses. Rural areas have been severely hit and mud houses and informal settlements have been worst hit.

Apart from devastating floods, climate change in Pakistan is causing severe temperature variations that is making already dry regions drier and wet regions wetter. Water evaporates quickly in dry regions due to rising temperature resultantly prolonging the dry period. Drought is a slow-onset phenomenon which is caused by reduced rainfall. During the past 70 years, three major drought periods have been experienced by Pakistan including 1962-66, 1968-72 and 1999-2002. Since, 2013, Pakistan saw five consecutive dry years in southwest Baluchistan region, with 2018 being the driest year since 1961. The intensity and frequency of droughts has alarmingly increased in Pakistan putting severe pressure on ground water tables which are resultantly depleting at a fast rate.

In the wake of recurring disasters in Pakistan, it is high time to understand the Global Warming and its adverse effects on economy of Pakistan. Pakistan faces existential threats including severe weather patterns, depleting water tables, glacial melting, and rise in sea levels. These impacts pose formidable challenges to the economy, infrastructure, and societal fabric. The probability of devastating climatic impacts in Pakistan merits prompt response to safeguard the lives of its people and protect its infrastructure and assets thereby padding its ecosystems and the economy. While Pakistan has initiated measures to address climate change, its adaptation policies need strengthening to effectively build resilience and reduce vulnerability. Pakistan must enhance its resilience and coping capacities to the global warming challenges. In the aftermath of 2022 floods, it must embark upon a more efficient and effect development strategy to build back better a more resilient country.

2. Literature Review

A study was conducted by Kashif Abbas et al in April 2022 on review of the global climate change impacts, adaptation, and sustainable mitigation measures. Their study design was a systematic review, and they collect data from various previous literature. The aim of the study was to examine the vulnerability of agriculture sector at the global level amidst growing climate vulnerability. The irreversible weather patterns has severely challenging the agricultural trends in countries where agriculture is an integral sector the economy. Hence, they concluded that government intervention is required for the nation's long-term growth through adoption of climate resilient



agricultural practices. The research advocates reducing the effects of climate change must be accorded highest significance. To maintain global sustainability, this global challenge demands worldwide resolve to confront its terrible effects. (Abbass et al., 2022).

Imran Khan et al in February 2021 conducted a study on Climate change impact assessment, flood management, and mitigation strategies in Pakistan for sustainable future. The aim of the study was to find out the climate changes and its effects on Pakistan as one of the main climate change. Furthermore, the adverse effects of floods on humans and their environment were explored. The research has proposed several sustainable options for consideration of the governments. To lessen the negative consequences of floods, the Pakistani government should create proper climate change policies at the national and provincial level, enhance disaster preparedness and management, construct new water bodies at feasible sites, and build capacities along with functional specialization of all relevant departments. (Khan et. al., 2021).

Irfan Ahmad Rana et al conducted a study in September 2022 at Lahore (Pakistan) on a localized index-based approach to assess heatwave vulnerability and climate change adaptation strategies: A case study of formal and informal settlements of Lahore, Pakistan. The heatwave index was based on number of components and was operationalized for formal and informal settlements through a questionnaire survey with sample size of 400 households in Lahore, Pakistan. The study concluded that informal settlement households had worse coping skills, which made them more susceptible to the effects of heatwaves. Even the adaptation techniques of every two villages also differed from one another. This study offers a heatwave index for the Global South, which adds to the conversation about reducing the risk of disasters and adapting to climate change. (Rana et al., 2022).

Mukhtar Ahmed et al in May 2022 conducted a systematic review on Impact of Climate Change on Dryland Agricultural Systems: A Review of Current Status, Potentials, and Further Work Need. The main objective of the research study was to suggest meaningful technology based solutions for dry land farming under climate variations. The study stresses optimum and efficient utilization of the available agricultural resources to overcome food insecurity in the future. Hence, they concluded that Global warming and climate change have an adverse effect on all farming patterns, but dry land agrarian practices are more vulnerable. There is a growing risk of irreversible losses in terms of soil capacities, yield and its various components, and resource use efficiency if practical mitigating measures are not implemented in the agricultural sector. Therefore, technology-based interventions are required to develop dryland

farming techniques in agriculture. (Monteiro, Ankrah, Madureira, & Pacheco, 2022).

Alam Rehman et al in January 2021 conducted a study in Pakistan on adoption of green banking practices and environmental performance in Pakistan: a demonstration of structural equation modelling. The aim of the study was to examine the direct and indirect impact of green banking on environmental performance. The key findings of the study were that the adoption of green banking practices is heavily influenced by investments, day-to-day operations, and policy. The study's suggested framework may be used by interested parties to access and identify the variables that might justify a certain degree of green banking practices in the nation. Furthermore, this study may contribute to the vast, current literature on green banking, which would expedite further research in this area. (Rehman et al., 2021).

3. Research Methodology

The method used in preparing this research paper was based on qualitative analysis of the literature and data available. The data used in this analysis is mostly secondary in nature available in form of research papers, journals, books, articles from the library and internet. Analytical research techniques such as content analysis, situational analysis based on the evidence provided by different research papers was undertaken.

4. Discussion

4.1. Global Warming

The gradual increase in the temperature of the planet is really disturbing and threatening. The phenomenon of this gradual increase in temperature due to manmade actions, is called global warming. The natural greenhouse effect normally captures the quantity of heat and keeps it there in a way that our Earth is protected from attaining the cooler temperatures and remains comfortable for all living creatures on Earth. Similarly extra heat is sent back to space through the atmosphere, so temperatures remain not very high as well. The problem starts when the amount of heat trapped by the atmosphere increases with the increase in greenhouse effect which results in warming of the planet. The human-enhanced greenhouse effect is the result of burning fuels which escalates the quantity of greenhouse gases in the atmosphere (oxides of carbon & nitrogen and methane etc.). The phenomenon which heats the Earth by the hot sunlight coming in and going out in equilibrium is normally known as the greenhouse effect. The GHG includes CO₂, CH₄, NO₂ and some chemicals which contain chlorine and bromine etc. These gases, when released in large quantity over a consistent period of time have the effect of changing



the equilibrium of gases around earth which directly imbalances heat trapping equilibrium in the atmosphere. Their normal function is disturbed and tends to warm the Earth's surface as greenhouse gases absorb the sun rays reflected from the surface of the Earth.

The planet Earth has experienced considerable increase in surface temperature in recent past. The average temperature of Earth surface has increased by 0.3° C and it has almost doubled in the last 50 years. It is noticed that huge quantities of methane gas and oxides of Nitrogen are released in the air through different human activities in agriculture like use of nitrogen-based fertilizers and decomposition of biomass and animal manure. Different chemical industries also produce these greenhouse gases round the clock as a waste and releases them into the atmosphere continuously. These free greenhouse gases remain present in the air for many years and do not decompose. According to the Intergovernmental Panel on Climate Change (IPCC), carbon dioxide and methane levels have risen by 35% and 148% respectively since the Industrial Revolution of 1750. This has put 16% of the global population at stake which are living in areas with decreasing water levels.

4.2. Effects on Pakistan

It may be very difficult to predict the exact effects and impacts of global warming on Pakistan. Abnormal rise in temperature may have so many abnormal effects which may include floods in different areas and at same time some areas may be under drought as well. This is due to abnormal evaporation of water in some areas and condensation in other parts. The glaciers melt increase due to an rising trends in the average temperature which may also enhance the probability of floods in some areas and droughts in others.

Pakistan is a predominantly agrarian economy with is heavily dependent on its available water resources. The river system of the country is dependent on snow and rains. With the environmental changes in the seasonal cycles of snow and rains and its change in low and high temperatures, there is considerable shortfall of water resources in the country. The rapid environmental changes occurring in country require serious planning for development of appropriate size water resources. These water dams will not only mitigate the dangerous affects of flash floods but will also contribute towards water regulation in the main river system of the country. There is considerable temperature variation in Pakistan from region to region. It has diverse regions with temperature varying from over 50°C in summer in the southern regions to far below zero degree in winter in northern regions.

Pakistan experienced one of the most wet years in 2022 which resulted in

unprecedented floods that played havoc with the lives, livelihoods and properties of the affected people. With 33 million people affected, 8 million displaced and an equal number pushed below poverty line, more than 1700 people dead; Pakistan faced the brunt of Global warming. As per conservative estimates, the financial losses have amounted to more than US\$ 15 billion. The havoc wrecked by the devastating floods of 2022 highlights the vulnerabilities of Pakistan to the growing threat of Global Warming and Climate change. Pakistan has to desperately adopt climate resilient strategies to develop coping capacities for such like future eventualities.

Table 1

Floods 2022 – Region-wise Damage, Loss and Needs

Region	Damage		Loss		Needs	
	(Billion PKR)	(Million US\$)	(Billion PKR)	(Million US\$)	(Billion PKR)	(Million US\$)
Baluchistan	349	1,625	541	2,516	491	2,286
Khyber Pakhtunkhw a	201	935	141	658	168	780
Punjab	111	515	122	566	160	746
Sindh	1,948	9,068	2,444	11,376	1,688	7,860
Cross- Provincial	587	2,731	14	67	975	4,540
Special Regions	7	32	11	49	10	48
Grand Total	3,203	14,906	3,273	15,232	3,492	16,260

(Reference Pakistan Post-Disaster Needs Assessment Report 2022)

4.3. International Climate Governance Framework

In order to study the International Climate Governance Framework, it is important to examine the historical development of international frameworks on Global Warming and Climate Change. In 1992, nations across the world came together at Rio DeGennaro Earth Summit with an urgency to control global climatic changes. This paved way for the first meeting of United Nations Framework Convention on Climate Change in 1995. Again, in the year 1997 at Kyoto, the first ever legally binding Climate Treaty was signed in the shape of Kyoto Protocol which would take effect from 2005. Here the global goals of fighting the climate change were set earmarking different responsibilities amongst different countries on basis of their development and geographic



locations. It transpired that the global North is historically responsible for major contributions in production of Green House Gases. The per-capita production share of the developed world is significantly higher than the developing world and they have benefitted from the global Green House Gas emissions. Yet, the developing world is being asked to play equal role in combatting climate change. Hence, it was voiced that there should be different sets of responsibilities for the developed countries viz-a-viz the developing countries. In 2015, a lot of diplomatic efforts led to the signing of the landmark Paris Agreement, which has a binding effect for signatory members in the form of setting global goals to fight climate change by taking concrete steps to reduce the temperatures of the globe by 1.5 C. In 2018, the Conference of Parties, Rules of Paris Agreement were decided. In the 28th Conference of Parties held in November 2023, Pakistan voiced concerns in the aftermath of devastating floods of 2022 stating that mitigation and climate adaptation measures are not enough in areas where losses are suffered. The vulnerable eco-systems need to have resilience to combat the rising temperatures and their adverse effects. Pakistan stated that losses and damage assessment of 2022 flood reveals that what has happened in Pakistan, will not stay in the geographical boundaries of the country as it will have ripple effect for the region and beyond. Hence, focus should be on climate financing since countries in the global South like Pakistan, Fiji and Bangladesh have recently sustained significant losses due to Global Warming. Global North has prospered even though they are also at the suffering end due to Global Warming however they have the finances and economic capacities to combat and mitigate the climate change challenge.

Countries today are unanimously advocating mobilization of finances and technology transfers for carbon capture and storage. In theory, it appears good but materializing it is not a fair possibility unless continuous phasing out of fossil fuels is adopted globally.

4.4. National and Provincial Climate Governance Framework

Globally, Conference of Parties meet every year where Pakistan has been proactively participating from the start. Pakistan is signatory to both Kyoto Protocol and Paris Agreement. It has undertaken number of initiatives to ensure that the Indus communities become more resilient to climate vulnerabilities.

National Climate Change Policy 2012 was Pakistan' first comprehensive policy targeting eight priority sectors that are most vulnerable to climate changes. Climate Change Act 2017 is a legal framework for climate change in Pakistan. It created the Climate Change Council and the Climate Change Fund at the

Federal government level. National Climate Change Policy was revised in 2021 to cater for the latest scientific evidence on climate change and its adverse impacts on the country. It further considered Pakistan's commitments under the provision of Paris Agreement by setting new climatic goals on resilient coping capacities, adaptation, vulnerabilities, and mitigation strategies. Finally, the National Adaptation Plan 2022 outlines over 100 specific adaptation measures that Pakistan will undertake to adapt to climate changes.

On the provincial level, Khyber Pakhtunkhwa faced the brunt of Global Warming impacts in the face of 2010 floods. Climate Change is a real threat to Khyber Pakhtunkhwa which requires urgent and collective actions from all stakeholders. The province faces multiple risks and challenges from the changing climate, such as floods, droughts, landslides, and food insecurity. These impacts not only affect the environment and economy, but the poor and marginalized segments of society as well.

The province approved its first Climate Change Policy in 2017 which was updated in 2022 inline with the National Climate Change Policy 2021, outlining sectoral adaptation and mitigation measures to reduce vulnerability of human systems along with reduction of emissions through technologies or natural means. The Khyber Pakhtunkhwa Climate Change Action Plan 2022 further outlines the strategies and measures based on national objectives to enhance its resilience, reduce its vulnerability, and achieve its sustainable development goals.

5. Situational Analysis of Impacts of Global Warming on Economy of Pakistan

The significant temperature variances caused by global warming have led to severe heatwaves and cold spells in Pakistan. These extreme weather conditions disrupt normal life and pose a threat to the country's agricultural sector, which relies heavily on predictable weather patterns for crop growth. The unpredictability of these conditions has threatened food security in the country, leading to crop failures and food shortages. Furthermore, the rise in temperatures has led to an increase in vector-borne diseases such as malaria and dengue fever, compromising health security. The economic security of the country is also strained due to the impacts on the agricultural sector and the costs of managing health impacts. Additionally, global warming has exacerbated water scarcity issues, leading to conflicts over water resources and posing threats to national security. The agriculture and industrial sectors are grappling with these challenges, facing issues such as changing weather patterns, resource scarcity, and increased operational costs due to the need for climate change mitigation measures. Situational Analysis of the economic

consequences of global warming on various sectors and indicators impacted by climate change from 2010 to 2022 helps in identification of key issues and challenges confronted by the economy of Pakistan.

5.1. GDP and Economic Growth

One of the major manifestations of Climate Change impact is the occurrence of floods in an area. Since 2010, Pakistan has grappled with a series of floods of varying severity, including occurrences in 2011, 2014, and 2015. However, the most recent flood in 2022 stands out as particularly severe, impacting the entire country from its northern to southern regions (Baloch, 2022). As per the World Bank's assessment, the year 2022 brought a harrowing combination of a heatwave and massive floods, underscoring the alarming effects of climate change-induced disasters on Pakistan's development goals and poverty alleviation endeavors. The toll of these disasters was staggering, leading to a tragic loss of over 1,700 lives and displacing more than 8 million people, while more than 8 million people have been pushed down the poverty line (Khan et. al., 2021). The resultant damage to infrastructure, assets, agricultural produce, and livestock was extensive, totaling over \$30 billion in economic losses. This surpassed the economic toll of the 2010 floods, which amounted to \$9.7 billion according to the same source. The Asian Development Bank's report further highlighted that the damages accounted for 4% of Pakistan's GDP in 2010, accentuating the profound economic impact of these calamities. Floods in 2022 sustained a loss of 2.2% to the country's GDP resulting to inflationary trends over 27% while directly affecting more than 84 districts of the country. Therefore, the disasters mentioned above have exposed the vulnerability of Pakistan's economy and society to the adverse impacts of climate change and highlighted the urgent need for adaptation and mitigation measures (Baloch, 2022).

5.2. Agriculture and Food Security

Climate change has adversely affected Pakistan's agriculture and food security, when the country faced extreme weather events such as heatwave, drought, and floods. The floods that ravaged Pakistan since 2010, particularly the monumental deluge in 2022, inflicted significant devastation on the country's agricultural landscape and food security. Spanning from 2011 to 2015, the intermittent floods posed challenges, yet the 2022 flood, stretching across the nation from north to south, emerged as a catastrophic event (World Bank report, 2022).

According to the World Bank, these calamities profoundly affected agriculture, displacing farmers, inundating millions of acres of farmland, and destroying

crops and livestock. This turmoil dealt a severe blow to food security, exacerbating vulnerabilities in a nation heavily reliant on agriculture. Pakistan is one of the world's largest rice exporters, ranking fourth globally. During the 2021-22 fiscal year, Pakistan exported a record \$2.5 billion worth of rice, according to the nation's Bureau of Statistics. Sindh province, which accounts for 42% of the country's rice production, was severely affected by flooding in 2022, resulting in an estimated loss of 1.9 million tons of rice, equivalent to an 80% loss of the province's forecast rice production. The report also highlights an 88% loss of sugarcane and 61% loss of cotton, amounting to a total economic impact of \$1.3 billion in Sindh alone. Additionally, three key vegetable crops in several districts in Sindh, including tomatoes, onions, and chili, face losses of \$374 million. Similarly, the 2010 floods in Pakistan wrought devastating effects on the agricultural landscape and food security of the nation. Approximately 20 million acres of land were submerged, resulting in the destruction of over 2.2 million hectares of standing crops, as estimated by the World Bank. The United Nations reported that around 10 million people grappled with food insecurity due to acute shortages post-flood. The Asian Development Bank noted economic losses of approximately \$5 billion in the agricultural sector, highlighting the widespread economic impact. Additionally, the floods' contamination of soil and disruption of transportation networks contributed to long-term challenges in restoring agricultural productivity and distribution. These statistics, drawn from reputable sources like the World Bank, United Nations, and Asian Development Bank, underscore the significant toll the floods exacted on Pakistan's agriculture, economy, and food stability.

5.3. Water Resources

Pakistan faces significant challenges related to water resources and climate change. It ranks among the top ten nations in the Climate Risk Index (CRI) based on exposure and vulnerability to extreme events. The Indus River, which is crucial for Pakistan's water resources, is highly sensitive and prone to climate change keeping in view its reliability on glacial and snow melt water, making it more susceptible to shifts in temperature and precipitation patterns. the temperature increases are certain in future so it is very obvious that precipitation patterns will remain uncertain across most of the country, potentially impacting water availability to meet the requirement of agricultural productions and ever-growing population.

Pakistan heavily relies on the Indus Basin Irrigation System (IBIS), one of the world's most extensive irrigation system. Water is primarily used for agriculture (92%), with industries (3%) and domestic/infrastructure (5%) also using it. However, it is expected that future socioeconomic development and



population growth will increase sector water demand. Pakistan current water storage capacity caters only for 30 days of its annual national needs despite possessing potential of 1000 days owing to its mountainous terrain in northern parts of the country. According to Ministry of Water and Power, Pakistan per capita water availability was 5260 cubic meter in 1951 however, it has now reduced to 1000 cubic meters due to exponential growth in population coupled with the fact that it has not been able to construct major water dams with large storage capacities in past 50 years.

Rising temperatures, saltwater intrusion in coastal areas, intense rainfall, glacier lake outburst floods and changing monsoon patterns adversely affect Pakistan's hydrologic resources and so the ripple effect will obviously put pressure on the economy and livelihood.

The climate variations in Pakistan will cause considerable increase in non-agricultural use of water with serious concerns for lower riparian provinces of the country. This will create food insecurity amongst the agrarian areas of Sindh province in turn fanning interprovincial discords. As per modest estimates, 10% of current irrigation water will get diverted to non-agricultural needs by mid of current century. Therefore, there is need for sustainable policy reforms to undertake water conservations in agriculture sector.

The World Bank Climate report on Pakistan issued in 2022 mentions that the average water supply will remain constant with greater variations in flow over different periods of times. Under a high global-warming scenario, the current water consumption by the agricultural sector of Pakistan can be maintained only up to 2037. Groundwater levels are sustainable only till 2030. The performance of the Indus Basin Irrigation System (IBIS) will come under increasing pressure for reallocating irrigation withdrawals.

5.4. Energy Sector

The energy sector is another major cause of creating imbalance in the global ecosystem as over the years it has evidently contributed heavily to ozone layer depletion and global warming due to its ever increasing demand in the day-to-day life. The energy demand requires a balancing act across the nations for a major shift to renewable resources. The energy sector of the country is the biggest contributor to the greenhouse gas emissions. It accounts for more than 46% of the total national greenhouse gas emissions. Due to alarming increase in the population of the country and the reciprocating demand to cater for the requirements of the energy sources, its consumption has triggered the emissions of hazardous carbon byproducts in the environment. While it is often discussed how the energy sector contributes to variations in the climate

patterns, it is also pertinent to understand that climate change also has implications for the energy sector itself. Therefore, it is crucial to implement adjustment measures to ensure the survival of Pakistan's energy sector in the face of impacts of climate variations.

Climate change can have severe effects on the output, efficiency, and financial viability of energy generation plants. Since Pakistan relies heavily on fossil fuels for its energy mix, it is extremely climate vulnerable as well. Pakistan is over dependent upon fossil fuels to meet its energy requirements. The shortages in availability of oil and gas is bringing about a serious energy emergency. The energy crisis contributed by numerous long stretches of load shedding, represented 7% of Gross domestic product losses in 2013 alone. Pakistan is the biggest gas client in the area, while it has the 6th biggest coal deposits on the planet. Notwithstanding, the country's energy reliance on gas and oil is a lot higher than on coal. It is assessed that gas deposits of the country will be significantly drained by the year 2025.

The domestic consumption of energy (47%), trailed by businesses (29%), agribusiness (10%), and other business clients. To guarantee energy security of the country, Pakistan must focus on other avenues of energy supply including wind, solar, and smaller hydropower plants. With environmental change will significantly impact the energy sector of the country. Due to melting of Himalayan ice sheets, the performance of the hydropower assets of Pakistan will come under pressure.

Around 33% of Pakistan's essential energy requirements are met through oil, moved by means of ocean. There is always a degree of uncertainty in reliable supply of imported oil amidst various international factors beyond control of the country. Pertinent to mention here that the 2010 floods disturbed the stock of petroleum gas and fuel oil because of extreme harm to a few significant establishments and the transport chains.

Thermal Power Generation through Fossil Fuels (Coal, Oil, and Gas) has imprinted consequences of the severe weather events like heavy rains and floods that threaten not only the extraction of coal, oil, and gas, but also their transportation. This is partly due to increased precipitation leading to flooding, which reduces the generation capacity and supply.

The energy sector, on one hand, contributes towards economic development, but it is also a major source for global warming which poses challenges on government to balance the economic growth with sustainable environmental mitigation measures. Dependence on fossil fuel must be reduced and investment prioritized in renewable energy sources for promoting clean and green ecosystem and strengthening climatic resilience.



5.5. Key Issues and Challenges

Different regions of Pakistan have been facing a multitude of challenges due to global warming. From the Situational Analysis of the economic consequences of global warming on various sectors and indicators impacted by climate change from 2010 to 2022, following key issues and challenges are being identified which are faced by the economy of Pakistan.

Temperature Variance: Global warming is causing significant temperature variances worldwide, leading to severe heatwaves and cold spells. These extreme weather conditions disrupt normal life and pose a threat to agricultural sectors, which rely heavily on predictable weather patterns for crop growth.

Food Security: The unpredictability of weather conditions, caused by global warming, is threatening food security globally. Crop failures and food shortages have become more common, affecting the livelihoods of farmers, and leading to increased food prices. This puts a strain on resources and leads to increased poverty and malnutrition rates.

Health Security: The rise in temperatures worldwide has led to an increase in vector-borne diseases such as malaria and dengue fever. Additionally, heatwaves have resulted in increased mortality rates. These health issues strain healthcare systems and pose a significant challenge to public health.

Economic Security: The economic impact of global warming is significant. Agricultural sectors, major contributors to many economies, have been severely affected. Furthermore, the cost of managing the health impacts of global warming is straining economic resources.

Threats to National Security and Conflicts: Global warming is exacerbating water scarcity issues, leading to conflicts over water resources. This poses a threat to national security as it can lead to social unrest and political instability.

Agriculture and Industrial Issues: The agriculture and industrial sectors are facing numerous challenges due to global warming. Changes in weather patterns have affected crop yields, while industries are grappling with resource scarcity and increased operational costs due to the need for climate change mitigation measures.

6. Analysis of Issues and Challenges

6.1. Temperature Variance

Pakistan has been experiencing rising temperatures, which have led to heatwaves and droughts. According to the Climate Change Profile of Pakistan,

the annual mean temperature has roughly risen by 0.5°C during past 50 years in Pakistan. Likewise, the number of heat wave days per year has also increased nearly fivefold in the last 30 years. The Environment and Climate Change Outlook of Pakistan report states that the average temperatures of the country are significantly higher than the world with a potential rise of 1.3°C - 4.9°C by the 2090s over the 1986 - 2005 baseline. The report also notes that Pakistan is facing serious threat of major disaster risks, with consistent high ranking on Inform Risk Index. (Abbass, 2022).

The Climate Change Knowledge Portal provides a detailed climatology of Pakistan. The country lies in a temperate zone, and its climate varies a great deal with its changing topography. Generally, the climate is dry and hot in the coastal areas and lower plains of central Pakistan and are considerably cooler in the north highlands of the country. Pakistan has four seasons comprising of a cool, dry winter period from December to February. It is followed by a dry spring season ranging from March to May. Then, the rainy summer seasons occur from June to September with considerable monsoon showers in the southwest of the country. Finally, the autumn season with retreating onsoon showers ranges from October to November.

There is very little rainfall in most of the country except for the Northern regions. There is significant variations in the inter-annual rainfalls in the northern areas of the country. This often results in repeated patterns of floods and droughts. El Niño is an important influence on the erratic patterns of climate in Pakistan. Both rising temperatures and increasing frequency of occurrences of floods have a strong correlation with El Niño cycle.

The rise in the average temperature of the country has adversely affected the agriculture sector and water resources of the country. Rising temperatures with intermittent changes in precipitation patterns along with extreme weather patterns have caused crop failures, reduced yields, and increased food prices. Additionally, climate change has led to water scarcity, which has affected the country's industrial sector.

6.2. Food Security

Global warming has had a major impact on the food security of Pakistan. According to the Climate Response Analysis for Pakistan by the World Food Program, climate change is one of the key drivers of hunger in Pakistan. The weather patterns are becoming more erratic with changing climate patterns of the country. As a result, the intensity of climatic disasters is becoming more frequent. This will further increase food insecurity in the country. Serious challenge to Climate change is posing a significant challenge to sustainable food security of the country.



A study published in SpringerLink states that Pakistan's agriculture presents a bleak picture of food security, and the climate-sensitive regions of the country are finding it increasingly difficult to achieve productivity targets. Vulnerability is further increased by deforestation, groundwater depletion, shrinking freshwater supplies, and ecosystem damage caused by extreme weather events, including heatwaves and heavy floods. The same study also estimates that if major steps are not taken by Pakistan to tackle the challenge faced by the agricultural sector of the country, Pakistan could lose approximately US\$20 billion in next 30 years due to climate change-induced rice and wheat crop production.

Pakistan Bureau of Statistics states that prices of essential items in the country have risen 44 percent due to climate change. According to the Pakistan Climate and Development Report of the World Bank, the poverty rate in Pakistan may go up by 4.7 percent, meaning that an additional 9 million people are going into poverty. These reports highlight the urgent need for Pakistan to take drastic measures for the food security. The government must take mitigating steps, such as promotion of sustainable agricultural practices through reduction of emission of greenhouse gases.

6.3. Health Security

Global Warming has also had a significant impact on the public health in Pakistan. Rising temperatures have led to an increase in heat-related illnesses, such as heat exhaustion and heatstroke. Additionally, variations in the precipitation patterns have resulted in an increase in waterborne diseases, such as cholera and typhoid fever. Between 2010 and 2022, Pakistan has experienced several extreme weather events, including heatwaves, floods, and droughts. In 2015, a heatwave in Karachi resulted in over 1,200 deaths. In 2019, heavy monsoon rains caused flooding in various areas, affecting over 900,000 people. These severe variations in the weather patterns have significantly impacted public health in Pakistan, exacerbating existing health challenges and increasing the risk of waterborne diseases.

6.4. Economic Security

Pakistan's economy has been affected by the adverse impacts of Global Warming. The energy sector of the country emits 46% of the total national greenhouse gas emissions. It is the largest contributing sector to greenhouse gas emissions with heavy reliance on oil and gas. The energy sector is also climate vulnerable to issues of rising temperatures and variations in precipitation patterns. The growing energy demand remains unmet on the supply side resulting in a crisis since 2006. This has resulted in productivity

loss of the economy since the industrial sector of the country is finding it increasingly difficult to meet its growing energy needs. (Baloch, 2021).

6.5. Threats to National Security and Conflicts

Global Warming can aggravate existing conflicts and create new ones. In Pakistan, climate change has led to water scarcity, which has increased tensions between different regions and communities. Additionally, climate change has the potential to create large-scale migration, which could lead to social and political instability. Provinces have repeatedly expressed distrust on water distribution amongst the federating units. Indus River System Authority has come under increasing pressure to ensure equitable distribution of water.

6.6. Agricultural and Industrial Issues

Global Warming has had a severe impact on the agricultural and industrial sectors of the country. The adverse effects of Global Warmings including variations in precipitation patterns, increase in average temperatures, and severe weather patterns have led to crop failures, reduced yields, and increased food prices. Additionally, climate change has led to water scarcity, which has affected the country's industrial sector. There is a growing need and realization for incorporation of climate resilient agricultural practices ranging from genetic crops to mechanized farming.

7. Conclusion

Global Warming has had a profound impact on the economy of Pakistan from 2010 to 2022, as evidenced by the occurrence of extreme weather events such as floods and droughts. These events have caused significant damage to the agricultural, industrial, and service sectors, leading to loss of lives, properties, and infrastructure. The floods in 2022 were particularly severe, causing an estimated economic loss of \$30 billion and displacing more than 08 million people. The floods have also affected the food security, poverty, and health of the population, exacerbating the existing vulnerabilities and inequalities. The World Bank and other international organizations have called for urgent interventions in climate resilient adaptation measures for economic security and poverty reduction. Therefore, it is imperative for Pakistan to recognize the limitations and challenges posed by climate change, identify the issues that require immediate attention, and propose policy recommendations for future resilience. The public and private sectors of the country, local community and global development partners must work together to mitigate the adverse impacts of Global Warming and promote sustainable development.



7.1. Policy Recommendations

Pakistan needs to take immediate action to address the challenges in priority areas to develop climate resilience through better coping capacities by undertaking climate adaptation initiatives.

7.2. Temperature Variance

- To address the challenge of temperature variance in the country due to Global Warming, it is recommended that comprehensive climate change adaptation strategies be implemented.
- These could include the development of heat-resistant crop varieties, the promotion of water conservation techniques, and the strengthening of healthcare systems to deal with climate-related diseases.
- Furthermore, policies should be put in place to promote the sustainable use of water resources and to reduce the impacts of extreme weather events.
- Finally, it is crucial to raise public awareness about the adverse impacts of Global Warming and the importance of sustainable practices.

7.3. Transforming the Agri-Food System for Food Security

- develop agricultural practices on sustainable basis,
- To transform the agri-food system in Pakistan, the following steps can be taken: Address food insecurity by improving production, processing, transport, storage, and marketing.
- Promote climate resilience agriculture and livestock systems by repurposing environmentally damaging subsidies and undertake ecosystem restorations for development of rural economies through promotion of food and water security.
- Prioritize ecosystem restoration to improve productivity in the agri-food system. By implementing these steps, Pakistan can transform its agri-food system on sustainable basis.

7.4. Health Security

- This includes enhancing public healthcare infrastructure along with adequate medicinal supplies to manage the increased incidences of heat-related illnesses and waterborne diseases.
- Development of diseases surveillance systems help in early detection and response to control diseases carrying vectors like mosquitoes and ticks etc.
- Human resource capacity constraints in dealing with such diseases

through coordinated mechanisms is needed.

- Furthermore, instituting early warning systems and disaster preparedness strategies to mitigate the health impacts of extreme weather events is essential.
- Additionally, health educational campaigns at school and college level with extensive coverage amongst masses about different types of health risks associated with climate change could aid in empowering communities to protect themselves during such events.

7.5. Building Sustainable and Climate Resilient Cities

- To make cities more habitable, it is imperative to implement urgent reforms in urban areas development comprising of adoption of land use zoning and master planning, special focus on development of municipal services on modern lines catering to the needs and demands of cities, along with urban mass transport systems based on efficient energies.
- Cities need to develop local indigenous self-sustainable solutions for stronger municipal governments with greater financial resource availability through targeted service delivery taxations.
- The public sector alone cannot develop infrastructure that can meet the housing needs of all its people, and it must develop strong partnership with the private sector in this regard. Collaboration between the public and private sectors is essential since the private sector of the country has a proven capacity to contribute towards housing supply development.
- The public sector needs to extend strong handholding support to the private sector for diverse sustainable housing options based on incorporation of innovative construction technologies.

7.6. Reliance on Sustainable Energy Development

- To mitigate the adverse impacts of climate change on the economy of Pakistan, urgent action needs to be taken in the energy sector.
- Strategies should focus on diversifying the energy mix along with increasing the efficiency of energy.
- Shifting the reliance on sustainable energy development through investments in development of renewable energy sources will pave the way for adoption of green and clean energy.
- Additionally, consistent investments in research and development for sustainable energy solutions could pave the way towards sustainable



energy sufficiency of the Pakistan.

- Reliance on accessible mass transportation systems with extensive feeder connecting routes will gradually discourage the use of private vehicles thus ensuring energy conservation along with control of air pollution.

7.7. Human Capital Enhancement on Climate Resilience Knowledge:

- Enhancing the human capital of the country can help the state and society to develop better coping capacities for the adverse impacts of Global Warming.
- Equipping people with knowledge and skills empowers them to undertake proactive informed decision making.
- Pakistan needs to ensure that the nutritional needs of its children and youth are fulfilled to overcome the challenge of child stunting so that the human capital of the country is preserved.
- Secondly, climate change impacts water resources making access to clean water sanitations and hygiene services difficult.
- It is imperative to undertake climate resilient infrastructure development initiatives for water conservation.
- Educating communities on water saving techniques, proper sanitation practices and hygiene measures will help develop coping capacities of the society during climate-related crisis.
- This includes educating individuals on the possible adverse impacts of climate change to develop effective coping strategies.
- Fostering collaborations and partnerships amongst public and private stakeholders, civil society organizations, international donor agencies and development partners can help realize the objective of climate resilient sustained and equitable development.

7.8. Water Governance

- To address the challenges posed by climate-induced conflicts and migration, Pakistan should implement policies that prioritize sustainable water management strategies, including equitable distribution and conservation measures.
- Additionally, proactive measures to anticipate and manage potential population movements due to environmental changes are vital for ensuring social cohesion and political stability.

- Collaboration between different regions and communities to find mutually beneficial solutions in the face of climate-induced challenges is imperative for fostering peace and stability.

7.9. Strengthening Governance and Institutions for Climate Resilience

- Pakistan needs to strengthen its governance and institutions to ensure that climate change is integrated into development planning and budgeting, and that climate risks are identified and managed.
- Public sector organizations need to impart professional trainings to their officers on important themes of Global Warming and its adverse impacts on the state and society of Pakistan.
- Inservice officers of Government of Pakistan and provincial governments of the country should impart trainings on the adverse impacts of Global Warming on the economy of Pakistan.
- Officers should be sensitized to cater for adoption of climate resilient strategies in sectoral developmental planning and implementation.
- Top priority should be accorded to Climate Change Policy implementation at multiple tiers of governance. Adoption of region specific mitigation strategies at the level of local governance will create better resilience amongst marginalized and vulnerable segments.
- At the national level, a climate change fund needs to be established and operationalized on urgent basis with dedicated contributions from the federal government and all provinces.

7.10. Agricultural and Industrial Correlation

- Pakistan needs to undertake concerted efforts to address the adverse impacts of Global Warming on its agriculture and industrial sectors.
- Implementing adaptive agricultural practices, water-efficient technologies, and diversified cropping patterns can enhance resilience in the agricultural sector.
- Simultaneously, the industrial sector could benefit from water conservation measures, investment in alternative water sources, and eco-friendly production technologies.
- Policymakers should prioritize initiatives that promote sustainable practices and ensure the efficient utilization of limited resources to safeguard these vital sectors.



8. References

- Baloch, S. (2022, September 2). Impact of Climate Change on Economic Development in Pakistan, STRASIA. Available at: <https://strafasia.com/impact-of-climate-change-on-economic-development-in-pakistan/>
- Zahra, S., Batool, M., & Bashir, Q. A. (2014). Impact of global climate change on the economy of Pakistan: How to ensure sustainable food and energy production.
- Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, 29(28), 42539-42559.
- Khan, I., Lei, H., Shah, A. A., Khan, I., & Muhammad, I. (2021). Climate change impact assessment, flood management, and mitigation strategies in Pakistan for a sustainable future. *Environmental Science and Pollution Research*, 28, 29720-29731.
- Monteiro, A., Ankrah, J., Madureira, H., & Pacheco, M. O. (2022). Climate risk mitigation and adaptation concerns in urban areas: A systematic review of the impact of IPCC assessment reports. *Climate*, 10(8), 115.
- Rana, I. A., Sikander, L., Khalid, Z., Nawaz, A., Najam, F. A., Khan, S. U., & Aslam, A. (2022). A localized index-based approach to assess heatwave vulnerability and climate change adaptation strategies: A case study of formal and informal settlements of Lahore, Pakistan. *Environmental Impact Assessment Review*, 96, 106820.
- Rehman, A., Ullah, I., Afridi, F. e. A., Ullah, Z., Zeeshan, M., Hussain, A., & Rahman, H. U. (2021). Adoption of green banking practices and environmental performance in Pakistan: A demonstration of structural equation modeling. *Environment, Development and Sustainability*, 1-21.
- Government of Pakistan, Ministry of Climate Change. (2012). *National Climate Change Policy*. Islamabad.
- Government of Pakistan, Ministry of Climate Change. (2021). *National Climate Change Policy*. Islamabad.
- Tariq, R., & Athar, G. R. (2015). *Possible Impacts of Climate Change on the Energy Sector of Pakistan*. Pakistan Atomic Energy Commission.
- World Bank. (2011). *Global Facility for Disaster Reduction and Recovery*. Climate Risk and Adaptation Country Profile.
- Climate Risks and Food Security Analysis: A Special Report for Pakistan. (December 2018). Islamabad.

Government of Pakistan & Asian Development Bank. Floods 2022 - Post Disaster Needs Assessment. Islamabad.

Government of Khyber Pakhtunkhwa, Forest, Environment & Wildlife Department. (2022). Khyber Pakhtunkhwa Climate Change Policy. Peshawar.

Government of Pakistan, Ministry of Finance. Economic Surveys of Pakistan 2010-2022. Islamabad.

