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Impact of Climate Change on Socio-Economic Security of Pakistan

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ABSTRACT
Climate change poses a significant challenge to Pakistan's socio-economic stability, threatening food security, water resources, energy supply, and public health. As one of the world's most climate-vulnerable country, Pakistan is facing floods, droughts, heatwaves, and rising sea levels, all of which are impacting agricultural productivity and enhancing poverty. This article analyse the multifaceted impacts of climate change on Pakistan's socio-economic security, focusing on agriculture, forestry, water, energy, and urban infrastructure. It also highlights how vulnerability to climate change leads to migration, health crises, and potential conflicts, thereby enhancing social inequalities. The study identifies crucial gaps in institutional capacity and governance that hinder effective climate change adaptation and mitigation. The article argues that sustainable resource management, renewable energy deployment, reforestation, and regional cooperation are essential to addressing these challenges. Ultimately, Pakistan's resilience depends on integrating climate policy into socio-economic planning to ensure future stability and development.

Keywords: *Impact, Climate Change, Socio-Economic Security, Climate Policy, Pakistan.*

1.0 Introduction

The worsening of the earth's climate can be seen and felt all over the world. As Pakistan is one of the most terribly affected countries by climate change, Pakistan faces numerous economic, social, geographical, and political problems. Pakistan is the seventh most vulnerable country to climate change. Pakistan is ranked at 135th amid the conservatory Gas (GHG)-emitting countries in the equivalent index.[1] The western and southern segments of the country represent the Indus River basin plain and Balochistan Plateau. The transboundary Indus basin covers 520,000 km^2 or 65% of the country's total area, including the whole provinces of Punjab, Khyber Pakhtunkhwa, most of the Sindh territory, and the eastern part of Balochistan.[2] The Indus Basin Irrigation System is

[1] Muhammad Zahid Rifat. "Climate Change Effects Human Life, Economic Growth – Pakissan.com." Pakissan.com, May 24, 2018. https://www.pakissan.com/2018/05/24/climate-change-effects-human-life-economic-growth/.

[2] Chaudhry, Qamar uz Zaman. "CLIMATE CHANGE PROFILE of PAKISTAN." ASIAN DEVELOPMENT BANK, 2017. https://www.adb.org/sites/default/files/publication/357876/climate-change-profile-pakistan.pdf.

the world's largest contiguous irrigation system, accounting for 95% of the country's total irrigation system.[3] The catastrophic force on the nation of Pakistan, above all the fall of the farming sector, is able to plummet the country into dire straits. In addition, to increase the social inequities, bringing about stark migrations and in-house displacements in unusual parts of the country, climate change prevails as a social, geographical, and political imbalance, which would need a host of challenging problems. Climate change has serious implications for the socio-economic security of Pakistan, which will only get worse with the passage of time unless satisfactory procedures are taken. Nature is wild; don't mess with it, a most famous quote, is true and always will be. Politics, in any country, is not carried out in isolation. As climate transformation increasingly influences the economy, the world, and geography, the following setting in Pakistan is on the fringe of change. The financially viable ramifications of climate cash will be at the midpoint of the following discord. opinionated parties in Pakistan have historically not responded successfully to failing monetary conditions. cost-effective doubts suddenly twist into broadcast uprisings, which entrepreneur politicians may instantly catch behind in peace to foster their particular biased goals. This opportunism has been witnessed scores of eras before; for instance, loans from the IMF in the past, even if not a catalogue but a necessity, have been criticized by many, reaping biased leverage. Such populist takes have not performed economically satisfactorily in the past, and if allowed to govern, the fallout would be decidedly risky for Pakistan's supporting institutions, which are, before now, at a hopeful stage of development.

1.1. Problem Statement

Climate modification has be converted into a important menace to Pakistan's Socio-Economic Security. The great magnitude climate modification threats to Pakistan are increased stress between upper riparian and lower riparian regions due to the distribution of irrigation resources, increased health risks, and climate change-induced migration. Such threats lead to main survival concerns for Pakistan, particularly in next of kin to the country's security and energy resources. Climate change is perceived as a major challenge to humanity due to its devastating effects on human lives, economic growth, and prosperity. Natural resources are being rapidly eliminated, causing loss of biodiversity and deforestation.

1.2. Significance of the study

The research, which is conducted and presented in this paper, is based on climate change and its impacts on Pakistan's Socio-Economic Security It will present the direct and indirect effects on the economy, agriculture, sustainability of natural resources, and further analysis of the conflicts, which are increasing rapidly (due to climate-induced causes).

1.3. Objectives

1. *To highlight the impacts of climate change on the socio-economic security of Pakistan*
2. *To explain the causes of climate change*
3. *To find out the solutions regarding this issue*

1.4. Research Questions

1. *What are the major effects of climate change in Pakistan?*
2. *How can climate change induce conflict in Pakistan?*
3. *Why is climate change a serious threat to Pakistan's Socio-Economic Security?*
4. *What measures can be taken to mitigate these threats?*

[3] Abid

1.5. Research Gap

The research gap identified is the thermal tolerance and acclimation capacities of both plants and animals and the direct impact of rising carbon dioxide on biodiversity. There is a limited pool of research and data available on the Socio-Economic conflicts in pakistan by climate change.

2.0. Literature Review

Pakistan faces countless challenges in the conditions of aggravated climate conditions. These problems are not limited to any certain region of life; rather, they extend to almost every sphere of life, complementing each other. In the economic sphere, climate change poses a terrifying threat. Water availability, over the years, has been decreasing for the cultivation sector.[4] As we know, Pakistan is heavily dependent on agriculture for its foreign earnings. Any damage to this sector would grant a difficulty of further getting cost.

Women are one of the most vulnerable groups in any society. A number of rural women in Pakistan are engaged in agricultural activities. In cases of natural uncertainties, such as droughts and deforestation, these women find it more difficult to relocate to greener pastures, owing to their families and children, and this leads to increasing poverty. The progress of women development is already poor in Pakistan, and the current drop of climate can cause significant harm to it.[5]

Climate Change will deteriorate human health. Warmer climate will result in many water- and airborne diseases.[6] Without solid steps to eradicate the impacts of climate change, the poor Pakistani population will be highly vulnerable to these diseases. Climate Change is perceived as one of the key challenges to humanity, as it should be, due to its devastating effects on individual lives, financial enlargement, and prosperity. Natural resources are being rapidly depleted at an alarming rate, causing a lot of biodiversity loss and deforestation. The underground and plant stream is grimy due to the expense of pesticides and fertilizers in the crop-growing sector. On the other hand, the burning of crop residues is additionally resulting in more pollution formation. As a material of fact, Pakistan has been facing the nastiest possessions of climate transformation in the preceding decade as of its geographic location.

The department of climate change has several initiatives in the quarter of climate swap adaptation and alleviation in accordance with the state policy.

The Pakistan climate loss change board and Pakistan climate coins have confidence in the progression of traditional consciousness to take up the issues of climate substitute and link Pakistan's obligations under global conventions involving climate change.

The Ministry of Climate change has finished the deal with the signing and confirmation of the Paris accord by the centralized Government.

A report from independent policy think tank "Lead Pakistan," which focuses on policy research, public engagement, and leadership development in the public, highlighted the effects of climate change on Pakistan. Pakistan contributes actual dimitive to the whole Green House Gas emissions. Glacier melt in the Himalayas is projected to proliferate flooding, which will have an

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[4] Rajendra Pachauri, Leo Meyer, and Stephane Hallegatte, "Climate Change 2014 Synthesis Report," *IPCC* (Gian-Kasper Plattner, 2014), 8. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf.

[5] Sabahat Zahra, Masooma Batool, and Quratul Ain Bashir, "Impact of Global Climate Change on Economy of Pakistan: How to Ensure Sustainable Food and Energy Production ," *MedCrave* 5, no. 2 (November 23, 2016): 512.

[6] Fahad Khan and Syed Ahmad Akbar Shah, "View of Climate Change and Human Health: Impacts and Vulnerability," jhrlmc.com (Journal of Health and Rehabilitation Research , 2024), https://doi.org/10.61919/jhrr.v4i1.438.

effect on irrigated possessions confined by the subsequent two to three decades. This will be followed by decreased canal flows over time as glaciers recede. Fresh water availability is, in addition, projected to drop off, which will go in front of biodiversity beating and cause availability of fresh water for the population. Coastal areas neighboring the Arabian sea in the south of Pakistan will be laid bare due to enlarged flooding from the sea, and in some cases, the rivers. The force of climate adjustment will ignite the free shared inequalities of reserve handling and deeper collective factors foremost to instability, conflicts, disarticulation of the nation, and changes in migration patterns.

Sabahat Zahra, in her article "impact of global climate change on the Economy of pakistan." says that Food is primarily associated with crop creation and provisions accessibility; both of these basics are at once exaggerated by climate change. The one on its own resulted from devastating 2010 flooding weather, which beat down 6 percent of our GDP. The humankind broadly accounts for Nature-Pakistan (WWF-Pakistan), in collaboration with the London School of Economics-Political Sciences and Lahore college of Management Sciences, undertaking an information campaign and highlighting the circulation of climate swap in Pakistan and its collision with cultivation and foodstuff security. According to this report, altering climate will precisely move agricultural productivity.

Impact of Climate Change by 2040 [7]	***Details***
On temperature Increase	*0.5°C increase nationwide*
On Crops	*8-10% loss in crop production (value: PKR 30,000 per acre)*
On Energy	*Increase in energy consumption in residential, commercial, and industrial sectors*
Energy Consumption Increase	*Higher energy demand for cooling (e.g., air conditioning, refrigeration, cooling of thermal plants)*
Agricultural Impact	*Increased energy use for irrigation and pumping*

According to the General Fiscal & Environmental Growth Reading Report

Energy Source	***2008-09 (%)***	***Previous 5 Years (%)***
Gas	*43.4*	*43.4*
Oil	*29.0*	*19.5*
Electricity	*15.3*	*16.3*
Coal	*10.4*	*11.9*
LPG	*1.5*	*1.5*

According to the report of DW (a TV channel), India and Pakistan are bitter rivals over water, and both hold nuclear weapons in their arsenal. The two countries obtain an extended but artificial arrangement over a division filled with tears from the Indus stream and its tributaries. Waters from the Indus, which stream from India and the disputed Kashmir constituency into Pakistan, were imprinted upon between India and Pakistan under the 1960 Indus Irrigation Treaty (IWT).[8] *The IWT divides the six chief rivers of the Indus hand basin between Pakistan and India. Pakistan*

[7] Areeja Syed et al., "Climate Impacts on the Agricultural Sector of Pakistan: Risks and Solutions," *Environmental Challenges* 6 (January 2022): 1, https://doi.org/10.1016/j.envc.2021.100433.

[8] "INDIA, PAKISTAN and INTERNATIONAL BANK for RECONSTRUCTION and DEVELOPMENT," 1960, http://treaties.un.org/doc/Publication/UNTs/Volume%20419/volume-419-I-6032-English.pdf.

arranged human rights as a rule to dampen the region's western rivers, the Indus, Jhelum, and Chenab, which course through Indian-administered Kashmir. The dispute over the Kashmir region, a flashpoint between India and Pakistan for more than six decades, is hugely entangled with filling security. Both countries apply for the unbroken region, but both simply push for a divide of it. While the IWT has managed to continue to exist despite the wars and other hostilities, it is increasingly living awkwardly to its limit. Pakistan has accused India of throttling its run resource and violating the IWT by constructing dams over the rivers flowing into Pakistan from Kashmir.[9] For Pakistan, the Indus waters are a lifeline: most of the country depends on it as the first source of freshwater, and it ropes in 90 percent of the country's agricultural industry. And bit by bit, Pakistan was careful, rather overflowing with water; a mixture of mismanaged irrigation, water-intensive crop growing, and climate differences has compacted the Indus to a drip in parts. In 2016, India came close to tearing up the IWT. It blamed Pakistani militants for an assault on Indian soldiers in Indian-administered Kashmir in September of that year.

Sherry Rehman, in her interview with DW,[10] said that "We are right away facing challenges brought about by climate alteration, which was not a most important focus during the negotiations for the Indus hose Treaty. It has converted into a material of survival," she said. "Aside from not having stiff dialogue, the language hanging around telling of a probable irrigating war is chiefly alarming."[11]

2.1. Theoretical Framework

Green theory captures this orientation in political terms of value and agency (Goodin 1992)—what is to be valued, by whom, and how to get it. Green theory belongs to the critical theory tradition, in the sense that environmental issues evoke questions about relations between and among ourselves and others in the context of community and collective decision-making. In turn, this has always raised the question of where the boundaries of political community are. For environmental problems, which transcend boundaries, these questions take the form of asking at what level of political community we should seek a solution. For green theorists, the answers are found in alternative ideas about political association based on our ecological relationships.

A green theory perspective on climate change understands it as a level consequence of personal collective choices. Specifically, these choices have led to historically anthropocentric money-making practices of historically capricious biased groups (states), who cover exploited makeup in their hold short-term interests. Climate difference presents a clear problem of injustice to present and coming humans who are not in charge of causing it and to the ecological unit as a whole. Since the birth of the business era, the atmospheric concentrations of quite a few radiatively vigorous gases have been ever-increasing as a result of business activities. According to the greenhouse theory of climate change, the climate system will be restored to equilibrium by a warming of the surface-troposphere system and a cooling of the stratosphere. The predicted changes during the next few decades may perhaps exceed unprocessed climate variations in chronological times by a great deal. Hence, the conservative philosophy of climate

[9] Shah Meer Baloch, "'India Can Starve Us': Farmers in Pakistan Decry Suspension of Crucial Water Treaty," The Guardian (The Guardian, April 29, 2025),

[10] Stuart Braun, "Pakistan: Climate Change Likely Worsened Extreme Floods – DW – 09/15/2022," dw.com, September 15, 2022, https://www.dw.com/en/pakistan-floods-climate-change-likely-worsened-impact/a-63142625.

[11] "INDIA, PAKISTAN and INTERNATIONAL BANK for RECONSTRUCTION and DEVELOPMENT," 1960, http://treaties.un.org/doc/Publication/UNTs/Volume%20419/volume-419-I-6032-English.pdf.

transformation has reached the crucial arena of verification. In Pakistan greenhouse gases are the causes affecting Pakistan's socioeconomic security.

2.2. Methodology

Qualitative research method is used for the study. Sources of study are the publications by the government sectors, research articles, media, and documents issued by different state departments working on climate change and its impacts on Pakistan's economic development.

2.3. Climate Change Trends of Pakistan

Pakistan has been facing different issues regarding climate change. In the past, the effects and level of climate change were different than now, and there is a comparison between past and current trends of climate change and future predictions.

2.4. Greenhouse Gas Emissions Profile of Pakistan

According to the Intergovernmental Panel on Climate change (IPCC), the Fifth Assessment Report (AR5)[12], total conservatory gas (GHG) emissions have accelerated to an exceptional level even with total hard work to discontinue down emissions. Climate change projections point toward that during the 21st century.

Climate Change Projection	Details
Temperature Increase (21st Century)	0.3°C to 1.7°C for stringent mitigation scenarios
	2.6°C to 4.8°C for high emissions scenarios (business as usual)
Target for Limiting Temperature Rise	Limit global temperature rise to 2°C above pre-industrial levels
Required Emission Reductions	40% to 70% reduction in emissions by mid-century compared to 2010 levels.
The end of the 21st century	Near-zero emissions

2.4.1. GHG Emission Inventories:

The Pakistan Atomic Energy Commission prepared the 3rd Inventory (2007-2008) for climate change forecasting.

Energy and Agriculture-Livestock sectors are the major contributors to GHG emissions, accounting for 90.7% of total emissions. (in below table)

Sector	GHG Emissions (%)	Emission ($MmtCO_2e$)
Energy Sector	45.9%	169.7 $MmtCO_2e$
Agriculture & Livestock Sector	44.8%	165.1 $MmtCO_2e$
Manufacturing Processes	3.9%	14.4 $MmtCO_2e$
Forestry Sector	2.6%	9.6 $MmtCO_2e$
Total GHG Emissions	100%	369 $MmtCO_2e$

2.5. Observed Past Climate Trends

A significant increase in the number of heat waves, being 11 for each decade, was experienced over the interlude 1980-2007 for Pakistan.

2.5.1. Trends and Projections of Heat Waves in Pakistan (1961-2011)[13]

[12] Ottmar Edenhofer, Youba Sokona, and Ramón Pichs-Madruga, "Summary for Policymakers XXI," *The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5)*, 2014, 6-7. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_summary-for-policymakers.pdf.

[13] Chaudhry, Climate Change Profile of Pakistan, 12-15

1. *Heat Waves: An increase in heat wave frequency and intensity Validity: junctions and intensity since 1990 have been noted in Sindh.*
2. *Temperature Threshold: Extreme heat waves are defined by the occurrence of temperatures of ≥45°C.*
3. *Future Impact: With increasing global temperatures, the frequency and intensity of heat waves is expected to recover further by differential in the future, including the status of common trends in Pakistan.*

Parameter	***Details***
Increase in Heat Waves (1980-2007)	*11 heat waves per decade for Pakistan*
Frequency of Intense Heat Waves (1961-2011)	*Significant increase in frequency of 5, 7, and 10 consecutive days of moderate heat (≥40°C) in Sindh*
Temperature for Intense Heat Waves	*45°C and above*
Regions Affected	*Sindh (especially), Punjab, and Northwestern parts of Pakistan*
Heat Wave Frequency in Sindh (1961-2011)	*Steady increase in frequency of heat waves with temperatures ≥45°C over consecutive days (5, 7, 10 days)*
Heat Wave Frequency (1961-1990)	*Less frequent compared to the 1990-2011 period*
Heat Wave Frequency (1990-2011)	*Increase in frequency of heat waves*
Future Projections	*Increase in heat waves is expected globally, especially in Pakistan.*
Rise in Heat Wave Frequency (Northwest)	*30-60 events increase in the northwestern parts of Pakistan.*
Changes in Heat Waves in Punjab/Sindh	*Decrease in the occurrence of heat waves in southern Sindh and Punjab.*
No Significant Trends Observed	*No substantial change in the frequency of freezing waves or consecutive wet/arid periods.*

2.5.2. Rising Sea Level: [14]

Sea Level Rise Trends and Causes along Pakistan's Karachi Coast (1856-2010) – IPCC AR5 Report

Parameter	***Details***
Sea Level Rise (1856-2000)	*1.1 mm per day along the Karachi coast*
Total Sea Level Rise (1901-2010)	*0.19 meters (m)*
Sea Level Rise Rate (1901-2010)	*1.7 mm per year*
Sea Level Rise Rate (1993-2010)	*3.2 mm per year*
Causes of Sea Level Rise	*- Thermal expansion of ocean due to global warming* *- Glacier melt loss*

Notes:

1. *Historical Sea Level Rise: The increase of sea level along the coast of Karachi rose by 0.19 meters from 1901 to 2010.*

[14] Ibid, 21-23.

2. *Increase in Rate: The rate of sea-level rise has increased from -1.7 mm/year (1901-2010) to +3.2 mm/year (1993-2010).*
3. *Main Reasons: The major causes of this rise are thermal expansion of ocean water due to global warming and loss of glacier melt.*

2.5.3. Projection of Future Climate Trends in Pakistan:[15]

Under future climate change scenarios, Pakistan is estimated to face greater than before changeability of tributary flows due exactly to augmented changeability of rain and the melting of glaciers. Yields of wheat and basmati rice are estimated to decline, and they may transport fabrication northward, subject to hose availability. fill up availability for hydropower creation may decline. Hotter temperatures are prone to swell energy and require suitable amplified atmosphere conditioning requirements; electric fire impressions and dampened temperatures may reduce the efficiency of nuclear and thermal authority placed in the ground generation. Mortality looked for in severe section waves may increase, and inner-city drainage systems may be additionally stressed by high precipitation and sparkle floods. Sea horizontal mutiny and storm surges may adversely impact coastal infrastructure and livelihoods. Using the general circulation model for future climate change, the Global change impact study Centre (2007) modeled twelve-monthly heat and rain exchange for imminent existence in 2020, 2050 and 2080. By 2080, the high temperature redoubled in Pakistan will be as sky-scraping as 4.38°C. concerning regional revolutions in twelve-monthly temperature, the reading advanced the renowned fact that (i) the high temperatures that proliferate in both summer and chill are superior in northern than southern Pakistan, and (ii) the high temperature increases in both regions are more advanced in frost than summer.

2.5.4 Projected Sea Level Rise for Pakistan by 2100: [16]

Parameter	***Details***
Average Sea Level Rise (Pakistan, 1900-2000)	*1.1 mm/year*
Projected Global Sea Level Rise (2100)	*0.2 to 0.6 meters (according to the IPCC AR5 report)*
Projected South Asia Sea Level Rise (2100)	*0.7 meters (with a range between 0.42 and 1.12 meters, 90% confidence interval).*
Impacted Areas in Pakistan	*Low-lying coastal areas south of Karachi, including Keti Bander and the Indus River Delta.*
Expected Outcome	*Coastal areas will be vulnerable to flooding and erosion due to the rise in sea level by 2100.*

2.6. Climate Change Impacts on Agriculture and Forestry

Climate Change affecting the agriculture sector and forestry, so the food security is not going to be balanced and fulfill needs, and the temperature is rising due to deforestation. So the impact on Agriculture and forestry is described below.

2.6.1. Agriculture Sector

[15] Ibid, 17-18.

[16] Muhammad Faisal Hayat et al., *Sea Level Rise Effects on Coastal Zones of Pakistan*, vol. 11 (International Review of Basic and Applied Sciences, 2023), 414.

Agriculture is a key economic sector that contributes 21% to the gross domectic product (GDP), employs 45% of all the employees, and contributes about 60% to exports. The total cropped area is 23.4 million hectares (Mha), in place of 29% of the full amount reported area, 32 percent of which are irrigated areas, which compose 18.63 Mha, with the percentage by realm of 77% in Punjab, 14% in Sindh, 5% in Khyber Pakhtunkhwa, and 4% in Balochista.[17] Currently, 3.8 Mha are under Sailaba/Rod-Kohi, riverine, and Barani agricultural systems generally called the craze irrigation undeveloped system. The latent part under rash irrigation is estimated to be around 6.935 Mha, not speaking as follows: 4.68 Mha in Balochistan, 0.862 Mha in Khyber Pakhtunkhwa, 0.571 Mha in Punjab, and 0.551 Mha in Sindh. Crops are categorized into two: rabi and kharif. Rabi crops are sown in autumn (October-December) and harvested in spring (March-April). Wheat is the foremost rabi crop. Crops that are sown in summer are called kharif crops. The kharif crop period is in general longer in Pakistan, beginning with sugarcane in February, followed by lime in March-May, rice in June-July, and maize in July-August. The key patterns are (i) rice-wheat, (ii) maize-wheat, (iii) cotton-wheat, (iv) sugarcane, wheat, and (v) coarse grain-wheat, and approximately other small patterns. Crops grown up in cooperation irrigated areas and individuals under crazy undeveloped systems are substantially touchy to the quantity of hose down on hand and fever variability. It is estimated that with getting out with a fever (+0.50C-20C), agricultural productivity will be cut by around 8%-10% by 2040.

Parameter	***Details***
Contribution to GDP	*21% of Pakistan's Gross Domestic Product (GDP)*
Employment	*Employs 45% of the total workforce*
Contribution to Exports	*Contributes about 60% to Pakistan's exports*
Total Cropped Area	*23.4 million hectares (Mha), representing 29% of the total reported area*
Irrigated Area	*18.63 Mha (24% of the total irrigated area)*
Distribution of Irrigated Area by Region	*- Punjab: 77% - Sindh: 14% - Khyber Pakhtunkhwa: 5% - Balochistan: 4%*
Area under Traditional Irrigation (Sailaba/Rod-Kohi/Barani)	*3.8 Mha (under traditional, rain-fed systems)*
Potential Area under Rash Irrigation	*Estimated at 6.935 Mha (including areas in Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh)*
Area under Rash Irrigation by Region	*- Balochistan: 4.68 Mha - Khyber Pakhtunkhwa: 0.862 Mha - Punjab: 0.571 Mha - Sindh: 0.551 Mha*
Crop Classification	*- Rabi Crops: Sown in autumn (October-December) and harvested in spring (March-April). Main crop: Wheat*

[17] Syed et al., "Climate Impacts on the Agricultural Sector of Pakistan," 2.

	- Kharif Crops: Sown in summer (February-August), main crops include Sugarcane, Rice, Maize, Cotton

Numerous simulation studies, by the crop-growth simulation model, estimated a fall in yield of key crops, expressly for wheat and rice, and the extent of increasing time in four agroclimatic zones of Pakistan. The standard predicted the major cut of around 14 times for 10°C growth in hotness in the mounting season's part of wheat in the northern colossal district compared to southern Pakistan.

2.6.2. Forestry Sector

Forests are a main true store purposely in the perspective of rural livelihood. It provides timber, fuelwood, food, a home for wildlife, and a choice of great consequence ecological unit services, such as explanatory carbon dioxide and calculating or sinking cyclones and storms in coastal areas. woodland matter in Pakistan is 4.19 Mha, in place of 5% of the computed territory area. Coastal mangrove forests prolong over 132,000 ha, in lieu of about 3% of the plant topic of Pakistan.[18] The Indus Delta on your own chains 97% of the calculated mangrove forests and is the birthplace to over one million people, 135,000 of whom depend on mangroves for their occupation. It is predicted that for the most part, the anticipated impacts of climate change, such as SLR, changes in high temperature and precipitation, and ever-increasing frequency and intensity of excessive events, will distress the forest severely, threatening the biodiversity status and soil quality.

2.7. Climate Change Impacts on the Water Sector in Pakistan

The water sector is one of the most sensitive sectors to the impacts of climate change. Pakistan has the world's largest contiguous Indus Basin Irrigation System that is largely dependent on precipitation, glaciers and snowmelt, and groundwater abstraction.[19] The primary sources of water are rainfall during the monsoon season (50 million acre feet MAF) and river inflows (142 MAF) in the IRS. Groundwater contributes around 48% of the surface water available at the canal head of the irrigation system. Water is mostly used in agriculture (92%), industries (3%), and domestic infrastructure (5%). It is expected that in the future, sector water demand will increase due to socioeconomic development and the increase in population. Impacts of declining glacier mass on river discharge as a result of climate change will be additionally extensive in the Indus hand basin as of the high point fraction of discharges from melt addition. This may cause considerable variations in the coming fill-with-tears quantity in the IRS. Western Himalayan glaciers are projected to refuge during the subsequent 50 years, primarily causing improvement of Indus stream flows. Then, the glacier reservoirs will be empty, followed by a cut in flows by as much as 30% to 40% over the subsequent 50 years.[20] These conflicting findings make the brunt of climate adjustment on Karakoram glaciers and Indus canal flows doubtful.

2.8. Climate Change Impacts on the Energy Sector

The energy sector is the foremost contributor to climate change through its great GHG emissions and is, besides, finely tuned to its impacts. It is predicted that rising population, lucrative growth,

[18] Ibid, 4.

[19] Nazam Maqbool, "Impact of Climate Change on Water in Pakistan," *The Pakistan Development Review*, November 29, 2023, 5–7, https://doi.org/10.30541/v62i4605-616.

[20] Umberto Minora et al., "A Simple Model to Evaluate Ice Melt over the Ablation Area of Glaciers in the Central Karakoram National Park, Pakistan" (Annals of Glaciology, August 2015), 202-204.

and altering patterns of use, including rising demand for flavor conditioning in the summer months, will probably step up energy calls and therefore intensify GHG emissions from the energy sector in Pakistan. In Pakistan, the energy sector is the main contributor of GHG emissions. In 2012, energy sector emissions accounted for 46% of the aggregate native GHG emissions stock. The chief liable contact of climate amendment on the energy sector is predicted to be changes in rain patterns, rising temperatures, and further extreme condition events. The country's recent energy requests are sturdily needy on lubrication and gas despite the fact that the outlying plea exceeds supply, therefore translating into a stern energy disaster that has crippled the country since 2006. The leading sources of energy in the country were chatter (48%), lubricant (32%), hydropower (31%), coal (7%), and nuclear energy (2%) in 2013. Pakistan is the prime consumer of chatter in the territory, little as it has the sixth-largest reserve of coal in the world. But the energy dependency on gas and oil is greater compared to coal. It is estimated that with moderate gab consumption, funds will be exhausted by 2025. The household sector (47%) consumes the largest portion of energy, followed by industries (29%), crop growing (10%), and other marketable users. To make certain of energy security, the leadership is paying attention to other energy sources plus wind, solar, and minute hydropower plants, but a good number of the projects are unmoving in the pipeline. With climate change in the future, the energy sector will on the whole be affected by extremist wear-away dealings such as flooding, storm surges, and famine that will assume energy sources and the distribution and dissemination infrastructure. Pakistan's irrigation assets are at dangerous hazard from climate change.

2.9. Climate Change Impacts on Coastal Areas

It is expected that sea level impacts on the coastal areas and their property may be huge as is by now evident in the flooding of low-lying areas, degradation of mangrove forests, declining drinking and irrigation quality, and drop in fish and shrimp productivity. Pakistan has a 1,046 km-long shore that stretches next to the border of the Arabian Sea in the South of the country, diminishing inside the administrative boundaries of the provinces of Sindh and Balochistan. The Sindh coastal zone's defenselessness is more advanced than that of the Balochistan coastal areas for the reason that of its even countryside and elevated populace concentration with evident built-up actions by the side of coastal areas, such as Karachi.[21] A 2-m SLR is estimated to dip 7,500 km^2 in the Indus Delta. The low-lying Balochistan coastal areas, such as Pasni, may as well be impacted by SLR since the normal sea level to the ground in the coastal civic of Pasni is about 1.4 m. However, the Balochistan coast is tectonically functioning and is uplifted at the speed of 1-2 mm/year right and proper to the subduction of the Indian Ocean plate. The bank in the sea horizontal is estimated to multiply the fee of wearing away by the side of the coastal belt. The creeks in the delta regions such as Hajamaro, Ghoro, Kaanhir, and Kahhar are the dynamic attrition hotspots with wearing away degrees ranging from 31 m/year to 176 m/year.

2.10. Climate Change Impacts on Transport and Urban Sector

A nation's economy is highly dependent on the system of transportation, which relies on infrastructure and vehicles. Alongside other infrastructure, climate cash, moreover, affects the transport-correlated skin texture of a field as these armed forces are located in the identical geographical location. In municipal areas with dense populations and from top-to-toe stress for

[21] Arshid Javed, "Sea Level Variations along Pakistan Coast," *Global Sea Level Observing System*, n.d., 6-10. https://glosssealevel.org/sites/gloss/files/publications/documents/pakistan_gexiii2013.pdf.

travel, the settings are demanding as compared to inhabited rural areas in Pakistan. suitable to the mature infrastructure of airports, ports, railway systems, and highways; besides overpopulation, cost-effectiveness, and environmental pressures, transportation systems are under noteworthy stress in Pakistan. The minor climatic events, which produce difficult flooding or snowfall, compel adverse personal property on the carrying system. Similarly, in gigantic areas, landslides can disrupt moving systems for comprehensive periods. Sea height set in motion adds up to storm heave during excessive endurance actions, containing and intensifying the frequency and enormity of floods in coastal areas. These dealings of flooding, brine intrusion, and decay owing to storm surges and wave action are capable of causing profound harm to coastal moving infrastructure; the average of temperatures and ultimate fever measures may also impair or give way to the structural integrity of transfer networks, plus bridges and toll road surfaces.

Climate change has the potential to affect environmental and social determinants of health—safe drinking water, clean air, adequate food, and confident shelter. This may play out through further boil events, instinctive disasters, and up-and-down rain patterns. Heat wave proceedings are projected to enlarge equally in frequency and duration. The heat wave of Karachi in June 2015 took more than 1,200 lives in Karachi alone and about 200 lives in other parts of the Sindh Province. In Karachi, a limit hotness of 44.8°C was recorded, which is the second highest fever after 1979. In Pakistan, excitement waves are universal in the premonsoon months (May-June) in the plains of the country. The variations in precipitation and fever were interconnected with the broadening of atypical diseases catching and cooking security. During the floods in 2010, in a preliminary study by UNDP, it was found that the proportion of the population below the minimum level of dietary energy consumption increased by 3%, thereby adding an additional 5 million to the population of undernourished people. Similarly, extreme events were correlated with the mental health of the affected population, I.e., extreme events generally cause depression, distress, aggression, etc. With the rise of temperature, the risk of water-borne and vector-borne diseases also increases. Higher numbers of dengue and malaria cases are due to changes in temperature and heavy precipitation, possibly resulting in the increased number of breeding sites for mosquitoes.

2.11. Institutional Arrangements for Climate Change

The role and importance of strong institutions to address climate change is highly acknowledged to mainstream the problem in education policies and programs. Strong institutions promote adapting to climate change and at last transform the system by building resilience.[22] However, developing countries, including Pakistan, suffer from inefficient and weak institutional structures, ultimately yielding poor governance systems. Pakistan signed and ratified 14 international environmental commitments between 1971-2001, including the United Nations Framework Convention for Climate Change and the Kyoto Protocol, which acted as stimuli in initiating and guiding the policy processes and efforts on climate change in the country.

2.11.1. Disaster Risk Management Arrangements

At present, the institutional setup for disaster risk reduction in the country is a prime representative of the cross-sector mainstreaming of climate change in government. This is evident from its effective and prioritized mainstreaming through appropriate policy, legal and

[22] Farrukh Iqbal Khan and Sadia Munawar, "Institutional Arrangements for Climate Change in Pakistan," July 2011, 2-6.

institutional arrangements, and implementing strategies and programs to minimize risks and vulnerabilities. The NDMA serves under the Ministry of Climate Change. The NDMA suffers from a lack of a separate and dedicated budget line and keen financial arrangements line; hence, its response to peril easing is for the most part imprudent and on an ad hoc basis. Also, the institutional incapability arises from not having access to research on climate cash impacts and discrete adaptation and/or alleviation plans.

2.11.2. The Ministry of Climate Change

The Ministry of Climate Change is the focal institution for climate change in Pakistan. It evolved from the Ministry of Environment after the 18th constitutional amendment, in 2010, when the Ministry of Environment ceased to be real as it should be due to the decentralization of authorization to local governments. The environment is instantly under the area of the local governments, but climate change remains federal, known as the basis for a state-owned rejoinder and illustration in international climate change negotiations. The Ministry of Climate Change handles and supports both the clean development mechanisms (CDM) and dipping Emissions from Deforestation and jungle Degradation (REDD+) initiatives in the country. Guided by the CDM Strategy (2006), the CDM cabal inside the agency of Climate modification is the designated countrywide evidence (DNA) on CDM projects in the country. The strategy allows for unilateral, bilateral, and joint CDM projects, if at all possible, in the areas of energy, plus renewable energy, energy efficiency, energy conservation, and fossil fuel cogeneration; land use, terrestrial taking advantage of change, and forestry (e.g., biodiversity protection, soil conservation, defining moment maintenance, and sustainable wooded area and rangeland management); agricultural and pig practices; waste management (e.g., landfills, concrete surplus management, recycling, and bean and farm animal wastes); hauling (e.g., marginal fuel vehicles, stack transit systems, cleaner engines, and compressed physical gas); and built-up processes.

3.0. Socio-Economic Threats Posed by Climate Change

Climate change has affected the socio-economic security of Pakistan very badly. Climate change is harming the survival needs of pakistan directly and the people of pakistan facing a number of problems due to climate change.[23] Owing to food shortages, the death ratio is increasing. Pure water is still needed because floods have mixed the waste and dirt in pure water, and different severe diseases are increasing.

3.1. Food, Water, Health

Pakistan is one of the most vulnerable countries in the world to the impacts of climate change. The risks it faces are worsened by high rates of food and nutrition. As the climate continues to change, weather patterns will strengthen, new unpredictable and intense climate-related disasters will become more frequent, and rates of food security will rise even higher. Climate change is likely to have a significant impact on all facets of food security in Pakistan, i.e., availability, access, utilization, and stability. Further, Pakistan can face food shortages due to water scarcity. 47 percent of the whole population is food insecure, as access to food is uneven and malnutrition is widespread. Food production depends significantly on irrigation, counting on the help of extensive volumes of water from stressed aquifers. A continuous trend leads to

[23] Abbas Sheer et al., "Impact of Climate Change on Pakistan and Proposed Solutions: Evidence from Literature," Migration Letters (www.migrationletters.com, n.d.).

unsustainable groundwater use. By 2025, the shortfall of water requirements will be 32%, which may cause food shortages of 70 million tons.

Common episodes of extreme weather events in Pakistan, like flooding, droughts, and abrupt changes in temperature, may at once and indirectly affect the public health in terms of physical injuries, mental stress, or infectious diseases. In Pakistan, 2010, the flood is the most recent event of climate change. It affected almost 14.20 million people, and 1,700 deaths occurred; 1,156 deaths were recorded in Khyber Pakhtunkhwa, Conflicts induced by Climate Change.

4.0 Mitigation Measures

A government of pakistan working to mitigate the effects of climate change according to the policy. The main objectives of Pakistan's climate change policy include:

i. *To pursue sustained economic growth by appropriately addressing the challenges of climate change.*
ii. *To integrate climate change policy with other interrelated national policies*
iii. *To focus on pro-poor, gender-sensitive adaptation while also promoting mitigation to the extent possible in a cost-effective manner.*
iv. *To ensure water security, food security, and energy security of the country in the face of the challenges Posed by Climate Change.*
v. *To minimize the risks arising from the expected increase in frequency and intensity of extreme weather events such as floods, droughts, and tropical storms*
vi. *To strengthen interministrerial decision-making and coordination mechanisms on climate change.*
vii. *To facilitate effective use of the opportunities, particularly financial, available both nationally and internationally*
viii. *To Foster the development of appropriate economic incentives to encourage public and private sector investment in adaptation measures.*

According to the scientific prediction, mitigation measures we take at some level don't matter because climate change will continue to affect owing to the atmospheric changes. As these changes become more intense, people have to protect themselves and increase their resilience to survive.

4.1 Recommendations for Forestry

Undertake urgent reforestation and afforestation programs on mountain slopes. Northern areas of the state suffered dangerous deforestation right and proper due to not having access to electricity and true gas. The Billion-tree Tsunami struggle is a blameless edge but requests to be scaled up in the long term. The communities and the common free, in addition, are required to be engaged in the lion's share of agricultural estate drives across the country.

4.2 Recommendations for Protecting Water Resources

Build dams in Thar to store rainwater. During our travels, we came across a barrier in Nagarparkar, a human being as old as a cricket pitch, for the reason that the direction did not consult, dwell in, or notice their acquaintance of everywhere to paramount form it. Sometimes, the clarification is as effortless as asking the people. They live nearby and engage in an attractive, decent intention of coming again? solutions would be an exertion in their context.

Devise and employ an unused management strategy for colossal areas. Since mountain communities come up with nowhere to dispose of their waste, they end up also throwing it in the rivers, burning the barren in sweeping heavens (which contributes to black carbon affidavit on

glaciers and accelerates their melting), or burying it underground (which resurfaces in the outcome of an instinctive ruin and adds to offered risks), individual waste disposal systems and awareness (especially for tourists) know how to benefit and assuage conservatory gas emissions, tone pollution, and disaster risk.

4.3 Recommendations for Vehicles

Ban diesel vehicles in the mountains. An escalating number of tourists visiting the lovely mountains in the north opt for via diesel (the on-the-whole inefficient fuel) in their four-wheelers. The particulate topic emitted by the shortened burning of fuels at such great altitudes absolutely contributes to the express melting of glaciers, so accelerating climate transformation and aggravating the health of people.

4.4 Recommendations for Energy Resources

Switch to renewable energy sources. We tolerate enormous promise for solar energy in Thar and hydropower in the north, which can offer clean, cost-effective, and continual energy.

These efforts are urgently required, but it is also important to recognize that the onus for change is not completely on the government. We, as aware citizens, need to demand action on these issues and work closely with governmental and non-governmental institutions to ensure that these measures get implemented. It is time to shun passivity and take an active part in climate advocacy.

5.0 Conclusion

The unclear and unpredictable environment of climate change poses a further challenge to rule makers who are tuned to building decisions based upon chronological and established denominators. wealth remained a challenge. The intercontinental refuge environment injunction will bite the bullet against great threats and pressures from climate change. Climate change, interacting with other risks to intercontinental security, is apt to grasp the best collision on unstable, conflict-prone, and strategically significant regions; opinionated and demographic realities, mutual with climate change, and food and stream insecurity imply that the inner East, North, and East and key regions of Africa, as well as a selection of nations in innermost Asia, will tackle momentous sanctuary risks from a shifting climate. However, an emergent coastal and municipal people in the broader Asia-Pacific region, coupled with projected climate change-exacerbated stresses on hose-down security, channel that the nations of the Asia-Pacific are chiefly vulnerable to climate replacement effects. A rapidly melting chilly, and shifting geopolitical dynamic in the part (including degenerating affiliation between Russia and its icy neighbors) may possibly reappear to augment geopolitical tensions in a more or less fast area. Sea level ascent, furthermore, constitutes an existential risk to low-lying island nations.

5.1 Recommendations

Even though climate change presents large challenges to Pakistan, in the community and in the future, it is not completely gone astray yet. In this era of science and technology, humans are in any case equipped with the obligatory expertise and skills to succeed in precautions against climate change. primarily and foremost, Pakistan requirements to jam its resources. The copy filled with tear-off insufficiency wants to be, in actual fact, conveyed to the public, inducing careful consumption of the stream in households. The command to spread fill with tears reproach to oppress extreme and its disproportionate use, and rein in fill-up theft and change by influential landowners. Dams are essential and must be built on a war balance to collect garden-fresh water.

Such steps know how to be of assistance to Pakistan in slowing down the impacts of climate change and export effective time to put into service other long-term policies.

As discussed by now, the farming sector is the leading object of climate change; consequently, exploration in this region is the need of the hour. The command has the technology to predict hardened conditions. Their acquaintance essentially communicated to the agricultural kinship to proceed so in personal belongings of rapid changes in weather, forestalling crop failures. An investigation additionally needs to be conducted on the newer multiplicity of seeds, which are supposed to be anti to the altering environment and produce top productivity. This way, the difficulty of ration guarantees may furthermore be tackled. Success of government measures to ease climate revolution impacts depends upon the people resilience. This course that the neighborhood communities in Pakistan comprise themselves informed of the harms life forms face by them and how they may downgrade their exposure to these dangers as a collective group. native governments and civil societies be capable of joining in a constructive job in this regard. They know how to assist in, to all intents and purposes, disseminating familiarity for the good of folks who are at risk. A highly flavored reply from the communities is supreme for productively holding out against climate change.

Since climate trade does not differentiate between borders, Pakistan requires a glimpse beyond its boundaries for help. The global unity is found attentive of climate substitutes and their sound effects on Pakistan. The residential humanity has the skills and technological familiarity to hack it with climate change. Pakistan is required to engage the global community at a range of fora for monetary and strict assistance. Consciousness as a participant in the Paris climate agreement, Pakistan deserves the aid of the intercontinental group of people to go into battle for climate exchange.

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