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Climate Change and Economic Vulnerability in Pakistan: An Analysis of Future Risks

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Abstract

This paper discussed effects of climate change on economic vulnerability in Pakistan. The findings show that the nation's economy is negatively impacted by climate change. Poverty, unemployment, crime, forest fire, diseases, migration, internal displacement, urban slum, flood etc. will be increase in future due to climate change. Biodiversity and economic balance will be disturbed. Food production, electricity supply, basic infrastructure will be badly affected. Development activities in water resources, as well as sectors such as agriculture, and health could clearly be affected by climate change as well as current climate variability. Fluctuation of climate variables influences the spread of infectious disease. Incidences of fresh flood or glacial lake outburst floods will be increase. Due to climate change industrial production will be affected for the shortage of raw materials and unfavourable climates. Agro-based industries and service sector will be more effected. As a result, the government will need extra funding for disaster relief. The government should establish robust policies that encourage community-based adaptation strategies, make investments in sustainable development, improve climate resilience, raise public awareness, fortify institutional frameworks, and incorporate climate change adaptation into local and national planning procedures in order to lessen the negative effects of climate change on the economy. Furthermore, creating a collaborative environment with stakeholders and international organizations will be essential to creating comprehensive plans for climate action.

Keywords: Adaptation strategies, climate change, economic vulnerability, global warming, natural calamities, disaster management

INTRODUCTION

Since the creation of the universe, climatic conditions of the world are changing regularly. Currently people from heavy industrialization and huge populated countries are facing the climate change impact more hastily (Babar, 2015) [1]. The global warming is now a debate in several respects. Every one realising that climate and economic outcomes are inter-related. This relationship regulates the opportunity and scale of impacts on market due to climate change (Newell et. al., 2021) [2]. Climate change has always adversatively affected the economy of developing countries due to lack of financial capacity for mitigating such effects (Ahmed et. al., 2019) [3]. Poor families are most helpless to global warming. Most of them are settled in disaster-prone areas and they are vulnerable to the impact of climate change. It is important task of developed as well as in developing countries to assessing the impacts of climate change (Amedie FA. 2013) [4].

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The South Asian Pakistan is a developing country with a modest middle class. The northern highlands, the Indus River plain, and the Balochistan plateau are Pakistan's three principal geographical regions. Climate is changing for encompassing temperate, topography and season, tropical and arid climates and seasonal monsoons. Pakistan is anticipated to

be significantly impacted by climate change. Its vulnerability to climate risk has been made clear by droughts, storm surges, floods, and other events.

OBJECTIVES OF THE STUDY

This study attempts to look into how Pakistan's economy is affected by climate change. The specific objectives of the paper are:

1. To study status of Pakistan in Long-Term Climate Risk Index among the south Asian countries.
2. To study vulnerability among provinces of Pakistan through the Human Vulnerability Index.
3. To identify the vulnerable districts in Pakistan in Human Vulnerability Index**.**
4. To study vulnerable and less-vulnerable districts in provinces of Pakistan on Human Vulnerability Index.
5. To identify the impact of climate change on various sectors of Pakistan, and
6. To study the efforts and initiatives of Government for mitigating the effects of the climate change.

MATERIALS AND METHODS

Study area Description

Pakistan is a country in south Asia. It is the 5th most popular country, and 33rd-largest country by population. It is the second-largest country in South Asia by land area, after India. It has international border with Iran, Afghanistan, China, and India. It has costal area with Arabian sea. Pakistan's largest city is Karachi, while the capital is Islamabad.

Design and Approach

The paper is based on secondary information and descriptive method of analysis. The secondary data are gathered from a variety of government publications, reports from foreign agencies, research papers, theses that have been published, articles, etc.

Method of Analysis

To reveal the climate change effects on economy in general and on the Pakistan economy in particular, different method of qualitative analysis comprising of tabulation, Human Vulnerability Index, Climate Risk Index and text analysis have been performed.

Hypothesis

Data analyses have been done on the following hypotheses:

H_{01}: There are no variation of vulnerabilities among provinces of Pakistan.
H_{1a}: There are variation of vulnerabilities among provinces of Pakistan.
H_{02}: There are no variation of vulnerability among districts in Pakistan.
H_{1b}: There are variation of vulnerability among districts in Pakistan
H_{03}: There are no variations of vulnerability within districts of Pakistan.
H_{ic}: There are variations of vulnerability within districts of Pakistan
H_{04}: There are no effects of climate change on economic sectors of Pakistan.
H_{1d}: There are effects of climate change on economic sectors of Pakistan.

CLIMATE CHANGE AND ITS CONSEQUENCES ON PAKISTAN'S ENVIRONMENT AND ECONOMY

Forestry & Marine Life

Forest and marine life will be change due to climate change. Mangrove forests in coastal areas are vital for balancing eco-system and it is source of food and fuel wood to local resident. Climate-sensitive crops will be badly affected. Production of spices, vegetables, rice, other grains and cereals will be decline. For dry and hot climate, forest fire also changes the pattern of forest in hilly areas (Farooqi et. al., 2005) [5]. Coastal residents are particularly vulnerable. Increasing sea levels on the 1,130 km coastline will be threat for many coastal towns and cities. Rising temperatures and the disruption of

saline water will have an impact on coastal ecosystems. For rapid climate change, food chain system in marine life will be change.

Agriculture: Climate Sensitivity and Declining Productivity

Among the three economic sectors, agriculture is climate sensitive. Crops productivity and yields will be change due to change in temperature or precipitation. Due to their detrimental effects on plant growth and development, climate change and global warming will be detrimental to the agriculture industry (Ahmad et al., 2017) [6]. As natural calamities (e.g. droughts, floods and storms) are increases in future, it will be threat of socio-economic losses. Increase or decrease of rainfalls and increases of pests as a result of warmer climate will decline crop production. Temperature increase of even 1ºC–2ºC will serious effects on agricultural sector. Industrial sector is also depending on agricultural sector (e.g. raw materials). Production in industrial sector will be decline due to shortage of raw materials in agricultural sector.

Productivity of agricultural sector will be adversely affecting due to soil degradation, severe drought/flood conditions, and high temperature. Rising sea level is a treat for cultivated land near the coastal areas. Declining agricultural productivity will be a treat for agricultural sector, because contribution of agricultural sector in national GDP is still high and majority of people in Pakistan depends on agricultural sector. Increasing temperature of sea will severely affect ecology of mangroves and coral reefs (Farooqi et. al., 2005). The falling per capita arable land, growing population, and water availability are challenges before Pakistan's agriculture (Naqvi et. al., 2019) [7]. Wheat is staple crop in Pakistan. Lack of water supply will reduce wheat production, and it will be a huge cost for country's food security (Imran, 2013) [8].

Food Security: Risk of Hunger and Socio-Economic Unrest

Food accessibility and crop production are directly related to food security. But the matter of concern is that both are related to climate change (Zahra et. al., 2016) [9]. Higher temperature in atmosphere due to climate change is the threat for agricultural production and food systems. This disproportionally affect most vulnerable people at risk to food insecurity and hunger. Extreme climate events continuing will further deterioration into food and nutrition crises (WHO Report, 2015) [10].

Agriculture production has two vital inputs, such as rainfall and temperature. However, there is a direct connection between the two and climate change. Pakistan is a dry land country. Rainfall is less in the Balochistan, Punjab and Sindh provinces. Large quantity of land is under desert-prone category. Rainfall is declining in many areas due to the climate change. River water is the main supply of water used for irrigation in agricultural areas. Changes rainfall and temperature directly affecting the irrigation facilities and availabilities. Growing season for cultivation will be change due to warmer or cooler temperatures. Changes in rainfall will directly lead to drought or flooding. All of those will affect the food production and food chain system (Akram, 2012) [11]. Therefore, there are more possibilities of food insecurity in the nation due to the climate change. It will increase food price and may create social unrest in in Pakistani society.

Water Resources: Threats to Supply, Quality, and Health

The water industry is essential to our ecosystem. Climate change has increased the vulnerability of its supply. Climate change may alter quality of the water. Water cycle will not be stable due to climate change. Water borne diseases may arise due to scarcity of fresh water. Lower water levels will increase pollutant meditations. Increase temperature due to global warming will accelerated glacial melt. It will increase frequencies of flooding from glacial lakes. Low or surplus water flows in rivers will adversely affects agricultural sector.

Less supply of water in rivers will unfavourably affects agriculture production, human lives and national economy. Low water flows and rainfalls will increase desertification. Glaciers in the Himalaya

region will be decline in future due to climate change (Khan et. al., 2012) [12]. Shortage of water and high temperature will increase health-related incidence, e.g. dengue fever, pneumonia, heatstroke, malaria, cholera, and other vector-borne diseases.

IMPACT OF CLIMATE CHANGE ON NATURAL DISASTERS IN PAKISTAN

Tropical Cyclones

Tropical cyclones could become more extreme. Incidences of cyclone in Arabian sea may rise due to climate change. It will increase the chance of loss of property and life in the coastal areas of Baluchistan and Sindh provinces. Karachi is commercial city of Pakistan, and its significances may be decline due to the tropical cyclones and other natural calamities.

Drought and Desertification

There are many past incidences of droughts in provinces of Pakistan. Punjab and Sindh province are well-known for agricultural cultivation. Drought and desertification will be serious effects on food cultivation in the regions due to climate change. Droughts will directly affect human lives, fauna, and agriculture. Less flow of water in the tributaries and decrease in rainfall are the major causes of the droughts. Such droughts will not only suffer people, but also may cause human migration from drought prone area to other areas. It will increase stress among the people. Lack of water supply will directly affect thermal power plant cooling and electricity from hydropower plants. Energy infrastructure is vulnerable due to floods, storms, hurricanes and sea-level rise (Hussain et al. 2020) [13].

Diminishing Flows in Indus Basin

Glacial melt water is vital source of water in rivers of Pakistan. In actuality, though, the glacier cover is steadily disappearing due to global warming. There will be shortage of water in river system in near future due to retreating sizes of glacier (Farooqi et. al., 2005). Karakoram glaciers are the major source of water in Indus river basin. Chashma, Tarbel and Mangla dams generates huge electricity which plays vital role for development of the surrounding regions. So in future energy production from those hydro-projects also will be affected due to climate change (Imran, 2013). Therefore, from the above analysis it has been found that climate change has been negatively affected sectors of the economy. So the *null hypothesis-4 is rejected, and alternative hypothesis is accepted.* It means that there are effects of climate change on economic sectors of Pakistan.

GOVERNMENT EFFORTS AND INITIATIVES

The National Disaster Management Authority in Pakistan is currently developing an integrated risk management system to increase resilience and enhance economic development. In order to shield lower income groups from the losses resulting from extreme events that are predicted to occur more frequently as a result of climate change, a risk transfer mechanism is being created with technical assistance from the Climate Development and Knowledge Network (Nachmany M et al., 2017) [14]. Government was enacted National Disaster Management Act in 2010 and National Disaster Risk and Reduction Policy 2013 for mitigating the effects of climate change. Inter-Ministerial/Inter-Agency Committee was formed by Ministry of Climate Change in 2014 for enactment of the National Climate Change policy.

RESULT AND DISCUSSION

Climate change is an important global environmental challenge for humanity. It has an impact on the freshwater supply, the forest, the environment, food production, natural ecosystems, health, etc. Due to the natural calamities (such as droughts, floods, cyclones, storms) there are the incidences of declining global food production (Mustafa, 2011) [15]. There are also some countries (e.g. Russia, Canada) who will be benefits from climate change, but in long-run they will be undesirably affect (Akram & Gulzar, 2013) [16]. Let's we discuss the effects of climate change on economy of Pakistan.

In Pakistan, many parts of the country are affecting by the climate change, particularly the rural areas and along the coastlines. A recent story in Dawn states that 20 of the 33 districts in Balochistan are experiencing drought, which has a significant impact on the livelihoods of a large number of people.

Agriculture plays vital role in economy of Balochistan and such climate change affects is a huge threat for the people of the province. Increasing deforestation is a major cause of the higher temperature. The province is affecting by floods, droughts, heat weaves and wildfires. In Punjab and Sindh province climate is becoming warmer day-by-day.

Industries in Pakistan are increasing, and majorities are near the Indus river. Extreme weather conditions are a threat for human death and economic damages. Increasing temperature changes the seasonal crop pattern. It delays planting and harvesting. It will reduce agricultural production. Primary export commodities include textiles, leader goods, sports, chemicals and carpets will also be affected. Industrial production will affect due to climate change. Raw material shortages and unfavorable weather for the industrial sector are expected. Agro-based industries will be more effected. Service sector also will affect due to climate change. Income from transport, tourism, retail sector, construction, hotel industry, restaurant etc. will also affect. Dependence of government on foreign aids or assistances/foreign remittances will be increase.

The Table 1 discussed the long-term Climate Risk Index of worst countries**.** It has found that Puerto Rico, Myanmar, Haiti, Philippines and Pakistan are the top five countries in Climate Risk Index**.** Vietnam, Bangladesh, Thailand, Nepal, and Dominica are the other countries in the list who are also adversely affected due to the climate change**.** Climate Risk Index shows the level of exposure and vulnerability to extreme events of any region due to the climate change. It highlights the effects of severe weather occurrences.

Table 1. The long-term Climate Risk Index of Worst Countries.

CRI 1999-2018 (1998-2017)	Country	CRI Score	Death toll	Deaths per 100000 inhabitants	Total losses in million US $PPP	Loses per unit GDP in %	Number of events (total 1999-2018)
1 (1)	Puerto Rico	6.67	149.90	4.09	4 567.06	3.76	25
2 (3)	Myanmar	10.33	7 052.40	14.29	1 630.06	0.83	55
3 (4)	Haiti	13.83	274.15	2.81	388.93	2.38	78
4 (5)	Philippines	17.67	869.80	0.96	3 118.68	0.57	317
5 (8)	Pakistan	28.83	499.45	0.30	3 792.52	0.53	152
6 (9)	Vietnam	29.83	285.80	0.33	2 018.77	0.47	226
7 (7)	Bangladesh	30.00	577.45	0.39	1 686.33	0.41	191
8 (13)	Thailand	31.00	140.00	0.21	7 764.06	0.87	147
9 (11)	Nepal	31.50	228.00	0.87	225.86	0.40	180
10 (10)	Dominica	32.33	3.35	4.72	133.02	20.80	8

Source: E.D., Künzel, V., Schäfer, L., and Winges, M. (2020). Global Climate Risk Index 2020, p.9.

Because for the climate change, developing countries are facing additional stress over their resources. Frequency of extreme rainfall events, probable sea-level rise, increase in surface temperature, and changing the monsoon circulation are the major projected climate change effects in south Asia. All the changes will adversely affect human settlements and human health, ecosystems and biodiversity, hydrology and water resources, forestry, and fisheries, agriculture, mountains and coastal lands (Farooqi et. al., 2005). Pakistan will be more vulnerable for climate change because of its high dependency on natural resources for livelihoods and agrarian base. Reduction in annual crop yields and food insecurity may be arise due to growing frequency of pest attacks and disasters, desertification of land and water logging.

The Table 2 shown that vulnerability level is very high among majority of the districts in Balochistan. Khyber Pakhtunkhwa and Sindh province is also in vulnerable due to climate change. Therefore, the *null hypothesis-1 is rejected, and alternative hypothesis is accepted*. It means there are variation of vulnerabilities among provinces of Pakistan.

Table 2. Human Vulnerability Index (HVI) Quintile Distribution of Province Numbers.

Province	Quintile 1 (Top HVI)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (Bottom HVI)	Total
Balochistan	12	7	4	2	1	26
KPK	1	4	4	11	4	24
Punjab	1	7	7	7	13	35
Sindh	6	3	6	1	2	18
Total	*20*	*21*	*21*	*21*	*20*	*103*

Source: Khan & Salman (2012). International Journal of Disaster Risk Science, 3 (3), p.167, "A Basic Human Vulnerability Index for Pakistan's Climate Change Hazards."

The Table 3 depicted the Human Vulnerability Index of top and least districts in Pakistan. It has found that out of 10 worst Human Vulnerability Index districts, seven are fallen in Balochistan province. They are Musakhel, Awaran, Lasbela, Panjgur, Kharan, Jhal magsi, and Khuzdar districts. Kohistan district of Khyber Pakhtunkhwa province, and Badin and Tharparkar districts of Sindh province are also included in the list. In Bottom 10 Vulnerable Districts, Punjab province have five districts, Sindh province has two districts, Balochistan province and Khyber Pakhtunkhwa province each have one district. Federal capital Islamabad is also included in the list. Therefore, Musakhel district of Balochistan province has the highest Index Value (6.14) and Federal capital Islamabad has the least Index Value (1.05) (Khan & Salman, 2012). Therefore, *the null hypothesis-2 is rejected, and alternative hypothesis is accepted*. It means there are variation of vulnerability among districts in Pakistan.

Table 3. Top 10 and Bottom 10 Districts on the Human Vulnerability Index (HVI) in Pakistan.

Top 10 Vulnerable Districts				Bottom 10 Vulnerable Districts			
Rank	***Province***	***District***	***Index Value***	***Rank***	***Province***	***District***	***Index Value***
1.	Balochistan	Musakhel	6.14	94.	Punjab	Sialkot	2.35
2.	Balochistan	Awaran	6.09	95.	KPK	Haripur	2.33
3.	KPK	Kohistan	5.86	96.	Sindh	Karachi West	2.30
4.	Sindh	Badin	5.75	97.	Sindh	Malir	2.29
5.	Balochistan	Lasbela	5.68	98.	Punjab	Gujranwala	2.20
6.	Balochistan	Panjgur	5.66	99.	Punjab	Jhelum	2.20
7.	Balochistan	Kharan	5.54	100.	Balochistan	Quetta	2.17
8.	Balochistan	Jhal magsi	5.50	101.	Punjab	Gujrat	2.14
9.	Sindh	Tharparkar	5.41	102.	Punjab	Rawalpindi	1.97
10.	Balochistan	Khuzdar	5.39	103.	Federal capital	Islamabad	1.05

Source: Khan & Salman (2012). International Journal of Disaster Risk Science, 3 (3), p.167, " Pakistan's Basic Human Vulnerability Index to Climate Change Hazards."

The top three and lowest three districts, per province, on Pakistan's Human Vulnerability Index were shown in Table 4. It has found that Musakhel, Awaran, and Lasbela are most vulnerable districts in Balochistan province. On the other hand, Mastung, Pishin, and Quetta are least vulnerable districts of the province. Kohistan, Shangla and Chitral are most vulnerable districts in Khyber Pakhtunkhwa province. Conversely, the province's least vulnerable districts are Kohat, Nowshera, and Haripur. The districts in Punjab province that are most vulnerable are Rajanpur, Muzaffargarh, and Bhakkar. Conversely, the province's least vulnerable districts include Jhelum, Gujrat, and Rawalpindi. The districts in Sindh province that are most vulnerable are Tharparkar, Thatta, and Badin. On the other hand, Ghotki, Karachi West and Malir are the least vulnerable districts of the province. *Therefore, the null hypothesis-3 is rejected, and alternative hypothesis is accepted*. It means there are variations of vulnerability within districts of Pakistan.

Table 4. Province-wise Top three and Bottom Three Districts on the Human Vulnerability Index**.**

	Balochistan		**KPK**		**Punjab**		**Sindh**	
	District	***Rank***	***District***	***Rank***	***District***	***Rank***	***District***	**Rank**
Bottom 3	Quetta	100	Haripur	95	Rawalpindi	102	Malir	97
	Pishin	70	Nowshera	93	Gujrat	101	Karachi West	96
	Mastung	67	Kohat	90	Jhelum	99	Ghotki	93
Top 3	Lasbela	5	Chitral	36	Bhakkar	31	Thatta	11
	Awaran	2	Shangla	24	Muzaffargarh	27	Tharparkar	9
	Musakhel	1	Kohistan	3	Rajanpur	16	Badin	4

Source: Khan & Salman (2012). International Journal of Disaster Risk Science, 3 (3), p. 168, "A Simple Human Vulnerability Index to Climate Change Hazards for Pakistan."

There will be water stress in several areas of the nation. There is high possibility of severely disturbing of agricultural production and declining of net revenues from crops. Risk of hunger and poverty will increase. The incidences and severity of life-threatening events, like floods and droughts are up surging. It is increasing health diseases, like as cholera, meningitis, dengue fever, malaria etc. Coast and coastal deltas, and in many major cities will be affected due to sea level rise, coastal erosion and extreme events.

CONCLUSION AND RECOMMENDATION

Climate change is effecting agriculture, manufacturing and services sectors. Production and revenue from the three sectors will be affected. Dependence of government on foreign aids and remittances is increasing. Agro-based industries will be more effected. Service sector also will effect due to climate change. Income from transport, tourism, retail sector, construction, hotel industry, restaurant etc. will also affected. Climate change will enhance the natural calamities which will threat on the social infrastructure. Migration and internal displacement of people will be increase. It is possible that regional conflict may be increase. Extreme weather events and other climate impacts already threaten the lives, livelihoods and wellbeing of communities, especially those that are already vulnerable due to non-climatic factors.

Regional co-operation and singularly plays significant role in securing environmentally sound and safe energy development between neighbouring countries. Special attention should be paid towards mainstreaming community based climate change adaptation into national development strategies and plans, since they formulate long-term investment priorities and goals. Some policies for reducing evil effects of climate change may be:

(a) There is an urgent need to monitor the consequence of climate change on national income and properly implement policies for mitigating the evil effects of droughts, mudslides, typhoons, cyclones, and floods in the country.
(b) There should be more cooperation among the SAARC countries for implementation of clean technology policies.
(c) There should be proper awareness among the people about the evil effects of the climate change.
(d) There should be proper policies of government department for mitigating effects of climate change. Massive investment in forest and tree cover across the nation and mangrove plantation in the coastal areas can be useful for mitigating the climate change effects, and
(e) Appropriate policies for green technology and technology transfer are needed to protect the environment from the unpredictable effects of climate change.

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