Research Article

Climate Change and Economic Growth Nexus: Time Series Evidence from Pakistan

Umar Hayat[1], Khalid Khan[2], Saima Liaqat[3*] and Balach Rasheed[2]

[1]Department of Economics and Development Studies, University of Swat, Swat; [2]Department of Economics, Lasbela University of Agriculture, Water and Marine Sciences, Uthal Balochistan; [3]Department of Economics, Lahore College for Women University, Jhang Campus, Punjab, Pakistan.

Abstract | Pakistan is one of the major victims of climate change resulting in water scarcity, low agriculture productivity, and variation in seasons across the country. The present study is an attempt to analyze the dynamic effects of variation in rainfall on economic growth in different provinces of Pakistan. Results show that low rains over the period of time have adversely affected the production, employment, and supply chain of crops. Furthermore, to avoid the adverse effects of climate change in the future, it is suggested to plant more trees and arrange different types of awareness campaign through print media and electronic media. It is also recommended to conserve water through the construction of dams and proper irrigation system may be managed on new footings to irrigate more lands to achieve the ultimate objectives of economic growth in Pakistan.

Received | February 16, 2019; **Accepted** | June 20, 2019; **Published** | June 27, 2019
***Correspondence** | Saima Liaqat, Department of Economics, Lahore College for Women University, Jhang Campus, Punjab, Pakistan; **Email:** saima.liaqat@jhang.lcwu.edu.pk
Citation | Hayat, U., Khan, K., Liaqat, S. and Rasheed, B. 2019. Climate change and economic growth nexus: time series evidence from Pakistan. *Journal of Innovative Sciences,* 5(1): 1-5.
DOI | http://dx.doi.org/10.17582/journal.jis/2019/5.1.1.5
Keywords | Climate Change, Precipitation, GDP Growth

1.Introduction

The total area of Pakistan is around 796,000 KM with the diversified background of precipitation and temperature. The summer monsoon lasts from June to September providing precipitation in the eastern areas through the southwest part of the country, while western and northern areas get precipitation in winter season ranged from December to March due to disturbances in western weather. The summer monsoon provides around sixty percent of total annual rain. The climate changes from semiarid to arid, whereas two-thirds of the country receives less than 250 millimeters of rainfall annually except sub-mountain and the Himalayan region of the country. The northern areas of the country having the highest mountain peaks of the World like K-2 (8,611 Meters) and the World's largest glaciers Baltoro (63 KM) and Siachen (70 KM, long) which is the major source of water resources for Indus River. The temperature in this region drops to –50˚C in the winter season and around 15 C0 in summer. The southwestern part of the country exemplifies Balochistan plateau and Indus River basin plain. The Indus basin transboundary covers 65 percent of the country total are or 520,000 KM which includes Punjab province, the major area of Sindh province, Khyber Pakhtunkhwa and eastern Balochistan. It is pertinent to mention that the world largest connected irrigation system is Indus Basin Irrigation System, that comprises 95 percent total irrigation system in the country (NIPS, 2013).

Pakistan has faced cataclysmic droughts, cyclones, heat waves, glacial lake outbursts and flood in recent past which resulted in the internal displacement of thousands of people and lead to infrastructure damage in the area. Climate change will maximize the severity and frequency of natural hazards in the coming decades and based on empirical evidence Pakistan is amongst most vulnerable countries to climate change. The contribution of Pakistan of global greenhouse gases is less than one percent while its 200 million population is on severe victims of the consequences of climate change. The Global Climate Risk Index (GCRI) 2018 reported that Pakistan is among the top ten countries badly affected by climate change.

In Agrarian economies like Pakistan, the sensitivity to climatic change threats arose from their socioeconomic factors, adaptive capacity, geography, and demographic trends. It will lead to a vicious circle of poverty and enlarge vulnerability profile of the country. The impact of climate change resulting melting of glaciers and disturbance in monsoon rainfall which in turn will affect agriculture productivity in the country. It also provides a shortage of energy resources which further hamper the economic growth in the country (World Bank, 2014).

Anderson (1981) concluded from his study that climate change and economic growth have examined how precipitation, temperature, and windstorms have influenced macroeconomic variables using econometric methods. The major focus of these studies was on the effects of weather changes on labor productivity, industrial output, agriculture output, energy, conflict, and energy demand among others (Dell *et al*., 2014). He added further that the fluctuations in temperature in panel countries, expected negative impact on economic growth, effects on industry and agriculture, and elements of political stability. These effects were significant in the case of underdeveloped countries. Burgess and Donaldson (2010) studied the effects of climate change on human adaptation and demonstrated that famine in India was resulted by rainfall shortage during 1875-1919. The current study is an attempt to examine the dynamic effects of climate change on economic growth in case of Pakistan. It also analyzes the rainfall variations in different regions of the country resulted from climate change. This article will contribute to the available literature in the context of regional inequality due to climate change.

2. Materials and Methods

Pakistan is a country with a significant diversification in poverty across provinces having around 37 percent of the population living below the poverty line. Moreover, in urban areas, the poverty rate is relatively lower than in rural areas and have comparatively better economic and social indicators (IFAD, 2015). The econometric approaches used so far in climate change and economic growth perspective have adopted error independence between various cross section units of data. It means that general factors have hardly affected this connection, which is one of the strong assumptions regarding the global economy and climate change. If this assumption is violated it will result in a contradictory result to the earlier assessment of the same correlation between climate change and economic growth. In the present study, we have identified the effects of precipitation and temperature on economic growth. The result showed that precipitation and temperature have a significant impact on industrial growth in less developed countries and characterized by low and high temperatures.Hence the present study is an attempt to re-assess the nexus of climate change and economic growth by applying Dell *et al*. (2012) aggregate production function is the baseline equation based on climate change and physical capital in the equation is as under:

$$Yit = e^{\delta 2 itempit \delta 3 iprecit} K_{iit}^{\delta 4} \text{ ----------I}$$

This equation shows the structural form of climate change and aggregate production function used as a proxy for GDP growth. Here we are following the same connection used by Dell *et al*. (2012) wherein exponential form the climate change variables is chalked while K_{it} represents the physical production factors are in linear form. We are considering dynamic effects and lag variables, where coefficients are depending on previous output and common factors. Based on this analogy the existing literature on economic growth become closer to the empirical model suggested by Dell *et al*. (2012). Taking in to account this assumption the logarithmic form of the equation is written as follows:

$$\ln y_{it} = \sigma_{0+} \sigma_1 \ln y_{it-1+} \sigma_2 \ln temp_{it+} \sigma_3 \ln Prec_{it} + \sigma_4 \ln Kit + eit \text{ ---II}$$

Where $\ln Y_{it}$ is the GDP in natural logs, $Prec_{it}$ is the precipitation, $temp_{it}$ is the temperature, and K_{it} is share of investment.

$$\Delta y_{it} = \alpha_0 + \alpha_1 y_{t-1+} \alpha_2 Tem it + \xi \text{-------III}$$

Table 1: Descriptive statistics of whole country (Pakistan).

Variable	Mean	SD	Min	Max
Economic Growth	7.39	1.94	3.67	11.35
Precipitation	4.21	1.91	0.05	8.49
Per capita industrial output	5.42	6.56	0.16	9.95
Share of Investment	−0.87	0.93	−4.82	−0.10

Table 2: Yearly precipitation and GDP per capita in Pakistan.

		Full sample	Subsample			
Region	Variable	1980-17	1980-90	1991-000	2001-10	2011-17
Whole Country	Yearly Precipitation	208.32 (1.70)	289.03 (1.43)	301.92 (1.35)	341.98 (1.23)	384.57 (1.08)
	GDP Per capita	5.10 (1.24)	11.33 (0.62)	5.13 (1.29)	3.3.2 (0.98)	4.50 (1.15)
Total observation		855	95	216	229	315

Table 3:Yearly precipitation and GDP per capita in Punjab.

		Full sample	Subsample			
Region	Variable	1980-17	1980-90	1991-000	2001-10	2011-17
Punjab	Yearly Precipitation	195.07 (1.14)	121.96 (1.55)	127.50 (1.30)	127 (1.19)	133.90 (1.39)
	GDP Per capita	6.69 (1.81)	13.70 (1.47)	7.56 (1.41)	4.08 (1.11)	5.25 (0.75)
Total observation		227	30	59	54	84

Table 4: Yearly precipitation and GDP per capita in Sindh.

		Full sample	Subsample			
Region	Variable	1980-17	1980-90	1991-000	2001-10	2011-17
Sindh	Yearly Precipitation	192.34 (1.34)	112.45 (1.19)	187.75 (1.02)	198.97 (0.92)	102.39 (0.58)
	GDP Per capita	2.38 (1.57)	3.91 (1.98)	2.99 (1.82)	3.19 (0.97)	3.05 (0.87)
Total observation		278	27	63	80	108

Where this model is an attempt to gauge climate change and GDP growth relationship. Following Pesaran (2006) and Barreca (2013) replaced the omitted and unobservable elements of the integration connection in cross-section sample of observation. However, small sample bias is experienced while using this approach by Pesaran and Chudik (2013) in case of time series panels with moderate dimensions. That's why they included further lags of the cross-section averages in the model as follows. This study uses data on variables including, precipitation temperature, industrial output, and investment and real GDP data during 1980-2017.

3. Results and Discussion

Table 1 offers the descriptive statistics of the variables used in the model. It shows the mean, standard deviation, maximum and minimum values of the variables; economic growth, precipitation, per capita industrial output and share of investment.

Table 2 shows that over the period as the annual precipitation rate decreases it has significant impact on GDP per capita in Pakistan. The intrinsic reason for this fall is that when rate of precipitation decreases, the agriculture production decreases and provide lesser inputs for agro-based industries and hence had a negative effect on employment and aggregate demand.

Punjab is one of the foremost provinces of the country comprising about 52 percent of total country population and one of the major shareholders of producing agricultural products. Table 3 shows that in long-run when the level of precipitation falls the same had a negative effect on GDP per capita.

Table 5:Yearly precipitation and GDP per capita in Khyber Pakhtunkhwa.

		Full sample	Subsample			
Region	Variable	1980-17	1980-90	1991-000	2001-10	2011-17
KP	Yearly Precipitation	234.71 (1.22)	391.23 (1.44)	298.67 (1.82)	151.91 (1.38)	201.29 (1.05)
	GDP Per capita	4.63 91.74)	38.48 (1.49)	6.91 (1.49)	2.56 (0.98)	4.81 (1.06)
Total observation		165	31	46	53	35

Table 6: Yearly precipitation and GDP per capita in Balochistan.

		Full Sample	Subsample			
Region	Variable	1980-17	1980-90	1991-000	2001-10	2011-17
Balochistan	Yearly Precipitation	172.61 (1.45)	162.34 (1.26)	156.91 (1.04)	187.67 (0.54)	145.91 (0.30)
	GDP Per capita	3.67 (0.98)	9.65 (0.92)	2.92 (0.32)	2.01 (0.19)	3.96 (0.44)
Total observation		97	28	21	22	26

The second largest province of the country (population wise) is Sindh. This province is also feeding the major population of the country. Climate change had also affected this province and it is evident from the precipitation rate over the period of 1980-2017. Historical figure shows that annual precipitation rate and GDP per capita are moving in the same direction as depicted in Table 4.

Table 5 displays that there is a significant positive relation between annual precipitation rate and economic growth in Khyber Pakhtunkhwa. The farmers in this province are mostly living in mountains, they received enough rains to cultivate better crops and this is the major source of their livelihood of inhabitance. When they receive lesser precipitation from nature, they had received lesser crops which led a fall in aggregate demand and GDP per capita growth in the province.

Balochistan is the country largest province (Area wise) but unfortunately, a major share of the province is composed of deserts. This province is badly suffered when they received lesser precipitation. Table 6 shows that there is a significant relationship between annual precipitation rate and economic growth in Balochistan but the intensity is relatively low than the other three provinces. The reason for such intensity is the major share of this province is deserts and even they received more precipitation in the sample period, but they have very production in the same location.
The results show in the above tables concluded the same results with minor differences of Colacito, Hoffman, and Phan (2015) and Burgess and Donaldson (2010). It also highlights that a fall in precipitation rate reduced the growth rate in the Khyber Pakhtunkhwa compared to other provinces. Moreover, a fall in precipitation in the Punjab province reduced the growth rate in all periods. Hence it can be concluded that there is a significant impact on the magnitude of coefficient estimates across provinces.

The government of Pakistan is conversant with the issue of climate change. The government introduces a new ministry under the title 'Ministry of Climate Change' to adopt effective measures on operational and policy level to ensure food, water scarcity and to minimize the adverse effects of climate change in the future. The Ministry of Climate Change is also setting standards, enacting legislation, implementing policies for the favorable environment. These steps will ensure the country from the adverse effects of climate change if applied efficiently and effectively.

4. Conclusion and Recommendations

The climate change has affected the four provinces in Pakistan due to precipitation level, but the level of impact is different across various provinces. For instance, the floods have badly affected the Khyber Pakhtunkhwa and Balochistan province due to its vulnerability to climate change. Therefore, it is suggested that proper forestation and other mitigation strategies might be used to avoid the unhealthy effects of climate change in Pakistan. It is recommended for future study to include migration, income inequality, and employment rate as macroeconomic variables to have a full understanding of the dynamic and multi-dimensional effects of climate change.

5. Authors Contribution

Dr. Umar Hayat is the principal author and developed the first draft of the manuscript while Khalid Khan, Saima Liaqat and Balach Rasheedled the data analysis and furnished the final draft of the manuscript.

6. References

Anderson, T. W., and C. Hsiao. 1981. Estimation of Dynamic Models with Error Components. Journal of the American Statistical Association. 76 (375): 598–606. https://doi.org/10.1080/01621459.1981.10477691

Barreca, A., Clay, K., Deschenes, O., Greenstone, M. and Shapiro, J. 2013. Adapting to climate change: the remarkable decline in the U.S. temperature-mortality relationship over the 20th Century. NBER Working Paper. 18692. https://doi.org/10.3386/w18692

Burgess, R. and Donaldson, D. 2010. Can openness mitigate the effects of weather shocks? Evidence from India's famine era. Am. Econ. Rev. 100(2):449–53. https://doi.org/10.1257/aer.100.2.449

Chudik, A. and Pesaran, M. 2013. Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute Working Paper. 146. https://doi.org/10.24149/gwp146

Colacito, R., B. Hoffman, and T. Phan. 2015. Temperatures and Growth: A Panel Analysis of the U.S. Available at SSRN: http://ssrn.com/abstract=2546456. https://doi.org/10.2139/ssrn.2546456

Cavalcanti, and A. M. Grimm. 2013. Influences of Two Types of ENSO on South American Precipitation. Int. J. Climatol. Climatol. 33 (6): 1382–1400. https://doi.org/10.1002/joc.3519

Dell, M., Jones, B. and Olken, B. 2012. Temperature shocks and economic growth: evidence from the last half century. American J. Econ. Macroecon. 4(3):66–95. https://doi.org/10.1257/mac.4.3.66

Jones., D.M,. and Olken, B.B. 2014. What do we learn from the weather? The new climate—economy literature. J. Econ. Lit. 52(3): 740–798. https://doi.org/10.1257/jel.52.3.740

Eberhardt, M. and Prebistero, A. 2015. Public debt and growth: heterogeneity and non-linearity. J. Int. Econ. 97:45–58. https://doi.org/10.1016/j.jinteco.2015.04.005

International Fund for Agricultural Development (IFAD). 2015. Rural Poverty Portal. Accessed May 11. http:// www.ruralpovertyportal.org

National Institute of Population Studies (NIPS) and ICF International. 2013. Pakistan Demographic and Health Survey, 2012-13. Islamabad, Pakistan and Maryland, USA: NIPS and ICF International.

Pesaran, M. 2006. Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica 74(4): 967–1012. https://doi.org/10.1111/j.1468-0262.2006.00692.x

World Bank. 2014. Country Partnership Strategy for the Period FY2015-19. Washington, DC.