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Environmental Implications of Deforestation: A Time Series Study of Pakistan

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ABSTRACT

Long lasting discussion regarding global warming still keeps on moving at national as well as international level. The environmental fabric, weather pattern and climate conditions have witnessed a considerable change due to some known factors. Deforestation is one of these factors. Formerly, researchers have paid due attention to assess the impact of deforestation on environment and associated threats to human lives. It is worth mentioning that reasonable amount of stock of forests are primarily required for balance the amount of CO2 and other environmental gasses. To advance this concept, the current study focuses on the impacts of deforestation on the environmental degradation and climate change in Pakistan. Since the dawn of humanity, there is a strong relationship, natural phenomena like forests and growth of human population. To explore this relationship, in this research study we use the data set that covers the time span of 1975-2020. In this regards we apply discreet time dependent variables such as amount of stock of forest and events, which poses threats to human, live in Pakistan. Our results of unit root test, the autoregressive distributed lag, ARDL, and Engel and Granger, EG, technique have verified short term and long-term association and relationship among selected variables. The results show a positive correlation between deforestation and environmental degradation and climate change in the long run and short run as well. These findings provide the guidelines to policy makers to enhance the forest area in the country to counter the environmental degradation and climate changes that have been occurring for the previous decade.

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1. Introduction

Global warming has become an internationally recognized phenomenon. Weather patterns and climate configuration play an utmost role in socioeconomic, political, and ecological fronts in a country. Average precipitation, temperature, and ecosystem shape the living standard, socioeconomic and political dimensions of a country. Pakistan, fortunately, has had been enjoying four seasons for almost all the past decades but presently, the seasonal trend has been disturbed. State of the environment in Pakistan has been changed for few years. Many exogenous and endogenous factors i.e. frequent floods, prolonged droughts and heavy rains have posed not only colossal threats such as scarcity of fresh water, food, clean air, shelter to the people but also advanced the issues related to human security such as displacement, health, and migration (E Derbyshire, Jijun, Perrott, Shuying, & Waters, 1984;

Edward Derbyshire & Owen, 1997; Otto et al., 1997; Warner, Hamza, Oliver-Smith, Renaud, & Julca, 2010).

According to the reports of World Bank and Asian Development Banks, 2.90 million Pakistani households were affected by the flood of 2010. Other than this, the estimated damages of health facilities were 49.6 million US dollars and damaged houses were 1,608,184 that costs 1588 million US dollar. Almost 3000 people had to face the severe injuries and 2000 people had to lose their lives. The reason of this flood was the heavy rainfall which remained continues for the whole months of August and September. The rain water flew to the Southern areas of Pakistan. Due to this cataclysm, the flood water broke the breakwaters of Indus River and its tributaries and damaged the rural and urban areas. Furthermore, the recent smog and summer heat wave in very previous years damaged seriously the health status of people and became the reason of a large number of deaths. All this happened and is happening due to the emission of Green House Gases whereas one major chunk of GHG_s is the CO_2 that is considered responsible of all these shocks (Sarwar, Ali, & Hussain, 2021).

There are many factors that are contributing to the CO_2 emission such as energy sector, deforestation, and transportation etc. The share of deforestation is almost 17% which makes it second major contributor after the energy sector (Baloch et al., 2021; Bellassen, Crassous, Dietzsch, & Schwartzman, 2008; Fazal, Gillani, Amjad, & Haider, 2020). According to Franklin D. Roosevelt "A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people" (AE Networks UK, 2015). In the case of Pakistan, factual analysis and available data show a grim and gloomy picture regarding forests and greenery. Forests are considered the most pivotal sources to stable and control the ecosystem and labeled as CO_2 sinker because forests discharge less carbon and store more (Bari, Ali, Waqar, & Sarwar, 2020). These are weighed natural filters for the absorption of carbon dioxide in the atmosphere (Haghipour & Burg, 2014). Around 9.4% (approximately one-third of the total land area) of the earth's land surface is covered by forests which store more than three-quarters of carbon in terrestrial setting (Percy, Jandl, Hall, & Lavigne, 2003).

Pakistan possesses a total forests area of 4.2 million hectares that is almost 4.8 percent of the total land area of Pakistan. Almost 40 percent of the forests covered area is concentrated in Khyber Pakhtunkhaw (KPK) whereas rest is shared by other provinces more or less equally. In addition to this, irrigated plantations occupied 103,000 hectares (0.117%) and rangelands covered 28.507 million hectares (32.40%) out of the total land area of 87.98 million hectares (879,800 km2). The total area of forests in the country was 4.34 million hectares (5.01%), 3.44 million hectares were state owned; 0.781 million ha (0.887%) were privately owned but were mechanized by state policies. Azad Jammu Kashmir (AJK) and Northern areas stood at 6.5 percent and 15.5 percent respectively (Economic Survey of Pakistan 2015-16).

Depletion of forest reserves continues as approximately 39000 hectares of forests are disappearing every year. Many studies have clearly shown that Pakistan's forests are under severe and ultimate pressure due to timber logging, cutting of trees for fuel, changes in the usage of land (crop cultivation), overgrazing, substandard quality planting and low regeneration of plants (Olagunju, 2015; Sarangzai, Ahmed, Ahmed, LEGHAR, & D SYED UMER, 2012). According to one of the reports of Monga bay, from 1990 to 2000, Pakistan lost an average 41,100 hectares of forest per annum at an average rate of 1.63%. Between 2000 and 2005, this rate has increased by 1.63% to 2.02% per annum. In totality, Pakistan lost 24.7% of its forest cover from 1990 to 2005. The report further states that forest covered area is adversely affected by fire (1.94%), insects (0.47%) and diseases (3.31% ha). These issues degrade and damage the forest on one hand and, contribute in disturbing and devastating the ecological system of Pakistan on the other hand.

Although global warming is a global issue yet Pakistan has faced many disasters like drought, erosion of land, flooding, and extreme weather. If the current rate of deforestation continues and increasing trend of land conversion keeps on moving without any check and balance, the country would face severe consequences of environmental degradation and climate changes and will fail to keep pace with international commitments. Pakistan has already failed to fulfill its promises made under the Millennium Development Goals (MDGs) to increase its forest cover from 4.5 percent to 6% percent by 2015 (Pakistan Development Goals Report, 2013).

Deforestation is not only posing the threat to this commitment but also degrading the air, making biological diversity stagnant, and distorting the water quality in Pakistan. Timber logging, cutting of trees for cropping and for fuel purposes has caused the CO_2 to accumulate in the environment. As a result, Pakistan faced the highest temperature i.e. 53.5 °C in 2010 which was ever recorded and resulted in a catastrophic flood in the same year followed by record-breaking rainfall of September 2014.

Most of the former studies focus on the theoretical linkages and qualitative analysis. A few numbers of studies used higher order analytical skills for empirical analysis. Furthermore, the past literature focused on either climate change or environmental degradation at a time. Thus, the objective of the current study is to conduct empirical research on the issues that how deforestation affects climate devastation and environmental degradation. As these both phenomena have a direct link with the living standard of people of Pakistan. Next is to disseminate the findings to the researchers and policy makers for the purpose of devising a valuable policy and mechanism in the future to minimize deforestation and environmental hazards. It will provide a significant understanding of the topic and further facilitates the researchers to have a critical outlook on the deforestation phenomenon. It will also help the government to devise an agreed mechanism and action plan to stop deforestation in the long as well as in the short run.

2. Literature Review

The trend to determine the climate change from various factors (deforestation, globalization, trade, growth, energy, urban population) varies with the passage of time. Furthermore, the ways (qualitative and empirical) to analyze the linkages between a factor that determine it also vary over the time. A review of previous studies is below. Fearnside (1997) conducted a descriptive study and conclude that different usage of land, burning of wood, construction, and cattle and pasture is the main cause of deforestation. Furthermore, this deforestation is responsible for the emission of GHGs which the main reason of climate change is (Chien, Sadiq, et al., 2021).

Similarly, J. Ali, Benjaminsen, Hammad, and Dick (2005) conducted a survey at Basho Valley which is situated in the western Himalayas of northern Pakistan and drew the conclusion that the main cause of deforestation in Pakistan is the high growth rate of population and infrastructure development. Furthermore, deforestation is the result of rapid commercial expansion and illegal cutting of trees along with poor management of the staff of forestry department. Their results support the theory of Himalyaan degradation.

In the same way, T. Ali, Ahmad, Shahbaz, and Suleri (2007) report that one of the major hindrances in the expansion of forest area and the cause of harvesting of forests is the wrong priorities of the people of Pakistan. They prefer financial assets and food to the forest area and cut them for the sake of of income. Thus, all of the policies of increasing forests have been facing failure since many decades.

On the other, Defries, Rudel, Uriarte, and Hansen (2010) argue that low level of CO_2 emission in the atmosphere can control the climate changes. But this could be possible in the case of high growth rate of forest area. Unfortunately, migration from rural to urban areas and rising demand of agriculture products at international level is a big hurdle for both objectives. According to the findings of this study exports of agriculture products are causing climate changes in Pakistan.

Webster, Toma, and Kim (2011) report that drought period of 2009 and very low rate of rainfall along with severe deforestation in Pakistan caused the catastrophic flood of 2010. Furthermore, the below average rate of rainfall and deforestation are responsible for sparse of vegetation which enhances the flow and speed of water from long northern hilly areas to Southern and cultivated areas. This quick flow of water generated severe flood which damaged the crops, houses, and health status of people of Pakistan (R. Ahmad, Bashir, & Hussain, 2018; Gillani, Shafiq, & Ahmad, 2019; Shafiq & Gillani, 2018). The study further concludes that due to these factors the rainfall spell floods in Pakistan can be predicted with high probability.

Mudakkar, Zaman, Khan, and Ahmad (2013) find that energy consumption and industrialization causes environmental degradation (emission of carbon dioxide) in Pakistan. They further conclude that urban population and natural resource depletion are the important determinants of the emission of carbon dioxide (Mohsin, Kamran, Nawaz, Hussain, & Dahri, 2021).

Ahmed and Long (2013) conclude that high growth rate is the most preferred target for developing countries. To achieve this target, they mostly rely on industrial and manufacturing sector and reduce the barriers for free trade and foreign direct investment (Shafiq, Hua, Bhatti, & Gillani, 2021; Yang & Shafiq, 2020). In the result of this the demand for energy consumption upsurges which enhances the emission of carbon dioxide in the atmosphere. This emission is responsible for environmental degradation in the short run and long run as well (Bakhtyar, Kacemi, & Nawaz, 2017; Nawaz, Ahmadk, Hussain, & Bhatti, 2020).

Ahmed, Shahbaz, Qasim, and Long (2015) argue that forests are the good proxy of environmental degradation and can be used as a proxy of the clean environment as they filter the air and makes its quality better. They further conclude that there is a non-linear relationship (Inverted U-shaped) between environmental degradation and economic growth. In addition, energy consumption and economic growth granger cause the deforestation as a proxy for environmental degradation.

Chaudhry (2015) reports that illegal encroachment of forest land and cutting of trees for agricultural, and construction purposes because of population pressure and political motives are causing severe climate changes. The average level of temperature is increasing that is responsible for delayed and irregular patron of rainfall followed by severe dry periods. In the result of these consequences threats to human security created in various ways, such as economic, food and health, environment, and political threats.

Cong and Brady (2012) document that temperature and rainfall are important determinants of climate change and both are interdependent. The high level of temperature causes abrupt and heavy rainfall followed by long dry periods. Due to their interdependence the prediction and forecast is a difficult task. According to the findings of their study temperature and rainfall are negatively correlated during April and September in Sweden.

3. Theoretical Background

Pakistan adds very small but bears severe impacts of climate changes in the form of floods, droughts, increased temperature, melted ice caps etc. Although the rank of Pakistan is number 135 in the list of GHGs emitter, yet it is among the top 12 countries which are bearing the severe consequences of climate changes (Tariq & Aziz, 2015). On the other hand, Pakistan ranked 2nd position in deforestation in South Asia Region (S. S. Ahmad, Abbasi, Jabeen, & Shah, 2012; Olagunju, 2015). It seems that GHGs emissions and deforestation go side by side and have a close relation to each other. We can define the deforestation as a removal of trees for the purpose of farming, construction, and ranching etc. It disturbs the carbon cycle of the soil, vegetation, and environment. According to the theory of Himalayan environmental degradation, high growth rate of population and illegal immigration upsurges the portion of the rural population. In the result of this, the demand for fuel wood, timber cutting for the purpose of construction, and agriculture land rapidly increased. These lead to massive deforestation and removed 50% forest area in just 30 years in Nepal and generated a vicious circle. Furthermore, the rapid cutting of trees from the mountain and steeper forest areas became the reason of soil erosion and land sliding because it disturbed the hydrological cycle. Due to this disturbance, the flow of water in summer monsoon period increases and creates a catastrophic flood for the lower regions, whereas, in the winter season it generates dry periods and become the reason of low water. The main consequents of the phenomenon are; the quick siltation of water reservoirs, the spread of barren sand in agriculture areas, unexpected changes in the paths of rivers, and greater frequency of diseases in the downstream areas. The nonstop damages of agriculture land in the mountain areas lead to another round or deforestation. Deforestation results in soil deterioration, carbon emission, and albedo effect (Percy et al., 2003).

Forests affect the global climatic scheme via physical, chemical, and biological courses that stable the hydrological cycle, temperature stability, and atmospheric composition. The area of forests has been reduced by 300 million hectares since 1990. As a result, the world has been suffering from global warming 15% more than that of previous years. Forests cover 42 million square km in tropical, temperate, and boreal lands. Forests deliver not only social, and economic advantages but also responsible for ecological and aesthetic aids to natural processes and people (Feng et al., 2014; Joseph, Wright, Mughal, & Khan, 2004).

Furthermore, forests play a vital role in life in different ways such as they provide shelter to many species, release oxygen, and absorb carbon dioxide. They are responsible for carbon cycle on the earth. On the other hand, cutting of trees not only ceases the absorbed of carbon dioxide but also releases the stored carbon dioxide in the air in case of burning of wood. This is the reason that deforestation became one of the important factors of climate change and environmental degradation at world level because we are continuously removing the tool that reduces the Co_2 emission in the atmosphere (Bari et al., 2020).

Deforestation, on the other hand, surges external temperature, soil dreadful conditions and enhances the surface deterioration because of floods. Cutting of trees changes regional climate system that not only becomes the reason of disastrous rainfall but also persistent dry periods (Strasser et al., 2014). The substantial increasing trend of urbanization has caused immense deforestation that triggering the distortion of global climate patterns and causing the catastrophic hydro-meteorological events. Along with deforestation, energy, transport and manufacturing sectors, residential and commercial areas are also responsible for GHGs emissions (Bari et al., 2020; Chien, Hsu, Zhang, Vu, & Nawaz, 2021). Almost all these factors contribute 60% of total emissions which is a significant number. According to the social movement theory, particularly environmental movement, the public policy and behavior of people of a society and country can make possible the sustainable development of resources and their management in an efficient way. The main theme of this theory is the human rights regarding their health status, environment and ecological developments because they treat human beings as contributor of the current ecological system.

In the light of above analysis of former studies, the current search develops a simple theoretical model to determine the impact of deforestation on environmental degradation and climate changes in the form of the following equations;

$$CO_{2t} = \beta_0 + \beta_1 DF_t + \beta_2 MNFC_t + \beta_3 UPOP_t + \beta_4 ECP_t + \mu_t)\ldots\ldots\ldots\ldots(1)$$

$$Rain_t = \beta_0 + \beta_1 DF_t + \mu_t)\ldots\ldots\ldots\ldots(2)$$

Where Co_2 and Rain is the proxy for environmental degradation and climate changes respectively, DF is the measure of deforestation and similarly, MNFC and UPOP are the measure of manufacturing and urban population respectively. Finally, ECP is the measure of energy and μ_t is a Gaussian random error. The subscript 't' is showing the annual frequency of the data used by the current model.

4. Data and Econometric Methodology

The detail of the variables and their proxies is presented in the table.1 Data is collected from World Development Indicators (WDI) and economic survey of Pakistan and covers the time span of 1975-2020.

Before moving further, we should keep in view the characteristics of the data, as it is a time series data, therefore, it should be analyzed carefully. The most important dilemma of the time series data set is the prevalence of stationarity in it which determines either a variable is stationary or not. In the case of the non-stationary data, we cannot go for simple OLS models keeping in view the very purpose to avoid the spurious results. In such cases, we can adopt the most appropriate models that deal with the non-stationary data. But each model has different characteristics and cannot work for all types of data due to different orders of integration of variables.

Thus, to determine the appropriate order of integration of each variable, ADF test will be applied under the assumption of constant and trend of AIC criterion of optimal lag selection. The equation for ADF test is below;

$$\Delta y_t = \alpha_i + \beta_t + \rho y_{,t-1} + \sum_{j=1}^{p_i} \beta_j \Delta y_{t-j} + \varepsilon_t \rightarrow \ldots\ldots\ldots\ldots\ldots(2)$$
$$t = 1,\ldots\ldots,T$$

Whether the data is stationary or not it depends upon the value of ρ. If the value is equal to one, series is non-stationary which advocates the fact that it contains a unit root. On the contrary, series is stationary if the value is less than one. Thus, null and alternative hypotheses of ADF test are:

$$H_0 : \rho = 1$$
$$H_1 : \rho < 1$$

Table 1: Variable Description

Variable	Proxy	Definition	Data Source
Environmental degradation (Co_2)	Natural log of Co_2 emissions	Co_2 emissions kg per person 2010 US$ of GDP	World Bank
Rain (Rain)	Rainfall in millimetres	Average precipitation in millimetres	Climate change Portal for Development Practitioners and policy makers
Deforestation (DF)	Natural log of Forest Area	Area in million hectares	Economic Survey of Pakistan
Industrialization (MNFC)	Growth rate of manufacturing sector	The growth rate of value added of the manufacturing sector in GDP.	World Bank
Urbanization (UPOP)	Growth rate of Urban population	Growth rate of urban population of male and female	World Bank
Energy Production (ECP)	Electricity production in percentage	electricity production from oil, gas, and coal as a percentage of total production	World Bank

Note: data is estimated/ projected for values of last three years

If all variables are non-stationary at level but stationary at first difference, it means all are integrated of order one, therefore the maximum likelihood-based approach proposed by Johansen (1990) and Johansen (1992) is most appropriate for further analysis to deal with non-stationary data. And if any one of the variables is stationary it implies that it has an order of integration zero. In this case, Autoregressive Distributed Lag (ARDL) for co-integration test proposed by Pesaran and Shin (1995) is the most appropriate one to deal with non-stationary data. According to the results of ADF test, all variables contain unit root except growth rate of manufacturing that is stationary and no one variable is integrated or order 2. It implies that growth rate of the manufacturing sector is stationary and all other variables are non-stationary. Stationarity of a variable means the mean, variance and covariance of this variable is independent of time. The results of ADF test are presented in Table 2.

Table 2: Unit Root Analysis

Series	ADF (at level)	ADF (at 1st difference)
CO2	0.9764	0.0001
DF	0.1281	0.0073
MNFC	0.0424	0.0001
UP	0.8219	0.036
ECP	0.4418	0.024
Rainfall	0.4330	0.0091

Thus, this study adopts ARDL model for environmental degradation and Engel Granger two step approach for climate change. The model has confirmed that not a single variable is I (2) which means all variables are integrated of order one. The lag selection is being done by AIC, whereas, the form of ARDL models is;

$$\Delta \ln y_t = \beta_0 + \sum \beta_i \Delta \ln y_{,t-i} + \sum \gamma_j \Delta \ln X_{1,t-j} + \sum \varsigma_k \Delta X_{2,t-j} + \sum \pi_g \ln \Delta X_{3,t-g} + \sum \eta_p \Delta X_{4,t-p}$$
$$+ \theta_0 y_{t-1} + \theta_1 \ln X_{1t-1} + \theta_2 X_{2t-1} + \theta_3 \ln X_{3t-1} + \theta_4 X_{4t-1} + e_t \rightarrow \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

One of the most important assumptions of above equation is that error term of equation (3) is serially independent. After this, we should check the stability of the model and for this, we analyze the graphs of CUSUM and CUSUMSQ that are the cumulative sum of recursive residuals and the cumulative sum of squares of recursive residuals respectively. Both graphs show the structural stability of the model.

Figure 1: Plot of Cumulative sum of squares

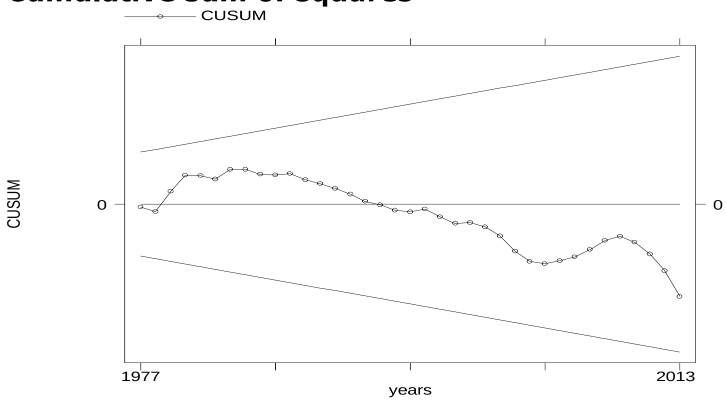
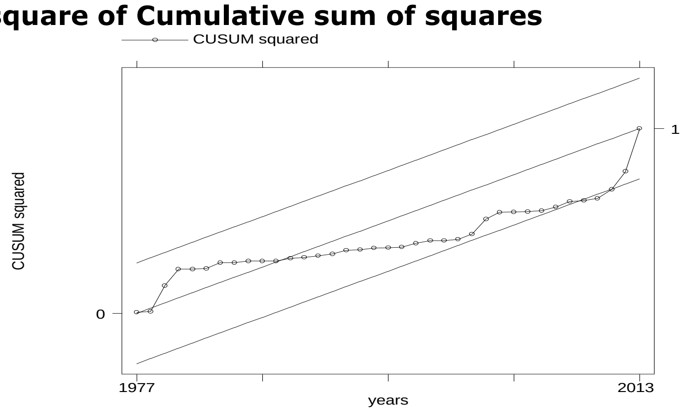


Figure 2: Plot of square of Cumulative sum of squares



Then we go for the "Bounds Test" to confirm the long run relationship among integrated variables. For this, we apply "Bounds Test" proposed by Pesaran, Shin, and Smith (2001). For this, we will consider the equation (4) once again where we will test that. $\theta_0 = \theta_1 = \theta_2 = \theta_3 = 0$. If this holds then there will be no long run relationship among these variables. Otherwise, we conclude with a long run relationship and can estimate it with the following equation;

$$\ln y_t = a_0 + a_1 \ln X_{1t} + a_2 X_{2t} + a_3 \ln X_{3t} + a_4 X_{4t} + v_t \rightarrow ....(4)$$

Similarly, we can find ECM:

$$\Delta \ln y_t = \beta_0 + \sum \beta_i \ln \Delta y_{,t-i} + \sum \gamma_j \ln \Delta X_{1,t-j} + \sum \varsigma_k \Delta X_{2,t-j} + \sum \pi_g \ln \Delta X_{3,t-g} + \sum \eta_p \Delta X_{4,t-p} + \varphi Z_{t-1} + e_t \rightarrow (5)$$

Where,

$$Z_{t-1} = \ln y_{t-1} - a_0 - a_1 \ln X_{1t-1} - a_2 X_{2t-1} - a_3 \ln X_{3t-1} - a_4 X_{4t-1} + \rightarrow ....(6)$$

Whereas $a's$ are the OLS estimates of the equation (5). To calculate the long-run effects, we once again use equation (3). Owing to the long run, change variables are zero and long run value for Xi is $-\left(\theta_i / \theta_o\right)$. Thus, we will report long run results after adjusting this negative sign. Then to investigate the relationship between deforestation and climate change we adopt the Engle and Granger (1987) two-step approach for testing the existence of a long run relationship:

We have confirmed that $(y_t, x_t)'$ is a vector of I(1) variables where Y is rainfall and X is deforestation. Thus, in first step we will run an OLS regression for the model, $y_t = a_0 + \theta_1' x_t + v_t \rightarrow ....(7)$ and test whether the residuals $\hat{v}_t = y_t - \hat{a}_0 + \hat{\theta}_1' x_t$ are stationary. If residuals are stationary it means both variables are in long run relationship means both are co-integrated. Then we can represent this model as an error correction model by using lag values of residuals calculated in the previous step. The error correction representation of the model is below;

$$\Delta y_t = a_0 + \gamma \hat{v}_{t-1} + \sum_{i=1}^{p-1} \phi_{yi} \Delta y_{t-i} + \sum_{i=1}^{q-1} \phi_{xi}' \Delta x_{t-i} + \eta_t \rightarrow ....(8)$$

5. Results and Discussion

Results of the ADF test have already been presented in the previous section. Similarly, the graphs of the cumulative sum of residuals and the cumulative sum of the square of residuals are presented in the previous section. These graphs confirm the stability of our model. Before presenting the results of the bound test for our first model, we should clear that how we would decide about our null hypothesis.

5.1 Test decisions of Bounds Test

If the calculated value of the test statistics is less than critical values of the lower bound then H_o^F (no level relationship or no long run relationship) cannot be rejected. However, H_o^F can be rejected if the calculated test statistic is greater than that of the critical values of the upper bound which implies that there is a long-run relationship between the determined and its determinants. Furthermore, the results of the test will be inconclusive if calculated value lies between above described values. The results of the "Bounds Test" presented in Table 3 confirm the long run relationship because the calculated value of F-statistic is greater than values of the upper bound. It means variables of the model are in long run relationship. Now we can present and interpret the results related to long-run equilibrium and short-run dynamics.

Table 3: Bound test for Cointegration, Pesaran/Shin/Smith (2001) ARDL Bounds Test

Column1	Column2	Column3
Dependent Variable	**F-Statistics=6.880***	
CO_2 emissions	**Lower Bound Value**	**Upper Bound Value**
Critical Value	**Pesaran et al. (2001)****	
1%	3.74	5.06
2%	2.86	4.01
10%	2.45	3.52

* Significant at 5% level of significance from to Pesaran et al. (2001); ** Critical values are obtained from Pesaran et al. (2001), Table CI (V): Unrestricted Intercept and no Trend.

5.2 Long run and short run results

The long run results, presented in Table.4, the forest area (deforestation) is significantly decreasing (increasing) the Co_2 emission in the long run. It implies that forests are helpful to purify the air which is degrading due to the carbon dioxide emission. These results are confirming the theory of Himalayan environmental degradation for the case of Pakistan. As we know all variables are in the form of log and percentage so coefficients are just elasticities. The coefficient of forest area is significant and according to the theory. These results are consistent with former studies (Haghipour & Burg, 2014; Percy et al., 2003). Similarly, the EC term and short run dynamic results are presented in Table.5. The value of ECT is within the bound having negative value. The value of ECT term in the model shows the speedy convergence of the short run dynamics towards the long-run equilibrium. It is describing that environmental degradation is converging towards its equilibrium by 82% each year via error correction term (ECT). The elasticity of forest area, in the long run, is greater than that of the elasticity in the short run because in the long run deforestation affects severely to the environment. All other control variables also have significant and expected signs except growth rate of manufacturing which is insignificant in the short run.

The results of the second model are also presented in table.4 after confirming the stationarity of the residuals of level form regression of climate change model. According to the results of the model, 1% increase (decrease) in forest area leads to increases (decreases) the average rainfall by 2.93 millimeters in the long run. It implies that dry periods and then abrupt heavy rains can be controlled by increasing the area of forest in Pakistan. These results have a similar patron in the short run but the magnitude is smaller than the long run and is consistent with Webster et al. (2011) and Chaudhry (2015). The error correction term for climate changes model is -.40 which is explaining that describing that climate change is converging towards its equilibrium by 40% each year via error correction term (ECT).

Owing to the lack of serial correlation, all of the diagnostic tests i.e. ARCH effect; omitted variable bias; Heteroscedasticity; and Multicollinearity are showing desirable results. The results of the diagnostic tests are presented in Table. 4. According to the result of Lagrange Multiplier Test and Durbin-Watson Test, there is no serial correlation and autocorrelation of order one as well in both models because probability value is rejecting the null hypothesis. These results ensure the efficiency of the results of the model. Similarly, Ramsey's reset test is rejecting the possibility of omitted variable biased-ness. It implies that our both model are appropriate and free from biased-ness. In the same way, the probability values of Breusch-Pagan and LM Test are rejecting the presence of Heteroscedasticity and ARCH effect in both models. Again, the efficiency of the results of the model is ensured by results of these both tests. Finally, the value of Mean-Variance Inflation Factor is rejecting the possibility of Multicollinearity, the degree of linear association between the right-hand side variables, which enhances the efficiency of the first model.

Table 4: Estimation Results

Regressors	Long run results (ARDL)	Short run results (ARDL)	Long run results (EG)	Short run results (EG)
DF	0.09* (0.0536)	0.073* (0.0424)	-2.93*** (.3636)	-1.81** (.8044)
MNFC	0.003* (0.0015)	0.001 (0.0009)		
UPOP	0.212*** (0.0257)	0.173*** (0.0412)		
EPC	0.003*** (0.001)	0.005*** (0.001)		
CO2(-1)				
Constant		-3.248*** (0.7343)		
EC1		-0.82*** (0.1576)		-.40* (.1936)

Note: Standard errors are in parenthesis

In conclusion, the results of the ARDL&EG approaches and their diagnostic tests are confirming the significant long run and short run relationship that is according to the theory of Himalayan degradation and consistent with the previous research. Most of the research on this phenomenon is conducted via qualitative analysis or base on the just theoretical basis. This study confirms the theoretical relationship after analyzing it empirically and provides consistent and efficient results for climate change and environmental degradation simultaneously. It finds that deforestation is enhancing carbon dioxide in the atmosphere of Pakistan. Thus, Pakistan has been facing severe climate changes in the way of heavy rainfall, floods, heat wave, smog, and droughts for a decade. All these consequences are creating threats for human life because many of the persons have to face injuries, financial hazards because of crops damaged, food deficiency, poor health status and even a number of persons have to lose their lives.

Table 5: Diagnostic Tests of ARDL

Null Hypothesis	Test applied	Value ARDL	Prob. Value ARDL	Value EG	Prob. Value EG
No Serial Correlation	**Lagrange Multiplier Test**		0.2758		0.2860
Auto Correlation	**Durbin-Watson Test**	1.75		1.88	
No omitted variable	**Ramsey's reset test**		0.4295		0.2969
Constant variance	**Breusch-Pagan**		0.8078		0.9795
No ARCH effect	**LM Test**		0.2598		0.3526
Multicollinearity	**Mean VIF**	8.3		N/A	

6. Conclusion and Policy Recommendation

A nation that destroys its soils destroys itself. Forests are the lungs of our eco system, purifying the air and giving fresh strength to our people. Formerly, researchers have paid due attention to finding the impacts of deforestation on climate changes and environmental degradation in different countries. The current research study focuses on the gravity of linkages between environmental degradation & climate change and deforestation in Pakistan empirically. According to the findings of the current study, forest area (deforestation) is significantly reducing (enhancing) the Co_2 emission in the atmosphere which is a proxy for environmental degradation. This impact is stronger in the long run than the short run. Climate change is converging towards its equilibrium by 82% each year via error correction term (ECT). It further implies that deforestation is responsible for climate changes and exogenous shocks like floods, drought, heavy rains, smoke, and heat waves etc. These external shocks might create social and economic challenges for Pakistan as these are the consequences of environmental and climate changes and only reforestation can mitigate them. The diagnostic tests are providing strong support to our argument and above findings, which confirm the empirical relationship and ensure the efficiency and unbiasedness of the results.

Climate change, environmental degradation and deforestation are the upcoming challenges for Pakistan and the country is facing severe consequences of unstable eco system. By keeping in view, the theatrical linkages and climate conditions of the Pakistan the current study contributes to the literature in the way that it provides a sound empirical analysis along with all diagnostic tests that make the findings of the study valid regarding the most challenging natural phenomenon for future generations. Furthermore, these results are confirming the theory of Himalayan environmental degradation for the case of Pakistan and former studies.

This study focuses on the role of forests in environment degradation and climate change of Pakistan and then tries to relate its consequences with human security. For this purpose, it only investigates the relation between deforestation, climate change, and environment empirically but does not analyze it further for human security and its consequences rather it relates both phenomena theoretically. This is the limitation of the current study.

For future research, the study recommends the researchers to incorporate the role of forest in environmental degradation in an empirical way and then link this environmental degradation to human security by an empirical analysis after measuring all required phenomenon with suitable proxies.

Based upon the findings of this study, we recommend to the government of Pakistan to take serious steps to control the deforestation and start campaigns and programs that create awareness about the importance of forests in the people of the country. Other than this, to increase the area of forests in the country government should start mega projects by itself. To create the awareness about global warming and its consequences government should use the print and electronic media as well.

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