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Impact of Environmental Degradation on Wheat Production in Pakistan

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ABSTRACT

This study investigated the determinants of environmental degradation and analyzed its effect on wheat production in Pakistan. Time series data was used from the period 1981-2011 for the empirical analysis of study. The data of the variables; carbon dioxide, fertilizer, population growth, urbanization, energy consumption, wheat production, area under wheat and wheat price were taken. Autoregressive distributive lag model and co-integration method were used on the both equations. Error correction model has negative sign for both models. It indicated that models were converging to their equilibrium from short run to long run. Causality between environmental degradation and wheat production was also analyzed. It was estimated that the environmental degradation was significantly impacting wheat production. Cumulative Recursive test for stability of the parameters revealed that parameters were stable at 5% level of significant. The results indicated environmental degradation was causing the yield reduction of wheat. Study findings suggested the need of proper management to reduce environmental degradation and enhance wheat production.

KEYWORDS: Environmental Degradation, Fertilizer, Equilibrium, Production, causality

I. INTRODUCTION

Environmental degradation (ED) today is a serious challenge to the life forms on the planet earth. It is adversely affecting not only the individuals and human societies in various ways and in different degrees, but is also influencing the changes that are detrimental to the health and growth of all forms of life [1]. The effect is cumulative in its nature and is in an acceleration mode now. The problem ED is approximately being faced by the whole world especially in developing countries where not much importance is given on this issue [2]. ED means the degradation of air, water, soil and distortion of ecosystem [3]. As any country move towards economic growth, results were started to appear in the form of environmental degradation [4]. So, economic growth is a main factor which causes ED. The trend of CO_2 emission is increasing according to the previous researches and if this situation will continue then the whole globe have to face the worse results. There is needed of such study that discusses the determinants of ED comprehensively.

The anticipated large expansion in the demand for its products could lead to an increase in the negative contribution of agriculture to global environmental quality, for example, loss of biodiversity through the clearing of grassland and forests, unsustainable pressure on increasingly scarce water supplies or increased water pollution by agro-chemicals and animal waste [5]. Although CO_2 emission leaves negative impact on wheat production but, there are some other factors that also affect its production. Wheat price and area under wheat production are major factors that affect the wheat production [6]. But, in Pakistan the wheat production area has decreased 9,138 thousand hectares during the period of 2015.So, if this situation will continue, then the problem of food shortage have to face, as the area under wheat production plays an important role in its production. But, during some past years tremendous changes were seen in the area of wheat production [7]. Previous researches on the wheat production indicated that if the production area is enhanced, wheat production can be increased [6]. Some previous research explained that not only ED affects the production of wheat but this can also affects the environment [8].

In Pakistan many factors are causing ED including, increasing population, urbanization, increasing number of vehicles, excessive use of fertilizer, forest depletion, and energy consumption. As population increases in any country, it depends more on natural resources and natural resources are depleted as a result and they contribute to the ED. Moreover, the excessive use of fertilizer also leaves the negative impact on environment and especially on the crop production. Fertilizer also cause water pollution and affect the production of crops and human health [9]. Due to increase in population areas for cultivation are squeezing gradually. In order to the fulfillment the needs of food for growing populations, fertilizers are being used heavily in the crop production [2].

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Urbanization is another major factor that is contributing in ED and its rate is increasing day by day. Urbanization causes to the depletion of natural resources. So, the high depletion of natural resources leaves the biodiversity in great thread. Rapid growth has led to unplanned urban development, causing major environmental problems and a severe lack of human contact with nature [10]. ED not only affects the economy of any country but also affect the agricultural sector [6]. The quality of environment is also affected due to the desire of getting higher production of food. In order to gain higher production of different crops, farmers use new technologies that are producing higher quantity of crops but at the same they are polluting the quality of environment [10]. Although agricultural intensification is giving a big quantity of production but this intensification is causing the loss of nutrients in the soils. So, if we want to secure our food then we will have to be take some immediate steps to cancel out the negative effects of the new technologies [11]. Salinity is another factor causing problem of ED and it is usually exacerbated by intensive irrigation and is one of the most important constraints in agricultural lands. Salinity has a considerable effect on world agriculture, significantly reducing productivity of agricultural plants [12].

Sustainability is an important factor for the economic growth of any nation because future growth depends on it [13]. Environmental sustainability is one of the sustainable development goal (SDG), and Pakistan is working to achieve this it. It can be achieved if Pakistan gives some more concentration on it. So, it is very important for every country to use natural resources in such a way that will remain sustainable for the coming generation. Fresh water, air and land are deteriorating due to pollution that can create problem for the next generation [14].

Geographically, Pakistan is included in the top countries that have unpredictable climate condition. But less capabilities and short resources to cope up with the climatically changes have pushed the Pakistan in worse situation [15]; [16]. Due to these shortcomings, we are facing extreme and sever events in the form of droughts, floods and increasing land sliding incidents. Flood events in the years 2012, 2011and 2010 are evidence of these climatic changes [17]. Now, government of Pakistan is making efforts to combat these disasters at the initial stages. Study is aimed at describing that how environment degrades due to energy consumption, urbanization, fertilizer, population growth, gross domestic product (GDP) and other factors. This section was gave the background of study. In the second section, materials and methods are explained, third part discussed the results and their interpretations and in the last portion conclusions are drawn in the light of investigated results.

II. MATERIALS AND METHODS

Data and sources

The study included the variables of CO_2 emission (Matric tons per capita), population density (people per sq.km of land area), fertilizer (crop wise use total), urban population (annual growth), GDP per capita annual growth (%), wheat production (000 tonnes), area under wheat production (000 hectares), wheat producer price (Lower currency / Tons) and energy consumption (kg per kg of oil equivalent energy use). Data were taken from Food and Agriculture Organization, World Development Indicator, National Fertilizer Development Center and different issues of economic survey.

Estimation Technique

Different estimation techniques were used in this paper during the whole result estimation. First of all stationarity of the variables were checked through unit root test. In unit root test ADF test was applied to test the stationarity of the variables. To investigate the environmental degradation equation and wheat production equation results, Autoregressive distributive lag model (ARDL) was used in this study on the basis of stationarity of the variables. But before using ARDL model bound test was applied to check the co-integration existence in the equation [8]. So, bound test is also used that indicated that there exist long run co-integration in both models of the study. For the application of ARDL model Eview 9 was used. In the last, cumulative recursive test was applied to check the stability of the parameters.

To test the stationarity of the variables unit root test was used. Stationarity means variance, mean and covariance remain constant over the time. In unit root test there were three types of test that were used to check the stationarity of the variables.

To investigate the both equations results, the study used ARDL method because this method is used for an equation when all the variables are stationary on different level. ARDL model was introduced by [18]. ARDL was also used in the studies of [8]; [14] and [19]. Autoregressive means that we can take the lag value of dependent variable. So, the autoregressive model is:

$$Y = \beta o + \beta 1(X1) + \beta 2(X2) + \beta 3\,(Yt - 1) + £ \qquad (1)$$

In this equation βo is the intercept where β_1 is the coefficient of x_1 the first independent variable. B_2 is the coefficient of X_2 the second independent variable andβ_3 is the coefficient of yt_{-1} the lag of dependent variable. Where £ is the error term of the equation 1.
In the distributive lag model means that in this type of equation we can take the lag value of independent variable. So, the distributive lag equation 2.

$$Y = \beta o + \beta 1(X1) + \beta 2\,(X2) + \beta 3\,(X1t - 1) + £ \qquad (2)$$

So, in equation 2 Xt-1 is the lag of independent variable X1.
ARDL is a model in which we take the lag of both dependent and independent variables. So, autoregressive distributive lag model can be written as (equation 3)

$$Y = \alpha\,0 + \alpha 1\,(X) + \alpha 2\,(Xt - 1) + \alpha 3\,(Yt - 1) + \mu \qquad (3)$$

In the 3rd equation Xt-1 represents the lag of independent variable where Yt-1 represents the lag of dependent variable. So, Equation is the ARDL model.
After applying ARDL, it is important to check the co-integration of the equation. To check the co-integration in the long run and short run equation bound test is used. According to [18] ARDL co-integration long run relation gives unbiased result. For the analysis of Long run co-integrating bound test was used. If the F-statistic value are below the lower and upper bound test value then result would be inconclusive [17].If there is co- integration in the specific equation then we move to long run and short run equilibrium relation between the variables [19]. Granger causality test is also used to test the direction of causality between Ed and WP. To analyze the results of their study [20] and [6] also used Granger causality test. In the last to check the stability of the models were checked through Cumulative Recursive test.

III. RESULTS AND DISCUSSION

This section is comprised of two parts, in the first parts impact of macro-economic determinants on ED is discussed, and in the second part, impact of ED on wheat production is assessed. First the results of bound test are presented, that explained the existence of long run cointegration between the variables. The estimated bound test value indicated that there existed long run relationship between the variables. The results of the study are displayed in the Table 1. In the bound test F-statistic value is compared with the critical values of bound test. On the basis of F-statistic value the long run cointegration results are estimated.

Table 1 F-Statistic value of Bound test

Test Statistic	Value	K
F-Statistic value	12.90151	5

Critical value of the Bound Test
The critical values of bound test is also presented below table.

Table 2 Critical Bounds Value

Significance Level	Lower Bound	Upper Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96-	4.18
1%	3.41	4.68

Equitation is significant even at 1% level of significance. So, we reject the null hypothesis that mean there is no co-integration between the variables. It means that there is existing long run relationship between the variables. On the basis of bound test result, ARDL long run equilibrium test is used to test the long run equilibrium between the variables. The results of the study are also similar to the study of [11]; [13] and [16].
Short run results were estimated for determinants of environmental degradation. Here, ED was taken dependent variable while energy consumption, fertilizer, population density, gross domestic product and urbanization were taken as independent variables. The Coint Eq (-1) is -0.283 that is negative. The negative value shows that the model is convergent to its equilibrium. So, this model is a convergent model. The coefficient of ECM is highly significant and describes, that it will converge to its equilibrium by 28 % each year from short run to long run.
In the long run ARDL co-integration result of energy consumption, fertilizer, population density, urbanization and GDP are presented (Table 3).

Table 3: Long run ARDL Co-integration result of ED analysis

Variables	Coefficient	Standard Error	t-Statistic	Probablity
EC	0.027	0.002	13.5	0.000
FER	0.028	0.017	-1.64	0.129
GDP	-0.047	0.017	-2.76	0.016
POPDNS	0.102	0.021	4.83	0.000
URBAN	0.145	0.018	8.05	0.001
C	-1.123	0.132	-8.498	0.040

ED is the dependent variable. All the independent variables are highly significant except fertilizer variable. The first variable energy consumption is highly significant and has positive impact on ED. The results of energy consumption of this study are similar to the results of [21] and [14]. All these results of the study have positive relation with CO2 emission. It means that energy consumption is the important determinants of ED. The co-efficient described, that one percent increase in energy consumption would lead to 0.027 percent increase in ED.

Fertilizer also has positive and significant relation with environmental degradation. It explained that one percent increase in fertilizer would cause 0.028 percent increase in ED. Studies of [6] and [9] also indicated that fertilizer has negative impact on the environment and has positive impact on the agriculture sector.

The next variable GDP has negative and significant relation with ED. The coefficient of GDP revealed that one percent increase in gross domestic product could contribute 0.047 percent decrease in ED. The results of [21] explained that as GDP of the county increases, environment degrades first, and then starts to improve. Population density and urbanization both have also positive and significant relation with ED.

In the second equation, wheat production is the dependent variable and environmental degradation, wheat price, area under the wheat production and fertilizer were taken as explanatory variables. These variables also showed different stationarity levels. It is why, ARDL model was used for the analysis here. Before the application of ARDL, bound test was applied to test the long run cointegration.

Table 4 F-Statistic value of Bound Test

Test Statistic	Value	K
F-Statistic	6.504	4

The F-Statistic value of bond test is 6.504 and 4 degree of freedom level. After the F-Statistic value of bound test the critical values of bound test are also presented below.

Table 5 Bound Test Critical values

Significance	Lower bound	Upper bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

The F-Statistic value of bound test was 6.5 that was high from all lower and upper bound. Model was significant at 1% level of significance. F-statistic value indicated that there exists long run relation between the variables. [11]; [13] and [16] studies also used bound test to check the long run relationship between the variables. The value of the Coint Eq (-1) of this equation was -0.215. The cointegration equation of the model is negative and highly significant that demonstrated the model is convergent from short run to long run at the speed of 21% each year.

Table 6: Long Run Cointegration Result of wheat production

Variable	Coefficient	Standard Error	t-statistic	Probability
AUW	7.196	0.084	85.541	0.000
ED	-1.003	0.014	-71.743	0.000
FER	-0.278	0.071	-3.909	0.004
WPRICE	0.016	0.004	3.993	0.005
C	-403.832	52.755	-7.765	0.000

Table 6 shows that in the long run, one percent increase in area under wheat production leads to 7.196 percent increase in the wheat production. The results of area under wheat production are matched to the results of [18] and [19].

Mostly previous work explained that CO2 emission has negative relation with wheat production. The results of [22] and [23] demonstrated that CO2 emission caused to the reduction of wheat production. However, the result of [24] has quite different results from other studies.
The fertilizer variable is negative and significant at 1%, and 5% level of significance. It revealed that one percent increase in the fertilizer would lead to 0.278 percent decrease in the wheat production in the long run. The results of [7]and [25] were similar to this study. The last variable wheat price was positive and significant at 5% level of significance. The similar results of wheat price and wheat production were found from the study of [18]; [26] and [27].

Granger Causality Test
The result of the causality between the variables is checked through the granger causality test and the result of the test is given in Table 7.

Table 7 Pairwise Granger Causality Test

Null Hypothesis	Obs	F-Statistic	Prob.
WP does not granger cause ED	29	0.15011	0.8614
ED does not Granger Cause WP		5.36239	0.0119

Table 7 indicated that WP does not cause to Ed but ED cause to WP because the probability value of it is 0.0119 demonstrated that we reject the null hypothesis means there is no existed granger causality. So, null hypothesis is rejected explaining that ED caused to degrade the environment. Causality test were also applied in the studies of [28]; [11] and [15].

IV. CONCLUSION

This study has two main parts. The first part of this study demonstrated the determinants of ED. All the statistical analysis of the study's result indicated that all the included variables in the study were significantly impacting the environment except GDP. The second part of the study describes that ED is effecting wheat production in Pakistan. Results described that one percent increase in wheat area would lead to 7.2percent increase in wheat production. It can be concluded that energy consumption, fertilizer, population density, and urbanization were contributing toward ED. The results of study are favored with the study of [3]; [7] and [11]. So, on the basis of the result it has been cleared that all the mention variables in the study highly affect the environment. Effective policies by the government should be developed that minimize the level of ED from the environment in the presence of above explained variables. Wheat is the most important variable in the second model. Higher wheat producer price encourages the producers to increase the production to get more benefits [8]. It can be suggested that government should devise policies to decrease the CO_2 emission level to tackle down the ED. Some alternate ways should be adopted for energy purpose like energy from renew able source to reduce the burden on environment [11]. Farmers should be educated regarding the use of suitable quantity of fertilizer in the production to avoid long term losses.

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