IMPACT OF ENVIRONMENTAL VULNERABILITIES ON HUMAN DEVELOPMENT; A CASE STUDY OF PAKISTAN

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Abstract
The research utilized WDI data for the period 1990 to 2022, and it used human development Index as a dependent variable while fuel consumption, population growth, and FDI inflow were used as independent variables. The OLS regression revealed that population growth has significant as well as negative effects on human development, and that other variables have no significant effects. The null hypothesis was supported, hence rejecting that population growth has a significant effect on human development. The test established that there is no issue of multicollinarity, autocorrelation and heteroscedasticity.

INTRODUCTION

The environmental vulnerabilities have posed a great hindrance to sustainable development all over the world, especially for developing nations like Pakistan. Pakistan has been the most vulnerable nation in terms of natural disasters such as floods, glacial lake outburst floods, climate change, water scarcity, deforestation, and air pollution. Pakistan is listed among the most climate vulnerable nations in the world and according to the Global Climate Risk Index, Pakistan suffered losses exceeding $3.8 billion with an extreme humanitarian crisis from natural disasters over the duration of 2000 to 2019 (Eckstein et al., 2021). There have been events such as the 2010

floods, long droughts in Balochistan, heat waves in Sindh that have proven a delicate balance between human development and environmental degradation. All of these shocks are not only causing health and migration crisis but also disturbs the education, health, and poverty alleviation of the future, (Rauf et al., 2020). These disasters are also far more than economic and social costs but also have a shortage in developmental plans.The United Nations Development Program (UNDP) conceptualized the Human Development Index (HDI), because they wanted the development dialogue to move away from an economic focus and towards a more holistic vision

of 'human development' (Morse, 2023) The Human Development Index (HDI) is a composite measure of health, education, and income, and is a strong measure of national development and social progress (UNDP, 2023).

A number of factors are included in the HDI measurement. While increased per capita income and investments in health and education positively influence the HDI (A Hashmat et. al, 2023) factors

such as environmental vulnerabilities and risks from disasters induced by nature detracts from a country's movement toward sustainability. Air pollution which is a result of carbon emissions can cause health concerns such as respiratory and cardiovascular diseases, and can also reduce life expectancy and quality of life, negatively affecting the HDI.

Following figure shows the summary of the human development index:
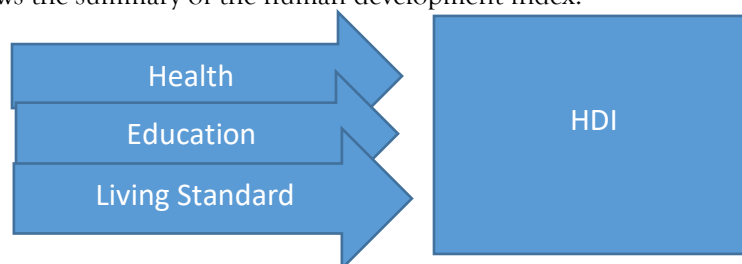
To establish contrasted values for each dimension of the HDI, a minimum and maximum (goalposts) is set, and then where the countries rank relative to these goalposts is conveyed with a value between 0 and 1.

Thus, a significant amount of work have been done to investigate the relationship between environmental vulnerability and human development, and various human development index measures have been used including environmental, ecological and climate vulnerabilities; none of the authors included the measurement of environmental risk and multidimensional human development as a longitudinal study together. Most of the studies I've to date primarily engaged in either cross-country comparisons (Neumayer, 2001) or a sectorally based vulnerability (Ali et al., 2017). They have primarily neglected and perpetuated the sorts of analyses we profess should be included in the measures of human development in consideration of significant environmental risks.

The climate change driven environmental transformation of densely populated urban areas may pose increasing susceptibility to

Vector-borne diseases. In general, since people in densely populated urban settlements are in close contact with each other, the higher rates of person-to-person contact may contribute to the rapid spread of infectious diseases. Rapid, unplanned urbanization often generates breeding sites for mosquitoes. In addition, the high human population density has many individuals who are susceptible to infection, and when temperatures increase, elevated absolute humidity will increase and may expand the range of some species. Diseases spread this way include dengue fever, malaria and filariasis. While climate change will likely result in some expansion of malaria-carrying mosquitoes into some places, it will likely also result in a contraction of this range elsewhere.

1.2 Problem Statement

Pakistan has been facing environmental challenges over an extended period of time that is affecting the core dimensions of human development index (HDI). Despite various efforts by government and non-governmental organizations the country continuous to face high impact vulnerability to climate induced disasters such as floods, drought and water shortage. There is a gap in literature about the impact of environmental vulnerabilities on the human development index using the time series analysis,

which limits the policy makers' ability to develop a practical plan to target the most affected variables. This research aims to address the gap by analyzing the impact of environmental vulnerabilities on human development in Pakistan.

1.3 Research Gap

This study seeks to address that gap by employing a time-series econometric analysis to evaluate the impacts of environmental vulnerabilities represented by indicators such as CO_2 emissions, deforestation and abnormal population growth on Pakistan's HDI during the period from 1990 to 20222. In the past studies the CO2 consumption was the main dependent variable for the environmental vulnerabilities. In this study the fossil fuel energy consumption, population growth and FDI are the dependent variables. All three have strong relationships with environmental degradation but have not been analyzed for Human Development relationships previously. Additionally, past studies haven't checked the endogeniety issue in the regression model and this study fills that gap.

1.4 Objective

To analyze the impact of environmental vulnerabilities on human development in Pakistan

1.5 Significance of the Study

This study is significant for the following reasons:
The forest area is vital to human development and impacts all aspects reflected in the Human Development Index (HDI) (Zhang & Wu, 2022). The HDI is a composite index that gives a measure of a country's average achievement in three basic dimensions of human development: health, education, and standard of living. Forests affect the HDI by supplying ecosystems services, income potential, and environmental sustainability (Zhong et al., 2024).

This study provides a guideline for the policymakers need to consider when approaching the resource allocation and the process should be staged in a research-based manner. Thus, the needed and prioritised resource allocation should be directed more in the necessary sector of the Human development

This research advances the limited work known to date on this subject area with time series data. It may be of use for knowledge by the academics and research scholars working in this area.

This study approached a multidimensional view by using a range of variables like carbon emissions, deforestation, foreign direct investments (FDI), and population growth. This will provide a better all-embracing understanding of the impacts of each variable as they affect human development.

2. Related Literature

Forests assist in the economic development of communities by providing timber, many types of non-timber forest products, as well as tourism and recreation opportunities (Suhadi, 2018).

Wang, Zhang and Wang (2018) have described human activity to be the world's largest energy consumer. It may, however, be important to consider the effect of renewable energy use on human development. There is a large body of work in this academic field. The authors utilized the Two-Stage Least Square (2SLS) method to study the relationship between renewable energy consumption, GDP growth, and the UN's Human Development Index in Pakistan during the period 1990-2014. The findings concluded that Pakistan's renewable energy consumption level does not help form Pakistan's position in the world's human development rankings. Remarkably, a country's level of human development decreases as the wealth of a country increases. The human development index increased through increases in CO2 emissions. Trade openness somehow impedes Pakistan's progress. The causal relationships supported the long-run trajectory of the feedback hypothesis within the environmental dimension and the human development process.

Environmental vulnerabilities play an important role in human development, impacting health, well-being and socio-economic benefits. Research highlights the complicated nature of the relationships between environmental change and human fortunes, especially in an over populated world requiring our best efforts at anticipating environmental management systems (Brown & Westaway, 2011). Climate change,

pollution and the depletion of natural resources are some environmental vulnerabilities expected to aggravate environmental vulnerabilities for marginalised communities more than privileged communities (Barrow, 2014). The same results were also found by the Blaise in (2020).

Li, X., & Xu, L. (2021) has examined the relationship between human development and overall environmental quality. Using China's provincial panel data from 2004 to 2017, this research has built the Environment Degradation Index (EDI) and Human Development Index (HDI) to quantify environmental pollution and human development, respectively, and employed the Simultaneous Equations Model (SEM) to test the relationship between them. The results has revealed that there was an inverted U-shaped relationship discovered between EDI and HDI, and the first and second power coefficients of HDI were 5.2781 and -2.3476, respectively. At the same time, the results also has proved that environmental pollution, in turn, postponed regional economic development, and each 0.01 unit increase in EDI was accompanied by a 3.15% decline in GDP per capita.

The area represented as 'forests' does contribute to human development as it mediates health, education and standard of living via ecosystem services, economic opportunities and sustainable environmental practices (Tiemann & Ring, 2022).

2.1 Theoretical Framework

This framework indicates that environmental vulnerabilities and human development happens through some interrelated direct and indirect paths. If we only look at progress in relation to human development metrics, there is a strong possibility that we will miss important indicators of the true progress and resilience of the society. Therefore, including environmental sustainability measures with human development indicators is essential.

A sound theoretical framework for studying the impacts of environmental vulnerabilities on the Human Development Index (HDI) contains the most important concepts from sustainable development theory, environmental economics, and human development theory. The framework acknowledges that both environmental vulnerabilities and human development are multidimensional and recognizes that environmental vulnerabilities and human development can affect each other reciprocally and dynamically.

The Human Development Index (HDI) is a combination measure of health (life expectancy), education (mean and expected years of schooling), and standard of living (GNI per capita). It relates to the well-being and actual capabilities of a population, Lai, S., & Chen, D. (2020).

Environmental vulnerabilities are the vulnerabilities of human and ecological systems to damage from environmental hazards, such as environmental pollution, depletion of resources, climate change, etc. Environmental vulnerabilities can also be measured through indices, like the Environmental Degradation Index (EDI), Environmental Vulnerability Index (EVI), Das, P., & Das, A. (2017).

Direct Effects: Deterioration of the environment (air pollution, water pollution, and so on) directly affects health and life expectancy, creating direct reductions in HDI, Lai, S., & Chen, D. (2020).

Indirect Effects: Environmental stressors can limit the economy productivity and educational attainment impacting human development more indirectly, Hughes, B., et al. (2012).

2.2 Conceptual Framework

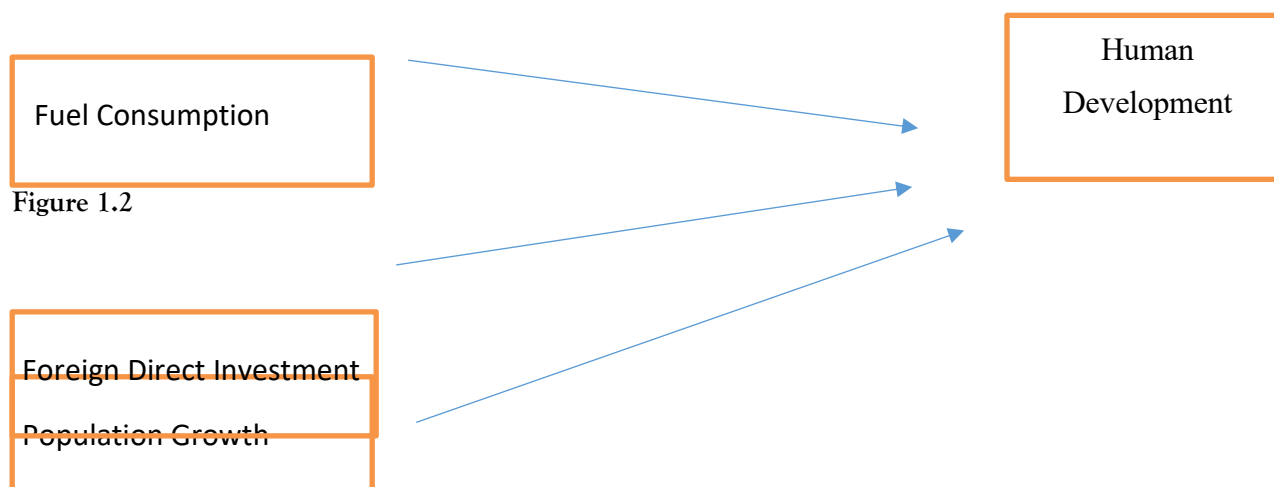The figure 2.1 highlights the conceptual framework of the existing study:

Figure 1.2

Human Development is the dependent variable of the existing study, while the fuel consumption, Forest area, Population growth and Foreign Direct Investment are the independent variables of the current study.

2.3 Hypotheses

Following are the null hypotheses of the present study:

H_{01}: Fuel consumption have no significant impact on the human development.
H_{02}: Population growth have insignificant impact on the human development.
H_{03}: FDI have insignificant impact on the human development.

3. Research Methodology

The current research is quantitative in design having a time span of 33 years (1990-2022).

The following table presents the study variable measurement, symbols, time frame and source of data.

Table 3.1

Variable	Measurement	Symbol	Time Period	Data Source
Human Development	Human Development Index	HDI	1990-2022	WDI
Energy Consumption	Fossil Fuel Energy Consumption (% of total)	Fuel. Cons	1990-2022	WDI
Population Growth	Growth per year of total population	Pop. Gr	1990-2022	WDI
Foreign Direct Investment	Foreign Direct Investment inflow % of GDP.	FDI	1990-2022	WDI

3.1 Econometric Model

The HDI is the dependent variable in this econometric model. Fuel consumption, Population Growth, and FDI are independent variables that are presented on the right of the dependent variable. Various types of econometric methodologies and tests were used that are suitable for the analysis of the data in this research.

$$HDI = \beta_1 + \beta_2 Fuel.Cons + \beta_3 Pop.Gr + \beta_4 FDI + \mu$$

In the above equation the μ for the error term which encompasses the effect of the excluded variables. While the βs are the coefficients of the mentioned variables in which $\beta 1$ shows the constant term.

3.3 Unit Root Test

Unit root test is applied in order to check the trends and stationarity in the data. So for this reason the Augmented Dickey Fuller Test is applied.

3.2 Model Specification

Table 3.1   **Following are the results of the ADF test:**

Variable	At Level	At First Difference	Decisions
HDI	-1.2939 (0.6201)	-7.5711 (0.0000)	Stationary at I(I)
Fuel Energy Cons	-1.4764 (0.5324)	-5.2643 (0.0002)	Stationary at I(I)
Population Gr	-1.5061 (0.5173)	-3.9069 (0.0054)	Stationary at I(I)
FDI	-2.8859 (0.1804)	-3.6420 (0.0423)	Stationary at I(I)

Table 3.1 illustrates that all the study variables are stationary at first difference. Stationarity is indicated by the probability as well as by the T-statistics. Since all the variables are stationary at its I(I). Therefore Ordinary Least Squares regression method is used. Since the time series data contain trends so for these reasons the test of stationarity is used. The present research used the OLS model of regression after tested all the variables stationary at first difference and tested error term stationary at level, which ensures the cointegration, the cointegration test used is the Engle Granger Residule. The diagnostic tests used are the multicollinearity, autocorrelation, heteroscedasticity, CUSUM test (demonstrates the stability of the mean) and the endogeniety test is used.

4 Data Analysis and Result Discussions

This chapter presents the results and discussion of this paper.

The table below shows the results of the OLS regression model.

Table 4.1

OLS Regression Model Regression:

Variable	Coefficient	Std. Error	t-statistic	Prob.
HDI(-1)	1.1610	0.2428	4.7813	0.0001
Fuel En.Cons	0.00546	0.0033	1.6320	0.1143
Pop.Gr	-0.0495	0.01915	-2.5885	0.0153
FDI	0.0069	0.0068	1.0091	0.3219
C	-1.5053	0.2047	-7.3517	0.0000

R^2 = 0.9378   Adj R^2 = 0.9286

F-Statistic = 101.9174

Prob.   (0.0000)   D.W 2.1861

4.1 Result Discussions

Value of R- Square indicates that 93% of the dependent variable variation is accounted by independent variables in the regression model. Value of Durbin Watson (D.W) is 2.1 which indicates zero or no autocorrelation. Fitness of the model as a whole is provided by the probability value of F. statistic which is 0.0000, indicates that the overall model is significant. Value of R square is negative compared to the value of D.W indicating that the regression results are not spurious. It can be verified by cointergration test.

Whereas with respect to the independent variables the HDI (-1) is used because of addressing the issue of autocorrelation. Whereas the rest of the independent variables do not have any effect on the human development except the population growth, which is also significant as well as with the undesirable effect on the human development of Pakistan. The probability value for the population growth is 0.0153 with the coefficient of -0.0495. The finding suggests that population alone is susceptible to human development as indicated by the HDI. Per unit change in population growth brings -0.0495% change

in HDI. The same finding was made by the Zehra et al., (2022), which noted the unwanted impact of population burden on HDI. The null hypothesis H_{02} holds in this case. Population growth at a fast rate can cause unemployment, loss of resources, poverty and health conditions due to these reasons Pakistan's population growth has negative effects on the HDI.

The Fuel Energy Consumption had no significant effect on the Human Development as shown by a greater than 5% probability (P-value for fuel consumption 0.114). In this case the H_{01} was accepted.

FDI has positive coefficient but found insignificant with probability 0.321. FDI in Pakistan is so small to vigor the Human development and as a consequence the impact of FDI on the Human Development is insignificant. Thus the null hypothesis H_{o3} is being accepted to Beaken FDI has no significant on the human development.

4.2 Cointegration Analysis

The null hypothesis for the co-integration analysis that, the residuals exhibit the unit root.

Table 4.2

Residuals	T- Stat	Prob.
	-3.8163	0.0286

The table above shows the stationarity exists in the residuals at the level, which strongly suggests that the results of OLS are not spurious. So, the results of OLS are reliable and can be used for further regression analysis.

4.3 Diagnostic Tests

Following diagnostic tests are carried out:

4.3.1 Multicolinearity

Table 4.3; shows the Variance Inflation Factors (VIF).

Table 4.3

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
HDI(-1)	0.05897	481.752	6.2279
Fuel En.Cons	1.12E-05	1379.800	4.10648
Pop.Gr	0.00036	70.751	4.9136
FDI	4.72E-05	2.834	1.0569
C	0.04192	1445.915	NA

4.3.2 Autocorrelation

The values of the centered VIF are below than 10.0, which signifies there is no problem of multicollinarity

.

Table 4.4

F-Stat	0.5389	Prob. F(1,26)	0.4695
Obser R Sqaured	0.6497	Prob. Chi – Sqaure(1)	0.4202

4.3.3 Heteroscedasticity

The F-stat and observed R-squared also confirm that there is no autocorrelation issue because the p-values are greater than the significance level, therefore, reject the null hypothesis of no autocorrelation and accept the alternate hypothesis.
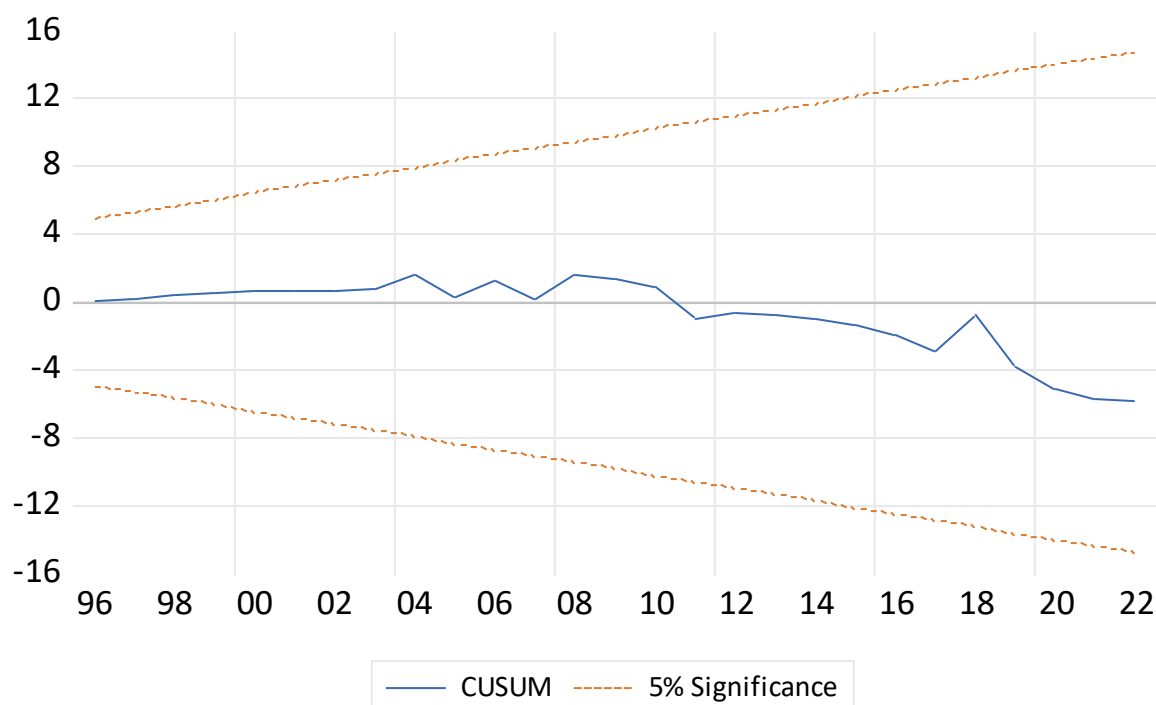
Table 4.5

F-Stat	1.5713	Prob. F(4,27)	0.2104
Obser R Sqaured	6.0426	Prob. Chi – Sqaure(4)	0.1960
Scaled explained SS	5.8808	Prob. Chi – Sqaure(4)	0.2082

The F-stat and the observed R Squared indicates there is no evidence of heteroscedasticity since the p-values are both above the significance level and therefore both support the null hypothesis of homoscedasticity.

4.3.4 Stability Analysis

For stability analysis the CUSUM test is carried out.

Figure 4.1

The figure 4.1 shows there no instability found in the means of the residuals.

4.3.5 Endogienity
Null hypothesis for this is that our study variables are exogenous:
Table 4.5

	Value	Df	Prob.
Difference in J-stat			
	5.0662	3	0.1670

The probability value of the J-stat is higher than the significance level therefore no endogeneity is present and the null hypothesis (have exogenous study variables) is accepted.

5. Conclusion and Recommendations
5.1 Main Findings of the Study
The main findings of the study are as under:
Fuel consumption and FDI are not statistically significant.
The population growth has negative impact and have influence the HDI of Pakistan unfavorably.

5.2 Conclusion
In this study, the time series data extending from 1990 to 2022 was sourced from the WDI. The human development measured by HDI was treated as the dependent variable while fuel consumption, population growth, and FDI inflow are taken into consideration as independent variables. As stationarity test (ADF) confirmed that all the independent variables along with the dependent variables were found stationary at its first difference. After confirming the cointegration (Engle granger residual base conintegration) among the variables, the multiple regression analysis OLS was applied to explain the relationship among the variables. The required diagnostic tests confirmed no diagnostic issue. The regression analysis's results showed that only population growth, negatively effects the human development significantly. The other variables do not have any statistically significant effect on the human development. The null hypothesis H01, H03 were

accepted, while the H02, which indicates there is significance of population growth on human development was rejected in this circumstance.

5.3 Recommendations
Following are the recommendations of this study:
Population growth should be regulated.
In addition, the population needs to be made productive in order to mitigate the effects of the population on the HDI.
Creating an environment to maximize the positive parts of FDI while minimizing the negatives is critical for sustainable human development.

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