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FACTORS IMPACT ON POPULATION AND ENVIRONMENT IN BANGLADESH AND INDIA

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Abstract: Population growth and trends are centrally important to the environment because it helps to determine the environmental impact of human activities. In this study, the World Bank database has been used. Here, carbon dioxide (CO_2) emissions, and energy intensity (EI) are considered as environmental indicators. The population indicators are the proportion of the population aged 15-64 years, and the percentage of the urban population. The Gross Domestic Product (GDP) is considered a development indicator in a country. This study tries to identify the association between population environment and development. Correlation analysis has been employed to know association and Path analysis is used to determine the important factors for environmental impacts such as carbon dioxide (CO_2) emissions. The result presents that the zero-order correlation exists among energy intensity (EI), the proportion of the population aged 15-64 ($P_{15\text{-}64}$), urbanization (UR), gross domestic product (GDP) per capita (US$), total population (P)) and carbon dioxide (CO_2) emission in Bangladesh and India. It is observed that 8 paths for Bangladesh and 7 paths for India out of each 12 hypothesized paths are found to be statistically significant. In Bangladesh, the total effects of exogenous variables like as energy intensity (X_1) and population aged 15-64 (X_2) are observed negative direction on carbon dioxide emissions (X_6) and the remaining variable like as urbanization (X_3) is observed as positive direction on carbon dioxide emissions. However, in India total effects of these two exogenous variables population aged 15-64 (X_2) and urbanization (X_3) are observed positive direction on carbon dioxide emissions (X_6) and the remaining variable like as energy intensity (X_1) is observed negative direction on carbon

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dioxide emissions (X_6). The total effects of endogenous variables like as GDP per capita (X_4) show a negative direction on carbon dioxide emissions and population (X_5) shows a positive direction on carbon dioxide emissions. The study demonstrates that CO_2 emission is important for environmental impact in Bangladesh and India. There is a strong association between population, GDP per capita, energy consumption and urbanization and CO_2 emission in Bangladesh and India. The factors of CO_2 emissions play an important role in environmental degradation. Thus, attention should be focused on using low energy consumption, and proper urbanization, particularly on modern technology which assures fewer uses of CO_2 emissions in Bangladesh and India.

Introduction

The world population reached 7.7 billion in 2019 implying that the world has added approximately one billion people in the span of every last twelve years and approximately 4.3 billion which is 56 per cent of the global population living in Asia (UN 2019, 1-2). In Asia region experiencing rapid population growth since the mid-twentieth century has expected to reach its peak population size in the coming decades. Over the last few decades, the population is growing at an alarming rate in Bangladesh and India. The growing population has increased demand for their basic needs of food, energy, water, education, health care, sanitation as well as housing and such a rapidly growing population becomes a threat to executing the SDG agenda in this region (UNFPA 2012, 22-23). In order to improve the quality of life, the utilization of resources has speeded up, which coupled with tenure insecurity or the absence of clear property rights, has resulted in the over-exploitation of natural resources (Goldstone 2010, 33). With the accelerated increase, more people require more food and shelter; then it is needed more land for irrigation and settlement (Ehrlich and Holdren 1971, 1213-15). Thus, to feed the growing population and their settlement large tracts of forested land are destroyed (Shaw 1992, 13). As a result of increasing population growth, the water demand is increasing for irrigation and industrial uses are also growing. The above facts of population impact, directly and indirectly, pressures on the environment and climate change (Coale and Hoover 1958, 19).

However, population and environmental relationships are crucially important to determine the environmental impact of human activities. Carbon-dioxide (CO_2) emission trend is increasing day by day due to rapid population growth in various countries. CO_2 emission is considered the main culprit of global warming and it causes adverse effects on our environment (Glaeser and Khan 2010, 415). As human communities use more resources, they generate contaminants such as air and water pollution and greenhouse gas emission along with increasing quantities of waste (Roca and Alcantara 2001, 555). Population interacts with several other factors to determine a society's environmental impact. The

impact of population pattern on various sectors and the variations of environmental impact in Bangladesh and India have grown at an alarming rate and makes concern among environmental researcher in this sub-continent. In this context, this study tries to know the relationship between population and environment and its impact. It also identifies the factors affecting the population and environment in Bangladesh and India.

Data and Methodology

Population and environment relationships are very complex. Studying the above relationships requires different kinds of multivariate data and sophisticated statistical techniques for analytical purposes. In this study, population and environment-related data are extracted from World Bank's current database which has been used. For analysis purposes, carbon dioxide (CO_2) emissions, and energy intensity (EI), are considered as environmental indicators. The population indicators are the total population in a country, the proportion of the population aged 15-64 and the percentage of the urban population. Gross Domestic Product (GDP) is considered as a development indicator in a country and the environmental variable includes CO_2 emission per metric ton. Correlation analysis has been employed to know the association between population and environment. Path analysis is used to examine the important factors' impact on an environmental indicator such as carbon dioxide (CO_2) emissions. This also reflects the simultaneous effects of several independent variables on the dependent variable and direct and indirect effects. It is to evaluate the joint effects of the designed dependent variables on the pertinent explanatory variables for the dependent variable.

Results and Discussion

Correlation Analysis: In this section, an attempt has been made to observe the direction (positive and negative) and magnitude (intensity) of the correlation of the phenomena under study. The analysis is performed on the basis of the correlation coefficient. The results of correlation among the total population (P), the proportion of the population aged 15–64 ($P_{15\text{-}64}$), gross domestic product (GDP) per capita (US$), energy intensity (EI), percentage of urban population (UP) and carbon dioxide (CO_2) emission in Bangladesh. Table 1 presents the zero-order correlation among energy intensity (EI), the proportion of the population aged 15-64 ($P_{15\text{-}64}$), percentage of urban population (UP), gross domestic product (GDP) per capita (US$), total population (P)) and carbon dioxide (CO_2) emission in Bangladesh. The results show that carbon dioxide (CO_2) emission is negatively correlated with energy intensity (-0.893) and positively correlated with the population aged 15-64 (0.998), percentage of urban population (0.999), GDP per capita (0.980) and population (.976) at 1% level of significance. It is also found that population is positively correlated with population aged 15-64 (0.981), urbanization (0.980) and GDP per capita (0.979) at a

1% level of significant but negatively correlated with energy intensity (-0.851). In the case of GDP per capita it is also found that the percentage of the urban population (0.989), the population aged 15-64 are positively (0.991) and energy intensity is negatively (-.912) correlated at a 1% level of significance. percentage of urban population (UP) is negatively correlated with energy intensity (-.900) and positively correlated with the population aged 15-64 (0.999) at a 1% level of significance and the population aged 15-64 is significantly negatively (-.903) correlated with energy intensity at 1% level.

Table 1: Results of correlation analysis among the selected variables in Bangladesh

Variables	*EI*	$P_{15\text{-}64}$	*UP*	*GDP*	*P*	CO_2
EI	1.000	-0.903**	-0.900**	-0.912**	-0.851**	-0.893**
$P_{15\text{-}64}$		1.000	.999**	0.991**	0.981**	0.998**
UP			1.000	0.989**	0.980**	0.999**
GDP				1.000	0.979**	0.980**
P					1.000	0.976**
CO_2						1.000

Note: ** Significant at 1% level and * Significant at 5% level.

Table 2 exhibits the results of the correlation coefficient in India. The result shows in India the coefficient of correlation between CO_2 emissions and energy intensity is -0.990 which is negatively significant at a 1% level but the population aged 15-64 (0.999), percentage of urban population (.0.985), GDP per capita (0.983) and population (0.972) are positively significant correlated at 1% level. Again population is positively correlated with the population aged 15-64 (0.976), percentage of urban population (0.917) and GDP per capita (0.989) but negatively correlated at energy intensity. GDP per capita is positively

Table 2: Results of correlation analysis among the selected variables in India

Variable	*EI*	$P_{15\text{-}64}$	*UP*	*GDP*	*P*	CO_2
EI	1.000	-0.928**	-0.941**	-0.963**	-0.941**	-0.899**
$P_{15\text{-}64}$		1.000	0.992**	0.960**	0.992**	0.994**
UR			1.000	0.983**	0.998**	0.979**
GDP				1.000	0.983**	0.933**
UP					1.000	0.979**
CO_2						1.000

Note: ** Significant at 1% level and * Significant at 5% level.

correlated with the population aged 15-64, the percentage of urban population (UP), and negatively correlated with energy intensity. Whose values are 0.987, 0.942 and -0.996 respectively. Urbanization is also found positively correlated with the population aged 15-64 (0.980) and negatively correlated with energy intensity (-0.961). Population aged 15-64 correlated negatively at a 1% level of significance. Whose magnitude is -0.993

Path Analysis: Path analysis was introduced by the biologist Sewall writing in 1934 in connection with decomposing the total correlation between any variable in a causal system. The technique of path analysis which was developed during the 1920s by Sewall Wright as an aid to the quantitative development of genetics gained popularity in social science studies with the further expositions made by Duncan and Land. Recently its application is gained popularity in demography (Balakrishnan et al. 1980: 84; Roy and Singh, 2016: 3).

Path analysis presumes the existence of causal framework interlinking different predictor variables with the response variables. The technique of path analysis is based on a series of multiple regression analyses with the added assumption of a casual relationship between independent and dependent variables. This technique lays relatively heavier emphasis on the heuristic use of a visual diagram, technically described as a path diagram. The representation of the causal variable is called as a path model and it is both stochastic and explanatory and it is said to be an extension of the multiple regression model (Cohen and Cohen 1975: 15-17; Retherford and Choe, 1993: 7-19;). It helps in estimating the magnitudes of the linkages between interrelated variables and provides information about the underlying causal processes. This technique explores a chain of relationships among the variables by using standardized regression coefficients of a set of regression equations. The fundamental to the path analysis is the path diagram which is the outcome of a set of linearly interrelated variables and the assumed causal relationship among them. In the path diagram the basic principles are to be considered as (i) the variables are arranged from right in such a way that all the endogenous variables are to the right of their exogenous variables; (ii) the unidirectional straight arrows called henceforth as causal paths that go from left to the right represent the endogenous variables; (iii) the two-headed curvilinear arrows represents the non-causal (correlated) relationship among the exogenous variables. This study employs a recursive path model relating to socio-economic, demographic and environmental variables. The merit of path analysis in comparison to correlation analysis is that it makes possible the assessment of the relative influence of each antecedent or explanatory variable on the consequent or criterion variables by first making explicit the assumptions underlying the causal connection and then by elucidating the indirect effect of the explanatory variables. Table 3 presents the selected variables considered in path analysis.

Table 3: Variables used in path analysis

Exogenous variable	X_1= Energy intensity X_2=Population aged 15-64 X_3=Urbanization
Endogenous variable	X_4=GDP per capita (US$) X_5=Total population
Dependent variable	X_6= Carbon dioxide emissions (metric tons)

(World Bank GEO Data)

This model is a recursive path model in which each variable is assumed to be dependent upon all prior causal variables. This system of equations for the model can be written as:

$$X_4 = P_{43} X_3 + P_{42} X_2 + P_{41} X_1 + P_{4x} R_x$$

$$X_5 = P_{54} X_4 + P_{53} X_3 + P_{52} X_2 + P_{51} X_1 + P_{5y} R_y$$

$$X_6 = P_{65} X_5 + P_{64} X_4 + P_{63} X_3 + P_{62} X_2 + P_{61} X_1 + P_{6z} R_z$$

Where, P_{ij} are the path coefficients and R_x, R_y and R_z are random disturbance terms. All the random disturbance terms are mutually independent and are independent of their corresponding explanatory variables. The residual of path coefficients can also be estimated with case from the regression equation as square root of $(1-R^2)$, where R^2 (unadjusted) is the multiple correlation coefficients (square) of the regression equation. From the path analysis the direct, indirect, implied and total effects of each selected explanatory variable for Bangladesh and India are obtained separately.

The results of zero-order correlation coefficients of various variables of population and environment in Bangladesh and India help us to get non-causal (correlation) relation among exogenous variables. The different types of effects and their percentage are shown in tables 4 to 7 respectively. In path analysis, we obtain path coefficients, the direct, indirect, and implied effects of each of the selected explanatory variables for the total population in Bangladesh and India.

According to figures 1 to 2, we observed that 8 paths for Bangladesh and 7 paths for India out of each 12 hypothesized paths are found to be statistically significant. The t-test was used to identify the estimated obtained path coefficients that are significant. The discussion that follows on direct and indirect effects is based on these significant coefficients only. It is worth mentioning here that the examination of the non-significant path has only a small effect on the power of the explanation of the model. The results and discussion of the path model in Bangladesh and India are shown below:

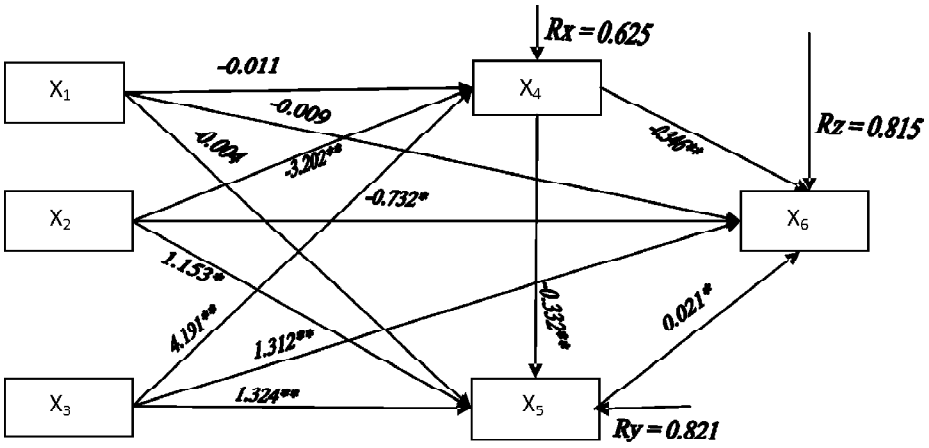

Figure 1: Path Diagram of the impact of carbon dioxide emissions on the population and environment for Bangladesh

Figure 1 shows that in **Bangladesh,** the total effects of exogenous variables like as energy intensity (X_1) and population aged 15-64 (X_2) are observed negative direction on carbon dioxide emissions (X_6) and the remaining variable like as urbanization (X_3) is observed positive direction on carbon dioxide emissions. Again we also observed that the total effects of endogenous variables like as GDP per capita (X_4) show a negative direction on carbon dioxide emissions and population (X_5) shows a positive direction on carbon dioxide emissions (table 4).

Table 4: Results of path analysis in the case of Bangladesh

Dependent Variable	*Selected Variable*	*Total Association*	*Total Effect*	*Non-Casual Effect*	*Indirect Effect Via*		*Other Variables (Implied Effect)*	*Direct Effect*
					X_4	X_5		
X_6	X_1	-.893**	-.011	-.882	.007	-.005	-.009	———
	X_2	.998**	-3.202	4.200	4.355	-1.885	-.732	———
	X_3	.999**	4.191	-3.192	-2.867	-.012	1.312	———
	X_4	.980**	-.332	1.312	———	-.014	———	-.346
	X_5	.976**	-.346	1.322	———	———	———	.021

Note: Non-Causal Effect = Total Association — Total Effect

In Bangladesh total effects of energy intensity (X_1) on carbon dioxide emissions (X_6) is -0.011, of which about 42.86% is transmitted through its implied effect and 23.09% acts

through the population (X_5) in the same direction and about 33.33% GDP per capita (X_4) is acted through in the opposite direction (table 5.9). From figure 1 it is observed that the total effects of the population aged 15-64 (X_2) on carbon dioxide emissions (X_6) is -0.3.202 of which about 10.50% is conducted through its implied effect and about 27.037% acts through the population (X_5) in the same direction and about 62.46% is transmitted through GDP per capita (X_4) in the opposite direction (table 5).

Table 5: Percentage values of path analysis in the case of Bangladesh

Dependent Variable	*Selected Variable*	*Percentage of Indirect Effect Via*		*Other Variables (Implied effect)*	*Direct Effect*
		X_4	X_5		
X_6	X_1	33.333	23.095	42.857	——-
	X_2	62.464	27.037	10.499	——-
	X_3	68.408	0.286	31.305	——-
	X_4	——-	3.889	——-	96.111
	X_5	——-	——-	——-	100.000

The direct effect of endogenous variables like GDP per capita(X_4) and population (X_5) are observed in positive and negative directions respectively. The total effect of GDP per capita (X_4) on carbon dioxide emissions (X_6) is 0.332 of which about 96.11% is transmitted through its directed effect and 3.889% is conducted through the population (X_5) in the same direction and the total effect of the population(X_5) on carbon dioxide emissions (X_6) is -0.346, of which whole effects is (about 100.0%) transmitted through its direct effect.

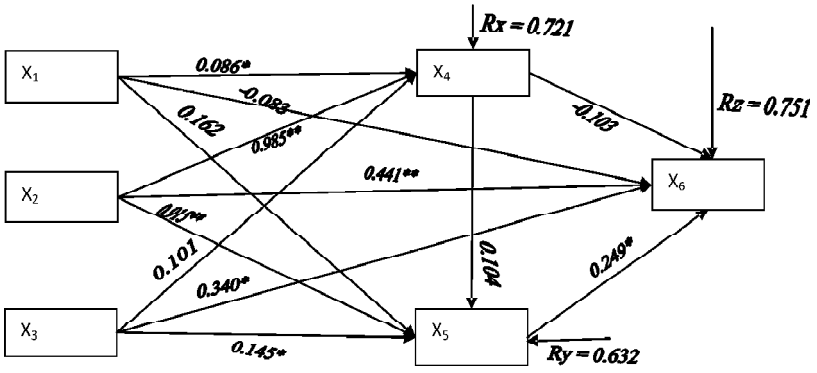

Figure 2: Path Diagram of the impact of carbon dioxide emissions on socio-economic and demographic variables for India X-$_2$

Figure 2 presents that in **India,** the total effects of these two exogenous variables population aged 15-64 (X_2) and urbanization (X_3) are observed positive direction on carbon dioxide emissions (X_6) and the remaining variable like as energy intensity (X_1) is observed negative direction on carbon dioxide emissions (X_6). Again it is observed that the total effects of endogenous variables like as GDP per capita (X_4) show a negative direction on carbon dioxide emissions and population (X_5) shows a positive direction on carbon dioxide emissions. It is observed that the total effects of energy intensity (X_1) on carbon dioxide emissions (X_6) is 0.086, of which about 60.64% effect is transmitted through the population (X_5) and about 20.55% acts through implied effect in the same direction, then about 18.81% is conducted through GDP per capita (X_4) in the opposite direction (table 7). In case of total effects of the population aged 15-64 on carbon dioxide emissions (X_6) is 0.985 of which about 7.11% effect is transmitted through GDP per capita (X_4) and about 48.12% is conducted by population (X_5) in the same direction and about 44.77% effect is transmitted through implied effect (table 7).

Table 6: Results of path analysis in case of India

Dependent Variable	*Selected Variable*	*Total Association*	*Total Effect*	*Non-Casual Effect*	*Indirect Effect Via*		*Other Variables (Implied Effect)*	*Direct Effect*
					X_4	X_5		
X_6	X_1	-.990**	.086	-1.076	.076	-.245	-.083	——-
	X_2	.999**	.985	.014	-.070	-.474	.441	——-
	X_3	.985**	.101	.884	.044	.195	.340	——-
	X_4	.983**	.104	.879	——-	-.207	——-	-.103
	X_5	.972**	.249	.723	——-	——-	——-	.249

Note: Non-Causal Effect= Total Association ¯ Total Effect

Table 7: Percentage values of path analysis in the case of India

Dependent Variable	*Selected Variable*	*Percentage of Indirect Effect Via*		*Other Variables (Implied effect)*	*Direct Effect*
		X_4	X_5		
X_6	X_1	18.812	60.644	20.545	——-
	X_2	7.107	48.122	44.772	——-
	X_3	7.600	33.679	58.722	——-
	X_4	——-	66.774	——-	33.226
	X_5	——-	——-	——-	100.000

It is also observed that urbanization's total effects on carbon dioxide emissions(X_6) is 0.101 of which about 7.60%, 33.68% and 58.72% are transmitted through GDP per capita (X_4), population (X_5) and implied effect respectively in the same direction. The direct effect of endogenous variables like GDP per capita (X_4) and population (X_5) are observed in negative and positive directions respectively (figure 5.2). The total effects of GDP per capita (X_4) on carbon dioxide emissions (X_6) is 0.104 of which about 33.23% is transmitted through its directed effect and 66.77% is conducted through the population (X_5) in the same direction and the total effects of population on carbon dioxide emissions (X_6) is 0.249, of which whole effects are (about 100%) transmitted through its direct effect.

Conclusion

The study demonstrates that as the CO_2 emission is increased the environmental impact is also increased simultaneously in Bangladesh and India due to environmental degradation. It is observed that there is a strong association between population, GDP per capita, energy consumption and urbanization and CO_2 emission. In both countries, the factors of CO_2 emissions play an important role in environmental degradation. It may conclude that urbanization has come out to be the most significant variable in environmental degradation. Thus, attention should be focused on the need for energy consumption low, and proper urbanization, particularly on modern technology which assures fewer uses of CO_2 emissions in Bangladesh and India.

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