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Population, Forest Degradation and Environment: A Nexus

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ABSTRACT: *In order to examine the trend and impact of relationship between growth of forest resource and population in West Bengal, a province of India, in the time series data for every ten-year from 1901-1991 this study suggests that the increase of population to forest land in West Bengal is alarming, because the ability of the forest to satisfy the demands is limited by the extent of forest resource of the state. The increasing population in West Bengal makes a negative impact on the forest. Though this impact is not highly significant at present, the long run relationship between density of population and forest area leads to substantial damage of the forest resource causing acute environmental problem of the state in future. Similarly, soil erosion, which is the only natural factor to damage forest resource in West Bengal, has some significant effect, though not highly. Keeping in view of such problems community forest management programme like social forestry or joint forest management seems to a positive step for protecting environmental problem.*

KEYWORDS: *Bengal forest resource, population pressure on environmental resource, Soil erosion, Distributed lag model, Time series econometrics.*

Introduction:

One of the important parameters, which have guided trade and development discussions in CTE (Committee on Trade and Environment) in 1994, is “that GATT/WTO agreement already provided significant scope for national environmental protection policies provided that they are non-discriminatory¹”. Being the heart and lungs of the world, forests act as barometers of environment and economy (Kumar 2001). The destinies of human and trees have remained tightly bound since the dawn of human history, with trees and forests being incorporated into culture, religion and

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mythology by people of every continent². Forests have exerted a tremendous influence on survival and economic development of many societies. There are two views about the management of forests in particular and that of renewable resources in general: one view is that macro level socio-economic factors, especially demographic pressures, chiefly affect forest use, and that population pressures have contributed to environmental degradation. An alternative hypothesis suggests the impact of larger socio-economic factors to be very limited and believes that technical innovations can help humanity solve environmental and scarcity related problems. According to the first view the clearing of forests land for subsistence farming is often inevitable in the poorer developing countries, particularly those with large and rapidly growing population. This paper, thus, attempts to examine the trend and impact of relationship between the growth of forest resources and population in West Bengal, a province of India, in the time series data for every ten-year from 1901-1991.

Forest damage as a part of natural factors like droughts, frosts, storm, soil erosion, air pollution, etc. have been increasing rapidly all over the world. Degradation of forests by soil erosion is the only factor in West Bengal as per State Forest Report, 2000. This paper also attempts to examine the extent of relationship between the area of soil erosion and the area of forests in West Bengal.

Review of Studies:

The literature of forest resources and population nexus suggests that the forest resources are depleting at a fast rate with the increasing pace of population (Mohan 2000, Bhattacharya 2001, Kumar 2001, Sengupta 2001). Food, fuel, fodder and other biomass play a crucial role in meeting daily survival needs in a vast majority of the Siwalik hill regions rural household comparing the State of Haryana and parts of Punjab. Collecting fuel is an important daily chore for most of these rural populations. Because of shortage of wood, villagers are being increasingly forced to traverse longer distance each day in search of food (Mohan 2000: 172-81). According to the estimate of the Indian Institute of Forest Management (IIFM), the total fuel wood removed from forest is of the order of 2.35 million cubic meters annually. The minimum requirement of green fodder for livestock in the country is 882 million tones per year, of which green fodder from pastures, agricultural land and forests that can be harvested is only 434 million tones. The remaining shortfall is covered by overgrazing or over harvesting of grass and other fodder in forest land.

Kumar (2001) is of the view that some important processes stimulating rapid deforestation in most Third World Countries are expansion of commercial agriculture and cattle ranching, growth of

industrial mining and timber exploitations, migration to agricultural frontiers, and speedy urbanization; “presumably, the greatest damage to forests is caused by growing rural population. Increasing urban population also stimulate demand for agricultural and forest products³.” The pressure of population and poverty has made rural households increasingly dependent on forest for their needs⁴. The fuel wood consumption in India has been 260 million m³ in 1997 while the sustainable population for the same year was estimated to be 52.6 million m³. As per survey of NCAER (1985), rural households of most of the populous states had more than 90 per cent dependence on non-commercial energy including fuel wood. Moreover, the intense pressure on land and absence of subsidiary occupation compel the local people to clear the forests and marginal land for cultivation⁵.

All over the world, forest degradation is caused by several natural and anthropogenic factors. Among the natural factors soil erosion is a significant factor for degradation of forest. The study, executed by Mohan (2001) in Siwalik hill region, reveals that occurrence of landslides following heavy showers is also a fall-out of soil erosion-precipitated by reckless felling of forest trees. Of the 28 thousand hectares of degraded land, at least a thousand hectare is affected by water erosion (Mohan 2001: 187). European forests continue to suffer decline and thinning of crown as becoming more and more widespread among the trees. The state of European forests is now much worse than it was 1980's. Annual survey in European forests showed that in the ten-year series the proportionate of damaged trees are steadily increase, from 13 % in 1988 to 23 % in 1997. Drought, frost, insect attack and continued acidification of the soil are the significant factors for the damage of European forests (Elvingson 1998). The major factor behind soil erosion is its erosion. Soil erosion can be due to water run off washing away top soil, or surface wind erosion which blows off top soil. Soil erosion by water and wind results in the loss of top soil, terrain deforestation and loss productivity of land (Sengupta 2001: 141-2). A large part of water erosion of soil is nature included, although human activities may aggravate the problem, for example, deforestation, overgrazing of land, shifting cultivation on the hills and hill-slopes have been responsible for the reduction of vegetation cover of soil and affected the physical property of soil making it more susceptible to erosion in India. Wind erosion has also caused mainly by the loss of vegetation cover resulting from felling of trees, over grazing and extension of agriculture to marginal and forest area⁶. Total soil erosion in India is distributed over regions in varying intensities. In dense forest area the rate of erosion is as low a rate as 5 tonnes/hectare/annum while the intensity goes up to 80 tonnes/hectare/annum for acid region of Rajasthan like Siwalik hill (Sengupta 2001: 142).

Methodology:

Nerlovian partial adjustment model (dynamic), cointegration test and regression model (static) were used to look into our stated objectives.

Partial Adjustment Model : Nerlovian partial adjustment model (dynamic) was used to perceive the dynamic association of forest area on density of population in West Bengal for every ten-year data from 1901 to 1991. The model specified below:

$$F_t^* = a + bP_t + U_{1t} \quad (1)$$

$$\text{But } F_t - F_{t-1} = c(F_t^* - F_{t-1}), c \leq 1 \quad (2)$$

Subtracting (1) in (2) and rearranging, we get

$$F_t = \alpha + \beta P_t + \gamma F_{t-1} + cU_t \quad (3)$$

Where $\alpha = ac$, $\beta = bc$, $\gamma = (1-c)$, $U_t = cU_{1t}$ and

F = actual area of forest

F^* = desired area of forest in long run equilibrium

P = population density

c = adjustment coefficient

U = random disturbance term

t = time period

Nerlovian partial adjustment model was also used to estimate both short run and long run elasticities of forest area with respect to population. To quote Timber (1974), “the dynamic adjustment model was much superior to the static model, even when the latter introduced time or income proxy variable”.

Cointegration Test: Stationarity of a time series is very essential as the use of a non-stationary time series in regression analysis can give rise to dubious and spurious relationship. Data series (Y) can be either: (i) trend stationary: if $\hat{Y} = a + bt$, then $e = Y - \hat{Y}$ is stationary; (ii) difference stationary: ΔY_t is stationary and/or (iii) the series may have to be de-trend and difference so as to obtain a stationary series (Enders 1995).

A prerequisite for testing the sets of variables for cointegration is to establish the properties of the individual series and the order of integration of each variable must be determined as series with different order of integration can not be cointegrated.

The order of integration of the series was determined using the Dickey-Fuller (DF) tests for a unit root. The test statistic is the τ (tau) test for the lagged level of the variable with the null being: the series contain a unit root.

Cointegration between two variables can be defined as: Time series X_t and Y_t are said to be cointegrated of order d, b where $d \geq 0$ and $b \geq 0$ written as: $X_t, Y_t \sim cI(d, b)$ (4)

If: (i) both series are integrated of order; (ii) there exists a linear combination of these variables, say $\alpha_1 X_t + \alpha_2 Y_t$ which is integrated of order $d-b$. The vector (α_1, α_2) is called a cointegrating vector.

It is said that in a long run relationship between two variables both must be integrated of the same order if the error term is to be $I(0)$ (Deadman and Charemza 1992).

The following test was used to test whether a set of variables is integrated. The null hypothesis being: X_t and Y_t are not cointegrated.

Prior to using the test for cointegration we run the following cointegrating regression:

$$X_t = \alpha + \beta Y_t + V_t \quad (5)$$

Where X = area of forest

Y = population density

If the error terms V_t are stationary i.e., $I(0)$, the two variables X_t and Y_t are said to be cointegrated.

The Dickey-Fuller Test : Let U_t denotes residuals from equation (5) and ΔU , their first difference and then estimate the following regression:

$$\Delta U_t = \phi U_{t-1} + \varepsilon_t$$

The τ (tau) statistic for ϕ is computed. If in absolute terms the estimated τ value exceeds any of the critical values, the conclusion would be that the estimated U_t is stationary (i.e., if does not have a unit root), and therefore X and Y are cointegrated.

Regression Model: Regression model (static) was used to examine the impact of area under soil erosion on the area of forest in a cross sectional data (district-wise) of West Bengal in 1996-97.

The model is specified below:

$$S_t = \lambda + \theta F_t + U_t$$

Where S = area under soil erosion

F = area under forest

U = random disturbance term

The model was estimated using the principle of least squares.

For this study the data was collected from State Forest Report, West Bengal (2000).

Results and Discussions:

Nerlovian partial adjustment model, used to perceive the dynamic association of forest area (F_t) on density of population (P_t) and one year lag of forest area (F_{t-1}) in West Bengal for every ten-year data from 1901 to 1991, indicates that a 10 per cent increase in the population density would result in a decline of the area of forest by 0.04 per cent (Table 1). The t value of P is significant only at 30 per cent level. The R^2 value reveals that the explanatory variable in the model accounts for more than 78 per cent in area of forest. The Durbin-Watson test ($d = 2.30$) tends to null hypothesis of zero autocorrelation ($\rho \rightarrow 0$) or indirectly the equivalent hypothesis $d \rightarrow 2$. The short run and long run elasticities of forest area with respect to population are 0.105 and 0.149 respectively. This study, however suggests that although the coefficient of dependent variable is not significant, the negative impact of forest area on population indicates a high goodness of fit, suggesting that population pressure in West Bengal has some positive contribution to environmental degradation in West Bengal.

Table 1: Estimated results of Dynamic Model for the area under forest in West Bengal (1901 to 1991)

Variable	Parameter Estimate
Intercept (α)	12.0485
Density of population (P_t)	-0.004* (-1.4376)
One year lag of forest area (F_{t-1})	0.28498** (0.9368)
R^2	0.781
d-w statistic	2.30259
Short-run elasticity	-0.105
Long-run elasticity	-0.149

* indicates significance at 30 per cent level

** indicates significance at 40 per cent level

Note: figures in parenthesis represent t values

The order of integration of the series was determined using Dickey-Fuller (DF) test for a unit root in order to show the nature of long run relationship between two variables, F and P. It is said that in a long term relationship between two variables, both must be integrated of the same order if the error term is to be $I(0)$ (). Prior to using the test for cointegration we run the cointegration regression of forest area (F_t) on population (P_t) and subject the residuals estimated from this regression to the DF unit root test. We obtain the following results:

$$\Delta U_t = -0.789U_{t-1}$$
$$\tau(-4.7341)$$
$$r^2 = 0.379$$

The coefficient of U_{t-1} is -0.789 , τ (tau), -4.734 and r^2 is 0.379 . As in absolute term, the calculated τ exceeds any of the critical values at 1 per cent, 5 per cent and 10 per cent levels, we can reject the null hypothesis (H_0) i.e., the estimated error term is stationary (i.e., it does not have a unit root) and therefore F and P are cointegrated, indicating that population pressure have contributed to long term effect for the decrease of forest area in West Bengal.

As to the second objective, the regression equation, used to examine the impact of area under soil erosion on the area of forest in a cross sectional data of West Bengal in 1996-97, shows that the value of coefficient of independent variable (area under forest) is 0.158 and it is significant at 20 per cent level (Table 2). The value of r^2 is 0.346 and d (Durbin Watson) value is 1.261 (positive autocorrelation). It implies that soil erosion has some significant for the damage of the forest resources in West Bengal causing environmental degradation and threatening sustainable development of the world.

Table 2: Estimated results of Static Model for the area of Soil Erosion in West Bengal (1996-97)

Variable	Parameter Estimate
Intercept (λ)	17738.02
The area of forest (F)	0.158* (1.4571)
r^2	0.346
d-w statistic	1.2616

* indicates significance at 20 per cent level
Note: figures in parenthesis represent t value

Summary and Conclusion :

This study suggests that the increase of population to land in our state is alarming, because the ability of the forest to satisfy our demands is limited by the extent of forest resources of the state. The increase of the population of our state makes a negative impact on our forest resources. Though the negative impact of forest area on density of population is not highly significant at present, the long run relationship between these two variables leads to substantial damage of the forest resources causing acute environmental problem of the state in future.

Similarly soil erosion has some significance, though not highly, for the damage of forest resources in West Bengal. But the degradation of forest resources owing to soil erosion is also alarming in the near future affecting environmental degradation and threatening the sustainable development to a large extent. Keeping in view of such problems some efforts was taken by the Government of India through the National Forest Policy, 1998. But such efforts on a large scale are to be taken by the Government and NGOs based on time bounded programme – both short run and long run – to increase the forest cover through social forestry/Farm forestry programmes including afforestation of the vested waste-lands and private lands to meet the demand of fuel, fodder and small timber. Efforts are also to be taken to check soil erosion and desertification as well as to improve the climate.

Notes:

1. Datta and Deodhar (2001), p – 519
2. Kumar (2001), cover page
3. Kumar (2001), p – 103
4. Sengupta (2001), p – 162
5. Mohan (2000), p – 184
6. Sengupta (2001), p –142

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