Empirical Evidence on the Linkages between Environmental Degradation and Poverty in Bangladesh

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Abstract
Inspired by the worldwide debate on the issue of environmental degradation, an attempt has been taken to examine the nexus between environmental degradation and poverty among former districts of Bangladesh based on secondary sources of data. Our empirical findings suggest a positive relationship between poverty and environmental degradation except Chittagong hill tracks and mangrove forest area. It was also observed that environmental degradation is sensitive to economic growth. The successful reduction of poverty in Bangladesh largely depends on both linear and non-linear relation of various climatic and non-climatic factors.

Introduction

The relationship between poverty, environmental degradation and sustainable development are closely interlinked. It is generally conjectured that poverty is the main cause and effect of environmental degradation in most developing countries that retard them to achieve sustainable development (Khan, 2008; WCED, 1987; Mellor, 1988; Cline-Cole et. al., 1990; Broad, 1994; Heath and Binswanger, 1996; Dasgupta and Mäler, 1996; Duraiappah, 1998; Sobhee, 2004). The link between poverty and environment has often been mentioned in the 'sustainable development' debate and is seldom systematically explored (Lele 1991). The literature that treats the link usually focuses on the 'vicious circle' between poverty and environmental degradation: the circle is Malthusian in inspiration where farmers pushed by population increase and poverty extend cropping onto fragile marginal lands and degrade them. As a result the yield is reduced and this further impoverishes farmers (Dasgupta and Maler 1994, Pearce and Warford 1993 and Mink 1993). A new dimension to the link between poverty and environmental degradation was brought out in 1995 when Reardon and Vosti

introduced the concept of 'investment poverty' and related the same to other measures of poverty (Reardon and Vosti 1995). The notion of poverty was examined by them in the context of categories of assets held and categories of environment change with particular focus on farm household income generation and investment strategies as determinants of the links. According to them, the strength and direction of the poverty-environment links in rural areas are to differ (even invert) depending on the composition of the assets held by the rural poor and the types of environmental problems they face. People having incomes above an established welfare poverty line still be too poor in key assets and thus overall cash and human resources to be able to make critical investments on soil conservation or follow key land use practices to maintain or enhance their natural resource base. They might thus be better off than the 'welfare poor' but still be 'investment poor'. Finally they argued that the link between poverty and environment in a given setting depend on the level, distribution and type of poverty and environmental problems. Rozelle et. al. (1997) studied the relationship among population, poverty and environmental degradation in China in 1997. They examined the impact that on the China's land, water, forest and pasture resources and found that the government policy to be ineffective in controlling rural resource degradation primarily because of its limited resource and poorly trained personnel. According to the report of Government of China, Ministry of Agriculture, rapidly expanding township and village enterprise sector have been the major sources of water pollution in China (G.O.C 1991). Next to industrial effluents, agricultural chemical runoff and leaching are also causing serious water pollution (Mei, F 1992). Housing investments, a major user of wood products, has been rapidly growing and causing widespread deforestation (World Bank 1992). All these environmental effects on the health and livelihood of the poor are directly or indirectly being felt. Some studies reveal that due to deforestation, agricultural expansion and overgrazing of livestock there has been widespread destruction of grasslands causing environmental

problems (Lieu et al 1991). Soil erosion is also taking place due to deforestation and overgrazing. Mountainous lands, hilly regions and plateaus are most vulnerable to soil erosion. Poorly constructed irrigation system has led to salinity of land in some environments, either from inadequate application of water or from sub-standard drainage. Salinity of farmland has caused significant decline in farm productivity and has induced the producers to remove land from production (Huang et al 1994). The net result is the reduction in income earning capability of the farmers and thus has an indirect impact on their health and future investments in agricultural activities.

Overview of Environment and Poverty in Bangladesh

Household Income Expenditure Survey (HIES) was carried out first in Bangladesh in FY1973-74. In subsequent years, a number of HIESs was undertaken; the latest one was conducted by BBS in 2005. HIESs carried out up to FY1991-92 were based on Food Energy Intake (FEI) and Direct Calorie Intake (DCI) methods in order to measure the incidence of income poverty. FEI method computes poverty lines by finding the value of per capita consumption at which a household can be expected to fulfill its calorie requirement. DCI method is used to calculate the incidence of absolute poverty where population or households fall below a threshold calorie intake (2122 kilocalories per person on a daily basis). Similarly, a person having daily calorie intake of less than 1805 kilocalories is considered to be in hard-core poverty. In Household Income Expenditure Survey (HIES) conducted in FY1995-96, the BBS for the first time adopted the Cost of Basic Needs (CBN) method for constructing poverty lines. Similarly, in the Household Income and Expenditure Surveys (HIES) of 2000 and 2005, CBN method was used. With this method, an absolute poverty line is defined as the value of consumption needed to satisfy minimum subsistence needs (food as well as non-food consumption) (Bangladesh Economic Review 2008)

Table 1: Alternative Methods for Measuring Absolute Income Poverty in Bangladesh

	Direct Calorie Intake	Food Energy Intake	Cost of Basic Needs
Indicator	Calorie intake	Expenditure (or income)	Expenditure (or income)
Threshold	2,122 kilocalories/person day	Expenditure level at which household members are expected to reach calorie intake threshold	Expenditure level at which household members are expected to meet basic needs (food and non-food)
Measure	Head-count or other	Head-count or other	Head-count or other
Strengths and weaknesses	Indicator not representative; threshold consistent (for monitoring calorie intake)	Indicator representative; threshold not consistent (for real expenditures)	Indicator representative; threshold consistent (for real expenditures)

Source: World Bank 2002, A Source Book for Poverty Reduction Strategies (Vol. 1) cited from Bangladesh Economic Review 2008

Trends of Poverty

Poverty is divided into two categories, such as (1) income poverty and (2) human poverty. The report of HIES-2005 reveals that at the national level, incidence of poverty registered a declining trend in 2005 as compared to 1991-92 based on CBN method. The incidence of poverty at the national level declined from 58.8 percent in 1991-92 to 40.0 percent in 2005 based on the upper poverty line (Table 2). During this period, the compound poverty reduction rate per year is recorded at 1.8%. But the rate of reduction in urban area (yearly compound rate 2.2 percent) is faster than that of the rural area. On the other hand, during 2000 to 2005, income poverty also reduced from 48.9 percent to 40.0 percent and the compound reduction rate is 3.9 percent. This time also reduction rate is faster in the urban area (yearly 4.2 percent) than that of the rural area (3.5 percent). Between 2000 and 2005, the depth (measured by poverty gap) and severity (measured by squared poverty gap) of poverty

declined simultaneously both in urban and rural areas. It is notable that between FY92 to FY01, reduction rate of poverty was faster in the rural area than that of the urban area (Bangladesh Economic Review, 2008).

Table 2: Trends of Poverty based on CBN Method

	2005 (%)	2000 (%)	Annual Change (%) (2000-2005)	1991-92 (%)	Annual Change (%) (1991/92-2005)
Head Count Index					
National	40.4	48.9	-3.9	58.8	-1.8
Urban	28.4	35.2	-4.2	44.9	-2.2
Rural	43.8	52.3	-3.5	61.2	-1.6
Poverty Gap					
National	9.0	12.8	-6.80	17.2	-2.9
Urban	6.5	9.1	-6.51	12.0	-2.5
Rural	9.8	13.7	-6.48	18.1	-2.8
Squared Poverty Gap					
National	2.9	4.6	-8.81	6.8	-3.8
Urban	2.1	3.3	-8.64	4.4	-2.7
Rural	3.1	4.9	-8.75	7.2	-3.8

Source: BBS, HIES-2005 cited from Bangladesh Economic Review 2008

The Major Environmental Problems in Bangladesh

Bangladesh suffers from a range of environmental problems, arising from drought, flood and other natural hazards because of its geographical location. Frequencies of hazards are on the increase day by day. The quality of soil has deteriorated due to needless use of agrochemicals, unplanned land use, undesirable encroachment on forest areas for agriculture and settlements and indiscriminate disposal of hazardous industrial wastes. Unplanned land use and intrusion of saline water are causing degradation of soil in the coastal area. The surface water of the country is polluted through capricious disposal of untreated industrial effluents and municipal waste water, runoff pollution from chemical fertilizers and pesticides and oil and lubes spillage in the coastal area from the operation of sea and river ports and ship wreckage. The arsenic concentration in the ground water in many areas is a major problem in Bangladesh now. The problem is acute in the Southeast, South Central (the northern part

only), and Southwest regions where shallow tube wells are used for extracting groundwater from 10 m to 100 m depth. This creates problems in getting safe drinking water. Bangladesh has 57 trans-boundary rivers, of which 54 are shared with India and 3 with Myanmar. A significant quantity of water flow is withdrawn and diverted upstream by neighboring countries for irrigation and other purposes and thereby reducing normal flow of water. The Farakka Barrage on the river Ganges is a notable example. Desertification prevails in some Northwestern areas of Bangladesh due to withdrawal and diversion of upstream water in the dry season by India. Besides, the proposed inter-basin river link project of India, if implemented, the annual water flow of Bangladesh will drastically decrease which will have profound negative impact on economy, society and environment of Bangladesh. Air pollution is one of the man-made environmental disasters that are taking place all over the world. There are two major sources of air pollution in Bangladesh, namely vehicular emissions and industrial emissions, which are mainly concentrated in the cities. There are also numerous brick-making kilns working in dry season all over Bangladesh, which is another source of air pollution. Almost all of these kilns use coal and wood as their source of energy, resulting in the emissions of sulfur-di-oxide and volatile organic compounds. An emerging issue of great concern in the cities and towns is the high concentration of lead in the air from vehicular exhausts. The depletion of biodiversity is the result of various kinds of human interventions that impinge on it through destruction and degradation of land, forest and aquatic habitats. These activities encompass the sectors of agriculture, forestry, fisheries, urbanization, industry, transport, tourism, energy, chemicals and minerals etc. In the fisheries sector, shrimp cultivation has become a major concern during the past decade. It has caused serious environmental damage that has harmed fish and other aquatic biodiversity significantly (Bangladesh Economic Review 2008).

Methodology to calculate environmental degradation

Using the calorie intake method, we define poor whose per capita intake is below 1822 calories per day. To measure environmental degradation, we consider two factors: (i) percentage of area under forest and (ii) average annual rainfall. It is assumed that the higher the rainfall and higher the forest cover, the lower the environmental vulnerability. Data on poverty and environmental indicators for the period 1981 and 2000 are explored from different Statistical Yearbook of Bangladesh Bureau of Statistics (BBS) to construct the corresponding indices.

To make a meaningful comparison of different former districts of Bangladesh in terms of indicators of poverty, forest cover and rainfall, the following formula are used to measure the degradation index of the indicator variables:

$$(PINDEX)_{ij} = \{Max\ (X_{ij}) - X_{ij}\} / \{Max\ (X_{ij}) - \{Min\ (X_{ij})\}$$

$$(FINDEX)_{ij} = 1 - \{Max\ (X_{ij}) - X_{ij}\} / \{Max\ (X_{ij}) - \{Min\ (X_{ij})\}$$

$$(RINDEX)_{ij} = 1 - \{Max\ (X_{ij}) - X_{ij}\} / \{Max\ (X_{ij}) - \{Min\ (X_{ij})\}$$

Where, PINDEX, FINDEX and RINDEX represent poverty, forest cover and rainfall degradation indices of the i th variable and the j th district respectively. Then environmental degradation index {EINDEX=½(FINDEX+RINDEX)} is constructed by taking an arithmetic average of the individual index of forest cover and normal rainfall. Lastly an average composite index {PEINDEX=½(PINDEX+EINDEX)} is constructed using both poverty and environment indices for the purpose of comparison across districts and over time.

We use environmental degradation and different indices which is related to poverty and environment. Degradation usually means that carrying capacity is reduced by some natural or human phenomenon. PINDEX, an index for poverty is a relative term which measures

incidence of poverty among different former district. RINDEX, FINDEX stand for rainfall index and forest cover index respectively, these are also relative terms to measure incidence. We also include EINDEX and PEINDEX in our measurement. EINDEX stands for environmental index and PEINDEX stands for poverty and environmental index.

Findings

Bangladesh is one of the poorest countries in this world. From its independence Bangladesh is trying hard to alleviate poverty. Analysis of data on poverty in Bangladesh revealed that on an average 36.75 per cent of people were below poverty line in 1984 (Table-3). At that time poverty was severe and people often struggle for their basic needs. Due to various policy initiatives of the Government it was reduced to 28 per cent in 1992. In that time period new window opens in front of Bangladesh like export promotion thus boosting industrial growth. And in 2000 poverty rate further fall to 20 percent. During that period Bangladesh has shown nice progress in poverty alleviation. Different NGO's expand micro credit program in rural area which helps poor people to be productive. Forest cover Data revealed that it witnessed a marginal decrease in the period from 1984 to 1992 (Table-3).

Table-3: Poverty and Environmental indicators of Bangladesh

Year/Subject	1984	1986	1989	1992	1996	2000
Poor People (%)	36.75	26.86	28.36	28	25.1	20
Forest Cover (%)	14.19	14.28	12.27	12.75	14.5	16.64
Rainfall(mm)	2690.55	2627.11	2234.86	1937.27	2414.41	2478.91

Source: Calculated By Authors

The main causes of deforestation were need of fire woods and rapid population increase. In 1983 the highest forest cover was in Khulna and the lowest cover was in Comilla. It was 1421 thousand acre in Khulna and 3 thousand acre in Comilla. And total forest cover of Bangladesh in 1983 was 5298 acres where in 2003 its stand 6418 thousand acres. At this period Government take several measures to increase forest cover. Especially community

forestation played a vital role for forestation. For saving sea coast from cyclone Government as well as different NGO's initiate forestation programs in coastal districts. So why forest cover in coastal district Chittagong, Khulna, Patuakhali and Barisal increase over the period 1984 to 2000. Average annual rainfall was maximum (4241mm) in Sylhet and minimum (1752mm) in Jessore in the year 1981. The situations changed a little after 20 years. In 2001 highest rainfall was in Sylhet where minimum rainfall was in Rajshahi. However, many of former districts like Chittagong, Comilla, Dhaka, Khulna, Patuakhali, Rajshahi and Faridpur experienced less rainfall year after year. Some of the Districts which experienced moderate increase in rainfall were Chittagong HT, Bogra, Dinajpur, and Ranjpur. Poverty and environmental vulnerability indices were measured in 0-1 scale and presented in table 4.

Table-4: Indices of poverty and environmental degradation

Former District	Reference Year									
	1981					2001				
	PINDEX	FINDEX	RINDEX	EINDEX	PEINDEX	PINDEX	FINDEX	RINDEX	EINDEX	PEINDEX
Bandarban	1	0.739	0.498	.619	0.809	0.99	0.56	1	0.78	0.885
Chittagong	0.414	0.373	0.337	.355	0.385	0.541	0.546	0.557	0.552	0.546
Chittagong HT	0.951	0.282	0.506	.394	0.673	1	0.388	0.625	0.507	0.753
Comilla	0.195	0	0.222	.111	0.153	0.435	0	0.246	0.123	0.279
Noakhali	0.563	0.037	0.69	.364	0.463	0.715	0.317	0.518	0.418	0.566
Sylhet	0.342	0.116	1	.558	0.45	0.55	0.138	0.897	0.518	0.534
Dhaka	0	0.04	0.168	.104	0.052	0	0.044	0.202	0.123	0.062
Faridpur	0.449		0.023	.012	0.23	0.664		0.106	0.053	0.359
Jamalpur	0.715	0.02	.095	.058	0.386	0.845	0.02	0.202	0.111	0.478
Mymensingh	0.233	0.018	0.095	.057	0.145	0.465	0.025	0.216	0.121	0.293
Tangail	0.727	0.075	.164	.12	0.423	0.846	0.085	0.216	0.151	0.498
Barisal	0.461	0.023	0.229	.126	0.294	0.663	0.256	0.202	0.229	0.446
Jessore	0.538		0	0	0.269	0.704		.268	0.134	0.419
Khulna	0.501	1	0.092	.546	0.524	0.683	1	0.173	0.587	0.635
Kushtia	0.746		0.09	.045	0.396	0.861		0.268	0.134	0.498
Patuakhali	0.799	0.028	0.501	.265	0.532	0.921	0.195	0.373	0.284	0.603
Bogra	0.693		0.002	.001	0.347	0.808	0.055	0.2	0.128	0.468
Dinajpur	0.637	0.016	0.084	.05	0.344	0.77	0.016	0.318	0.167	0.469
Pabna	0.61		0.201	.101	0.355	0.753		0	0	0.377
Rajshahi	0.388	0.002	0.154	.078	0.233	0.563	0.067	0.12	0.094	0.328
Rangpur	0.24	0.002	0.279	.141	0.190	0.458	0.004	0.434	0.219	0.339
Bangladesh	0.5334	0.1732	.7458	.4595	0.496	0.662	0.213	0.651	0.432	0.547

Source: Calculated By Authors

Higher the values of poverty index the lower the poverty level; and also higher the values of forest cover and rainfall indices lower the forest cover and rainfall and thus higher the vulnerability of environment on account of these indicators. Analysis of these indices revealed that there was former District-wise variation of the incidence of poverty, forest area and rainfall (Table-5). These individual indices also changed by their magnitude over time from 1981 to 2001. Particularly incidence of poverty index changed to a large extent in comparison to other two indices. But one of the striking features about these indices was that there was mixed findings of various indicators in different Districts. Some districts like Chittagong, Comilla, Dhaka, Mymesingh and Rangpur has high poverty indices with low forest cover and rainfall indices.

Table-5: Index wise groupings of districts

INDEX	MAGNITUDE	FORMER DISTRICTS
POVERTY	LOW (PINDEX≥0.7)	Bandarban, Chittagong hilltracts, Jamalpur , Tangail, Kushtia, Patuakhali, Bogra, Dinajpur
	MODERATE (0.5≤PINDEX<0.7)	Noaakhali, Faridpur, Rajshahi, Pabna, Barisal, Khulna, Sylhet
	HIGH (PINDEX<O.5)	Chittagong, Comilla, Dhaka, Mymesingh, Rangpur
FOREST COVER	HIGH (FINDEX≥O.7)	Khulna, Bandarban
	MODERATE (0.5≤ FINDEX <0.7)	
	LOW (FINDEX <0.5)	Chittagong hilltracts, Jamalpur , Tangail, Kushtia, Patuakhali, Bogra, Dinajpur, Chittagong, Comilla, Dhaka, Mymesingh, Rangpur, Noaakhali, Faridpur, Rajshahi, Pabna, Barisal, Sylhet
RAINFALL	HIGH (RINDEX≥O.7)	Bandarban, Chittagong hilltracts, Sylhet
	MODERATE (0.5≤ RINDEX <0.7)	Chittagong, Noakhali
	LOW (RINDEX <0.5)	Jamalpur , Tangail, Kushtia, Patuakhali, Bogra, Dinajpur, Comilla, Dhaka, Mymesingh, Rangpur, Faridpur, Rajshahi, Pabna, Barisal, Jessore, Khulna

One important reason could be that we depended on cross section data from secondary sources across the Former District which was not always natural geographical regions. Another reason lied in the fact of externality or spillover effect of improvement or deterioration of environment of one District on another. Again Bangladesh is a small country thus environmental quality more or less equal all over the country. In case of Bangladesh as a whole from Table-6 we see both PEINDEX and EINDEX rises over time on an average.

Table-6: Indices of Bangladesh

Year	PINDEX	RINDEX	FINDEX	EINDEX	PEINDEX
1981	.5334	.2542	.1197	.1869	.3602
1982	.5957	.3047	.1225	.2136	.4047
1983	.5959	.3184	.1257	.221	.4089
1984	.596	.3235	.1731	.2483	.4221
1985	.5959	.3428	.1869	.2648	.4303
1986	.5962	.3628	.1789	.2708	.4335
1987	.5957	.4242	.1622	.2932	.4445
1988	.5959	.3376	.1593	.2485	.4222
1989	.5958	.2243	.1575	.1909	.3934
1990	.5960	.3491	.1483	.2487	.4224
1991	.6498	.3666	.1443	.2555	.453
1992	.6535	.3908	.1425	.2667	.4601
1993	.6441	.4164	.1426	.2795	.4618
1994	.6461	.3051	.1585	.2318	.4389
1995	.6426	.4215	.1496	.2855	.4641
1996	.6422	.3611	.164	.2625	.4524
1997	.6428	.3909	.172	.2815	.4622
1998	.6436	.3965	.1995	.298	.4708
1999	.6623	.2901	.2132	.2516	.4569
2000	.6622	.2461	.1268	.2315	.4468

Source: Calculated By Authors

It indicates that poverty condition and environment quality improves simultaneously. Composite index of poverty and environmental degradation revealed that the District which was hardest hit in 1981(PEINDEX > 0.7) was Bandarban. The least affected District

(PEINDEX < 0.5) were Chittagong, Comilla, Noakhali, Sylhet, Dhaka, Faridpur, Jamalpur Mymensingh, Tangail, Barisal, Jessore, Kustia, Bogra, Dinajpur, Pabna . The rest of the districts were moderately hit (0.5 ≤PEINDEX< 0.7). After a period of 20 years the situations, of course, changed in many respects. The District such as Bandarban which was in the worst affected category District in 1981 further deteriorated in 2001. All other least affected District during 1981 also deteriorated in 2001. From Table 7 we see that both the GDP growth and income inequality rises over the period of 1981 to 2001. At the same time the value of environmental index also rises to some extent. It means that the overall environmental condition improved over that time. Though the income inequality rises by 0 .66% over this 20 years, the economic development also occurred significantly (at an average growth rate of 4.31%) thus the overall environment condition improved especially in the last decade of the last century, forest cover rises by 20% (in 2001 comes at 6366 thousand acres from 5298 acres in 1981) and rain fall also rises slightly thus economic improvement may impact positively on environmental situation.

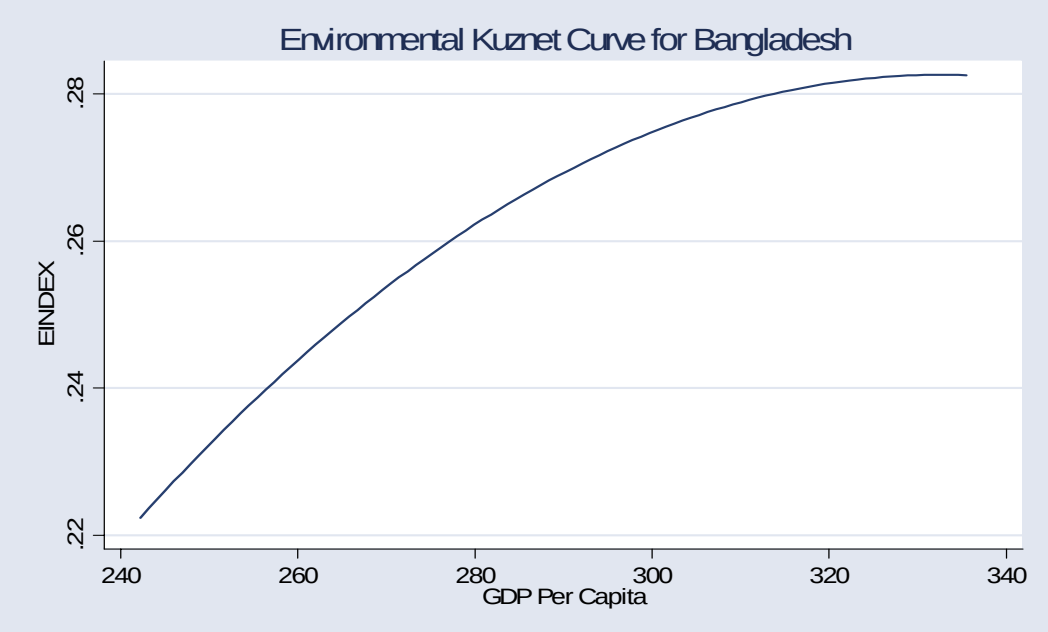
Environmental degradation occurs for various reasons. Such as higher deforestation results lower annual average rainfall and it creates higher temperature which is due to the climate change. This results sea level raises and it creates overall environmental degradation.

Table: 7: Environmental index, income inequality, GDP growth of Bangladesh

Year	EINDEX	INCOME INEQUALITY	GDP GROWTH (%)
1981	.1869	34.90	3.8
1982	.2136	34.94	2.4
1983	.221	34.97	4.0
1984	.2483	35.01	5.2
1985	.2648	35.04	3.2
1986	.2708	35.07	4.2
1987	.2932	35.11	3.7
1988	.2485	35.15	2.2
1989	.1909	35.18	2.6
1990	.2487	35.22	5.9
1991	.2555	35.25	3.3
1992	.2667	35.29	5.0
1993	.2795	35.32	4.6
1994	.2318	35.35	4.1
1995	.2855	35.39	4.9
1996	.2625	35.42	4.6
1997	.2815	35.46	5.4
1998	.298	35.49	5.2
1999	.2516	35.53	4.9
2000	.2315	35.56	5.9
2001	.2678	35.60	5.3

Source: Calculated By Authors Ave. 4.31

On the other hand, the urbanization results the rise in per capita income through industrialization which creates finally the substantial income inequality in the rural and urban areas. Modernization increases the growth rate of an economy but at the cost of environmental degradation. It is generally conjectured that higher environmental degradation will inevitably increases income inequality. Our findings also support the above proposition.



Conclusion

Bangladesh as a whole witnessed a significant progress in poverty alleviation. However, the progress made was uneven across the Districts. Poverty indices have decreased all over the country except Dhaka and Bandarban. But forest cover and rainfall indices give us a mixed picture. Forest cover indices rise in Chittagong, Barisal, Sylhet, Tangail and Patuakhali. But indices fall in Bandarban and Bogra. Rain fall indices rise in Bandarban, Chittagong, Comilla, Dhaka, Faridpur but fall in Noakhali, Sylhet, and Barisal. We have found a definite relationship between the poverty and environment. In our research, we have seen that when poverty decreases, the environmental degradation also decreases. So we should emphasis on the poverty alleviation in Bangladesh.

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