Ecology, Inequality, and Poverty: The Case of Bangladesh

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Abstract. *This paper explores the connections between environmental damages, inequality, and poverty for Bangladesh. Starting with a new concept of national income and its distribution, which takes ecological damages into account, standard measures of poverty and inequality are modified by using the adjusted income distribution for their measurement. Under fairly conservative assumptions of modest environmental damages and a uniform distribution of the damages among the population, it is shown that both inequality and poverty worsen when environmental deterioration is taken into account. From a policy perspective, since there is no inevitable environmental Kuznets curve, developing countries like Bangladesh can enhance the poverty alleviation effects of growth by improving environmental quality through effective interventions.*

Introduction

More than three quarters of a century ago, the famous Bengali poet Rabindranath Tagore brooded over the modern industrial civilization on his way to Japan. Depressed by the ugly sights of the Rangoon harbor and Penang, he wrote, "As our ship slowly sailed up to port, and the ambitious projects of man began to loom larger than nature, and the factory chimneys kept drawing their straight lines across nature's curves–then I could see what an amount of ugliness had been created in the world through man's passions ... the trade monster ... wearies the world with its weight, deafens the world with its noise, soils the world with its refuse ...".[1]

[1]Rabindranath Tagore, *Japan Jatri*, pp. 4, 24, 32, 61 translated in *Viswa Bharati Quarterly*, new series, 4.2:96, 104 and 4.3:187, 190, 193.

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Tagore was not an economist. However, his reaction to the negative externalities generated by haphazard industrialization would be understood by many serious economists today. Even as economic growth is recognized as necessary, the ecological consequences of unrestrained growth have come to be viewed as important issues that economic analysis should also address.

This paper focuses on some specific consequences of ecological damage. The possible connections between ecological damage, income distribution, and poverty are explored. Adjusting the existing income distribution by taking into account the ecological consequences will result in a different, typically unobserved income distribution. What are the consequences for the measurement of inequality and poverty, once we are able to construct this new income distribution? After offering some theoretical answers to this question, the paper applies the approaches developed to the case of Bangladesh. Despite limitations of data, some reasonable simulations can be carried out showing the possible implications of existing and ongoing ecological damages for poverty and inequality in Bangladesh.

The simulation results actually carry a significant policy message. Since the well-being of the people is seen to depend on both economic growth and quality of the environment, addressing ecological issues in a timely fashion can lead to improvements in economic well-being. In the case of a poor country such as Bangladesh, improvement of environmental quality will, together with sustainable economic growth, lead to a more rapid diminution of poverty as measured here. At the same time, relative inequalities along some important dimensions will decrease. In general, a combination of policies of pro-poor, pro-environment, and pro-sustainable growth leads to greater well-being for all, and in particular, the poor.

The main body of this paper is divided in three parts. In the next two sections the theoretical links between ecology, inequality, and poverty are pointed out. The third section starts with a quick summary of the present state of ecological destruction in Bangladesh. The main contribution of this section is to explore the possible consequences of the environmental damages for inequality and poverty measurement in Bangladesh via two sets of simulations based upon reasonable assumptions of environmental damage in Bangladesh.

The Link between Ecological Damage and Inequality [2]

As is well known, comparisons of inequalities in income distributions can be either ordinal or cardinal. In this paper an axiomatic approach to cardinal compari-

[2] The work in this area is of recent origin. Khan and Parvin (1984, 1990) proposed the incorporation of environmental factors in an axiomatic treatment of inequality and poverty comparisons. More recently Khan and Sonko (1994, 1997) have applied this framework to study the ecological and distributional aspects of structural adjustment programs in Africa.

sons in terms of Gini indexes is used. This is to facilitate comparisons with existing calculations of the Gini index in the simulations that follow. It is also assumed for the sake of simplicity that monetary equivalents of damage are either available or can be computed from the available data.[3]

The starting point for inequality comparisons is the vector of incomes of the individuals (or households) in a particular society ordered from the lowest to the highest. The normative axiom on transfers between individuals (or households) in the income distribution profile is crucial for comparisons of two income distribution profiles. This is sometimes referred to as the Pigou-Dalton transfer axiom. According to this axiom, any transfer from a richer to a poorer individual that preserves the relative ranks of the two individuals decreases inequality. Conversely, a regressive transfer (i.e., from a poorer to a richer person without changing anyone's ranking in the income distribution profile) likewise will increase inequality. This statement applies to both ordinal comparisons using Lorenz curves and cardinal comparisons using indexes with numerical values. Clearly, cardinal indexes such as the Gini index can unambiguously rank income distribution profiles even when their respective Lorenz curves cross.

Suppose now we start with a given income distribution vector y for a particular society. There will be a certain cardinal index of inequality, say a particular value of the Gini index, associated with this income distribution y.

We now simplify by assuming that all environmental damages can be given a monetary expression. Of course, this damage may or may not be evenly distributed among the population. We have to therefore arrive at an observed distribution of the damage. But this is not available for most developing countries. However, we can still make some progress in examining the links between ecological damage and inequality by making plausible assumptions regarding their distribution. Even these results, as subsequent exercises will try to demonstrate, can be quite revealing for both environmental and poverty alleviation policies.

In any case, given an environmental damage estimate x monetary units per person, and its distribution over the population α we can derive a new or adjusted distribution z by subtracting the monetary equivalent of the damage from observed incomes. More explicitly, this can be done in the following way. Suppose there are n individuals in the economy, with the actual income of the ith individual given by y_i (i = 1, 2, …$_n$). After the environmental damage (which we may recall is assumed to be uniform across individuals) has taken place, real income, i.e., income adjusted for environmental damages of the same individual i is: $z_i = y_i - x$. We now compute

[3]It is possible to construct some types of cardinal indexes by specific aggregation schemes when all the components of environmental damage are not convertible to money. Massoumi (1986) constructs such an index without identifying environmental components. Khan (1992b) identifies such components explicitly. Intuitively, this involves weighting different components of welfare, including money income, environmental bads, and public goods and adding up the weighted components. There are significant technical problems that are not relevant to discuss here. The interested reader is referred to the two sources cited here.

Gini indexes for $y = (y_1, y_2 \ldots, y_n)$ and $z = (z_1, z_2 \ldots z_n)$ and compare $G(y)$ and $G(z)$, where $G(y)$ is the Gini index for observed income distribution and $G(z)$ is the "real", (i.e., post-environmental cost accounting) Gini index for income inequality. Likewise, poverty indexes, for example, the familiar head count ratios, can be computed for both the observed income distribution y and the adjusted income distribution y. Comparison of the headcount ratios in these two cases will tell us how accounting for environmental damages in this manner will affect poverty measurements.[4] This is the essence of the inequality and poverty comparison methodology followed in this paper. A step-by-step description of the derivation of the inequality and poverty measures using the data from Bangladesh is given in the appendix. In the process of deriving the inequality and poverty index values for various years after environmental damages have been taken into account, a special assumption is used. It is assumed that the damages affect rich and poor alike. Therefore everyone loses an amount which is equal to the average, i.e., per capita damage is assumed to be identical. This assumption, which is explained and justified later in the paper, is called the "equality of misfortune assumption."

Some Welfare Theoretical Issues

At this point some further analytical issues arise regarding the welfare economics of comparing inequalities when environmental damages not only reduce (true) income, but also contribute to growth. We must note that the relevant dynamic welfare comparisons are of two sorts. One is between the national welfare before the spurt of industrialization and modernization of agriculture (which increase both national incomes and the extent of ecological damage) and after. A second type of dynamic comparison is between the successive states of a growing economy after it has begun industrialization and modernization. In both cases (but especially in the former), growth by itself enhances welfare. What is being claimed here is that the actual (environmentally adjusted) level of national income will be lower and hence the welfare effect of growth will be less than what is appears to be, if we follow the approach suggested. Furthermore, distributional effects of growth will also need to be taken into account in comparing the relevant welfare levels. More specifically, if, as we have just seen, both income inequality and poverty are affected by ecological damage, then we must also take these effects into account in judging the welfare effects of growth. On both counts, ecological damages are likely to reduce the overall welfare-enhancing effects of growth.

At the outset, let us distinguish between the accounting and economic aspects of the problem. As the recent literature on environmental accounting makes clear,

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[4]In the next section, the methodology for poverty index comparisons (in the context of the FGT index of poverty) is discussed. The general approach presented in this paper should be applicable to any poverty index.

subtracting environmental damages from total observed income is defensible on accounting grounds. However, this does not answer directly the question of how to evaluate (in utility terms or otherwise) the net social gain or loss from both growth and environmental costs of growth. The problem arises because in the context of the present paper (and for the inequality comparison literature in general) the relevant social welfare function (SWF) values both equality and increases in aggregate income. Without specifying a particular SWF we cannot be sure a priori whether welfare is higher or lower with or without environmental costs. However, if we choose a certain type of SWF (which has the property of weighting relatively more egalitarian distributions more positively) then under our assumptions the following two statements are true:[5]

(i) The aggregate income after environmental damages are accounted for must decrease.

(ii) Any cardinal inequality index will show more inequality than it did when environmental costs had not been subtracted from people's incomes.

Therefore, on both counts, for any growth rate of income, the post-environmental damage level of welfare will be lower than the pre-environmental damage welfare level. It is, however, fairly certain that compared to the pre-industrial level of welfare, the growing economy will exhibit a greater level of economic welfare. Unless the pristine state of nature before growth is valued so highly (perhaps because the welfare economist in question is a luddite) that no amount of growth can compensate for the loss of environmental assets, this judgment will stand. The real problem is achieving an environmentally sustainable rate of growth, which also preserves a modicum of distributional equity according to the society's perception of justice as fairness (Rawls 1970)[6] and thus optimally enhances welfare. Therefore, the discussion above should not be construed as antigrowth, but rather as a nuanced approach to the problem of sustainable growth with equity.

The Role of Equality of Misfortune Assumption

It is necessary to pinpoint the role of the equality of misfortune assumption (EMA) in the following analysis. There are two aspects of EMA—formal and substantive. Formally, EMA is in the nature of an a fortiori argument. In other words it is a weaker assumption than, for example, one that distributes costs of pollution

[5]Technically, this class of welfare functions is known as Schur-concave welfare functions.

[6]Rawlsian maximin principle is not the only principle of justice that can apply. Sen (1992) offers justice as "capability equalization" as an alternative. For further discussion and an extension of the capabilities approach see Khan (1998).

more to the lower end of income distribution profiles. Given the previously mentioned Pigou-Dalton condition, it then follows that under EMA, the resulting inequality, other things being equal, will be higher than that reflected by the original (i.e., observed) distribution.

More substantively, EMA reflects our ignorance about the actual distribution of environmental bads in Bangladesh. Volume II of the National Environment Management Action Plan (NEMAP) for Bangladesh (1995, 16-29) acknowledges the problems of measurement and information and proper policy formulation in this regard. However, the overall picture is one of rapid environmental deterioration from which the poor may suffer the most:

> It is estimated that over 40 percent of the population regularly consume less than the absolute critical minimum of 1800 calories per day. These 50 million people are amongst the world's poorest by any standard of development. Furthermore, others have estimated that the numbers of absolute poor have risen significantly. The poverty of these deprived people is deep rooted, pervasive and multi-faceted, relating not just to the absence of reliable incomes and productive assets, but also to food, safe water, sanitation, education, shelter, inequalities, injustice and lack of power. These most deprived persons of the world are also extremely vulnerable to disaster and disease. The challenges posed by this mass of poverty are enormous for a country which is now populated in total by over 120 million, on a land base which is already the most densely populated in the world at over 800 persons per sq. km., with accelerating environmental degradation (p. 18).

Thus EMA is a much more conservative assumption regarding the distribution of environmental bads than the actual situation—in all probability. The actual states of postecological accounting inequality and poverty are in all likelihood even worse than what is presented in this paper. Since no estimates are presently available of either the distribution of environmental bads or of post-ecological accounting inequality and poverty, the results reported in this paper may be seen as the best conservative estimates that policy makers may be able to use.

Ecological Damage and Poverty

By not considering the role played by ecological damage in effectively reducing people's incomes the extent of poverty may be underestimated. I consider here the question of how one particular index of poverty, the Foster, Greer, and Thorbecke

(FGT) index may be affected, so that comparisons with the earlier estimates for Bangladesh (for example, Ahmed et al. 1991; Khan 1992a, 1994) are possible.

Since Sen's (1976) axiomatic treatment of poverty comparisons, several new indexes of poverty have emerged. Among them, the one developed by Foster, Greer, and Thorbecke satisfies both desirable theoretical conditions and is also additively decomposable. Thus this index can take into account the intensity of poverty for different groups of poor people. This is done by looking at the deprivation of calories. The poverty measure is given by:

$$p = \frac{1}{n} \sum_{j=1}^{q} (G_j / z)^{a}$$

where n = total population
q = number of poor
z = poverty line
G_j = food expenditure shortfall of the jth individual

In the simulation, a value of $a = 2$ is used. At a lower value of a some of the axioms are violated. At a higher value of a the shortfalls of the poorer segments are weighted more heavily. Therefore the intensity of deprivation by the poorer segments (in particular the poorest) will be magnified for values of a greater than z. For this value of a both the monotonicity and transfer axioms of Sen are satisfied. We may recall that both these axioms have to do with the sensitivity of the index to the incomes of the poor as opposed to simply the number of poor. Thus, the monotonicity axiom states that, ceteris paribus, a decrease in the income of a poor person should increase the poverty index. The transfer axiom states that, ceteris paribus, a transfer of income from a lower-income poor person to a higher-income poor person increases the poverty index. It can be checked easily that this is true for the FGT index when $a = 2$.

Intuitively, this index measures the severity of poverty in terms of shortfall of food expenditures. Therefore, the lower the value of the index, the more the shortfall, therefore the more intensive the poverty. A higher value (always less than 1) will indicate comparatively less severe poverty. A value close to zero will indicate extremely severe poverty. We note also that the households with the higher shortfalls are weighted more heavily regardless of the value of the index. Hence, the index is quite sensitive to what happens to these households.

It should be emphasized that ecological damage does not affect the food poverty line (i.e., cost of minimum calories that are required). However, ecological damage does result in a reduction in income if proper accounting for such damage is done.[7] An intuitive way of justifying this is to think of such damages as increasing certain defensive expenditures for the family, for example, increased health care expenditures due to pollution-induced illnesses. This will force the individual to operate at a lower level of welfare than in a world without ecological damages offering the same money income. With this justification in mind some simple experiments assuming various degrees of damage and the EMA can be carried out. In all cases, we compare before and after damage poverty.[8]

Economic Growth and Ecological Damage in Bangladesh: Impact on Inequality and Poverty

After an initial decade of relative stagnation and after the country's independence in 1971, the growth rate picked up in the 1980s and 1990s. The average GDP growth for the 1980s was 4.3 percent per annum. In 1990 the growth rate accelerated to 6.6, but could not be sustained. But from 1992 onward, growth has been over 4 percent, and in 1996 and 1997 exceeded 5 percent, reaching the highest level of 5.7 percent in 1997 (Asian Development Bank 1997, 1998). At the same time, inspite of success in population planning, population growth is still close to two percent per year. Hence, the per capita growth rate is somewhat less impressive. As the following sections show, this growth record has certainly led to some poverty alleviation, but the extent is not very large. Inequalities have remained fairly the same, increasing somewhat in the 1990s. There is, however, no reason to believe that there is an inevitable Kuznets curve in Bangladesh. As discussed later, there need not be an environmental Kuznets curve that is unavoidable as well.

At the same time, it is also true that this growth process necessary for poverty alleviation does have an environmental cost that is usually not taken into account. As the Bangladesh Bureau of Statistics (1998, 3) points out:

> However, on the input side of the economy, both the non-renewable and renewable resources are being used up in an unplanned way that cannot be sustained in the long run. On the output side, ambient environmental qualities are being deteriorated continuously, ill effects of which are felt on the biotic system in particular and on the entire ecosystem in general. Thus the growth process is physically constrained by the stock and flow of natural and environmental resources.

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[7] See for example, the volume on ecological economics edited by Costanza (1991). In particular, Salah El-Serafy in his essay "The Environment As Capital" in this volume argues that capital depreciation can be linked to a diminution of actual present and potential future incomes.

[8] We should keep in mind the distinction made previously between static and growing economies. The relevant comparisons are between poverty with and without environmentally adjusted growth.

Recent attempts to classify the various types of environmental damages have led to the identification of six areas. These are: flora, fauna, atmosphere, water, land/soil, and human settlements. Unfortunately, systematic environmental accounting is only at a conceptual stage right now. One purpose of this paper is to show the importance of such accounting by presenting some simulation results. This is all one can do in the present context, but in the future, when systematically collected data become available, the methodology of this paper can be used to gauge the exact effects of environmental damages on inequality and poverty. Part of the message of this paper, therefore, is to underline the need for detailed environmental accounting in Bangladesh, among other things.

In what follows simulations are carried out under fairly conservative assumptions of income loss from environmental damage. The distribution of damages, as mentioned before, is assumed to be the same for each individual.

Given the limitations of data it is possible only to offer some range of estimates of ecologically adjusted inequality (EAI) and ecologically adjusted poverty (EAP) measures for Bangladesh. The main assumption made in the analysis that follows is quite conservative, as was pointed out in the first section.

Any loss of income is assumed to be uniformly distributed among the whole population, the "equality of misfortune" assumption. It may be surprising that by this assumption the poor suffer in absolute terms as much as the rich. But that is precisely the role the assumption is meant to play. In reality it is quite likely that the poor suffer more than the rich in absolute terms as well. A consideration of the location of poor people's houses, their work environment, and the daily hazards of inhaling polluted air or drinking contaminated water will be enough to make a stronger assumption (one that makes the poor suffer more absolutely) justifiable. True, under the equality of misfortune assumption, rich and poor seem to suffer alike absolutely. However, in terms of the standard axioms of inequality comparisons, it can be shown that even under the mild assumption of "equality of misfortune" inequality will increase. This is because the lower income groups lose proportionately more than the upper income groups.[9] If for some groups the loss is more than the difference between their incomes and the poverty line, poverty as measured by the head count will increase. Since the poor experience an increase in their shortfalls, poverty as measured by the income gap ratio will also show an increase.[10] It is likely that the FGT measure will also record more (food) poverty. In what follows the consequences of equality of misfortune are explored in terms of the Gini index of inequality and the FGT index of poverty. For inequality comparisons this is done for three different income loss assumptions. First, a loss of mere 0.5% is assumed. Next, the loss is

[9]Although the proposition is intuitively almost self-evident, the application of Pigou-Dalton transfer axiom requires a few extra steps. For a proof see Khan and Sonko (1994, 195).

[10]For a proof of these as well as the condition under which the Sen Index will register more poverty, see Khan and Sonko (1994, 197-9).

increased first to 1% and then to 2%. Tables 1 and 2 describe the ordinary inequality index and EAI respectively. Tables 3 and 4 give the results for ordinary FGT index and the EAP and FGT index respectively.

Table 1: **Inequality in Bangladesh**

Year	**Gini Index of Inequality**
1973/74	0.36
1981/82	0.39
1983/84	0.35
1988/89	0.38
1991/92	0.37
1995/96	0.43

Sources: Hossain and Khan (1989) and author's computations from BBS data (Household Expenditure Survey 1995/1996, 32).

As expected, the EAI in each case are indicative of greater inequality. Moreover, the increase in inequality is directly related to the increase in the size of ecological income loss. Given the nature of this particular index this is not surprising. In terms of welfare loss any welfare function consistent with the condition Pigou-Dalton transfer axiom will rank the EAI states as welfare-lowering as compared with the ordinary values of inequality. Thus it is clear that ecological losses matter very much in terms of inequality and welfare. Does it also matter for poverty measurements? Our theoretical answer to this question was that it should matter in most cases. Let us turn now to the simulation results using the FGT index of poverty.

Table 2: **Loss of National Income and Resulting Inequality**

Year	0.5 Percent	1 Percent	2 Percent
1973/74	0.41	0.43	0.49
1981/82	0.42	0.46	0.51
1983/84	0.39	0.42	0.47
1988/89	0.40	0.44	0.49
1991/92	0.39	0.43	0.48
1995/96	0.46	0.48	0.53

Source: Author's calculations.

Table 3 shows the profile of poverty in Bangladesh before incomes are adjusted for ecological damage. Even so the situation looks quite grim for both FY82 and FY86, the two years for which this index was computed. Rural and urban poverty are both severe, but rural poverty is much more severe than urban poverty, especially in 1982. Table 4 shows the computation for 1 percent income loss.

Table 3: **A Profile of Poverty in Bangladesh during the 1980s**

Area	Poverty Line (Kcal/cap/month)	Poverty Severity (P)	Percent Contribution to Total Poverty[a]	Poor	
				Area	Percentage
			FY82		
Rural	61,472	0.0401	94.3	71.8	61.8
Urban	63,115	0.0150	5.7	65.3	9.1
Bangladesh		0.0366	100.0	–	70.9
			FY86		
Rural	61,472	0.0197	89.9	51.6	45.1
Urban	63,115	0.0153	10.1	66.8	8.4
Bangladesh	–	0.0191	100.0	–	53.5

[a]Calculated as: 100 (area population/total population) (area P)/total P.

Source: Ahmed, Khan, and Sampath (1991).

Table 4: **A Profile of EAP in Bangladesh during the 1980s**

Area	Poverty Line (Kcal/cap/month)	Poverty Severity (P)	Percent Contribution to Total Poverty
			FY82
Rural	61,472	0.0812	96.1
Urban	63,115	0.0325	3.9
Bangladesh	–	0.067	100.0
			FY86
Rural	61,472	0.0315	90.2
Urban	63,115	0.0191	9.8
Bangladesh	–	0.0231	100.0

Using the same poverty line in terms of the cost of calorie consumption, the income loss leads to a worsening of the poverty profile in both rural and urban areas. Even under the assumption of equality of misfortune, regardless of the socio-economic class and location (urban vs. rural), poverty worsens. Thus the conclusion that EAP indicates more poverty is warranted. Equally true is the conclusion that the severity of poverty as measured by this particular index also increases in the presence of ecological costs.[11] These conclusions are likely to hold for most other poverty indexes as well.

Poverty during the 1990s

How has the situation evolved up to now with respect to poverty? In order to answer this question it is necessary to look at recent data. For this purpose, the latest household expenditure survey available (for 1995/1996) can be used. Another earlier year in the decade for which data are available is 1991/1992. Results of the computations are summarized in Table 5:

[11] Although the results for poverty here are derived via the FGT index, the logic of the discussion suggests a broader "ecological" notion of poverty. Short of a complete conceptual overhaul in the direction of poverty as "capability failure", income shortfall may also be used. As Thorbecke and Jung (1996) and Khan (1998) have shown, the direction of movement in these two indexes is the same. Therefore, at least for a broader income shortfall index, the results here should hold qualitatively.

Table 5: **A Profile of EAP in Bangladesh in Recent Years**

Area	Poverty Line (Kcal/cap/month)	Poverty Severity (P)		Percent Contribution to Total Poverty	
		1991/92	1995/96	1991/92	1995/96
Rural	61,472	0.0652	0.0531	85.4	83.5
Urban	63,115	0.0415	0.0426	14.6	16.5
Bangladesh	–	0.0597	0.0481	100.0	100.00

By comparing Tables 4 and 5, it appears that the environmentally adjusted poverty index in the 1990s shows less poverty than in FY86; but it still shows more poverty than FY82. It is clear that during the 1990s, economic growth has led to some poverty alleviation. However, the deterioration of the environment in both urban and rural areas has attenuated the real impact of growth on poverty alleviation. Furthermore, in recent years, urban environmental problems have become progressively more severe. If, in accordance with this observation, allowance for greater loss of welfare in urban areas is made, the EAP will show greater poverty than is indicated in these tables.

Conclusions

It has long been conjectured that ecology and income distribution are connected. The foregoing theoretical observations and simulations show that these connections exist. Although it cannot be ruled out that theoretically, the possibility that there may be circumstances where upper income bracket members of the society may lose proportionately more than the poorer individuals, under typical conditions the actual effect is likely to be inegalitarian.

Using a fairly neutral and conservative assumption of uniform distribution of loss, it can be shown axiomatically that inequality increases when effective income is considered, leading to ecologically adjusted income distributions. The simulations presented here for Bangladesh demonstrate that both inequality and poverty measured by some popular indexes increase significantly under even this mild assumption and the assumption of moderate income loss.

Bangladesh is one of the poorest countries in the world. Poverty amelioration requires vigorous policy intervention according to many economists. Unfortunately the continuing ecological damage worsens the already serious condition of poverty. Thus ecosystem balance and maintenance is a sine qua non not just for sustainability but also for preventing the distributional and poverty problems from getting worse.

From the policy perspective, the results actually offer a useful policy complement to the usual poverty alleviation measures. To the extent that policies can be implemented to improve the environment, a corresponding reduction in poverty could be effected. What is necessary is to engage in improvement of the deteriorating environmental conditions and in defensive activities designed to prevent future environmental deterioration. Appropriate environmental policies of this type will benefit everyone, particularly the poor and the most vulnerable groups. It should be emphasized that there is no logically or empirically inevitable relationship between income growth and environmental deterioration. As a recent paper by Islam (1997) shows, there is no inevitable "environmental Kuznets curve" for Asia. Therefore, there is no good reason to believe that Bangladesh is doomed to have environmental decay as income grows to a sufficiently high level before a turning point is reached.[12] Much depends here on appropriate environmental policies. One way to estimate the "window of opportunity" in terms of available resource flow for sustaining policies of defensive environmental expenditures is to calculate the "environmentally adjusted surplus" for the country, as suggested by Khan and Lippit (1993). Recent formulation of such policies in the National Environmental Management Action Plan is a good step forward as is the crafting of an overall framework for national environmental accounting. These steps at the national level have raised the hope that realistic policies based on solid data will be able to reverse the trend of environmental damage in the foreseeable future. With such environmental policies in place, further economic growth and complementary public action to help the poor (DeHaan and Lipton 1998) can also be expected to lead to further reduction in poverty levels.

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[12]In order to avoid any possible confusion, it should be pointed out that Islam uses the usual definition of income (that is, income unadjusted for environmental damage). However, the conclusion that there is no "environmental Kuznets curve" should also hold if the definition of income adopted in this paper is used. An increase in income and a decrease in environmental damages is a possible scenario. Happily, according to the approach adopted here, such a scenario can also lead to lower poverty and inequality.

APPENDIX
Computing Environmentally Adjusted Inequality and Poverty Indexes

Gini Index

1. Estimates of National Income, Y (available from BBS)

$$\sum_{i=1}^{n} y_i = Y$$

2. Estimates of household income distribution (y_1 ... y_n)

3. Equally distribute the environmental damage X to n households:

$$\sum_{i=1}^{n} x_i = X \text{ and } x_i = \frac{X}{n}$$

4. Calculate Gini indexes for

   (y_1, ...y_n) and ($y_1 - x_1, y_2 - x_2$, ... y_n - x_n)

   The results for various values of X are shown in Table 2.

FGT Index

1. Household expenditure data for a particular year from BBS.

2. Poverty line for minimum food expenditure Z (estimated by calculating the cost of acquiring a minimum level of nutrition).

3. Divide the food expenditure of the *j*th household, *Gj* by *Z*.

4. Calculate (G_j / Z) squared.

5. Add for all poor households and normalize.

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