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POPULATION AND ENVIRONMENT IN BANGLADESH: DESIGNING A POLICY ACCOUNTING FOR LINKAGES

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It is now widely recognised that there is a need to take the scope of the population policy in Bangladesh beyond the confines of achieving population stabilisation through reduction of fertility. Although in recent years the approach to reduction of fertility has changed from narrow family planning to a broad based reproductive health approach, it is being increasingly felt that Bangladesh's population policy should encompass other equally important issues which have wide implications for the development process and the quality of life of people of Bangladesh. To address some of the related pertinent issues the Centre for Policy Dialogue has initiated a programme which aims at undertaking a series of studies covering the broad area of **Population and Sustainable Development.** The major objective of these studies is to enhance national capacity to formulate and implement population and development policies and programmes in Bangladesh, and through close interaction with the various stakeholder groups, to promote advocacy on critical related issues. The programme which is scheduled to be implemented by the CPD between 1999 and 2002 shall address, *inter alia,* such issues as population dynamics and population momentum and their implications for education and health services, the nexus between population correlates, poverty and environment, impacts of urbanisation and slummisation and migration, as well as human rights. The study has benefited from generous support provided by the United Nations Population Fund (UNFPA). The programme also envisages organisation of workshops and dialogues at divisional and national levels and also holding of international thematic conferences.

As part of the above mentioned CPD-UNFPA collaborative programme the CPD has planned to bring out a series of publications in order to facilitate wider dissemination of the findings of the various studies to be prepared under the aforementioned CPD-UNFPA programme. The present paper on the theme of ***Population and Environment in Bangladesh: Designing a Policy Accounting for Linkages*** has been prepared by Dr. Fahmida Akter Khatun, Research Fellow, Bangladesh Institute of Development Studies, Dhaka.

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I. Introduction

The link between population growth and the environment is not simple. Both population growth and environmental degradation are caused by many factors for which blaming population growth as the only cause of environmental degradation and vice versa is misleading. Population growth contributes to the depletion of natural resources and degrades environmental quality which induces poverty and reduces human welfare. But population growth may not always deter development and not deteriorate natural resources. However, since population growth, increased poverty and environmental degradation often occur together in the developing countries, population growth is seen as a cause of environmental degradation occurring through poverty. Population control, migration and poverty reduction are therefore suggested to improve the environmental quality. But these can solve the problem only partially and temporarily as the root of these problems lies in adverse policies. This emphasises the need for an integrated policy which could control population growth and reduce poverty as well as lead to sustainable natural resource management.

In Bangladesh both rapid population growth and degraded environment pose serious threats to the economic development. This leads to other serious problems such as poverty, malnutrition and illiteracy. On the other hand the environment is extremely vulnerable to damage and degradation as a result of many factors, increasing population outstripping the carrying capacity of the local resources among others. Since the vast majority of the people in Bangladesh derive their livelihoods from the use and extraction of natural resources, the livelihood system in Bangladesh especially of the poor becomes extremely vulnerable to environmental damage.

Though population control received high priority in the national policy packages which brought success to some extent in reducing birth rate, environmental issues could not attract proper attention to the policy makers of Bangladesh till the recent past. Population

pressure is still felt tremendously while the environmental degradation is at its worst situation which calls for immediate and effective agenda for action. In the face of the importance of the problems and linkages between them the challenge is to formulate policies to arrest both the problems at the same time.

This paper explores the population-environment relationship in order to examine how environmental degradation affects the population and how the people are the agents of degradation in the context of Bangladesh. It also aims at suggesting a set of policies which will solve both population and environmental problems. The paper is organised as follows. Chapter 2 reviews the population and environmental problems in Bangladesh. Chapter 3 presents the theoretical views as well as empirical evidences from other countries on the relationship between population growth and environmental degradation. In Chapter 4 estimation of population-carrying capacity for Bangladesh is presented. Finally Chapter 5 presents a policy framework for a sustainable development which will take care of population as well as the environment.

II. Population Growth and the Environment

2.1 Population Growth Trends

The historical perspective reveals that population growth has been faster than ever before during the last 50 years which stands at 2.17 percent per year currently. Despite the successful lowering of total fertility and growth rates over the past few years the population of Bangladesh has shot up from 89.9 million in 1981 to 111.45 million in 1991 growing at a rate of 2.17 percent per year. Accordingly, the density of population has increased from 609 in 1981 to 756 in 1991. At present the population of Bangladesh stands at 129 million and growth rate is 1.5 percent (Fifth Five Year Plan, 1998). It has been projected that by 2020 the population of the country will add up to 169.8 million with a growth rate of 1.05 annually (Fifth Five Year Plan, 1998). The projection on population growth and other indicators are presented in Table 1.

Table 1. Basic Indicators of Population in Bangladesh

Indicators	***Year***			
	1990	***2000 (Projected)***	***2010 (Projected)***	***2020 (Projected)***
Total Population (million)	111.45	129.2	146.4	169.8
Crude Birth Rate (per 000)	32.8	22.4	20.8	18.0
Crude Death Rate (per 000)	11.3	8.2	7.7	7.5
Population Growth Rate (%)	2.17	1.42	1.31	1.05
Total Fertility Rate (per woman aged 15-49 years)	4.33	3.0	2.2	2.2
Child Death Rate under 1 year (per 000 live births)	94	70.0	35.0	25.0
Life Expectancy Male Female	56.0 56.4 55.4	60.8 60.7 60.5	64.0 64.0 64.0	67.0 66.5 67.5

Source: BBS, 1992; Fifth Five Year Plan, 1998.

Crude Birth Rate has fallen (from 34.6 per 1000 in 1985 to 19.9 in 1998) but not enough to control population growth. Despite decline in fertility rate (from 4.71 in 1985 to 2.98 in 1998) continuous population growth may be linked to the reduction in mortality rate due to the immunisation and mother and child health programmes. Child Death Rate per 1000 of children between 1-4 years has come down from 12.5 in 1987 to 11.8 in 1996. Life Expectancy at Birth has improved from 56.9 years in 1980 to 60.8 in 1998 (BBS, 1998). Slow reduction in birth rate can also be attributed to other demographic, social cultural and economic factors. The age structure is such that females aged between 15-49 years account for 48 percent of the total female population. Age at marriage is still low. Forty nine percent of women in the age group of 15-19 are married. In the poor families more children are considered to be a future investment which can ensure economic and social security of parents during their old age which acts as a barrier to successful population control programmes.

The future scenario of population in Bangladesh is shown to be slightly brighter though population will keep growing at a rate higher than expected and stable growth will still remain as a distant goal to be achieved. In the year 2020 crude Birth rate will be down to 18 per 1000 persons from the present 22.4 per 1000 people., while Crude Death Rate will come down to 7.5 from 8.2 per 1000 persons. Total Fertility Rate per woman is projected to be 2.2 in 2020 compared to 3.0 in 2000. Life Expectancy will improve to 67.0 years from 60,8 years at present (Table 1).

Another feature of population growth trend is the increase of urban population faster than rural population which could be linked to the increase of poverty and unemployment in the rural areas. The urban population accounted for 19.6 percent of the total population in 1991 compared to 2.4 percent in 1901. Table 2 shows the annual growth of population. The rate of growth of urban population between 1981 and 1991 was 4.7 percent while the growth of the rural population during the same period was 1.5 percent per year (BBS, 1996). It has been projected that total urban population will be 35 million in 2005 which will be 27 percent of the total population of the country (Fifth Five year Plan, 1998). The ratio of urban and rural people will be 4:6 in 2020 from 2:8 at present. Such growth has negative on the urban environment and in turn, on the quality of life.

Table 2. Population Growth Trends

Census Year	***Total Population (million)***	***Urban Population (million)***	***Annual Growth (Exponential) Rate (percentage)***	
			National	*Urban*
1951	44.16	1.83	0.50	1.74
1961	55.22	2.63	2.26	3.72
1974	76.39	6.00	2.48	6.62
1981	89.91	13.56	2.35	10.03
1991	111.45	22.45	2.17	5.43

Source: BBS, Various Issues.

2.2 Environmental Concerns

In Bangladesh degraded environment is being manifested mainly in water and sanitation problem, soil erosion, air pollution, deforestation, wetland loss, biodiversity loss and degradation of the coastal environment. Increasing population, industrial and vehicular pollution, excessive use of chemical fertiliser and unsustainable commercial exploitation of resources coupled with market, institutional and policy failures are the major causes of environmental degradation. The following section gives a brief overview of the major environmental concerns in Bangladesh.

2.2.1 Land Degradation

Land use pattern shows that more than 50 percent of the land is under crop production. About 20 percent of the total land is used for homestead, cities and settlements, while 14.5

of the land is under forestry. The rest of the land is used for industry, infrastructure and social needs (BBS, 1998). Limited land resources and the increasing demand for food led to the practice of intensive agriculture based on the use of irrigation, chemical fertilizers and pesticides. Extensive and inappropriate use of these land-augmenting technologies is reported to degrade the soil resource base ((Pagiola, 1995). The energy crisis in the rural areas, resulting in the burning of twigs and fallen leaves which reduces the amount of organic mater in the soil, contributes to the removal of the fertile topsoil.

In addition to declining soil fertility, waterlogging, salinization and lowering of water table are also prevalent in Bangladesh, and are adversely affecting the productivity of crops and livestock. Much of the problems of waterlogging and salinity have been attributed to the lack of maintenance of existing flood control, drainage and irrigation (FCDI) structures and the poor design and planning of new infrastructures (discussed in Section 2.2). The problem of ground water mining can be traced to the policy decision of deregulation in the importation and sale of shallow tubewells, and the failure to implement regulations regarding the siting of tubewells. Thus land degradation in Bangladesh can be associated not only with the existing economic activities of people (over and inappropriate use of fertiliser and pesticides and subsistence gathering of fuelwood and leaves), but also with policy and implementation failures.

Though land degradation is apparently a serious problem in Bangladesh, the extent of degradation and its impact on production and income are not known exactly. One study shows that the hill areas of Bangladesh such as Chittagong Hill Tract and Modhupur Tract are affected by soil erosion. An area of about 808 square kilometre (sq km) in Moulvibazar and Sylhet districts face the problem of soil erosion (Shahabuddin *et al*, 1994). In another study it has been shown that about 4.5 million hectare (Mha) and 1.75 Mha of land have been identified to be deficient of sulphur and zinc respectively (Karim and Iqbal, 1992).

Land degradation has serious implications for the supply of non-degraded land for agriculture and for current and future agricultural expenditure on less fertile land. Hence despite being the most common economic activity in Bangladesh, agriculture may face the

danger of unsustainability in terms of declining incomes as a direct result of environmental damage arising from activities of the people aimed to maximise their gains.

2.2.2 Water Pollution

The shortage of water and deteriorating water quality are major problems with respect to water resources. Though a water abundant country, Bangladesh faces severe water shortage in the dry season. Access to safe water still remains an urgent need in the country. In Bangladesh though about 89 percent of the rural households has access to safe drinking water only 16 percent use clean water for all purposes, that is for drinking, cooking and washing (World Resources, 1996-97; UNDP, 1995). In the urban slum areas only half of the households use tubewell water for all purposes. Recently, in the rural Bangladesh, arsenic problem has become a life threatening issue. Thousands of people are identified with symptoms of severe arsenic poisoning, a deadly disease that can disrupt normal functioning of the vital body organs and subsequently can lead to cancer. In addition to shortage of clean water sanitation facility is also inadequate for the huge population. About 28 percent of the rural households and 44 percent of the urban households have access to sanitation (World Resources, 1996-97).

Industry and agriculture are the other sources of water pollution in Bangladesh. The major polluting industries are chemicals, textiles, pharmaceuticals, cement, electrical and electronic equipment, glass and ceramics, pulp and paper board, leather tanning, food processing, and petroleum refining. The increase in the use of chemical fertiliser also contaminates ground and surface water.

In the south-west parts of Bangladesh waterlogging is severe occurring as a result of flood control embankments, the failure to repair damaged sluice gates, faulty constructions and badly designed drainage systems and failure in the operation and maintenance of FCDI projects. The siltation of rivers and land within poldered areas is another acute problem in some areas, often disrupting riverine transportation. It has been reported that the failure to repair damaged sluice gates and other FCDI structures as well as to drain out trapped water from 1987-88 floods had resulted in waterlogging in seven upazillas (sub-districts) of

Jessore and Khulna districts. More than 16,000 hectares covering 96 villages have been waterlogged for over a decade after the construction of embankments in the area of Beel Dakatia in Khulna district, and there are many other instances of waterlogging in a number of areas (Adnan, 1994).

The reduction of river flow due to siltation has been causing increase in salinity in the coastal areas. An area of 1.47 Mha of coastal and offshore areas has saline soils (Ahmed *et al*, 1994). Most of this saline area is in the Sunderban mangrove (0.62 Mha). In other parts of the country (Comilla and Brahmanbaria districts) excessive ground water withdrawal for irrigation is causing salinity. In the urban areas domestic sewage and industrial effluents are causes of water pollution. In the rural areas excessive use of chemical fertilisers and pesticides causes water contamination.

A specially glaring example of the negative consequence of poor planning leading to environmental damage on the people is evident from the history of shrimp farming in Bangladesh. In Bangladesh shrimp farming covers more that 300,000 acres of land of which 80 percent is in Khulna, Satkhira and Bagerhat, the southern districts of Bangladesh. The rest is in Chittagong, Barisal, Patuakhali, Jessore and Noakhali districts. Taking over agricultural lands, extensive farming is done engaging women and children. Shrimp cultivation has a number of environmental problems including salinity in water. Shrimp cultivation needs holding of water for a period of six to nine months. A large area of agricultural land and mangrove forests has been converted into saline shrimp ponds. The salinity in the shrimp ponds affects the soil and water system in the adjacent land. This results in reduction of agricultural production, scarcity of drinking water and loss of vegetation which in turn affects livestock, poultry and fish in the adjacent water bodies. Agricultural production is reported to decline by 30 percent, and scarcity of water, loss of vegetation and grazing land have reduced livestock and poultry by 75 percent (Ahmed *et al*, 1994).

2.2.3 Air Pollution

Consumption of energy at an increasing rate by the industry and transport sector pollutes the environment through deteriorating the air quality. Air pollution in Bangladesh is significant, especially in Dhaka city, it is far above the international as well as national standard. The concentration of suspended particulate mater (SPM) in Dhaka city is much higher than the acceptable level set by the World Health Organisation. For example, the SPM concentration at three points in Dhaka city was 570 micrograms per cubic metre in 1992 compared to 75 micrograms per cubic metre of the WHO standard and 400 micrograms per cubic metre of the Bangladesh Department of Environment standard (DOE, 1993). In Chittagong, at four sample points the concentration was 319 micrograms per cubic metre; in Khulna at two sample points it was 371 micrograms per cubic metre; and in Bogra at one sample pint it was 547 micrograms per cubic metre (DOE, 1993). Concentration of sulphur dioxide in Dhaka was estimated to be 312 micrograms per cubic metre, again far above both the WHO and DOE standards (50 micrograms per cubic metre and 100 micrograms per cubic metre respectively) Chittagong, Khulna and Bogra had very sulphur dioxide concentrations.

Vehicular and industrial emissions are the main sources of urban outdoor air pollution in Bangladesh. Vehicular exhausts appear to be a major contributor to SPM levels. A survey done by the Department of Environment shows that emissions from 86 percent of the vehicles in Dhaka city exceeded the acceptable level of emission in terms of Bangladesh standard and 77 percent of them were found to be highly polluting (DOE, 1990).

Indoor air pollution is also affecting the health and environment, especially in the rural areas. In Bangladesh about 70 percent of total energy is provided by the traditional sources, such as agricultural residue, fuelwood and animal dung. Particulate concentration from indoor cooking is also very high. In the absence of any measures of this we do not know the extent of the pollution.

2.2.4 Deforestation

During the last decade the rate of annual deforestation was between 3 to 4 percent in Bangladesh which was much higher than the South Asian average of 0.8 percent (World Resource Institute, 1996). In many parts of the country deforestation is taking place fast and half of the country does not have any public forest (ADB, 1993). Sal forests are heavily degraded due to illegal felling. In the Sal Forests near Tangail district, forest cover is reduced from 1000 hectares in 1970 to about 500 hectares in 1990. In less than 35 years, the volume of commercial species, Sundari and Gewa has declined by 40 and 45 percent respectively due to increase in the salinity of water resulting from reduced flow from the Ganges and due to deforestation (Task Force Report, 1991). An area of about 85,000 hectares is under shifting cultivation in the Hill Forest reserves (excluding Chittagong Hill Tracts) with the engagement of 60,000 families. The encroachment problem exists both in the Hill Forest and Sal Forest. Around 12,200 families have encroached on 77,000 hectares of forest. Till 1984 the extent of land transfer was about 61,000 hectares (ADB, 1993). Deforestation in the reserved and unclassified state forests has taken place mainly due to logging. Forests are over-harvested in the state forests. Underpricing and inefficient use of wood products sold to government owned industries and illegal logging by timber merchants are the major factors in the mismanagement of forest resources.

2.2.5 Biodiversity Loss

Most of the environmental problems discussed above such as water pollution, salinization, deforestation and overfishing are threatening the biological diversity. The Royal Bengal Tiger, Gangetice Dolphin, elephant, leopard and White Wined Duck face the danger of extinction. The loss of biodiversity is related to activities like clearing and burning forests, conversion of natural ecosystems for agriculture, desertification of natural grasslands, reclamation of wetlands and illegal harvesting of animal and plants. Mono-cropping practices in agriculture and animal husbandry can result in genetic erosion.

Table 3. Extent of Resource Degradation in Bangladesh

Problems	
Area affected by shifting cultivation (000 hectares)	1000
Forest area in Bangladesh (000 hectares), 1996 % of total land area in Bangladesh Annual deforestation (1990-1995; sq km)	2156 14.5 88
Estimated degraded land (000 hectares) % of total land area in Bangladesh	989 7
Loss of original habitat (%)	94
Estimated CO_2 emission from the use of fossil fuel (metric tonnes of carbon)	Actual (1986): 3 Year 2000: 6 (Business as usual scenario)

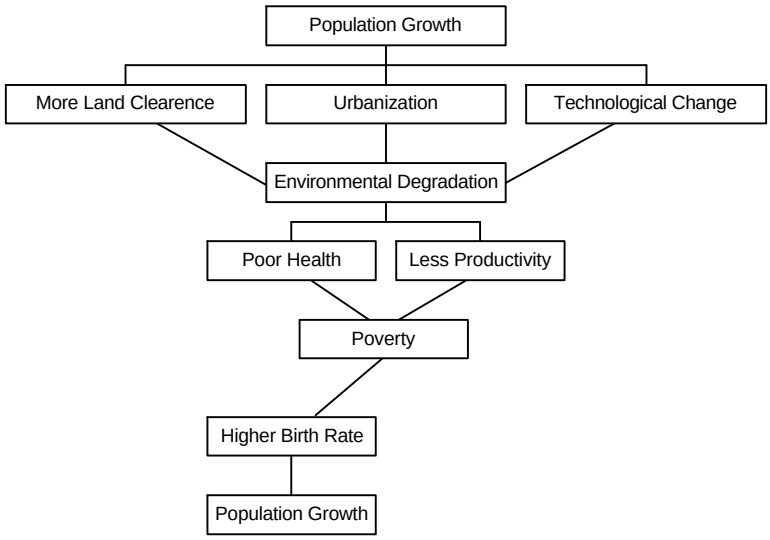
Source: BBS, 1998; ESCAP, 1992; MacKinnon and MacKinnon, 1986; World Bank, 1999.

III. Interaction Between Population and Environment

3.1 Theoretical Views on Population - Environment Relationship

Rapid population growth in the face of finite environmental resources will have catastrophic effect on human well being (Ehrlich and Ehrlich, 1970). This view has been supported by the proponents of sustainable development. The theoretical literature of sustainable development tends to suggest that rapid population growth will seriously impair the chances of truly sustainable development. More people means more mouths to feed and more resources to be exploited which induces poverty. Poverty, on the other hand leads to population growth as more family members to the poor mean more labour to perform household activities, more economic opportunities and higher income. More children also mean security in old age. Deforestation and lack of drinking water can increase the time cost of fuelwood gathering, livestock pasturing and waterlogging. Children can perform these activities and make themselves valuable to their parents. The linkage among population-poverty-environment can be expressed as follows.

Figure 1: Population, Poverty and Environmental Degradation: Linkages



On the other hand, increased population can indirectly enhance output and productivity (Thirwall, 1986), and, therefore, it could be that the sustainable development explains some pessimism as it does not capture the complex interactions that exist between population growth, technology and productivity. More people may bring higher number of entrepreneurs. Also there may be a pressure for more efficient provision of infrastructure for bigger population (Simon, 1986).

3.1.1 Positive Externality

The view here is that population is not necessarily a cause of environmental degradation and increased population means a spur to technological change. The arch exponent of this view Ester Boserup suggests that land extensification ceases as good land is exhausted, or as other factors prevent further development of new lands. Then intensification occurs. In fact the evidence is that intensification occurs before this point of exhaustion and the two often run in parallel. The resulting farmer-induced technological change is sufficient to support the new population level, the argument goes, although others doubt that farmer technology alone could support high rates of population growth.

A few recent work has tended to give the Boserup hypothesis some support. English, Tiffen and Mortimore's (1994) work on Land Resources Management in Machakos Dostrict, Kenya 1930-1990 is perhaps the most widely cited modern study. Machakos in east central Kenya was in the 1930s regarded as a seriously degraded area. Inhabited by the Akamba people, the area today has five times as many people as in the 1930a and a real per capita agricultural output that is three times as many people as in the 1930s level. Soil erosion still exists but is modest due to terracing of virtually 100 percent of the land, and repeated projections of fuelwood scarcity have not maintained because trees have been planted and are actively managed. The area cultivated has expanded by a factor of 4-5. Livestock have increased, despite a decreasing social emphasis on their importance by the Akamba. New technology has expanded rapidly. The study found 45 technologies in place that were not there in the 1930s, including ox drawn ploughs, early maturing maize, use of crop residue for forage and animal manure for fertiliser, and monocropping of crops in rows to facilitate weeding. Only some of the technologies owe their introduction to government support – the early maturing crops being the main one. Most technologies have been introduced by the Akamba themselves without support. Nor has credit been used to achieve all this; profits from off farm work have been reinvested in the technologies, as have profits from sales of cash crops. The nature of the crops grown has changed, from subsistence crops in the 1930s to cash crops today. The authors claim Machakos is a clear example of Boserupian forces at work.

A study of 23 Latin American countries in the 1980s found that agricultural area expansion was positively related to population growth (Southgate, 1990). Examining the case of Colombia, Heath and Binswanger (1995) conclude that eliminating the adverse policy nexus should be the highest priority rather than the reduction of population growth.

Additionally, various reviews have suggested that reducing population growth cannot be demonstrated to have major impacts on economic growth. If there are impacts, they are modest, and hence the high profile given to population changes as a cause of poor economic and environmental performance is not warranted (Kelley, 1988)

3.1.2 Negative Externality

Population growth and environmental degradation (as well as economic development as a whole) are linked negatively in the following ways.

In terms of the theory of economic development:

(1) Population growth was thought to lower the ratio of capital to labour and hence lower the marginal product of labour, thus lowering the wages. To keep pace capital must be widened and this may have deleterious effect elsewhere, for example, reducing funds available for infrastructure. Slow population growth permits a rising capital-labour ratio - capital deepening - and hence rising productivity and wages. This link between population growth and capital went out of fashion when capital was thought to be less important in growth. Given the reappearance of the role of capital and the capital theoretic base of the environmental economics literature where environment is considered as a capital, this view may be due for reappraisal.

(2) Burden of Dependency: It is argued that rapid population leads to a higher proportion of young people dependent on the older working population. The latter have to divert resources to services such as care, food, housing and education. In poor countries the dependency ratio is at least one dependent per worker. And if the older population fails to divert resources the young suffer ill health and poor education. Thus growth worsens.

(3) Household Effect: Within families more children means spreading limited family resources widely but thinly. Then nutrition suffers. More children affects the ill health of mothers through rapid child bearing. In general, both parental and child well-being are thought to suffer in large families. Also, large families depress education, especially education of females due to the spreading effect. Hence large families have a negative effect on the overall economic growth.

(4) Natural Resource: This can be discussed by resource type.

(a) Land and food: It is widely argued that until the Second World War food output increases were mainly by extensification. Since then they have been secured by intensification. More intensification as population expands leads to soil degradation which lowers the marginal product of land relative to labour. More application of labour to land simply worsens the degradation. Degradation can only cease if (i) labour out-migrates to the towns or if there is other off-farm employment, or if (ii) land saving techniques are developed.

(b) Fuelwood, water: Population growth has simply to imply demand levels that increase faster than the regenerative capacity of trees and water for a simultaneous ecological and economic crisis to emerge. The major effect of population on water is via food demand and hence irrigation. Seventy percent of the world's fresh water is used for irrigation. Poorly managed and under-priced irrigation water also results in salinisation of soils. Hence population growth threatens water supplies most by these indirect routes.

In terms of Boserup hypothesis:

The Boserup hypothesis is refuted by Lele and Stone (1989), and Cleaver and Schreiber (1993). They tend to suggest that 'Machakos style' is more an exception than the rule. First, it is argued that such situations arise mainly when there is strong external support for the new technologies, although the Machakos authors deny that this was very relevant there. Second, if off-farm work does not exist, the chances are that other adaptations will take place, especially the solution in which internal conflicts marginalise the poorest of society on to marginal lands. Thirdly, if all the policy signals are wrong, no amount of autonomous effort will prevent the vicious cycle occurring.

3.2 Empirical Evidence of Resource Scarcity and Environmental Degradation

Though it is difficult to measure the extent of the effect of population growth on the environment it is not difficult to understand that in Bangladesh, population growth affects the availability of natural resources such as land, forests, fisheries and natural gas. It also

contributes to the environmental degradation through polluting the air and water resources. Since Section 2.2 has already described the environmental degradation this Section will discuss the impact of population growth on the environment and vice versa, and present some monetary estimates of environmental degradation in Bangladesh from the existing literature.

3.2.1 Population and Resource Scarcity

Increased population leads to resources scarcity. More people means the use of the same land continuously. So land available for other uses declines. This effect has been characterised by the ecologists as uses competing for Net Primary Product in the ecosystem of the world. This phenomenon is observed in Bangladesh where an extremely high population is struggling to survive by using natural resources till its exhaustion.

To start with the renewable resources, forest and fisheries are the major resources being exploited extensively by the people. Greater demand for fuelwood and forest products especially in the urban and commercial sectors, conversion of forest land into agricultural land and for infrastructural development for a bigger population are the important factors for deforestation. Scarcity of fuelwood due to deforestation and lack of alternative energy sources lead village people to use grass, crop residue, cattle dung and other biomass, causing depletion of an important source of fertiliser. This results the use of chemical fertiliser on a large scale which degrades the soil quality in the long-run and pollutes the ground water and the air.

Exploitation of fish resources has also increased to a large extent. Fish production has been increasing constantly. In 1997 total production of fish was1492 thousand metric tones compared to 827 thousand metric tones in 1987. Though a renewable resource unlimited exploitation can reduce the future yield and cause extinction of the resource. Tsai and Ali (1987) presented evidence that major carp stocks in beels were being severely deleted by overfishing. Heady *et al* (1995) found that in the north eastern districts of Bangladesh fish are nearest to being overexploitation and some species of fish suffered from overfishing.

Non-renewable resources such as natural gas face the risk of being exhausted fast due to population growth. Though Bangladesh has a large reserve of natural gas the supply cannot be ensured beyond a certain point of time. The energy consumption pattern shows that the contribution of natural gas to total consumption has been increasing (BBS, 1998). It was estimated that with a reserve of 19847.7 billion cubic feet (BCF), an annual growth of 12.7 percent in gas consumption and with a production of 172.8 BCF per year the stock of natural gas will be able to meet up the demand till the year 2019 (Khatun, 1996). Even if discoveries occur, exhaustion cannot be stopped. But the length of consumption period can be expanded if the population size is small and if the resource is used efficiently. Table 4 shows that per capita resource availability including natural gas is very low.

Table 4: Population and Resource Availability in Bangladesh

Resource	***Per Capita Availability***
Land	0.13 hectare
Forest area	0.016 hectare
Fuelwood	0.02 cubic metre
Fish consumption	36.10 gram
Natural Gas	59.6 metre
Commercial energy use	67 kg of oil equivalent
Access to safe drinking water	79 % of population

Source: BBS, 1998; World Resources, 1998; World Bank, 1998.

3.2.2 Population and Pollution

As discussed in section 2.2 pollution level is very high in Bangladesh which is mainly due to population growth. The effect of environmental degradation is felt through damage of health and losses in production and amenities. Environmental degradation reduces society's welfare through ill health and premature mortality. In Bangladesh where people are less healthy, effects of air and water pollution and of other environmental damages on them are stronger. Impaired health will, in turn, have negative impact on the productivity. Environmental degradation reduces the productivity of natural resources, for example, water pollution destroys fisheries, which in turn reduces the productivity of human being as they have less for consumption.

Health Effect: In Bangladesh people face serious health risks from water and air pollution. Health consequences of SPM are sickness and death. Respiratory diseases, asthma attacks, bronchitis and lung cancer are among the morbidity effects of increased particulate concentration in the cities. Estimates show that the costs of avoided health damage from Dhaka city's outdoor particulate air pollution are in the range of Tk. 12.8 to Tk 171.8 billion accounting for 2.5 to 33.4 percent of the national GDP in 1990 (Khatun, 1996).

Due to the use of dirty and unsafe pond water various water-borne diseases attack the poorer section of the society. The cost of increased mortality and morbidity due to lack of clean water and sanitation varies from Tk 45 to 100 billion (Shibli, 1996).

Shrimp culture is yet another example of health threat to many including women and children. While the foreign exchange earned through shrimp export can be seen as a positive contribution to the national economy, the achievement is done at a very high cost, part of which cannot be recovered even with investments. This is the social cost inflicted on the poor workers in the shrimp farms in terms of mortality and morbidity risks. A recent study has estimated that the cost of shrimp cultivation varies from Tk 2.5 to 3.6 billion (Bhattacharya, Rahman and Khatun, 1999). This cost includes the opportunity cost of land degradation due to salinity, health costs in terms of mortality and morbidity and the cost of mangrove destruction. Table 5 shows the cost of resource degradation in Bangladesh.

Table 5: Cost of Resource Degradation in Bangladesh

Resources	***Cost (Tk. Billion)***	***Share in GDP (%)***	***Study***
Soil	4.5 – 11.2	0.83 – 2.1	Shibli, 1996
Forest	3.2	0.6	Khatun, 1996
Fisheries	14.0	2.7	Khatun, 1996
Natural Gas	1.3 – 46.3	0.3 – 9.1	Khatun, 1996
Water	45.0 - 100	8 –18	Shibli, 1996
Air	12.8 – 171.8	2.5 – 33.4	Khatun, 1996
Shrimp Cultivation	2.5 – 3.6	0.23 – 0.33	Bhattacharya, Rahman and Khatun, 1999

Source: Khatun, 1996; Shibli, 1996; Bhattacharya, Rahman and Khatun, 1999.

Productivity Effect: Environmental degradation reduces the productivity of many resources used directly by people resulting in perpetuation of impoverishment. Industrial water pollution and municipal sewerage, agricultural chemicals, degradation of wetlands and flood plain soils damage fisheries. Waterlogging and salinisation of soil due to shrimp cultivation, and excessive ground water withdrawal for irrigation lower crop yields. Saline water destroys trees, reduces agricultural production, and creates scarcity of drinking water. Soil erosion and land degradation due to clearing of forests, low organic matter, poor soil structure, heavy rainfall and inappropriate land management practice equally contribute to poverty through loss in productivity, scarcity of drinking water and loss of vegetation, livestock, poultry and fish.

Environmental degradation also lowers the productivity of the people by changing the time allocation on various activities. For example, when deforestation takes place and scarcity of water arises, women and children have to spend greater time on collecting fuelwood and fetching water from longer distances. This is a burden on the poor who could spend their time and energy elsewhere on gainful activities. As environment degrades, the poor have to spend more time to search for their livelihood. A study in villages with massive deforestation in Nepal shows that women had to collect fuelwood for over an hour longer than their counterpart in less deforested areas (Kumar and Hotchkiss, 1988). The loss in labour availability for agriculture was estimated to be one and a half hours a day due to collection of forest products. The diversion in labour use could not be compensated for, and families experienced reduction in household income from agriculture, and a deterioration in food consumption levels and nutritional status.

IV. How Many People are Sustainable in Bangladesh?

4.1 Conceptual and Methodological Issues

It is quite understandable that there are too many people for too little resource, and the present population growth is not sustainable for Bangladesh. Vigorous efforts and measures are needed to control the population growth and to bring it down to an expected level. The limits of population growth must be in accordance with the carrying capacity of natural resources.

Human life depends on healthy ecosystems which supply life-sustaining resources and absorb wastes. However, current growth and consumption patterns are placing increasing stress on ecosystems. Environmental degradation, biodiversity loss, deforestation, and the breakdown of social and economic systems are a few of the signs which indicate that ecosystems are stressed.

There are thresholds at which the levels of stress will lead to the disruption of the system. Beyond a given threshold of degradation, the human community would become progressively less sustainable. One concept used to understand these critical limits of population growth and thresholds of environmental degradation is the Carrying Capacity which assumes that there are a finite number of people who can be supported in a given area without degrading the natural, cultural and social environment that is without reducing the ability of the environment to sustain the desired quality of life over the long term.

Carrying capacity is usually related to a specific resource and is defined as its ability to support consumption to specified limits (Fernie and Pitkethly, 1985). In simple words, the carrying capacity of a given area is the maximum number of people that can be sustained by the resources on that land (Pearce and Warford, 1993). The application of carrying capacity concept to human is difficult though, because of the following reasons:

(a) per capita natural resource consumption by human varies quite often;
(b) people can control, to some extent, the natural resources on which they depend;
(c) they can also expand carrying capacity through technological innovation and trade;
(d) conversely, they can diminish carrying capacity through environmental mismanagement, usually caused by rapid population growth.

On a global scale Giampietro *et al* (1992) estimated a maximum sustainable global human population of approximately 8 billion based on a largely vegetarian diet, but

stressed that their scenario would impose a much lower standard of living than enjoyed by industrialised nations, and would require fundamental changes in social structure. Goodland (1992) concludes that global carrying capacity has been exceeded, citing evidence in five reinforcing categories: (1) human biomass appreciation, (2) global warming, (3) ozone shield rupture, (4) land degradation, and (5) loss of biodiversity. He does not however, deduce a maximum sustainable global human population.

Notwithstanding these limitations the concept of carrying capacity is an important measure of the ability of regions to support human population and so an important tool in development planning. It can be useful for discussing the land-man ratio without much quantification.

In the following Section the population-carrying capacity of Bangladesh is presented on the basis of an already available estimation by Food and Agriculture Organisation (FAO) of the United Nations as well as a new estimation done in the present study. The methodology used to estimate the population-carrying capacity of crop and fuelwood, two important uses of land resources is very simple and is discussed in course of the estimation of each resource in Section 4.2.

4.2 Population-Carrying Capacity in Bangladesh

The FAO) had estimated the carrying capacity of 117 countries for the year 1975 and 2000 in terms of potential production of food at three levels of technologies. Low level input refers to the use of no fertilisers, pesticides or improved seeds and no long-term conservation measures – equivalent to subsistence farming; intermediate input is the use of some fertilisers, pesticides and improved seeds, conservation measures and improved cropping patterns on half the land; and high input refers to the full use of all inputs, full conservation measures and the most productive mix of crops on all land (FAO, 1984). The estimated potential output of calories was divided by the calorific intake per capita recommended for each country by the FAO and WHO.

If all cultivable land is devoted to food crops, Bangladesh will be able to support only 79 percent and 97 percent of its expected year 2000 population (153.3 million as projected by the UN) with low and intermediate level input respectively. However, as technological assumptions improves the carrying capacity improves too. So with high input Bangladesh would be able to feed 21 percent more than its expected year 2000 population (FAO, 1984). This implies that with high input Bangladesh will be able to support about 185 million people which will be reached around the year 2020 as projected in the national population policy 2000 (Government of Bangladesh, 2000). The estimation was done for the year 1975 as well. Table 6 shows the ratio of potentially sustainable population to the expected population in 1975 and 2000 at three levels of technology.

Table 6: Population Growth and Carrying Capacity

Input Level	***Potentially Sustainable Population***		***Ratio of Potentially Sustainable to the Expected Population***	
	1975	2000	1975	2000
Low	35	121	0.46	0.79
Medium	100	148	1.31	0.97
High	160	185	2.10	1.21

Source: FAO, 1984.

Though FAO carried out an extensive estimation we have attempted an alternative estimation using a very simple method. In 1995-96 food grain production including minor cereals was 19.13 million metric tonne and the total population was 122.1 million implying that annual per capita availability of foodgrain production was 156.7 kilograms (kg). Assuming that per capita requirement of cereals is 250 kg (or 0.25 metric tonne) per year we have estimated a supportable population of 76.5 million (19.13/0.25 = 76.5) for Bangladesh which is only 62 percent of the actual 1995-96 population.

Another use of land is forestry and fuelwood is one of the most essential products of forests. The exploitation of fuelwood is uncontrolled. The country has only 2156 thousand hectares of forest which is only 14.5 percent of the total land area of the country. Fuelwood is being cut without equivalent replacement, the result of which is the fast destruction leading to fuelwood crisis. Per capita availability of forest area is only 0.016 hectare.

The carrying capacity based on fuelwood from the natural forest cover is done in the following way. The natural forest cover is 769 thousand hectares (World Resources, 1998). Assuming 0.7 cubic metre (m^3) as the growth of forest per year (as there is no estimates of mean annual increment of forest in Bangladesh, the growth of Indian forest is taken to be the growth of Bangladeshi forest) (Forest Survey of India, 1988), the annual growth of forest is estimated to be 0.54 million cubic metre (Mm^3). Requirements of fuelwood vary enormously, for example, 0.2 m^3 per person in parts of the Indo-Gangetic plain and up to 1.9 m^3 per person in the hilly and cooler parts of rural Africa (FAO, 1981). We assume that fuelwood consumption in rural Bangladesh will be 0.2 m^3. This means that fuelwood carrying capacity is 2.7 million (0.54/0.2 = 2.7) people which is far below the projected population of 2000 (129.2 million in the national population policy 2000). This implies that only 3.5 percent of the current population is sustainable if fuelwood demand has to be met.

The results of the foodgrain and fuelwood carrying capacity are presented in Table 7. The ratios of the sustainable to the actual 1995-96 population are 0.63 for foodgrain and 0.02 for fuelwood. The environmental implication of the above results is that population is the limiting factor to sustainable development. Immediate efforts are needed to control the rapid growth.

Table 7: Actual and Sustainable Population

Sustainable Population (million)		***Actual Population (1995-96)(million)***	***Ratio of Sustainable to the Actual Population***	
Foodgrain	Fuelwood		Foodgrain	Fuelwood
76.5	2.7	122.1	0.63	0.02

Source: Calculated in this study.

V. Policy Framework for Sustainable Development

The environmental perspective of the population and the population perspective of the environmental problems are not adequately reflected in the related policies of the country. The national five year plans assign great importance to the population issue and spell out various measures to control the growth through effective family planning and

ensure better health services. However, environmental aspect is not included as a strategy to solve the population problem. Recently the Government of Bangladesh has prepared a draft national population policy recently. The aims and objectives of the national population policy do not include improvement of the environmental situation as one of its objectives to ensure a better life for the people. A number of negative impacts of population growth is discussed without suggesting any policy. It has been rightly said that increased population will increase the population density and reduce the land-man ratio as well as food supply. This will aggravate the poverty situation and a large number urban population will either be floating or have to live in the slums. While describing the main components of the new population policy it is said, referring to the International Conference on Population and Development (policy 2 and 3) that the right of development has to be met for the development of the population for the present and future generation and for meeting the environmental needs equally. This does not describe, however, that what are the environmental needs and how these will be met.

On the other hand, environmental issues did not receive as much importance as the population issues. The country did not have a separate Ministry of Environment till 1989. At present the country has a National Conservation Strategy (NCS) and a National Environment Management Action Plan (NEMAP) which are under implementation. There is also an Environment Policy and the Environment Protection Act, 1995. The Fourth Five Year Plan (1990-95) of the country has expressed some concern on environmental problems at first. The plan identifies some major environmental problems, reviews the past performance of the government in this respect and outlines objectives and strategies to improve environmental situation (GOB, 1990). The Fifth Five Year Plan (1997-2002) addresses the problems, issues and strategies at length in a separate chapter.

However, policy makers fail to address the population issues while discussing the environmental problems. The need for sectoral coordination is underscored as environment is a cross-cutting issue. The Fifth Five Year Plan recommends a number of interventions to help promote sustainable development among others. At the policy level these interventions include, among others, education and health. The policies are not elaborated, however and the issue of population control is missing.

The present rate of population growth and the resource utilisation practice are not sustainable and they pose threat to the existence of both human and non-human inhabitants of the country. The primary objective is therefore to control population growth and maintain it at a sustainable level, and to ensure long-term maintenance of the livelihood of these people through sustainable management of the natural resources. Thus the importance of the population and environmental problems and linkages between them put the challenge to the policy makers to formulate policies arresting both the problems simultaneously.

An environmental perspective of population and health issues reinforces the emphasis on developing human capital through education, family planning and public health programmes. The purpose of education should be to excel quality and to improve the ability of people to use natural resources efficiently and productively, and to diversify their sources of income, which will not be dependent on natural resources alone. Education is required for gathering information not only on contraception and the benefits of small family size but also to understand and modify the economic and cultural factors that favours large families and thus for successful family planning. Education of women is particularly important as women are engaged in resource management directly. Preventive measures capable of reducing environmental health risks from degraded environment such as, polluted water and air, lack of sanitation and others faced by the people should be incorporated in the public health programmes. The poor should have access to low cost treatment of diseases such as diarrhoea, respiratory problems, skin disease, cancer arising from environmental hazards.

Rapid population growth undoubtedly depletes resources and threatens sustainable development but it is often accompanied by misdirected policy measures or other factors. So the solution lies not only with the reduction of population growth but also correcting policies regarding price and property rights. For example, immediate measures to achieve the objective of sustainable population include correction of the inadequacies of the land tenure policy. Inadequate definition of tenure rights to natural resources managed by the poor tends to exploit the resources. Due to the sense of insecurity the farmers may not

take care of the land properly. Therefore, property rights should be defined to replace uncertain ownership to conserve resources. Open access exploitation of the natural resources can be managed efficiently with the involvement of the local communities.

In the long-run solution to the population as well as environmental problems depends on the macroeconomic policies which will promote stable and broad based income growth for larger section of the population who have to depend on the extraction of the natural resources for their livelihood. This will help alleviate poverty as well. Equal access to services, infrastructure and resources among the poor is also essential for the reduction of poverty and environmental degradation, and population growth in turn.

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