National Environmental Trust
Washington DC, 2000

In Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations

Bangladesh

Prepared by

Mozaharul Alam, Research Fellow
A. Atiq Rahman, Director
Nasimul Huq, Research Fellow
Sughra Arasta Kabir, Research Fellow
Bangladesh Centre for Advanced Studies (BCAS)

BANGLADESH

Introduction

Bangladesh is a South Asian developing country covering an area of 147,570 sq. km. Its population is 119.8 million with a very low per capita gross domestic product, i.e., $350 dollars (US). Geologically it is a part of Bengal Basin filled by sediments washed down from the highlands on three sides of it, and especially from the Himalayas, where the slopes are steeper and the rocks are less consolidated. This low-lying deltaic country formed mainly by the Ganges, the Brahmaputra and the Meghna (GBM) river system. It is bordered on the west, north and east by India, on the southeast by Myanmar and on the south by the Bay of Bengal. Figure 1 shows the geographical location of Bangladesh.

In 1992, the Government of Bangladesh signed the United Nations Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro. It ratified the Climate Convention in April 1994, and in 1997, representatives from the Government of Bangladesh attended the Third Conference of Parties in Kyoto.

Vulnerability of Bangladesh to climate change and sea level rise is well recognized by the scientific and international community. Over time a number of studies has revealed that the country is vulnerable to climate change from changes of physical agents, socio-economic conditions and institutional settings. Moreover, the degree of vulnerability depends on how the nation, community or an individual perceives the forces of change and makes necessary modifications to adapt to altered circumstances.

Agriculture, manufacturing industry and various service sectors are the economic backbone of the country. Flat terrain, low economic growth, high population density, intensive dependence on agriculture and agricultural production, lack of institutional infrastructure, etc., combine to make the country vulnerable to any nuance in climate change and sea level rise. Table 1 summarizes the social, economic, and environmental indicators of Bangladesh from 1981 to 1995.

Table 1–National Statistics for Bangladesh 1981-1995

Indicators	**1981**	**1991**	**1995**
Population (million)	89.9	111.45	119.8
Land Area (square kilometers)	144,000	147,570	147,570
-- Forest (percentage)	15.00	12.80	12.74
-- Agriculture (percentage)	60.52	55.08	52.06
-- Cultivable Wasteland (percentage)	1.62	3.93	4.28
-- Current Fallow Land (percentage)	3.39	6.49	2.68
GDP in 1989-90 constant price (US$ in millions)		26500	32060
GDP in terms of PPP (1990 US$ in billion)	NA	NA	125.15
-- Industrial GDP (percentage)		22.14	24.18
-- Services GDP (percentage)		49.45	50.98
-- Agriculture GDP (percentage)		28.13	24.83
GDP per capita (1995 US$)		241	336
PPP per capita of GNP (1995 US$)	NA	NA	1380
Urban Population as % of Total Population	15.20	17.20	22.00
Population below poverty level	73%	47%	45.8%
Life Expectancy at Birth (years)	55	56	58
Literacy Rate	23.8	32.4	37.2

Note: PPP stands for Purchasing Power Parity

Source: Population Census 1981, 1991 and Statistical Year Book 1996 of Bangladesh Bureau of Statistics, Draft Fifth Five Year Plan, World Development Report, 1997of World Bank, Key World Energy Statistics, International Energy Agency, Paris.

Geography

Figure 1-Geographical location of the country

The physical environment of Bangladesh is diverse and complex, and both traditional and modern systems of land use are very closely adapted to the heterogeneous conditions. This heterogeneity has important implications for climate change vulnerability. Moreover, the physical environment and technology are not static: dynamic changes are taking place in the hydrological system, which influence land use. Rapid and frequent natural changes are occurring in the river system, part of it due to human intervention.

Physiography and Relief

Except for hilly regions in the northeast and southeast, the whole of Bangladesh consists of low and flat land formed mainly by the Ganges-Brahmaputra-Meghna (GBM) river systems, a network of rivers, tributaries, and waterways that criss-cross the country.

Floodplains of the major rivers occupy 80 % of the country. In relief they are generally smooth, ridges (former river levees) and depressions. Differences in the elevation between adjoining ridge tops and depression centers range from less than 1 meter on tidal floodplains and 3 meters on the main river and estuarine floodplains, and 5 or 6 meters in the Sylhet Basin in the northeast. Only in the extreme northwest do land elevations exceed 30 meters above sea level.

Climate

The climate of Bangladesh is controlled primarily by summer and winter winds and partly by pre-monsoon and post-monsoon circulation. The southwest monsoon originates over the Indian Ocean and carries with it warm, moist, and unstable air. The easterly trade winds are also warm, but relatively drier. The northeast monsoon comes from the Siberian Desert, retaining most of its pristine cold, and

blows across Bangladesh, usually in gusts, during dry winter months. The country has a humid, warm, tropical climate, which is fairly uniform throughout the country.

Mean annual rainfall varies widely by geographical location within the country, ranging from 1.2 meters in the extreme west to 5.8 meters in the East and northeast. While the connection of these wind movements and rainfall have been studied rather in-depth, the possible connections with *El Nino* have only now begun to attract attention as a major possible influence on climate patterns in the Sub-continent.

Economy

Agriculture, manufacturing industry, and various services (such as transport, trade services, and housing) are the major economic sectors in Bangladesh. While there is some debate regarding the direct relative contribution of agriculture to national income, two facts remain undisputed: there is a falling trend in agriculture, yet despite this it remains of paramount importance because of the dependence of most other sectors or activities either for processing the products of or servicing the sector. According to the Bangladesh Bureau of Statistics, agriculture's share of GDP fell from 25.6% in 1991-92 to 21.3% in 1995, adjusted to 1989-90 constant market prices. The significant exception to this is ready-made garment manufacturing. Detailed major sectoral share of GDP for the year 1989-90 and 1994-95 at constant (1989-90) prices and current prices are presented in Table 2.

Table 2–Major Sectoral Share of GDP: 1989-1994

Sector	GDP at current Prices		GDP at constant prices	
	1989-90	1994-95	1989-90	1994-95
Agriculture	25.62	20.32	25.62	21.31
Transport	10.78	12.66	10.78	11.39
Manufacturing	11.44	12.88	11.44	13.62
Trade	16.27	16.80	16.27	17.42
Construction	8.98	8.95	8.98	9.00

Source: BBS, 1997

Economic development of the country depends upon a number of factors, one of which is high and stable level of agricultural production. Agricultural growth, however, critically depends upon weather conditions, which are subject to the variability of climate change. Consequently, manufacturing and service sector output, dependent to a large extent upon processing of agricultural output or servicing agriculture, are correspondingly variable.

Greenhouse Gas Contribution to the Global Atmosphere

Energy Production

Bangladesh has one of the lowest per capita commercial energy consumption rates in the world with about 75 kilograms oil equivalent (kgoe) per year (1994-95). Therefore, Bangladesh's energy sector contributes a relatively small amount of greenhouse gases (GHG) to the global atmosphere. On an average, more than 60 percent of total energy comes from renewable energy sources either biomass or hydropower. Similarly more than 55 percent of commercial energy comes from natural gas, known as cleaner fuel.

Power generation capacity of the total installed power plants (up to 1995) in Bangladesh is about 2900 MW of which 2400 MW is located in the eastern region and 500 MW is in the western area. For total installed power plants, power generation for 1995 was about 10,800 million KWH of which 372

million KWH was generated by hydropower and more than 85 percent of electricity was generated using natural gas. The noteworthy feature is use of cleaner fuel for electricity generation has increased over time and will keep increasing pace in future due to policy intervention and available from indigenous source. One important aspect of electricity generation in future using natural gas will be persuaded by energy exporting policy of the government and interest of the international oil companies. Table 3 presents the generation of electricity by fuel types from 1970-71 to 1994-95.

Table 3–Generation of Electricity by Fuel Types (million KWH)

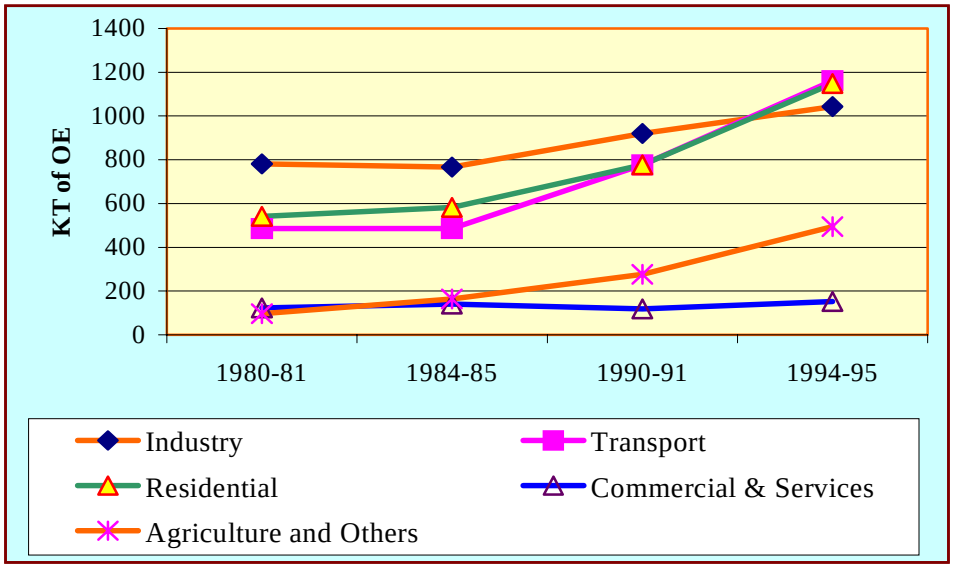
	Hydropower	Furnace Oil	Diesel	Natural Gas
1970-71	276	50	170	428
1974-75	463	216	97	572
1980-81	625	162	530	1343
1984-85	739	640	248	2918
1990-91	838	50	96	7286
1994-95	372	357	565	9521

Source: Bangladesh Power Development Board.

Energy Consumption

Bangladesh depends heavily upon traditional biomass fuels, but the proportion of commercial fuels is greatly increasing due to increased use of indigenous natural gas and the limited increase in consumption of biomass fuels. Commercial energy consumption by different sectors gets pace after 1984-85 and increasing trend has been observed for all sectors except commercial and service sectors. Significant increase has been observed in transport and residential sectors those exceed the consumption level of industrial sector in 1992-93. Figure 2 presents the trend of consumption of commercial fuels by different sectors from 1980-81 to 1994-95.

Figure 2-Trend of Consumption of Commercial Fuels by Sectors from 1980-81 to 1994-95



In 1994-95, among the users of different commercial fuels, 35% of total commercial fuels was used for non-energy purposes (e.g., fertilizer production). The residential sector consumed 19%, industry used 17%, and transport accounted for 19%. Commerce and services sectors accounted for 2% and agriculture sectors used the remaining portion. Figure 3 presents consumption of commercial fuels by sectors in 1994-95.

Commercial energy of the country comes from both indigenous and imported sources. Natural gas, hydropower and a little amount of petroleum product comes from indigenous source and the country import a significant amount of petroleum product. Over time, share of oil in total energy has declined and use of natural gas has increased. In 1980-81, share of oil in the total energy was about 56% which become 36% in 1994-95 and on the other hand share of natural gas has increased from 32% to 54% at the same time. Figure 4 presents changes of energy mix from 1980-81 to 1994-95.

Figure 3-Consumption of Commercial Fuels by Sectors in 1994-95

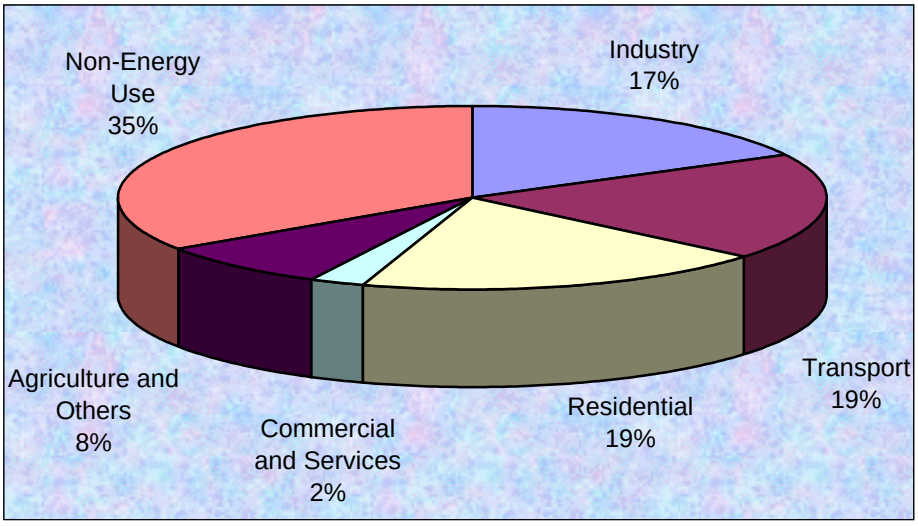
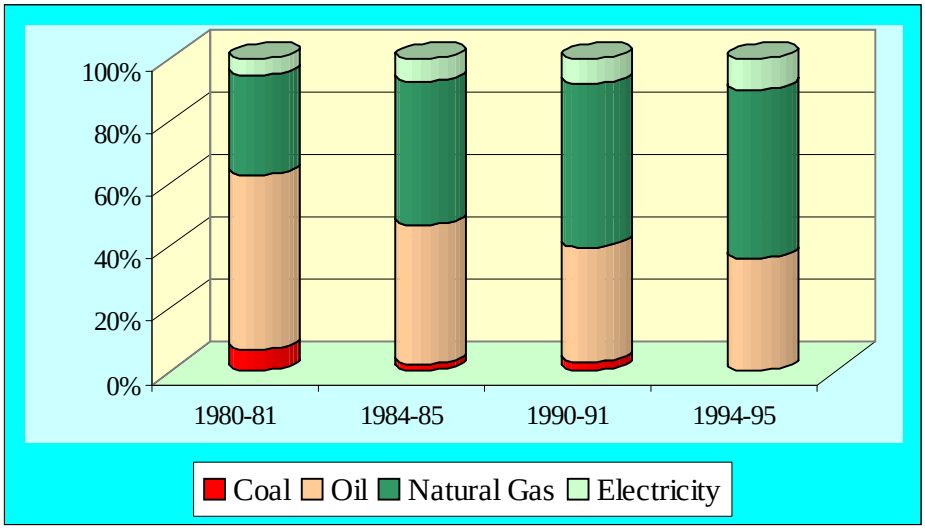


Figure 4-Changes of Energy-Mix from 1980-81 to 1994-95



Greenhouse Gas Emissions

A number of studied have estimated greenhouse gas emissions but the Asian Least-cost Greenhouse Gas Abatement Strategy (ALGAS) project conducted a comprehensive inventory of emissions in 1990 for energy, agriculture and livestock, and forestry and landuse changes using IPCC methodology. ALGAS studies revealed that per capita emission of greenhouse gas for Bangladesh in terms of CO_2 equivalent is less than a ton, about 670 kg per year.

The detailed estimate revealed that 21,186 thousand tons (Kt) of CO_2 equivalent greenhouse gas is released from the energy sector of which 4,392 Kt is emitted by energy and transformation, 3,050 Kt from the industry sector, 1,875 Kt from the transport sector, and the remaining from small combustion and fugitive emissions.

The emission inventory of the forestry sector for 1990 revealed net emission of carbon. The existing forests can not absorb more carbon than the rate of removal from the forests. The present net emission from the forestry and land use change sector is 19,738 Kt in CO_2 equivalent.

Total methane emissions from livestock due to enteric fermentation is estimated at about 519 Kt of which contribution by cattle is approximately 374 Kt, nearly 72% of total emissions from enteric fermentation. Within the cattle population, dairy and non-dairy cattle accounted for 73 Kt and 301 Kt, respectively. The goat population contributed about 123 Kt (24%) of total emissions. Buffaloes contribute about 3%, and the remaining 1% comes from sheep.

Manure management in the livestock sector is also another source of methane gas, estimated to produce 73.07 Kt of methane annually. The contribution of cattle population is nearly 83% of which dairy cattle account for about 31% and non-dairy cattle emit 52%. The contribution from poultry is small (4%).

Methane gas emissions due to rice cultivation has been estimated at 767 Kt. Much of it is due to non-irrigated rainfed and deep water rice cultivation contributing about 518 Kt (68%) and 120 Kt (17%) of total emissions, respectively. The remaining methane gas is emitted from irrigated rice fields.

Since the major crop in Bangladesh is rice, estimation for emission of non-CO_2 gases was done in terms of field burning of paddy-straw only. The amount of CO_2 released was not estimated assuming that it would be balanced by growing plants during the next cropping season. The estimated amounts of CO, CH_4, N_2O and NOx released due to field burning of biomass reveal that about 695.4 Kt carbon and about 9.7 Kt nitrogen are being released annually from field burning in the form of 4.63 Kt of CH_4, 97.33 Kt of CO, 0.11 Kt of N_2O and 3.87 Kt of NOx.

Much of the CH_4 emissions (82%) in Bangladesh comes from rice cultivation and livestock management. Of this, 43% is due to enteric fermentation and manure management of livestock and the rest comes from the rice field. Table 4 presents emission sources and sinks with their sectoral contribution to global greenhouse gas concentrations.

Table 4–Emission of Greenhouse Gas in 1990 (Kt)

Sources and Sinks	CO2 Equivalent (excluding CO2 emission from TBB)	Percent of Total CO2 Equivalent
Net National Emissions	72000	100.00%
1. All Energy (Fuel Combustion + Fugitive)	21186	29.43%
A. Fuel Combustion		
1. Energy and Transformation Industries	4392	6.10%
2. Industry	3050	4.24%
3. Transport	1875	2.60%
4. Commercial-institutional	259	0.36%
5. Agriculture	680	0.94%
6. Residential	5523	7.67%
7. Others (please specify)	400	0.56%
8. Traditional Biomass Burned for Energy	4084	5.67%
B. Fugitive Emission		
1. Oil and Natural Gas Systems	149	0.21%

Sources and Sinks	CO2 Equivalent (excluding CO2 emission from TBB)	Percent of Total CO2 Equivalent
2. Industrial Processes	1491	2.07%
1. Cement Production	153	0.21%
2. Ammonia Production	1130	1.57%
3. Metal (iron & steel)	208	0.29%
3. Agriculture	28667	39.82%
4. Land use Change and Forestry	19738	27.41%

Note:
TBB stands for Traditional Biomass Burning
CO_2 emissions from traditional biomass burning are not included in subtotals and the national total.
CO_2 equivalents are based on GWPs of 21 for CH4 and 310 for N2O. NOx and CO are not included since GWPs have not been developed for these gases.

Priority Area of National Development

Priority areas for national development may not have direct links to greenhouse gas emissions, but the sectoral development necessary to achieve these goals and objectives have significant bearing on future GHG emissions both in terms of sources and sequestration or "sinks." Poverty alleviation is the prime concern for most of the developing countries, and development of some sectors has already incorporated certain policies with implications for GHG abatement. It should also be noted that most of these policy options will facilitate economic growth and reduce atmospheric concentrations of GHG, producing a "win-win" scenario for Bangladesh.

Poverty alleviation is the major concern and thrust for the Government of Bangladesh. As it addresses this, however, it will also need to consider environmental and natural resource management issues by adopting appropriate policy measures. As a concern for development, the environment was first addressed in the Fourth Five-Year Plan and received more emphasis in the Fifth Five-Year Plan. Chapter Ten of this plan, "Environment and Sustainable Development," elaborately described the goals and objectives, suggesting policy outlines and strategies for environmental and resource management towards sustainable development.

Combustion of commercial energy and use of forestry products are the main sources of CO_2 that accumulates in the atmosphere. The CO_2 emission due to biomass burning from the agriculture sector does not contribute to global atmospheric concentrations assuming that the same quantity of CO_2 is consumed by the plants in next growing season. Therefore, the following section reviews major strategies, policy and legal framework mentioned in the national development plan for energy and forestry sector development.

National Development Plan

Bangladesh has been preparing its medium term national development plan known as the Five-Year Plan since 1973. It has already passed two and half decades of development efforts at lifting the economy out of its abject poverty. We are in the middle of the Fifth Five-Year Plan, an objective of which is to ensure the provision of basic needs for every citizen, providing new employment opportunities and building proper infrastructure to facilitate increased production primarily in private enterprises.

Along with the other sectoral development strategies and priorities, the Fifth Five-Year Plan strongly addressed the need of environmental development to achieve sustainable development for the nation. The major environmental issues identified and addressed in the Fifth Five-Year Plan are Natural

Disaster, Industrial Pollution, Health and Sanitation, Deforestation, Desertification, Changes in Climatic Condition, Salinity and Deteriorating Habitat of Flora and Fauna.

The national development plan recognizes an adequate and reliable supply of electricity at a reasonable cost, which is pre-requisite for attaining the projected growth rate. It also urges environmentally sound sustainable power development with minimum environmental damage. It implies additional requirements and expansion of energy supply, having implications, in turn, for greenhouse gas emissions.

The strategic recommendation for low-cost electricity is to exploit indigenous coal deposits. Bangladesh, however, does not generate electricity using indigenous coal. Instead, strategies highlight augmenting energy capacities by rehabilitating power plants and better maintenance, development of biomass energy, distribution of improved cooking stoves, application of new and renewable energy technologies, and private sector participation in the power sector.

In addition to being sources of GHG, forest and forestland are important sinks or reservoirs of carbon. They have received adequate attention in the national development plan. The natural forest of the country will be set aside for conservation and productivity will be increased through creation of a tree plantation with public participation as far as applicable. A total of 105,000 hectors of timber wood plantation with various rotation periods will be grown in the reserve, protected and unclassified state forestland of the hilly area. A total 32,000 hectares agro-forest and woodlot plantation and 25,000 kilometers strip plantation will also be raised by 2002.

Parties Involved in Climate Change Activities

Both government and non-government parties are involved in activities to mitigate GHG emissions. These activities relate to energy supply, energy efficiency, regulation, financial incentives, technological innovation, climate change research, impact study, policy advocacy, etc. These all are interrelated and reinforce one another.

The Ministry of Energy and Mineral Resources and its related departments and agencies is responsible for surveying indigenous fuels, granting leases for mineral extraction, and exploration, production and marketing of indigenous fuels. Use of natural gas is encouraged as much as possible for power generation along with compressed natural gas for vehicles. The ministry advocates state of the art technology such as combined cycle for power generation. It also conducts research and development on renewable energy technologies.

The Department of Environment under the Ministry of Environment and Forest is the national focal point of climate change activities. It has carried out studies on vulnerability assessment, GHG emission and abatement options and potentials for Bangladesh. It also pursues cleaner industrial technology and less polluting vehicles for urban areas. The Forest Department is responsible for forest management and enhancement.

The Ministry of Fisheries and Livestock is undertaking different activities for the development of livestock resources and to promote improved livestock food for milk and meat production, which reduce methane emission from this sector. It should be noted that this activity has yet to be implemented mason a large scale.

The Bangladesh Meteorological Department (BMD) collects climatic data and forecasts daily weather. The department researches climate change and variability based on primary data. The Space

Research and Remote Sensing Organization is working on *El-Nino* along with its other space research activities.

In addition to the government sector, Bangladesh has a very active and thriving non-governmental (NGO) sector and academic research institutions working in the area of environment and climate change. Institutions such as the Bangladesh Centre for Advanced Studies (BCAS), Bangladesh Institute of Development Studies (BIDS), Bangladesh University of Engineering and Technology (BUET), and Bangladesh Unnayan Parishad (BUP) have all done extensive study and research works on climate change, GHG emissions and abatement options, and GHG mitigation potentials.

Thematic Analysis

Bangladesh is well known as highly vulnerable to the effects of climate change, though its commercial energy use is one of the lowest in the world. Therefore, its energy sector contributions of GHG to the global atmosphere are very low. A large number of people depend on agriculture and agricultural activities which contribute about 40% of the country's total of greenhouse gas emissions to the global atmosphere although this amount is very small relative to other countries. The forestry and land use sector contributes about 27% where proper attention and investment could possibly reverse the situation and could make this sector a net sink. The following section provides a brief description of the energy, agriculture and forestry sectors with special emphasis on present and future greenhouse gas emissions.

Energy Sector

Commercial energy consumption in Bangladesh is growing at a rapid rate (>5% per year). With population growth and economic development, energy consumption will increase further. The energy sector is a high priority area for the government because industrial production and commercial activity are being severely hampered due to the chronic shortage of electricity and natural gas. The highest priority is on power generation, and the shortfall is being met through the participation of Independent Power Producers (IPP). In the natural gas sector the government is trying to increase supply by leasing out exploration and development blocks to Independent Oil Companies (IOC). Other energy sector priorities are rural electrification, which is undoubtedly a moral obligation of the government, and the introduction of CNG as a transport fuel, which arises out of the need to reduce the reliance on foreign oil.

Present (1990) and Future Projection of GHG Emissions

In the energy sector, the two largest GHG emitting sources are electricity generation and non-energy use (urea fertilizer production). These emit approximately 50% of all the GHGs. The other significant GHG emitting sources are traditional biomass burned for energy (non-CO_2 emission - CH_4 and N_2O), diesel for transport, kerosene for rural lighting, and coal for manufacturing bricks.

In 1990, total emissions from Bangladesh including those from land use and forestry were 72,000 Kt of CO_2 equivalent, of which 21,186 Kt was from the energy sector, 1,491 Kt from the industrial processes sector, 28,667 Kt from the agriculture sector, 19,738 Kt from the forestry and land use change sector, and 918 Kt from the waste sector. Thus the energy sector's contribution was approximately 30%.

Tables 5 and 6 present CO_2 emissions by source for the base year (1990) and Figures 5 and 6 present the 1990 GHG inventory. The first number gives the GHG emissions due to fuel use by the different sub-sectors of the demand side. The second number gives the total GHG emissions resulting from the

different fuels. As can be seen in the demand side, the residential sector of Bangladesh is the largest emitter of GHG followed by the industry and transport sectors when only emissions from fuel use are considered.

Table 5–CO_2 Emission from Energy Sources in 1990

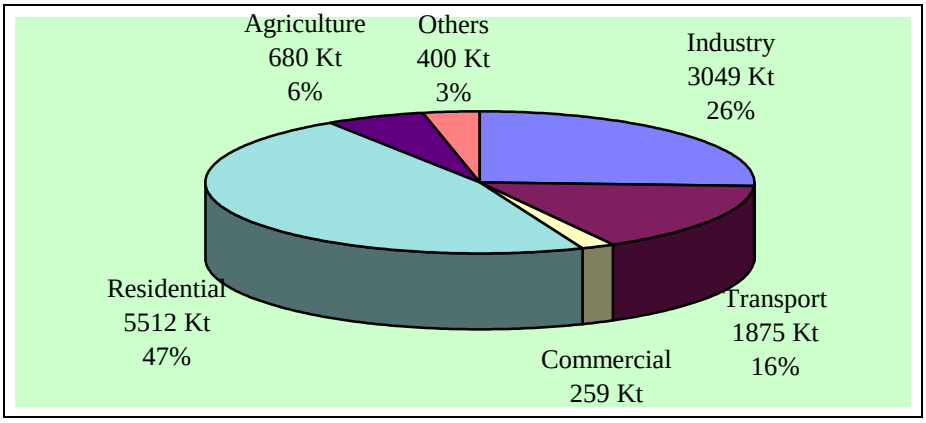
	Apparent Consumption (Kt)	Apparent Consumption (Tera joule)	Carbon Content (Kt C)	Carbon Stored (Kt C)	Actual CO_2 Emission (Kt CO_2)
Liquid Fossil	1,799	77,237	1,540	85	5,287
Solid Fossil	458	12,374	320	3	1,141
Gaseous Fossil	2,837*	144,107	2,205	441	6,435
Total	5,094	233,718	4,065	529	12,863
Solid Biomass	39,150				55,000

* *Does not include natural gas used for ammonia, which is accounted for in Industrial Processes according to the latest IPCC guidelines.*

Table 6–Non-CO_2 Emissions in 1990

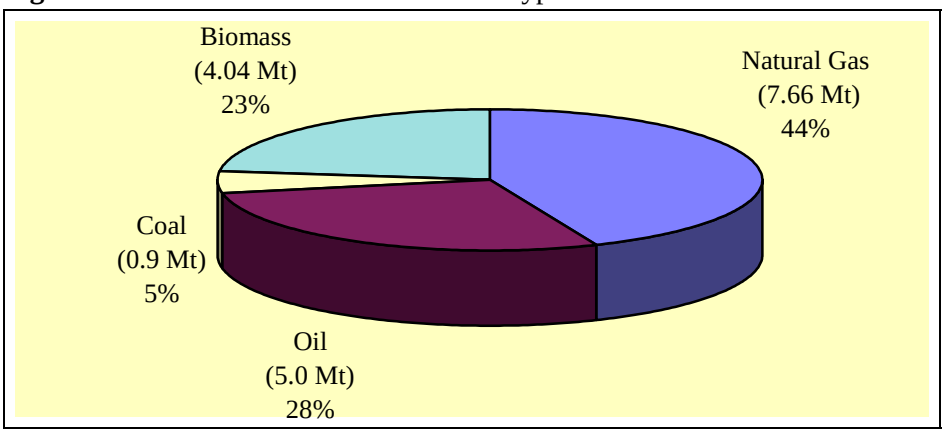
ITEM	GHGs in Kt			
	CH_4	CO	N_2O	NO_x
Gas Activities	6.1	–	–	–
Oil Activities	1	–	–	–
Biomass	162	2100	2.2	79

Figure 5–Energy Demand Sector GHG Inventory in CO_2 Equivalent in 1990



Note: The Residential Sector includes Biomass emission of CH_4 and N_2O

Figure 6–GHG Emissions from Different Types of Fuels in 1990



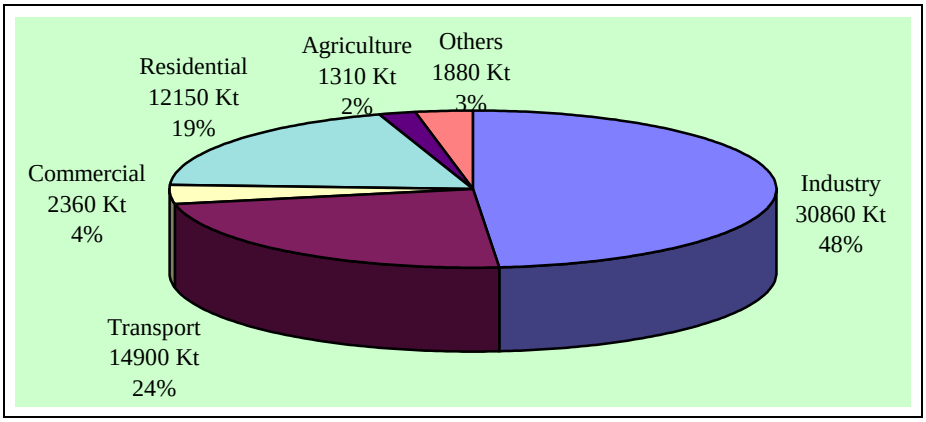
Note: The emissions from biomass are due to CH_4 and N_2O; Emissions from Natural Gas used for Ammonia are included

Many factors will play a role in determining future GHGs emission of which the supply of natural gas is an important one. But the fact that the emissions from coal and oil will also increase implies that the supply of natural gas is limited due to lack of infrastructure and cannot be used to meet the demands. Increase demand of oil is due to the increase demand of transport sector and captive generation for uninterrupted power supply. The reason for the insignificant growth of biomass fuels despite the increase in rural population is that there will be a perceptible shift in cooking fuel from biomass to commercial fuels like LPG, coal and kerosene.

The 2020 emissions inventory is shown in Figure 7 and 8 reflecting the following noteworthy features:

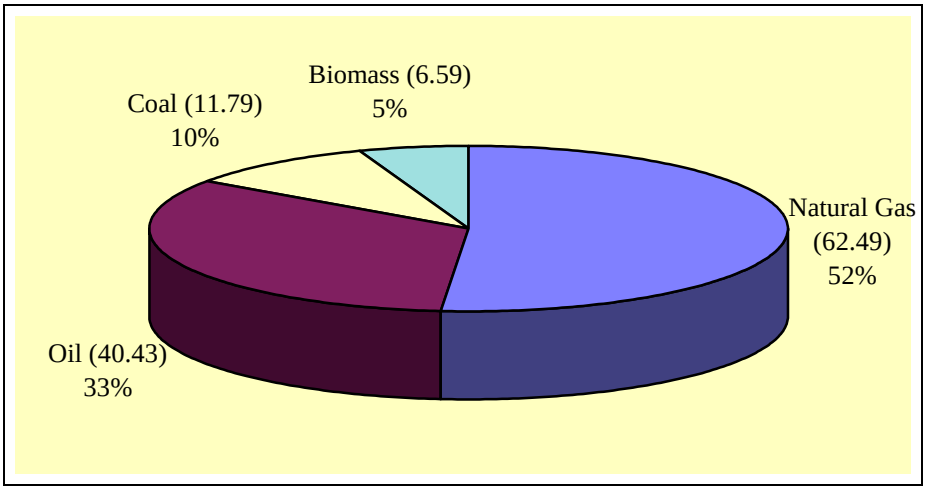
- Emission from Biomass has become an insignificant category in relative terms
- Energy and Transformation Industries is the single largest category
- Industry sector has become the largest category among the demand sub-sectors
- Residential sector has dramatically shrunk in size
- Transport sector has gained importance

Figure 7–Energy Demand Sector GHG Inventory in CO_2 Equivalent in 2020



Note: The Residential Sector includes Biomass emission of CH_4 and N_2O

Figure 8–GHG Emissions from Different Types of Fuels in 2020



Note: The emissions from biomass are due to CH_4 and N_2O; Emissions from Natural Gas used for Ammonia are included

Forestry and Land Use Sector

The total area of Bangladesh is approximately 14.40 million hectares, of which agricultural land constitutes 64%, while government-owned forest land occupies about 15% of which classified and unclassified state forest land account for 10% and 5% respectively. Private forest land occupies 2% of total land area (Table 7). Classified state forest land has good to moderately good forest cover while unclassified state forest land is virtually barren. The total land under forest is about 2.56 million ha which includes officially classified and unclassified state lands and forest lands accounted for by village forests and tea/rubber gardens. Although a significant part of existing forest area is designated as state forest, most of the land is barren of tree vegetation (FMP, 1995). In Bangladesh natural forest areas constitute almost 31% and forest plantation 13% of forest areas. Only 5% of the existing forest land is designated as protected areas. Almost half of the existing forest area is under different types of non-forest land use, e.g., shifting agriculture, illegal occupation, unproductive areas, etc.. In terms of forest land per capita, Bangladesh ranks amongst the lowest in the world, with about 0.02 ha per person.

Table 7–Bangladesh Land Area Classification

Landuse Category	Million ha	Percent
Agriculture	9.25	64.2
State Forest		
Classified	1.49	10.3
Unclassified	0.73	5.1
Private forest		
Village	0.27	1.9
Tea/Rubber Garden	0.07	0.5
Sub-total (forests)	2.56	17.8
Urban	1.16	8.1
Water	0.94	6.5
Other	0.49	3.4
Sub-total	2.59	18.0
Total	**14.40**	**100.0**

Source: Forestry Master Plan, 1995.

Present (1990) and Future Projection of GHG Emissions

Calculations of forests as sinks or sources are based on the IPCC methodology. In Bangladesh, net emission of carbon occurs from changes in forest and other woody biomass and forest and grassland conversion. Only estimated abandonment of managed land revealed net carbon uptake or sequestration. Total estimated carbon emissions are 5,410 Kt and total uptake is 27 Kt. From the estimation, it is clear that land use change and forestry are net emitters of carbon—about 5,383 Kt annually.

Projection of future greenhouse gas emission from the forestry and land use change sector was restricted to 2013 due to the availability of forest area projection given in the FMP. For the base year (1990) total forested area of the country is about 1,890 thousand ha. including plantation, unclassified state forest, and village forest. It is also assumed that the rate of deforestation is 20,880 ha/year. Considering the deforestation rate, forested area for the year 2013 will be 1,696 thousand ha including additional plantation and unclassified state forest land. The following assumptions have been used to calculate the forested area for the year 2013:

- The base year forested area is considered as fixed stable forest land

- New plantation under the status quo is added to 1990 plantation assuming that the long rotation will remain up to 2013. For the short rotation plantation, area will be replanted after the end of the rotation.
- Total deforestation area (417.6 thousand ha.) was taken from the Forestry Master Plan and the figure was distributed proportionately among the forest categories including plantation.

Estimated CO_2 emission from 1990 to 2013 in forestry and land use changes are presented in the Table 8. It is clear that the future emission from the forestry and land use change will increase. In the base year (1990) net emission in CO_2 equivalent is 19738 Kt and for the projection year (2013) it is 21,908 Kt. The incremental emission over the base year is only 10% or 2,170 Kt in CO_2 equivalent. Emissions will be relatively low over the base year due to the large afforestation rates under the government programs. Major causes of this additional emission are the high rates of deforestation, demand for biomass energy etc.

Table 8–CO_2 Emission from Forestry and Land Use Sector, 1990 to 2013

	1990	**2013**
Carbon emission from changes in forest and other woody biomass stock (KtC)	4,927	5,222
Carbon emission from forest and grassland conversion (KtC)	483	798
Carbon uptake in abandonment of managed lands (KtC)	27	45
Total Net Carbon emission (KtC)	5,383	5,975
Total Carbon emission in CO_2 equivalent (Kt)	19,738	21,908

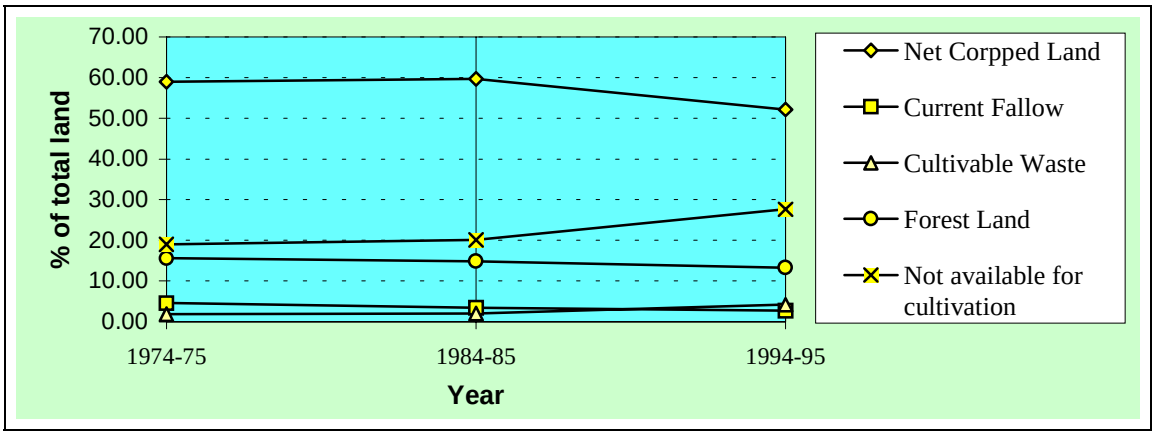
Apart from slash and burn agriculture, forest fire does not usually take place in Bangladesh. Naturally-caused forest fire is not a common phenomenon here, perhaps due to moist and wet conditions. Therefore, no significant amount of net carbon emission is expected from open biomass burning and land clearing from the forestry sector.

Agriculture and Livestock

Almost all of Bangladesh lie in the active delta region of three of the world's major rivers, which provide suitable conditions for agriculture. Most of the land area is used for agriculture, forest and settlement. Less than one per cent of the land area is occupied by industry or used for other miscellaneous social needs. In Bangladesh, land use is generally classified into five categories. With the growing population and their growing needs in various sectors, land use patterns are changing all the time. In 1974-75, landuse under various categories revealed that 59 per cent was for cultivation, 19% for Forest, 2% for cultivable waste, nearly 4% for current fallow and 19% was not available for cultivation (BBS, 1998). Decadal land use changes, from 1974-75 to 1994-95 is presented in Figure 9 reveals that the area under the category of "area not available for cultivation" is increasing, which includes mainly urban and rural settlement and industrial land. On the other hand net cropped and forest land shrunk. The increasing rate of area "not available for cultivation" and the decreasing rate of "net cropped and forest land" are almost the same now.

Livestock plays a vital role in the agro-based economy of Bangladesh. Cattle and buffaloes provide draught power for ploughing and rural transport. This sector provides meat, milk, and eggs which are important sources of animal protein for the people. Excreta of cattle are generally used as organic manure to enrich nutrient level of the topsoil and as fuel in rural areas.

Figure 9-Decadal Changes of Land Use from 1975 to 1995



Source: BBS, 1998

Present (1990) and Future Projection of GHG Emissions

Crop agriculture and livestock are the most significant sources of methane emission in Bangladesh. Methane emission from agriculture is due to rice cultivation in flooded fields. In addition, non-CO_2 greenhouse gases are emitted when crop residue is burned in the field.

Herbivores produce methane as a by-product of enteric fermentation. The amount of methane produced by an animal depends on its type, age and weight and also on the quality and quantity of the feed given.

Anaerobic decomposition of organic materials in flooded rice fields also produces methane, which escapes to the atmosphere primarily by the process of transportation of the rice plants. The amount of methane emission depends on rice species, number and duration of harvests. Other factors influencing methane emissions are type of soil, atmospheric temperature, water regime management practices, and fertilizer use.

Bangladesh ALGAS study prepared the greenhouse gas (GHG) inventory for the crop agriculture and livestock sectors, based on 1990 livestock population data provided by Bangladesh Livestock Research Institute (BLRI). The methane emission from the rice field cultivation and other greenhouse gases emissions from the burning of agricultural residues in the fields were also calculated for the year 1990-91 on the basis of BLRI data.
For Bangladesh, total methane emission from livestock sector due to enteric fermentation is estimated to be 519 Kt of which cattle contributed some 374 Kt, nearly 72% of the total emissions. Within the cattle population, dairy and non-dairy cattle accounted for 73 Kt and 301 Kt, respectively. Goat herds contributed about 123 Kt (24%) of the total emissions, buffaloes about 3%, and sheep the remaining 1%.

It is estimated that 73.07 Kt of methane are emitted from manure management. The contribution from cattle is nearly 83% of which dairy and non-dairy cattle account for about 31% and 52% respectively. Poultry contribute only 4%.

Methane gas emission due to rice cultivation has been estimated at 767 Kt. Much of it is due to non-irrigated rainfed and deep water rice cultivation contributing about 518 Kt (68%) and 120 Kt (17%) of total emission, respectively. The remaining methane gas is emitted from irrigated rice fields.

The estimated amounts of CO, CH_4, N_2O and NOx released due to field burning of bio-mass reveal that about 695.4 Kt carbon and 9.7 Kt nitrogen are released annually in the form of 4.63 Kt of CH_4, 97.33 Kt of CO, 0.11 Kt of N_2O and 3.87 Kt of NOx.

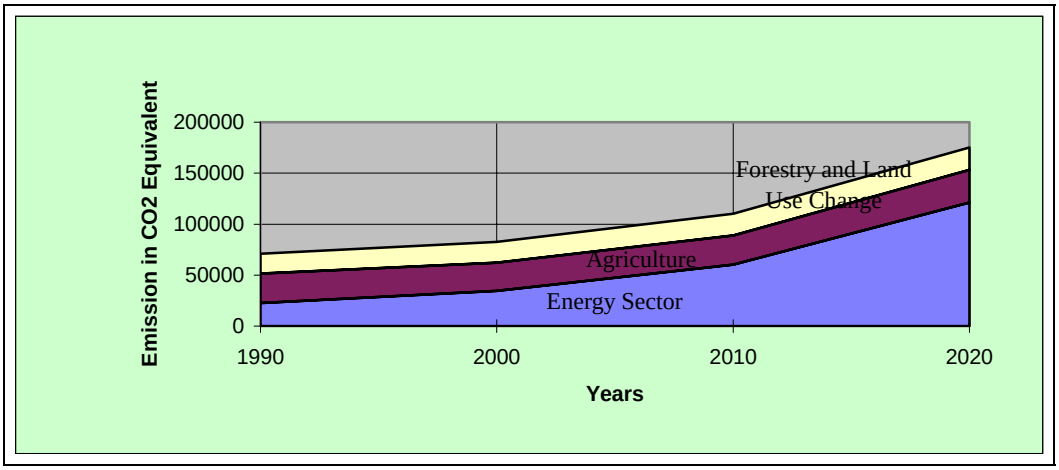
The emission of methane from crop agriculture and livestock sector is significant. Out of a total 1,577 Kt of methane emissions in 1990, 86% was emitted from three sectors: flooded rice cultivation, field burning, and enteric fermentation and manure management in the livestock sector.

Future emissions from the agriculture sector were calculated based on different assumptions. It is revealed that the total methane emission from the agriculture and livestock sectors is 1,527 Kt of which 638 Kt comes from crop agriculture, 8.8 Kt from field burning, and the remainder from livestock rearing. Table 9 presents present and future emissions from the agriculture sector and Figure 10 presents current and future greenhouse gas emissions for Bangladesh from different sectors.

Table 9–Methane Emissions from Agricultural Sector (Kt)

	Present (1990)	**Future (2020)**
Livestock	591.75	880
Rice Field	767	638
Burning of Agri. Residue	4.63	8.8
Total	**1363.37**	**1527**

Figure 10–Greenhouse Gas Emissions: 1990 to 2020 (Kt)



Present and Future Policies and Measures

The government of Bangladesh established the Ministry of Environment and Forest in 1989 with two major departments under it, namely the Department of Environment (DoE) and Forest Department (FD) to address environmental issues for sustainable development. The government has also instituted an inter-ministerial committee on climate change with the secretary of the ministry as the chairman and the director general of the Department of Environment as the member secretary. The DoE has been designated as the focal point in the government for matters relating to climate change and it has produced a number of reports, publications, and media advisories on climate change.

Activities Carried Out Under the Convention

As a signatory to international agreements and treaties related to climate change, the Government of Bangladesh has prepared a number of studies including an inventory of greenhouse gas emissions, vulnerability, adaptation, and mitigation over time. Bangladesh is well known as one of several developing countries, highly vulnerable to climate change, which will face the irony of adapting to and mitigating the consequences of global warming and climate change even though its own contribution to global GHG emissions is insignificant.

On behalf of the Government of Bangladesh the Bangladesh Centre for Advanced Studies (BCAS), in association with Resource Analysis, the Netherlands, and Approtec Ltd, Bangladesh undertook a study for Bangladesh's input to the Intergovernmental Panel on Climate Change (IPCC) with support from the Government of The Netherlands. The study concluded that climate change and sea level rise will not only affect coastal areas but also the whole country through inundation, drought, and salt water intrusion. It recommended that salt water intrusion be studied as a function of changes in river discharges and sea levels rise during periods of low stream flow.

A second study, undertaken by Bangladesh Centre for Advanced Studies (BCAS) in association with The Bangladesh Institute of Development Studies and Bangladesh Unnyan Parishad examined the country's greenhouse gas emission inventory, its vulnerability and adaptation, mitigation options, and information dissemination. This study also concluded that climate change and sea level rise would affect the entire country, primarily through inundation and lost crop productivity. This study also concluded that the southern part of Bangladesh would be most vulnerable in terms of inundation and salt-water intrusion.

A third study, Asian Least-Cost Greenhouse Gas Abatement Study (ALGAS), completed in 1998 by the Bangladesh Centre for Advanced Studies (BCAS) in association with Bangladesh Institute of Development Studies (BIDS), Bangladesh University of Engineering and Technology (BUET) and Bangladesh Unnyan Parishad (BUP), considered three components: greenhouse gas emission inventory for energy, the agriculture and forestry sector, analysis of several mitigation options for GHG reduction, and portfolio of bankable project.

Strategic Areas for the Implementation of the UNFCCC

Generally speaking, the country has not yet developed a strategy for the implementation of the UNFCCC in the arena of greenhouse gas mitigation. One may have to depend on a mixture of several strategies and policy depending on the specific circumstances. The ALGAS project identified probable mitigation options, which could be considered with further identification of appropriate technology availability and transfer mechanism. Further the institutional capability and social acceptance. However, as an abatement strategy, the following areas have significant mitigation potential and could be considered as national priority. These are also win-win options for the country.

a) Industries appear to be the most promising sector for mitigation, whether sector as a whole, or in terms of improvement of efficiency of energy using technologies/equipment such as boilers or motors.

b) Power generation could be another priority area for intervention. The present technology is often old and inefficient and can be replaced with significant GHG reduction potential. Recent discovery and increasing availability of domestic natural gas make it much more efficient and also consistent with government energy policy.

c) The transport sector is highly polluting and also has significant potential to improve its efficiency. Urban transport is a major consumer, the imperatives of cutting down on the energy consumption of a large consumer has both health and GHG reduction impact.

d) The use of cooling system is also often old and inefficient. The efficient cooling devices for refrigeration and air-conditioning should be encouraged as much as possible. Here, in this small sector savings are consequently very small.

e) The forestry sector mitigation may be achieved using two of its sub-sectors. In the government organized forestry sector afforestation opportunities are significant. In Bangladesh social forestry has emerged as a major social movement. It could be an important carbon-sequestration as well as having important socio-economic and nutritional benefit particularly for the rural poor.

f) Improved biomass cooking stoves in domestic and commercial sectors appears to be one of the most promising GHG abatement option which will lower pressure on bimass demand i.e. deforestation. This also has significant health benefit of the poor and rural women.

Based on national priority, GHG mitigation potential, pollution control and environmental development, ALGAS study developed six GHG abatement projects for investment, three of which have been identified by the modeling exercise: gas-based power, four–cycle engines, and compact fluorescent lamps. Others include cooking stoves (identified under national prioritization exercise), CNG vehicles as part of an incentive program relying on higher gasoline prices, and photovoltaic cells as an example of a spatially diffuse system of renewable technology. Detailed analytical results for each of these are presented below:

Project Title	Potential Investment Agency	Economic Rate of Return	Estimated Incremental Costs of CO_2 Mitigation	Abatement Cost, per Ton of CO_2 (in US$)	Non-quantifiable Benefits
POWER SECOTR					
Efficient Power Generation : Power Sector	GoB; International Financial Institutions; International Power Development Companies	14.45%	US$ 466 million	$ 10.6	Intensification of industrial activity and production; irrigation in agriculture; awareness building and mass education involving electronic media; social & economic change particularly in rural areas; other social benefits associated with availability of electricity and etc.
DOMESTIC SECTOR					
Dissemination of Improved Cooking Stoves in Rural Areas of Bangladesh	GoB; GEF	NPV cost = US $ 0.59 million; NPV saved cost = US $ 1.04 million	US $ 5.92 million	$ 1.0 (even less if carbon sequestered by trees saved is considered)	Save time for cooking; lower health hazards for women from smoke; natural balance benefits due to less deforestation for firewood, etc.
TRANSPORT SECTOR					
Replacement of two-stroke engines with four-stroke engines for auto-rickshaws	GoB, GEF	NPV of net benefit = $13.51 (US $, single unit basis) B:C ratio = 1.032	$ 6.49 million US $	$ 147 (US$)	Improve air quality

Project Title	Potential Investment Agency	Economic Rate of Return	Estimated Incremental Costs of CO_2 Mitigation	Abatement Cost, per Ton of CO_2 (in US$)	Non-quantifiable Benefits
Conversion of Petrol-powered Cars to CNG-powered ones	GoB; Individual Users; GEF		US $ 3.75 million	$ 28.82 (US$)	Enhanced engine life, less pollution from smoke, lead particulate and suspended solid particles, saving operating and maintenance costs, etc.
DOMESTIC ENERGY SECTOR					
Replacement of Incandescent Bulbs with Compact Fluorescent Lamps	GoB, Individual Users; GEF	NPV cost = US $ 15.1 per CFL unit	US $ 3.5 million	$ 6.0 (US$)	Brings satisfaction by offering brighter lumen, longer bulb life, significantly much less energy use
RENEWABLE ENERGY (DOMESTIC) SECTOR					
Solar Electricity with Photovoltaic Systems	GoB, GEF	NPV cost = $14.65 mil US $; NPV saved cost =$ 1.3 mil. US $	$ 162.0 million (US $)	$ 3.47 (US$)	Facilitate reading at night; increased possibilities for recreation and small scale productive activities at night; better security from theft etc.

Source : ALGAS, 1998

Bangladesh also has a national forestry policy and a 20-year Forestry Master Plan in effect. Along with other objectives, the forestry policy emphasizes fulfillment of national responsibilities and commitments relating to global warming and desertification. The forestry plan asserts that attempts will be made to bring about 20 percent of the country's land under the afforestation programs of the government and private sector by the year 2015 by accelerating the pace of the program through the coordinated efforts of the government and NGOs and active participation of the people.

The Forestry Master Plan of Bangladesh added two reforestation options to its status quo activities: medium rotation artificial hill forest plantation and plantations in Sal forest area. It should be noted that the government will maintain status quo by any available means, and the development scenario will be implemented subject to the availability of funds. The ALGAS study comprehensively analyzed several options for carbon sequestration for both a status quo and a development scenario.

Long Rotation Artificial Reforestation (LR) : Under the status quo or baseline scenario, 74,000 ha of hill forest area would be considered for long-rotation planting, versus 78,000 ha for the development scenario. The objective of this planting is to meet timber demand particularly sawlog and poles. The total life-cycle cost is $1.8/tC abated and investment is $1.0/tC abated, which is cost-effective for long rotation hill plantation. Total mitigation potential for the status quo scenario is about 8.58 MtC and 9.05 MtC for the development scenario.

Medium Rotation Artificial Reforestation (MR) : Medium rotation plantation is considered only for the development scenario, with 200,000 ha of hill forest area planted. Again, the objective of the plantation is to meet timber demand, particularly sawlog and poles. The total life-cycle cost is $2.7/tC abated and investment is $1.2/tC abated. The option is cost-effective for long rotation hill plantation. Total mitigation potential of the option is about 18.4 MtC.

Short Rotation Artificial Reforestation (SR) : The objective of short rotation planting is to meet demand of pulpwood. Under the status quo scenario 33,000 ha of hill forest would be planted for short rotation and for the development scenario 50,000 ha would be planted. The total life-cycle cost is $7.8/tC abated and investment is $4.4/tC abated. The option is cost-effective for short rotation hill

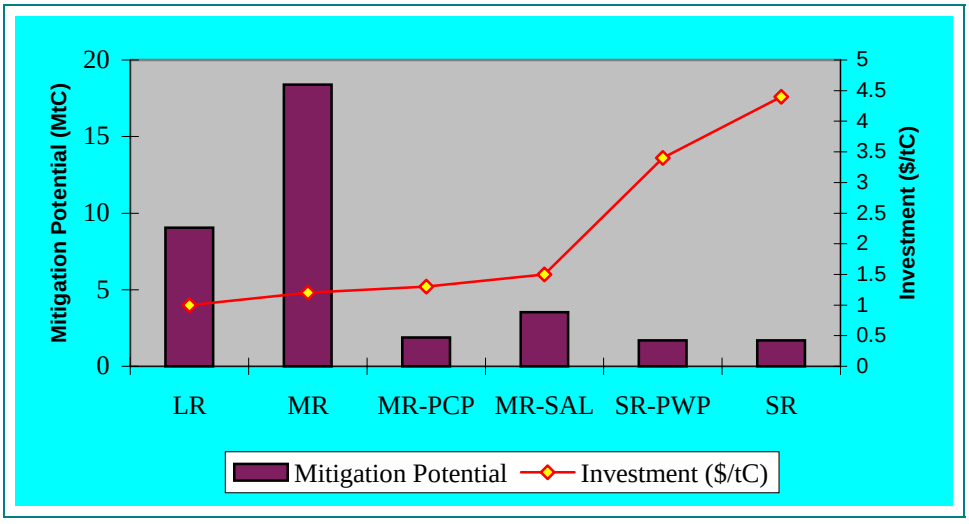
plantation. Total mitigation potential of the option is about 1.12 MtC and 1.7 MtC in status quo and development scenario respectively.

Medium Rotation Participatory Coastal Plantation (MR-PCP) :The objective of this plantation is to meet demand of sawlog and fuelwood. Under the status quo scenario, 33,000 ha would be planted and with the development scenario 30,000 ha would be planted. The total life-cycle cost is $2.6/tC abated and investment is $1.3/tC abated. The option is cost-effective for coastal plantation. Total mitigation potential of the option is about 2.08 MtC and 1.89 MtC in status quo and development scenario respectively.

Short Rotation Participatory Woodlot Plantation (SR-PWP) : Short rotation planting will meet the demand of fuelwood. quoin coastal areas 34,000 and 50,000 ha would be planted under status quo and development scenarios respectively. The total life-cycle cost is $6.2/tC abated and investment is $3.4/tC abated. The option is cost-effective for long rotation plantation. Total mitigation potential of the option is about 1.19 MtC and 1.7 MtC in status quo and development scenario respectively.

Comparison of the combined mitigation potential and investment cost of the status quo and development scenarios found that the total mitigation potential of the baseline scenario is 12.97 MtC with an investment of $20.34 million dollars(US$). On the other hand, the mitigation scenario has the abatement potential of 36.27 MtC with an investment of $52.59 million dollars. The overall investment cost is $1.57/tC for the baseline and $1.45/tC the mitigation scenario respectively. Figure 11 summarizes the mitigation potential and investment costs for each of the rotation options.

Figure 11–Cost of Carbon and Abatement Potential of Mitigation Options through Forestation



Economic and Financial Incentives

Although Bangladesh has no treaty obligations to reduce or mitigate its GHG emissions, most of its policy documents and development plans recognize the necessity of incentives *to promote cleaner technology for GHG mitigation.* Moreover, its Fifth Five-Year Plan recommends establishment of a "Green Fund" to facilitate investment in clean technology for pollution control where other commercial moneylenders may not willing to invest. Such a fund would partially help reduce local pollution in Dhaka, the country's capital city.

The government's Ministry of Finance plays a key role in setting economic and financial incentives to encourage or discourage goods and services. In the national budget of 1999-2000, the supplementary tax on two-cycle engines and vehicles powered by them has been increased up to 100% to discourage importation of them. Similarly, the supplementary tax on four-cycle engines and vehicles operated by them has been removed to encourage import.

INVOLVEMENT OF STAKEHOLDERS

With particular respect to climate change issues and greenhouse gas emission and abatement activities, the country needs the involvement of different government officials and non-government organizations. Stakeholder participation and their roles will depend on the types of activities and participation can be ensured by the National Environment Committee (NEC) chaired by the Honb'le Prime Minister.

The ALGAS study team identified first-priority cut stakeholder participation for different greenhouse gas abatement options.

Abatement Options	**Stakeholder and Integration**
Gas Based Efficient Power Generation. ***Status*** : A number of Memorandum of Understanding (MOU) has been signed with foreign private companies for natural gas exploration and setting up of new gas based efficient power plants.	Integration needed among the various institutions under the Ministry of Energy, Oil, Gas and Mineral Resources.
Dissemination of Improved Cooking Stoves in Rural Areas of Bangladesh. ***Status*** : Present dissemination program is not working properly due to lack of motivation. Two similar projects are in the pipeline (to be implemented by LGED and DoF).	Governmental-NGO collaboration is required for a motivational campaign in rural areas. NGOs should organize training programs for users. MoEF should provide a small environmental initiative fund and make and broadcast motivational information in electronic media.
Conversion of Petrol Driven Vehicles to CNG. ***Status*** : Conversion process has been started with a limited capacity. In principle, the government agreed to convert their petrol driven vehicles to CNG without any delay. But implementation has been very slow. Due to limited production capacity and short supply of CNG, interested vehicle owners got frustrated.	Institutional coordination among the Ministry of Energy, Oil, Gas and Mineral Resources, the Ministry of Information and the Department of Environment is required. More info should be broadcast through television and radio spots explaining the advantages of using CNG. DOE should continue their existing awareness campaign on this program.
Replacement of Incandescent Bulbs with Compact Fluorescent Lamps. ***Status*** : Mass level use of CFL is not yet started. A few self motivated commercial centers are using CFL as energy efficient devices.	A coordinated effort is needed among the Ministry of Energy, Oil, Gas and Mineral Resources, the Ministry of Finance and the Ministry of Commerce to overhaul the tariff structure. MoLG should revise their existing building code, especially for the large buildings (government, commercial, and multipurpose, etc.).

Abatement Options	Stakeholder and Integration
Solar Electricity with Photo-voltaic (PV) System. ***Status*** : The Rural Electrification Board (REB) is already involved in a pilot activity, and the proposed program might be considered as an extension of the pilot work.	The following agencies should coordinate among themselves to implement the proposed activities: the Ministry of Energy, Oil, Gas and Mineral Resources; the Rural Electrification Board, and the Department of Environment.
Phasing-out Two-stroke Engines with Four-stroke Engines for Auto-rickshaws. ***Status*** : The price of petrol has been raised recently. Incentives should be given to popularize four-stroke engines.	The MoEF and the DoE should immediately coordinate with the respective government agencies to devise a plan for rapid implementation of the project.
Implementation of the Development Scenario of the Forestry Master Plan. ***Status :*** The Department of Forestry under the Ministry of Environment and Forest is involved in developing project proforma for attracting local and foreign investment.	Department of Forestry should immediately coordinate regarding the development of various project components under the master plan. Ministry of Information should assist in disseminating information through electronic media concerning the participatory forestry programs.

National involvement in the Kyoto Protocol

Project Eligible for Clean Development Mechanism (CDM)

Kyoto Protocol for the first time in the arena of climate negotiation has recognized sustainable development which could be promoted through flexible mechanism particularly through clean development mechanism. The foremost objective of the mechanisms is to reduce greenhouse emission of the developed countries using carbon reduction credit in developing countries and subsequently help the developing countries to attain sustainable development. There are on going debates on the mechanism particularly on equity, fund management, additionality and fund for the disadvantage and vulnerable countries. There is a growing debate on the good and bad sides of the mechanisms but a general consensus is emerging on developing best ways of using the Kyoto Protocol mechanism for national benefit.

A number of workshops and meetings have been organized both by the government department and private sector policy and research organizations as well as NGOs. The most promising area for CDM projects in Bangladesh have been identified so far in the areas of energy, industry and transport sectors. The CDM project can be developed on the following areas.

a. Energy Sector: Advanced Turbines, Retrofitting Steam Turbines, Improvement of Power Transmission and Distribution, Cogeneration and Combined Cycle Power Plant and Introduction of Compact Fluorescent Lumps (CFLs) replacing incandescent bulbs;

b. Industry: Efficient Design of Brick Burning Chamber, Use of Natural Gas for Brick Burning, Continuous Digester for Pulp and Paper;

c. Transport: Large Scale Conversion of Vehicles to Compressed Natural Gas, Modal Shift from Road to Rail

Experiences with Activities Implemented Jointly (AIJ)

Internationally more than 150 AIJ pilot projects are in stage of implementation or planned for implementation. The ongoing projects have been accepted, approved and endorsed by the designated national authorities for AIJ of the host and investing countries. However, there is no AIJ project implemented by the government of Bangladesh and not even any project in pipeline.

The traditional international development agencies are giving significant portion of their assistance for infrastructural development, health and sanitation and education through government agencies and assistance for environment and development, sustainable livelihood system and natural resource management through government and private sector. The non-traditional development fund such as GEF is very little and insignificant that needed to explore for sustainable development and resource management.

Think Globally, Act Locally

Bangladesh is one of the most vulnerable countries to the impacts of climate change. There is an increasing awareness of the issues involving mitigation, adaptation as well as the roles of government, NGOs and private sector. The NGOs are particularly prominent in their contribution to the global debate on climate change, specially the opportunities and potential use of conventional development efforts which have climate benefits also. The non-traditional financial source may offer new opportunities for investment but there is emerging national debate which is critically analyzing many of the users involved.

Government of Bangladesh has initiated several policy actions which support activities under the climate convention, reduction of GHG and considerations on adaptation. Many of the key policies and actions are focussed towards the sustainable development goals. The water sector for example is initiating a process to integrate climate change scenarios. Energy sector policy has emphasized the role of renewable energy particularly Solar PV. The government in cooperation with NGOs has already established a solar village with over 900 household electrified by Solar PV. This has worked as a good demonstration and public awareness project. Further many houses of the poor are being electrified and appropriate micro-credit is being made available.

The existing analyses have shown the benefits of using compact fluorescent lump (CFL). New infrastructures are increasingly incorporating CFL into its matrix. Attempts are being made to replace the old ones. Market mechanisms of tax benefits are ongoing.

In the transport sector, the thrust of GHG reduction in from pollution control and threat of health hazards. A good example is the initiation of use of compressed natural gas (CNG) in place of gasoline/petrol. Experiments are in progress and initial result is attractive. Many of the new taxies in Dhaka City is on dual -fuel system of CNG and gasoline. The market response will determine the success of transfer to CNG. More efficient traffic management is also being developed. This will have some positive impact on GHG reduction and pollution control.

In Bangladesh, tree plantation has become a major annual event and festival involving government, NGOs and local communities. This is adding significantly to carbon sequestration potential as well as supply of nutrition for the rural poor by providing fruits.

In Chittagong, the second largest city and the port city of Bangladesh is undertaking an urban waste management project as recovering methane as a useful energy from landfill. The results will have a significant impact on urban planning, waste management and GHG reduction.

Synthesizing

In the country such as Bangladesh with high level of poverty, malnutrition, and low human development index, it is unlikely that climate change will be a central focus for policies and measures. However, there are many interesting, conventional as well as innovative options, polices and measures those can benefit GHG reduction, better adaptation and increase sustainable livelihood potential.

Widespread poverty and material deprivation characterize the economy of Bangladesh. The first and foremost imperative of any organized socio-economic activity at any level, government or non-government should therefore is to eradicate poverty. However, economic growth and environment protection does not necessarily conflict. Energy efficiency, emphasizing use of renewable energy, increasing efficiency in transport sectors etc. can be adopted that meet development needs and at the same time have long term environmental and climate benefits.

In spite of the issue of climate change, environment and resource management becomes important for sustainable development, which practically required integrated approach for accomplishment. The Fifth Plan enumerates 12 areas of major environmental concern and emphasizes their inter-linkages with the economy. Such areas include

> *degradation of agricultural resource base particularly land and soil, bio-diversity, biomass crisis, increased chemical use and resultant pollution, industrial pollution, deforestation, wetland and fisheries degradation, the ecological problems of the mangrove ecosystem, coastal and marine pollution, salinity, sanitation issues and environmental problems arising out of fast urbanization.*

The goals and objectives for a sound environmental health have the two overriding principles of poverty alleviation and balanced participation by all including men and women. It urges for (i) promotion of environment-friendly activities in development interventions, (ii) preservation and development of the natural resource base, (iii) control and prevention of pollution and degradation related to soil, water and air and (iv) creation of public awareness and institutional capabilities for managing environmental change. The government has already declared some areas as ecologically sensitive area and developing management plan to control further degradation of natural resources of those areas. Concept of community participation in resource management has already emerged and some demonstration projects are in place.

The Government has several policy pronouncements, management and action plans in place which may be used either directly or with suitable revisions towards attaining the above goals and objectives. In 1992, the Government announced the National Environment Policy which has its main objective of maintenance of ecological balance along with overall progress and development of the country and sustainable, long-term and environmentally sound utilization of all natural resources.

Other plans and programs include the National Environment Management Action Plan (NEMAP), a forestry policy and a recently prepared Forestry Master Plan, and a draft National Conservation Strategy (NCS) in its final stage of approval. There are other sectoral plans and policies which emphasize the interaction with environment and the containment of the adverse effects of resource development on

environment and ecology. Such plans, programs and policies include the Flood Action Plan (with emphasis on water resource management) and the National Energy Policy. There is also the Environment Conservation Act, 1995 under which various rules, regulations and guidelines have been published for its enforcement.

The government of Bangladesh is supporting a number of programs and projects to address environmental degradation and natural resource management particularly through stakeholders participation. The Ministry of Environment and Forest is implementing Sustainable Environment Management Program (SEMP), which is a follow-up implementation of NEMAP. SEMP is the largest environmental program of UNDP at global scale with a grant of US$ 26 million which has 26 components under five sub-programs such as Policy, Legislation and Institutions, Participatory Ecosystem Management, Community Based Environmental Sanitation, Awareness and Advocacy and Training and Education to mainstream the environment in collaboration with 17 line Ministries, 15 National NGOs and 3 international organizations including IUCN and the World Bank.

Institutional strengthening is essential and early actions are being taken by the government. The NGOs are however very active and imparting their actions, knowledge base and research output to affect both global and local policies and measures.

Bibliography

ADB, 1998. *Asia Lease-cost Greenhouse Gas Abatement Strategy, Bangladesh,* Asian Development Bank, Global Environment Facility and United Nations Development Programme, Manila, Philippines.

BBS, 1996. *Statistical Pocket of Bangladesh,* Bangladesh Bureau of Statistics, Government of Bangladesh.

BBS, 1997. *National Accounts Statistics of Bangladesh (Revised Estimates, 1989-90 to 1994-95),* Bangladesh Bureau of Statistics, Government of Bangladesh.

BCAS/BIDS/BUET/BUP, 1996. *Bangladesh Climate Change Country Study* under U. S Climate Change Country Programme, Bangladesh Centre for Advanced Studies (BCAS).

BCAS/RA/Approtec, 1994. *Vulnerability of Bangladesh to Climate Change and Sea Level Rise: Concepts and Tools for Calculating Risk in Integrated Coastal Zone Management.* Technical Reports Volumes I and II, Summary Report and Institutional Report. Bangladesh Centre for Advanced Studies (BCAS).

FMP, 1995. *Main Plan, Forestry Master Plan,* Government of Bangladesh, 1995.

International Energy Agency, 1997. *Key World Energy Statistics,* Paris.

World Development Report, 1997. *The State in a Changing World,* Oxford University Press, Inc. New York, N.Y. 10016.