ENVIRONMENT-FRIENDLY RENEWABLE ENERGY

Electrification through biogas

There is a huge possibility to produce electricity using biogas in Bangladesh, if proper research is carried out by research agencies, professionals and the implementing authority, i,e, the government.

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THE Renewable Energy Policy of Bangladesh, published in 2008, states that renewable energy will take a vital role for off grid electrification in the country. The main renewable energy resources in Bangladesh are biomass, solar, wind and hydropower. The hydropower potential of Bangladesh is low due to the relative flatness of the country. Wind power generation in Bangladesh has certain limitations due to the lack of reliable wind speed data and the remarkable seasonal variation of wind speed. The country has good prospects of utilizing solar photovoltaic (PV) systems for electricity generation, but the high capital investment cost is a big barrier for adopting such systems. Biomass is the major energy source in Bangladesh and biomass utilization systems represent a proven environment-friendly option for small- to medium-scale decentralized electricity generation.

Energy situation

Bangladesh's per capita energy consumption is very low. The 2008 energy consumption value stands at about 250 kgOE(oil equivalent), compared to 550 kgOE for India, 515 kgOE for Pakistan, and 430 kgOE for Sri Lanka. Total primary energy consumption in 2008 was 33.50 MTOE (million ton oil equivalent) and the energy consumption mix was estimated as: indigenous biomass 62%, indigenous natural gas 25%, imported oil 12%, imported coal and hydro together about 1%.

Contribution of biomass in total primary energy consumption of Bangladesh is around 60%. The major sources of traditional biomass are agricultural residues, wood and wood wastes, and animal dung, and their shares in energy supply are approximately 45%, 35% and 20%, respectively. Industrial and commercial use of biomass accounts for 14% of total energy consumption. 63% of energy required in the industrial sector comes from biomass fuel. Natural gas, Liquefied petroleum gas (LPG), electricity, kerosene and biomass fuels are used for cooking. In areas without natural gas and electricity, biomass is used to meet the household cooking needs.

Natural gas is currently the only indigenous non-renewable energy resource of the country, which is being produced and consumed in significant quantities since 1970. Gas, the main source of commercial energy, plays a vital role towards the growth of the economy of Bangladesh. The gas market is dominated by power and fertilizer (using gas as feedstock) sectors, which account for 46.65% and 21.71% of the demand, respectively. According to the 2008 BP Statistical Energy Survey, Bangladesh had 2007 proven natural gas reserves of 0.39 trillion cubic metres. Although the remaining recoverable gas reserve is enough for the time being, it is understood that there is significant field growth potential, as most of the state-owned gas fields have not yet been fully appraised.

Therefore, using biomass energy might be the sustainable option of using renewable energy to electrify the rural Bangladesh in this present context.

Biomass resources

The economy of Bangladesh depends principally on agriculture. The main crops produced are rice, sugar cane, vegetables, wheat, jute, pulses, coconut, maize, millet, cotton and groundnut. Agricultural crops generate large quantities of residues. Such residues represent an important source of energy both for domestic as well as industrial purposes. Other sources of biomass in the country are farm-animal waste and poultry droppings produced by the national herds, fuel wood from existing forests, tree residues and saw dust from the forestry industry. The 15 million citizens of Bangladesh produce huge amounts of human waste and municipal solid waste (MSW) annually.

Agricultural residues: There are two types of agricultural crop residues: field residues and processing residues. Not all field residues are recoverable. The percentage of field residues of a crop to be recycled onto the land depends upon the specific local climatic and soil conditions. There is no available specific data concerning the common practices in Bangladesh . However, in developed countries, it has been established that only about 35% of field crop residues can be removed without adverse effects on future yields. Crop processing residues, on the other hand, have a 100% recovery factor. Accordingly, it is estimated that the total annual amount of recoverable agricultural-crop residues in Bangladesh is about 42 Mtonne, of which 63% are field residues and 37% process residues.

Animal waste and poultry droppings: Manure from cattle, goats, buffaloes and sheep are the common animal wastes in Bangladesh. The quantity of waste produced per animal per day varies depending on body size, type of feed and level of nutrition. The average amount of droppings (on air dry basis) produced by broilers and layers are 0.02 and 0.03 kg/bird/day respectively. The recovery/collection factors for animal waste and poultry droppings were reported in many literature to be 60% and 50%, respectively. Accordingly, it is estimated that the total annual amount of recoverable animal waste and poultry droppings in Bangladesh is 20.619 Mtonne.

Human waste and MSW: The total rate of human waste generation by the 138.1 million citizens in Bangladesh has been estimated as 4.537 Mtonne of dry matter/year (corresponding to 0.09 kg/capita/day). The MSW generation rate in urban areas of Bangladesh is between 0.4 and 0.5 kg/capita/day. In rural areas of the country, the generation rate is only 0.15 kg/capita/day. Considering that human waste and MSW are 100% recoverable, the total annual amount of the biomass available from these two sources in Bangladesh is 14.793 Mtonne.

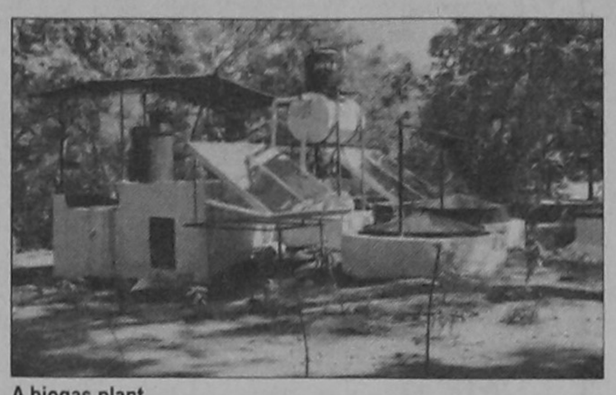
Forests and the forestry industry: Forest biomass includes tree components such as trunk, branches, foliage and roots. Tree trunks and main branches constitute what is commonly known as fuel wood. Twigs, leaves, bark and roots are tree residues. Both wood processing residues (e.g. sawmill off-cuts and sawdust) and recycled wood (e.g. that derived from the demolition of buildings, pallets and packing crates) are important sources of energy. The annual amount of such recycled wood, on a sustainable basis, is, however, not known. It has been estimated that only about 20% of a tree, initially harvested for timber, results in sawn products. The remaining 80% is discarded, in equal proportions, as forest residues and process residues (i.e. bark, slabs, sawdust, trimmings and planer shavings). Ply mills produce about the same amount of residues as sawmills. In 2004, 0.123 Mtonne of sawdust was available for energy purposes. Considering 100% recovery rate, the annual amount of recoverable biomass from forests and forestry industry in Bangladesh is 8.871 Mtonne.

Available for electricity generation

The total annual generation and recoverable rates of biomass in Bangladesh are about 165 and 9 Mtonne/year, respectively. In 2006, the biomass consumption for energy in Bangladesh was reported as about 350 pico-Joule (PJ). At an average annual growth rate of 1.3%, the consumption in 2010 will be about 370 PJ. The total available recoverable biomass energy of the country in 2006 was about 1250 PJ. Accordingly, in 2006, about 820 PJ of biomass energy was available for the generation of electricity. On the other hand, the total biomass energy consumption in 2006 was about 473 PJ. Assuming the same average annual growth rate of 1.3%, the biomass consumption in 2010 will be about 286 PJ. Therefore, the amount of biomass energy available in 2006 was 777 PJ, which is equivalent to 216 terawatt-hour (TWh). According to these two estimates and considering that the consumption of biomass for non-energy purposes is negligible, the annual available biomass energy potential for electricity generation in Bangladesh is in the range of between 216 and 250 TWh.

Prospects for electrification

Therefore, there is a huge possibility to produce electricity using biogas in Bangla desh, if proper research is carried out by research agencies, professionals and the implementing authority, i,e, the government. The government agency Infrastruc-ture Development Company Limited (IDCOL) sources said Bangladesh has 215,000 poultry farms and 15,000 cattle farms. By establishing biogas plants in these farms, electricity could be generated. So far 35,000 biogas plants have been established across the country and these plants are producing gas, which is being used for cooking purposes in the rural areas. The agency has set a target of establishing 60,000 biogas plants by 2012. One plant produces on an average 94.22 square feet gas. At present 33 lakh square feet biogas is being produced in the country daily. If this generated gas can be utilized properly, it can serve to produce about 1,000MW electricity and if the opportunity is utilized the growing shortage of electricity could be greatly met in this power-starved country.



A biogas plant.

However, the successful application and extension of this option depends on:

- Institutional measures -- close collaboration between sectors involved. This should include, among others, provision of soft term loans and/or subsidization of this technological option as an integral part of total sanitation programme, which currently prevail in Bangladesh;
- Availability of standard design for construction, and maintenance guidelines for the specific site, adopted to local socioeconomic condition;
- Meaningful public involvement -- should have objective to pass relevant information of this technology to the community, to increase awareness to maximize the acceptability of this technology; and,
- Prediction of realistic benefit of this technology.

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Impact of forest fragmentation on biodiversity

Different studies show that all our natural old forests have become critically fragmented to the point where they are considered unlikely to maintain rich level of biodiversity, nor support viable populations of natural and native species of flora and fauna.

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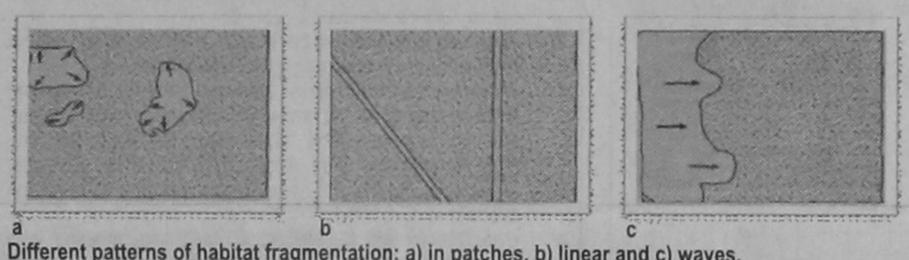
THE biodiversity hotspots of the globe contain a high degree of endemism and are undergoing gradual loss of habitats. Maximum portion of these hotspots are located in tropical forests, which are considered as the most endangered. Habitat fragmentation is one of the major causes of the biodiversity loss. Habitats can either disappear completely or they may become degraded and/or fragmented, both causing serious impact on biodiversity as well as ecosystem processes. Loss of natural forests and the fragmentation of remaining areas into progressively smaller patches is a significant global trend. The habitat fragmentation occurs in different ways, like in patches (e.g.), in waves (e.g. by urbanization) or linear (e.g. by construction of roads).

Tropical deforestation involves the conversion of continuous forest to the remnant of forest patches set in a matrix of non-forest vegetation. This manipulation of ecosystems has consequences for biodiversity at both landscape and fragment levels. The altered microclimate becomes unsuitable for certain species by reducing the fragment size further, increasing mortality rates near the edge and reducing recruitment to their populations. The tropical forest ecosystem is often characterized by a heavy dependency on mutualistic species interactions for its stability. Many plant species in the tropical forests are reliant on animals as agents of dispersal for either pollen or seeds or both. If habitat fragmentation causes the extinction of certain important pollinating or seed-dispersing animals, this severely limits regeneration of rare plant species and hence initiates an extinction vortex.

Both population size and species richness decreases as the habitat abundance decreases. Rare and patchily distributed species requiring a large range or specialist habitats seem particularly susceptible to fragmentation. With the decrease of habitat proportion, patch size decreases and between patches increases. Larger patches contain more species than do small patches. This occurs because small patches experience more extinctions (small populations are more vulnerable to chance events) and receive fewer immigrants. Patches that are more remote from the mainland or source population have fewer species because the extinction rate is the same but the immigration rate is lower.

Larger species may have trouble finding habitat in not sufficient density to support a home range in heavily fragmented forests. Factors such as fragment size, degree of isolation and time since excision from the continuous forest directly influence the biodiversity of a fragment. Species distribution patterns are usually patchy in the tropical forest landscape and this increases the likelihood of certain species being exterminated by fragmentation. As a fragment gets very small, populations fall below specific levels and extinction ensue. Small populations are more liable to fluctuations which inevitably include local extinctions; as they also tend to suffer from genetic drift and inbreeding.

The failure of many animals to move between fragments can also restrict the immigration of plant species when these animals include seed dispersers; gene flow is restricted if they are pollinators. If they do not cross open areas, they are unlikely to utilize fragmented habitats so the conservation value of isolated forest patches will diminish. Immigration is an important phenomenon for the maintenance of high local levels of diversity in tropical forests. In isolated fragments the rare species will die out relatively rapidly and not be replaced by other species because of a failure of immigration.



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Different patterns of habitat fragmentation: a) in patches, b) linear and c) waves.

Edge phenomenon in the physical environment may have direct effects on the forest community. Fragment edges are inhospitable to a majority of forest species. If certain animal or plant groups are more susceptible to local extinction through fragmentation than others, a change in community structure within the fragment is highly likely, which may ultimately lead to further changes and more extinctions, producing second and higher order effects. The deforested matrix of a fragmented landscape is often dominated by alien species, because few of the native species are tolerant of the extremely exposed conditions in the cleared areas.

Habitat fragmentation, introduction of exotic species, and management of exploitable systems tend to decrease species richness and heterogeneity. The alteration of land use pattern results in fragmentation of habitats, ecosystems and landscapes in most parts of the world. Different studies show that all our natural old forests have become critically fragmented to the point where they are considered unlikely to maintain rich level of biodiversity, nor support viable populations of natural and native species of flora and fauna. Encroachment, clear felling, illegal logging, lopping, shifting cultivation, zhum cultivation, urbanization, industrialization, agroforestation, land use change and agricultural expansions are the major causes of forest fragmentations.

Abundant species has become occasional, occasional become rare, rare become very rare and very rare become extinct. Once upon a time, Sal forests of Bangladesh were sweet home of beautiful Capped Langur ("Sonamukhi Bandor" in local language). It lives in group and the home ranges are large. The Capped Langur group wakes with the dawn, but they remain in their sleeping trees until the sun has fully risen. They need undisturbed and continuous natural habitats to live. Now it is threatened by habitat loss and fragmentation, and has become an IUCN- red listed species.

Large-scale habitat fragmentation and decimation of prey populations are the major long-term threats to the existence of the Royal Bengal Tiger population in the Sundarbans. Less than a hundred years ago, tigers prowled all across the Indian sub-continent. But increasing habitat loss and fragmentation have contracted the tiger's former range. Tigers need large territories for roaming and preying.

The Population Viability Analysis (PVA) predicts a 95% decline in the population of Western Hoolock Gibbons in Bangladesh over the next two decades based on the current effects of human impacts and habitat fragmentations. Asian Elephant once roamed across Sylhet to Chittagong Hill Tract. Now it is the largest critically endangered terrestrial animal in Bangladesh. The major causes of the decline in the wild elephant population in Bangladesh are habitat fragmentation and destruction, expansion of agriculture and human settlement.

There has been rampant habitat loss of Marbled and Fishing Cat throughout the Sal forests over the past 20 years. They are secretive, elusive and arboreal in nature, relying on the treetop canopy for both shelter and food. Marbled Cat prefers to prey squirrels, fruit bat, mice and rats living on tree canopy. These cats are also intolerant of other human disturbances and abandon a forest that is even moderately disturbed. Fragmentation of forest throughout Southeast Asia is occurring at an alarming rate to the peril of biodiversity.

The core of 'The Convention on Biological Diversity (CBD)' is the promotion of an integrated approach to natural resource management on large landscapes and to biodiversity conservation through enhancing wildlife habitat and reducing habitat fragmentation. In this context, the writer likes to propose an integrated approach which will include: a) introducing biological corridors; b) maintaining buffer zones in between core and peripheral zones; c) preventing fragmentation of land blocks and ecosystems; d) developing restoration programme in conjunction with local communities; e) involving indigenous peoples and traditional communities in conservation programme; f) strengthening forest monitoring, research and development, education, and capacity building to maintain a "cradle" of biodiversity within the core areas of each protected forests; g) halting the continued introduction of alien invasive species; h) gap filling by rare tree species; i) aforestation and reforestation by native and natural species; j) facilitating natural regeneration in degraded forests; k) leaving denuded forest lands as untouched for 20 years to promote natural succession of forests; l) stopping further clear felling and illegal logging; m) protecting natural regenerations (seedling, sapling and juvenile trees) from cutting; n) introducing pioneer and early successional species in the degraded forests; o) taking effective actions against the encroachers and land grabbers; p) establishing gene banks to conserve the gene pool of endangered species; and p) bringing endangered animals in captivity for breeding.

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Biodiversity disturbed by climate change

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EVERY species plays an important role in maintaining an ecological balance among the living systems of the earth. Loss of any species threats the survival of several species inclusive of man. Man's own survival depends on his willingness and ability to co-operate with the living environment as it provides critical benefits to humans. These benefits encompass ecosystem services, such as air, water, and soil purification, climate regulation, and the generation of moisture and oxygen. Human beings turn to biodiversity also for spiritual, psychological and cultural benefits. Biodiversity is aesthetically pleasing and provides opportunities for recreational activities.

Neither the earth can afford to replace these services if it is lost once nor these services can always be measured in terms of money alone (WRI, 2002). The direct economic benefits of biodiversity run into trillions of dollar per year (Constanza et al., 1997). It has much scientific value also. Scientists have gained medical knowledge and discovered important medical products by studying wildlife. Besides, we are normally and morally responsible to the coming generation to leave as an inheritance an unspoiled world with intact living beauty and richness.

How biodiversity is affected

Over the last 100 years atmospheric temperature has increased by 0.5 úC but in the next 50 years that is, by 2050, the temperature is projected to rise by 1.5ú to 2úC (IPCC 4th Assessment Report, 2007). This increased temperature is affecting precipitation intensity, pattern and distribution. It is also causing the occurrence of numerous climatic disasters with severe intensity and frequency. Scientists agree that an increase in the atmospheric concentration of greenhouse gases, such as CO2 and methane will result in an increase in global temperature and a change in the global distribution of precipitation that will eventually cause change in the global biodiversity pattern.

A model was developed by Hokdridge in 1997. According to the model, there will be a poleward shift of vegetation patterns. Approximately 30% of the vegetation of the Earth will experience a shift as a result of the predicted climate change. Although the climate change is expected to be significant, the major threat for biodiversity is the speed with which this change will occur. The rapid change in climatic conditions will hamper the ability of individual species to migrate to regions with climatic conditions similar to those of the present. Moreover, in Polar regions, the area favourable for the survival of individual species will be largely reduced. The reduction of suitable areas for a large number of species, and a change in climate faster than the migration rate of most species, is certain to result in a drastic reduction of global species diversity.

Climate change could bring increased frequency and destructiveness of hurricanes, more protracted droughts, longer and hotter waves, and more severe rainy periods and some where severe cold waves (Frolich, 2008) that will have tremendous impact on Earth's biological diversity. While there is clear evidence that climate change is altering the distribution of animal and plant pests and diseases, the full effects are difficult to predict. Changes in temperature, moisture and atmospheric gases can fuel growth and generation rates of plants, fungi and insects, altering the interactions between pests, their natural enemies and their hosts. All these will eventually take a toll on biodiversity (Parry and Jiachen 1991, Gates 1993).

Schlesinger (1998) predicts that rising temperature and precipitation will result in the expansion of boreal forests, but overall forest area is expected to contract, with grasslands and deserts increasing in extent. In North America, Europe, Asia and South Africa, desert and other areas of sparse vegetation may expand at the expense of grasslands, shrublands and prairies. The 1982-83 El Nino event gave Galapagos increased rainfall that barred many sea birds from breeding. As a result, the Galapagos penguin and the flightless cormorant populations were reduced by 49% and 77% respectively (Valle and Coulter, 1987).

Again tree species dependent on animals for pollination or seed dispersal may be affected by the changing ranges of animal species. Populations located near the edge of a species' range, narrowly endemic species, and endangered species that exist only in reserves or other extremely limited habitats, are especially vulnerable to global vegetation shifts.

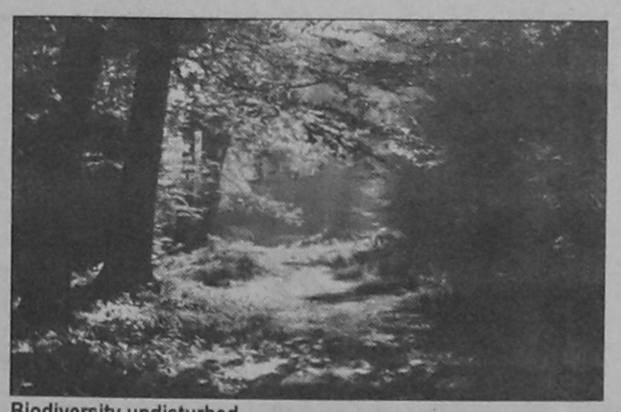
Alexander (1992) notes that the melting of sea ice could also affect marine mammals that use ice floes for rest, travel and reproduction. Rising ambient temperature may result in decreased fertility and fetal survival in mammals, fish, reptiles and invertebrates that are subject to environmental sex determination may also be affected directly by rising temperatures. For example, higher temperatures produce more males of alligators and crocodiles and more females of some turtles... (Head et al. 1987).

Dr. Mohammad Ibrahim, a prominent scientist notes that about 40% of about 44 thousand species of the world are at stake due to climatic and other disasters (Ittefaq, July 7, 2009). The 2005 Millennium Ecosystem Assessment estimates that by the end of this century, climate change will be the main cause of biodiversity loss. The Intergovernmental Panel on Climate Change (IPCC) reports that a significant number of species will be at risk of extinction as the global mean temperature increases.

Existing limitations and suggested actions

Here an attempt is made to present the existing problems and to suggest some actions in conservation of biodiversity under the projected scenario of climate change.

- §Still there is much lack of quantitative data as to the climate change impacts on biodiversity how much biogene, species, and ecosystems are being lost due to climate related disasters? Which species are facing endangeredness and extinction and at which rate and where in particular? How much species are vulnerable to climate change at present and will be in future if climate continued changing at present rate? So, it is now exigent to carry out sufficient scientific researches to assess the impacts of climate change on biota.
- Global concerns such as climate change and loss of biodiversity require concerted efforts among various stakeholders and institutions at local, national and international levels along with close association among other Multilateral Environmental Agreements (MEAs).
- Awareness raising and communication materials on biodiversity conservation and climate change should be developed and awareness building and information dissemination should be done globally about biodiversity and the ways to conserve biodiversity under the present stress of climate change through advertisement in mass media, documentary films and other means of propaganda and motivation.
- Development of international and national biodiversity conservation strategy and actions plan taking climate change and other threats to biodiversity into account is a must. Hopefully, in line with the Convention on Biological Diversity, different countries of the world have already developed National Biodiversity Strategy and Action Plan (NBSAP). Necessary support-- both financial and technical -- from the international community should be made, if necessary, for the sound implementation of NBSAP in respective countries.



Biodiversity undisturbed.

Concluding remarks

Under the present circumstances of climate change and climate change-induced disasters, the future of the floral and faunal kingdom looks very bleak. If it can't be preserved, this world would be a virtual paradise lost. But to save the earth's living kingdom from the impact of climate change, climate change mitigation is simply an urgency. Time is just running out. Less than 40 days left world leader are scheduled to meet in the 15th UNFCC in Copenhagen (December 7-18, 2009) for adopting a climate change agreement. In case of formulating effective international measures, there must be clear-cut policies and actions for climate change mitigation. In that biodiversity protection deserves highest priority.

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