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Sustainable Tourism Development in Darjeeling Hills of West Bengal, India: Issues & Challenges

By Dr. Sherap Bhutia
Chandernagore Government College, India

Abstract- At present tourism has been seriously considered in the national sustainable development strategies of many developing countries and placed on the agenda of many international conferences on Sustainable Development/ Tourism in a broader sense has existed for a long time in this Hill region of Darjeeling in West Bengal. The tourism activities are still in its conventional state, not put in the track of modern concept though efforts are being made to give it the real shape under eco-tourism but no avail. Sustainable tourism development provides the opportunity to take proactive approaches based on broad participation by stakeholders, which would contribute to more effective policies and plans. Based on secondary sources, literature search and discussions with key stake holders and interaction with the tourist, the existing tourists' scenario and situation were studied. The information collected from different sources has been verified with the field experience. Darjeeling receives around 3.5 lakhs domestic tourists annually, besides 50,000 foreigners.

Keywords: *sustainable tourism, eco-tourism, tourist.*

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Abstract- At present tourism has been seriously considered in the national sustainable development strategies of many developing countries and placed on the agenda of many international conferences on Sustainable Development/ Tourism in a broader sense has existed for a long time in this Hill region of Darjeeling in West Bengal. The tourism activities are still in its conventional state, not put in the track of modern concept though efforts are being made to give it the real shape under eco-tourism but no avail. Sustainable tourism development provides the opportunity to take proactive approaches based on broad participation by stakeholders, which would contribute to more effective policies and plans. Based on secondary sources, literature search and discussions with key stake holders and interaction with the tourist, the existing tourists' scenario and situation were studied. The information collected from different sources has been verified with the field experience. Darjeeling receives around 3.5 lakhs domestic tourists annually, besides 50,000 foreigners. The present study attempt to identify the major issues and challenges of the region regarding its natural resources which can be utilized in a proper scientific manner through a planned natural resource management with active participation of local people and other government and non-government organizations in a sustainable manner. The major conclusion that has emerged from the present study is that the overzealous and unplanned growth of tourism and limited infrastructure in the Darjeeling hills of India is identified and it has been suggested that sustainable tourism development should be properly adopted to arrest further environmental decay and encourage a new approach to planning in the region.

Keywords: *sustainable tourism, eco-tourism, tourist*.

I. Introduction

Tourism comprises the activities of persons travelling to and staying in places outside their usual permanent places of residence for not more than one consecutive year for leisure, business and other purposes. Based on this definition, tourism industry includes all socio-economic activities that are directly involved in providing services to tourists. Tourism turns the largest industry worldwide in terms of employment and gross domestic product. The tourism industry has been growing rapidly as well as changing at a fast pace. As more people are interested in spending their holidays in nature, ecotourism as well as rural tourism has become one of the segments of the tourism industry. This creates opportunities in areas characterized by natural attractions, wildlife and wilderness habitats, agriculture, farm stay, local craft, bird watching, local cuisines etc. Local communities may benefit in economic terms as well as create an employment opportunities and commitment to conservation and sustainable development.

The principles of sustainable tourism were envisaged by the World Tourism Organisation in 1988 as "leading to management of all resources in such a way that economic, social and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity and life support systems". Sustainable tourism has been defined as development that meets the needs of today's tourists and host regions, while protecting and enhancing opportunity for the future.

Darjeeling in West Bengal is one of the most magnificent hill resorts in the world. It conjures visions of snow peaks, serenity of vibrant green hills steeped in splendor, a land of breathtaking beauty crowned by the majestic Himalayas and attracts young, adventurous and enthusiasts across the age groups. The tourist spots and attractions in the region are serene, pristine and hub of adventure, leisure and special interest tourism. The tourism products of Darjeeling and adjoining areas are Tea Tourism, Toy Train-a World Heritage product, Trekking, Water Rafting, Bird Watching Tour, Butterflies Tours, Forest Safaris and Wellness Tourism.

II. Significance of the Study

Everyone should have the right to travel, should they choose to, and be able to explore even the farthest edge of the globe. Accessible tourism certainly makes this more possible. It gives those with accessibility needs, as well as their traveling companions, more options to choose from. It strives for equality and helps make the world a more open place. It is a focused journey to natural areas to understand the history of environment, without altering the genuineness of the ecosystem, while producing economic opportunities that make conservation of natural resources beneficial to the local people.

The economic and social factors are closely interrelated, as the economy can provide the infrastructure and investment required for human development. Consequently the significance of tourism for people can be examined by how positively economic

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and social factors impact on each other. As society becomes more mobile and prosperous tourism will become increasingly significant for people.

Tourism is now one of the world's largest industries and one of its fastest growing economic sectors. The expected growth in the tourism sector and the increasing reliance of many developing countries including small regions like hill region of Darjeeling District, depends on this sector as employment generating mechanism and contributor to local, national and regional economies which highlights the need for special attention to the relationship between environmental conservation and protection and sustainable tourism development. In this regard considerable mechanisms are required of national and international financial institutions and capacity building training facilities for better implementation and management. Darjeeling being one of the oldest tourists spot in the country has been under tremendous set back due to manifold reasons. The tourism activities are still in its conventional state, not put in the track of modern concept though efforts are being made to give it the real shape under eco-tourism but no avail. There is conspicuous lacking coordination between government agencies like forest department, government run tourism department, public works department, Darjeeling Improvement Fund, the District Administration and the Municipality so far as sustainable tourism development is concern. They all seem to work in the area but all are in complete isolation and that has resulted in absence of conformity in their work.

All the hill towns are overcrowded with concrete building and people with their money and muscle power pushing aside all the existed public amenities to disappear like public toilets, park and gardens, resting places etc. to give way to mushrooming up of illegal constructions all over the hills.

III. Aims and Objectives

The literature review identified a number of gaps and weaknesses in the existing literature on tourism development in destination regions. The overall aim of this study was to build upon these resources by analyzing a sustainable tourism development in the study region not just factors associated with failure, but also factors that contribute to success.

The present paper is structured to elucidate with the following main objectives:

a) to explore the status of tourism in Darjeeling hills and its impact on economy.
b) to explore the tourism that acts to promote local economy, socio-cultural changes and life style of the people residing in and around the tourist locations in Darjeeling hills.
c) to explore the reasons for which the foreign and domestic tourists visit the destination for recreational and leisure purposes and also to gain experience from art, culture, lifestyle etc, which in turn create a tremendous impact on local economy.
d) to identify the issues and challenges for sustainable tourism development in the study area.
e) to examine the sustainable tourism development and suggestions for future prospects.

IV. Materials and Methods

The study has been based on empirical observation available from different reports, various journals, and e-journal. Collection of available literature, detection of situation in the place of importance was gathered through personal observations and, collection of related information's. Observations were made based on news reports, interaction with some of the local people associated with tourism and tourist, discussions with some of the Officials, NGOs, travel agencies etc. who are actively working on tourism. The nature of the present research work is explorative and the whole work has been done by descriptive as well as analytical methods.

V. Location of the Study Area

The area chosen for study has been delineated as cultural region where the elements in the landscape are closely interrelated. Darjeeling is the northernmost district of the frontiers state of West Bengal, extending between 26°27'10" to 27°13'05" North latitudes and 87°59'30" to 88°53'00" East longitudes, at an altitude of 2134 mts. This district consists of four sub-divisions. These are Darjeeling Sadar, Kurseong, Kalimpong and Siliguri. The Hill Areas of Darjeeling have first three sub-divisions, which are considered for the study area with the total area of 2477.83 Sq. kms. in 2011.

Darjeeling is actually a widespread district although the popular Darjeeling hill town is the nucleus of the place. The name *'Darjeeling'* came from the Tibetan words '*dorje*' meaning thunderbolt (originally the scepter of Indra) and *'ling'* is a place or land, hence '*the land of the thunderbolt*'. With it's temperate climate, magnificent nature all around, Darjeeling came to be called as 'Queen of the Hills.'

Darjeeling hills is formed of comparatively recent rock structure that has a direct bearing on landslides. The Himalayas serve as the source of natural resources for the population residing in the hills. A mountain terrain with its varied geologic, physiographic, climatic and other environmental conditions offers a wonderful geographical area, for the study in detail. This is more so in mountainous areas like Darjeeling Hills, inhabited by simple societies where environment articulates to a great extent to determine the socio-economic aspects.

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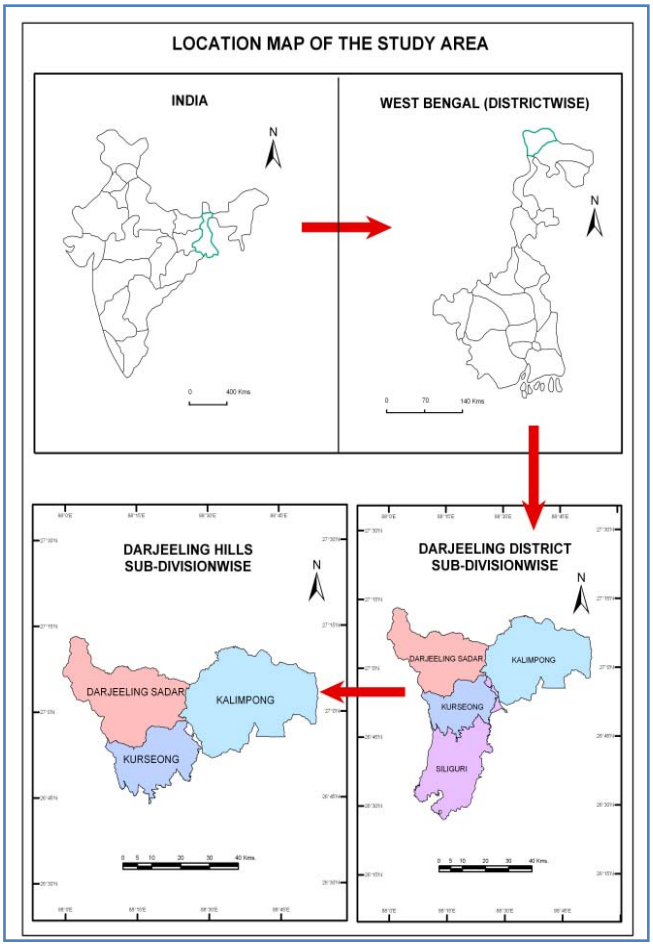


Figure 1 : Map showing location of the study area

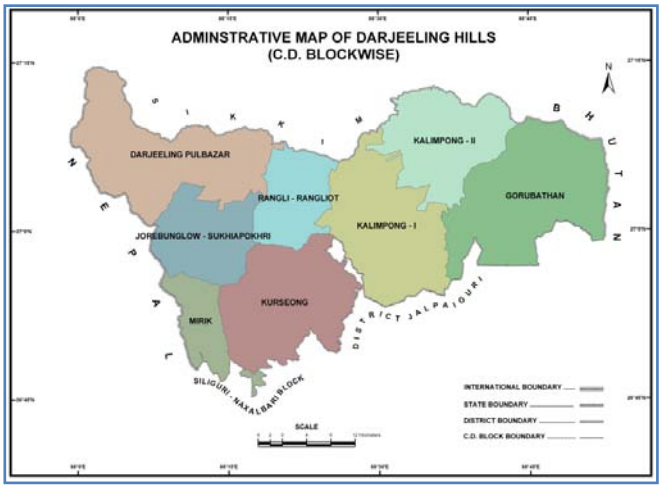


Figure 2 : Map showing administrative divisions of the study area

The Darjeeling Hills consist of eight Community Development Blocks or C.D. Blocks which include 311 inhabited villages and 31 uninhabited villages as per 2011 census. The total population of the study area during 2011 is 8,75,703 persons, of which 583639 persons are rural and 2,92,064 persons are urban. This hilly region is bordered by Sikkim in the north, Bhutan in the northeast, Nepal in the west and Siliguri Sub-Division and Jalpaiguri District in the south. Darjeeling is located in the Lesser Himalayan range and provides beautiful views of the mighty Himalayas, especially Kanchenjunga the world's third highest mountain peak.

Table 1 : Administrative Divisions of Darjeeling Hills

Name of Sub-Division	Name of C.D. Block	Area in Sq. Km.	Rural Units			Urban Units		
			Inhabited Village	Unhabited Village	Total Village	Municipal Town	Non-Municipal Town	Total Town
Darjeeling Sadar	Darjeeling-Pulbazar	426.57	47	1	46	1	1	2
	Rangli-Rangliot	272.99	29	-	29	-	-	-
	Jorebunglow-Sukhiapokhri	222.12	47	-	47	-	-	-
Kalimpong	Kalimpong-I	369.14	44	7	51	1	-	1
	Kalimpong-II	241.26	33	6	39	-	-	-
	Gorubathan	442.72	27	11	38	-	-	-
Kurseong	Mirik	125.68	21	-	21	1	-	1
	Kurseong	377.35	65	6	71	1	1	2
Darjeeling Hills		2477.83	311	31	342	4	2	6

Source: District Census Handbook, Darjeeling, 2011

VI. Importance of Darjeeling Hills

The hill areas of Darjeeling District is important both from ecological and economic point of view. As a matter of fact, ecosystems of Darjeeling hills require special considerations for their preservation, eco-conservation and development and not the same methods applicable to the development in plain areas which are entirely different. Various parameters such as agro-climatic complex and the biota are peculiar and typical in the study areas. Darjeeling region being in high altitudinal zones are of special and further interest with regard to their highly specialized conditions, and adaptations of plants, animals and human life in these remarkable eco-zones. A rich heritage of social, cultural and spiritual values in the areas is still preserved here and deserves protection. Inhabited by several ethnic and religious groups, Darjeeling Hills is characterized by

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religious harmony, racial and linguistic tolerance and regional amity.

Darjeeling is one of the most magnificent hill resorts in the world. Perched at a height of 2,134 metres with a backdrop of the mighty Himalayan peaks, Darjeeling has attracted generations of visitors to sample the joys of cool, healthy gracious and adventurous living. This heavenly retreat is bathed in hues of every shade. The flaming red rhododendrons, the sparking white magnolias, orchids, the miles of undulating hillsides covered with emerald green tea bushes, the exotic forests of silver fir – all under the blanket of a brilliant azure sky dappled with specks of clouds, compellingly comfounds Darjeeling as the "Queen of Hill Stations".

Darjeeling, nestled among rolling mountains, is a perfect destination for outdoor enthusiasts. Popular places to visit include Tiger Hill, Batasia Loop and the War Memorial, and the Himalayan Zoological Park and Snow Leopard Breeding Center, tea gardens and many more. The majestic ranges in Darjeeling hills are unforgettably beautiful, every possible variety of form and colour is theirs, waterfalls break into a thousand rainbows and relentless glaciers wind their ways down into dark precipices, while through narrow winding gorges mighty rivers carry their message into distant plains.

There is no finer place than Darjeeling to step in the grandeur and beauty of the towering snow capped Himalayas where man has added to nature's bounty. From numerous points in the town we get view of the mountains, scarcely rivalled in any part of the world. Set against the majestic backdrop of the great Himalayas, there is lovely verdure everywhere – evergreen woods, firs and pines. Even the institutions, museums, botanical and zoological gardens of Darjeeling offer delightful experience to visitors. Besides attracting ordinary tourists the place offers excellent trekking routes in the downhills to Maneybhanjan (1,969 mts), Tonglu (3,071 mts), Sandakphu (3,630 mts) and Phalut (3,596 mts). The dense forests, the verdant meadows, the savage mass of Mt. Everest, the everlasting beauty of Kanchenjunga, the rugged Lhotse or the mysterious Makalu all in one sweeping glance, present an experience that can never be equaled.

Darjeeling Tea is world renowned for its flavour. It is the best tea producing areas not only of India but also of the world. Besides the saga of toy train i.e. Darjeeling Himalayan Railways, which is also a UNESCO World Heritage Site further makes the town more magnificent with highest Ghum Railway Station, which is situated at an altitude of 2,258m.

VII. Historical Background

Darjeeling continues to be a popular holiday destination in India, owing to its scenic beauty and pleasant climate. Apart from tourism, Darjeeling is also popular for its many British style public schools, which attract students from across India and even neighbouring countries. When Darjeeling was acquired by the British as a potential summer resort, it was practically uninhabited. The process of development it into a 'hill-station' commenced around 1835. Over the next 15 years, the town had grown sufficiently for the authorities to consider it reasonable to set up a municipality to look after the provision of civic amenities. Darjeeling Municipality was thus set up in 1850 when population of the town was around 10 thousand. Population in the township now exceeds more than one lakh and its pressures already exceed urban carrying-capacity.

The beginning of urbanization, therefore, had an innocuous look and it had no pretension of starting on a big scale. The present site of Darjeeling became the first choice for the establishment of a town at a time when urban development was too uncommon a feature to be found until one came down to the plains. Urbanization having its original seat at Darjeeling had its influence felt in the surrounding region and this, coupled with the introduction of the tea industry, took an active role in the colonization of the region.

The development of Darjeeling as a health resort and a frontier station as well as the progress of tea industry could not take place without the development of a transportation system. The construction of roads began, and by 1840 a road between Pankhabari on the foothills and Darjeeling was completed. Between 1849 and 1852, the old military road linking Pankhabari with Kurseong, Dow Hill, Ghoom and Darjeeling was completed. The construction of another road, i.e. Darjeeling Hill Cart Road was completed in 1865. The roads providing direct access into the hill areas made way for the encroachment of settlements and the rate of development was further accelerated by subsequent improvement in the transportation system in the following years when, in 1881, the railway line was extended upto Darjeeling providing uninterrupted traffic between the hills and the plains.

VIII. Sustainable Tourism in Darjeeling Hills

The concept of sustainability arose from the recognition that the earth's limited resources could not indefinitely support the rapid population and industrial growth as economic development moves to reduce poverty and increase standards of living among all countries. Although it is recognized that tourism can be beneficial to the natural environment by promoting environmental conservation, tourism also has a negative impact on the environment. It is increasingly a concern of the public sector to pay more attention to the

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protection of the natural environment. Most tourists wish to visit areas that are attractive, functional, clean and not polluted. Tourism can provide the incentive and means to maintain and, where needed, improve the environmental quality of areas. A high level of environmental quality is also very important for the local residents to enjoy. Tourism can help make residents more aware of the quality of their environment and support its maintenance and, where necessary, improvement. Tourism and the environment are strongly linked and interdependent. If tourism continues to grow, ways must be found to improve the relationship between the two, making it more sustainable.

The varied landscape, eternal weather, and the slopes with tea plantations make up most of tourism in Darjeeling. There is a variety in scenic attractions that tourists would come across here. It has a stronghold on the map of India for being a place having highest tea exports. Thus, tea tourism in Darjeeling calls for thousands during the plucking season when women in the fields are plucking the leaves. The aroma in the hills engulfs international visitors. It conjures visions of snow peaks, serenity of vibrant green hills steeped in splendor, a land of breathtaking beauty crowned by the majestic Himalayas and attracts young, adventurous and enthusiasts across the age groups. Urban tourism in the Darjeeling hill is shared to a certain degree by two other centres-Kalimpong and Mirik, the first of which developed with British initiative, while Mirik is avery recent development, likely to get stretch seems to have lacked the proper spirit todevelop as a tourist place in spite of its beautiful attraction for Kalimpong has visiblyincreased. Further, there are quite a few spots like Lava, Mongpu, Algara, Munsung and Pedong around Kalimpong offering the serenity of the misty mountains.

If tourism development is to be sustainable it must move away from its traditional growth-oriented model to one concerned with a sustainable set of goals and principles. All forms of tourism can either be considered sustainable or not. Sustainable tourism must be seen as a goal in tourism development. Achieving such a goal is a difficult task to accomplish; however, developing tourism in a sustainable manner must be an important objective in the developing process.

There are many stakeholders in the field of sustainable tourism. The major areas include; the host community, governmental bodies, tourism industry, tourists, pressure groups, voluntary sector, experts, and the media. It is essential that all stakeholders work together towards the common goal of developing tourism in a sustainable manner. Tourism development activities are in general related to the overall economic and social sector. So tourism concerns a great deal of inter-sectoral dependence and coordination.

IX. Tourist Inflow in Darjeeling

Darjeeling also known as the "Queen of the Hills" has some of the most attractive tourist attractions which results in inflow of large number of tourists each year to enjoy a vacation in this beautiful city in West Bengal. Darjeeling owes' its grandeur to its natural beauty, its clean fresh mountain air and above all, the smiling resilient people for whom it is a home. Known for its natural splendor, Darjeeling's best gift to its' visitors is the dawn of a new day.

Table 2 : Monthly tourist Inflow in Darjeeling during 2012-13 & 2013-14

Month	2012-13			2013-14		
	Domestic Tourist	Foreign Tourist	Total Tourist	Domestic Tourist	Foreign Tourist	Total Tourist
April	48823	2034	50857	49042	1966	51008
May	82076	1085	83161	72988	945	73933
June	66730	468	67198	65434	425	65859
July	17511	609	18120	13395	430	13825
August	14521	687	15208	488	28	516
Sept	15151	1100	16251	5988	548	6536
Oct	45824	2511	48335	30334	2178	32512
Nov	41481	2029	43510	21860	3729	25589
Dec	39293	1181	40474	31051	3018	34069
Jan	25081	930	26011	22694	711	23405
Feb	18273	1170	19443	18719	973	19692
Mar	39518	2296	41814	45729	1527	47256
Total	454282	16100	470382	377722	16478	394200

Source: Department of Tourism, Gorkhaland Territorial Administration, Darjeeling

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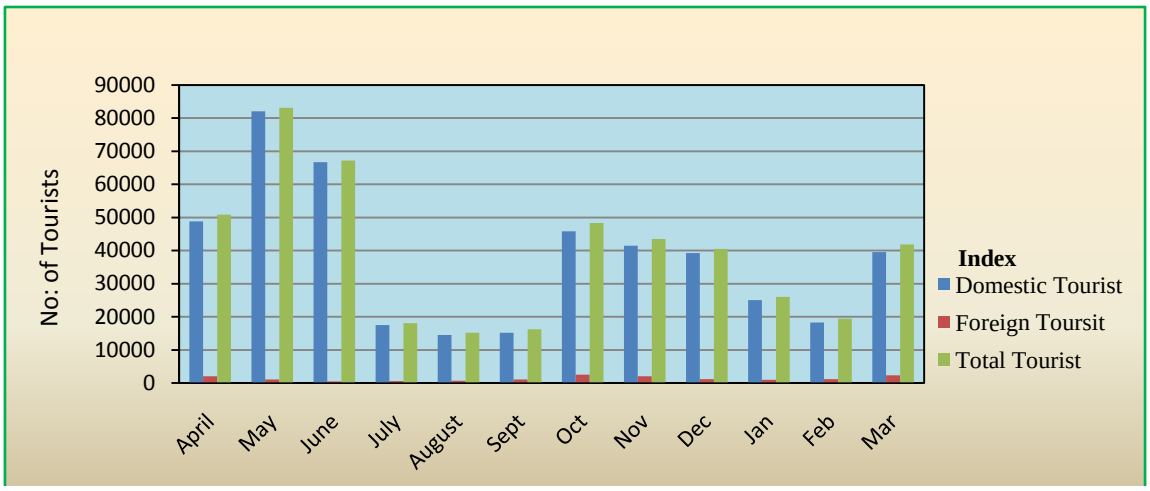


Figure 3 : Bar diagram showing tourist inflow in Darjeeling during 2012-13

The figure 3 & 4 shows the tourist arrival in Darjeeling during different months for the year 2012-13 & 2013-14. A statistics from the Tourism Department, Gorkhaland Territorial Administration, Darjeeling shows that there had been 4.7 lakhs tourists in the year 2012-13 while in 2013-14 the figure has shot up to 3.9 lakhs including both foreign and domestic tourist. Tourism is one of the largest net earners of foreign exchange in Darjeeling nest to tea. The Domestic tourist visits to Darjeeling have decrease from 4.54 lakhs in 2012-13 to 37.7 lakhs in 2013-14 (Table 2). The Foreign Tourist Arrival has increased from 16.1 thousands in 2012-13 to 16.4 thousands in 2013-14 at a compounded annual growth rate of 2.34%. The domestic tourist visits maximum in the month of May-June and the foreign tourist use to visit specially in the month of October-November. The diagram further implies that during the time of tourist season especially in summer and winter, the growth in number of both domestic and foreign tourist sharply increases.

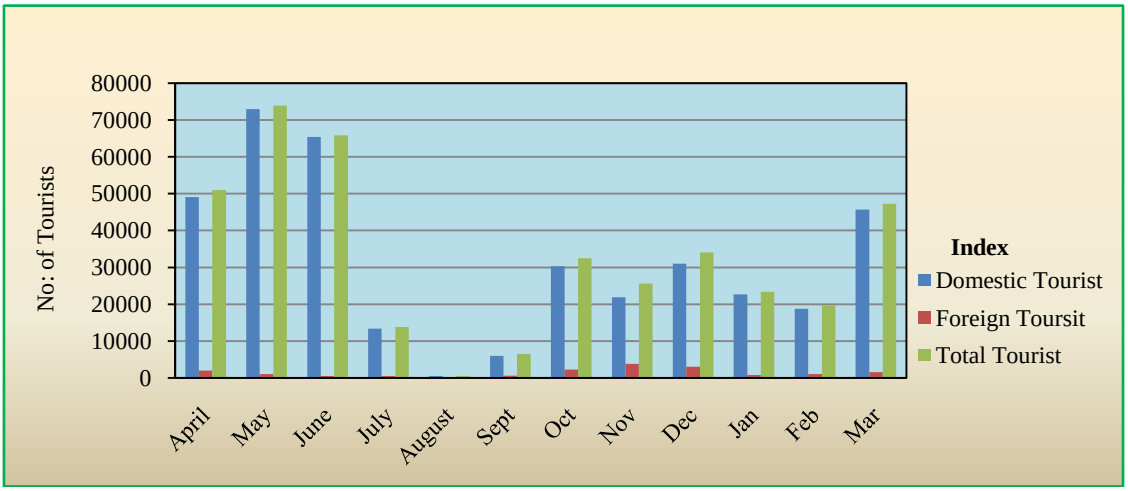


Figure 4 : Bar diagram showing tourist inflow in Darjeeling during 2013-14

During the season, the tariff and rate of hotel and vehicles also increases and the income of those who are attached to tourism also increases tremendously. Unplanned expansion of tourist accommodations, resorts and shopping areas constantly displace the local population and consequently lead to a sense curtailment of housing amenities.

X. Issues of Tourism

Tourism is an important fast growing smokeless industry of Darjeeling Hills. It plays a vital role in the economic development of a region. It brings about changes in the life style and attitudes of the local inhabitants. This is only possible if tourism is taken proper care of and is well organized and developed. Though tourism offers great scope but it still in infancy. It is the most viable but also the most neglected of all resources of the region. But tourist business is mainly confined in Darjeeling and it occupies a prominent place from the view point of scenic beauty. Darjeeling emerged as an important tourist center since British times. It also came up as a health resort.

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The vast panorama of scenic beauty and grandeur, the majestic view of the mighty snow capped ranges with jutting peaks, exhilarating climate, varied and rich flora and fauna, gushing streams all attracts the attentions of visitors. The tourist spots and attractions in the region are serene, pristine and hub of adventure, leisure and special interest tourism. Besides, scenic attraction, the rugged terrain provides ample scope for a wide variety of sports and adventure like trekking, climbing, rafting and riding etc. A land of breath taking beauty crowned by the majestic Himalayas, it is one of the most magnificent hill resorts in the world. The flaming red Rhododendrons, the sparking white Magnolias, the miles of undulating hillsides covered with emerald green tea bushes, the exotic forests of silver fir, all under the blanket of a brilliant azure sky dappled with speck of clouds, compellingly confronts Darjeeling as the "Queen of the Hills".

Tourism is an important economic activity of hill areas of Darjeeling District generating incomes and employment for the local population. Darjeeling receives around 3.5 lakhs domestic tourists and 50,000 foreign tourists per year that generates near 30% of total tourism business of the region worth around Rs 350 crore per annum. Everybody right from a chaiwala upto the hotel owner benefits from the tourism. Apart from an increase in the income and the demand for local products, tourism also results in a multiplier effect. This refers to the way in which tourist expenditures filter through the economy and generate other economic activities. The multiplier effect is based on the concept of interdependency of different sectors of the economy the result of which is that any change in the host economy's level of output, income, employment, government revenue and foreign exchange flows will be greater than the value of the initial change. The multiplier is expressed as a ratio of change in one of the above variables to the change in tourist spending that brought it about. In addition to its contribution to economic growth in the host economy, the labour intensive nature of tourism and tourism related industries results in a significant impact upon the level of employment in this sector. Income and employment generation are the most obvious positive impacts of tourism.

The facilities and services deteriorate sharply during the peak season as the amenities available cannot cope up with the huge rush. There are shortage of drinking water, electricity cut, deterioration of municipal services, congestion in public transport and lack of accommodation all these leading to a chaotic condition. Not only the visitors are inconvenienced and put to unnecessary tensions, even the local inhabitants get exasperated. Demand for more tourist accommodation and provision of service industries associated with tourist activities need more space. Mushroom growth of hotels, shops, restaurants, have defaced much of the pristine glories of the hill station for which once it was so famous. Uncontrolled urban growth, high-rise building construction, over-looking government regulation, dumping of dirt and filth has robbed the scenic beauty. Uncontrolled and widespread falling of trees for the urban expansion have not only defaced the scenic beauty and grandeur but has caused the imbalance in the ecological set up.

During the peak season, the visitors are greatly inconvenienced by soaring prices. Not only the essential commodities are in the short supply but the traders also charge undue prices. Even the hotel charges fluctuate according to the demand. The private transport owners demand higher fares and accommodate more passengers than the available capacity. Service conditions in the hotel deteriorate sharply thereby affecting the valuable customers. The porters and guides take their opportunity to charge higher rates. Thus, the tourists go with a bad impression and sometimes lead to social tensions and occasional crimes and vices. Though most people look upon tourist as a means of making a living, it is seen that the assets of tourism do not belong to the people. When it comes to running hotels it is the people from the plains who run these hotels or lease them. And in the rural areas there is very little or no people who are involved in tourism, so the question of them benefiting does not even arise. The only ones who benefit are the travel agencies.

Inspite of so many adverse effects of tourism in the Darjeeling hill areas, there is not denying the fact that the economy of Darjeeling relies on the three 'T's, Tourism, Tea and Timber, among which the Tourism plays the vital role. In order to revive the glories of the past, recouping the sagging trade and certain measures are essential so that the tourist get the maximum comforts and go back with happy memories. Preservation of the already damaged environment, creation of biospheric reserves like Sandakphu, creation of park, wildlife sanctuaries, trekkers traits and resting are important step to the development of tourism in hill areas of Darjeeling District. There should be an improvement of the existing condition and facilities, conservation of urban amenities and provision of better transport facilities and the development of infrastructural facilities, the provision of modern tourist facilities etc.

Darjeeling excels in tourism but much of its vast potential still awaits exploitation. The area is, however, ecologically fragile and under severe pressure due to the demands made on environmental resources by growing tourist traffic and rapid urbanization. Tourism, here a purely seasonal activity, shows an economic weakness because the people are out of employment during the slack season. The whole region, therefore, needs a proper policy and planning for fullest and efficient exploitation of the existing tourist industry. The development of Tourism in the hill areas of Darjeeling is necessary but it should not proceed at the cost of the ecological balance. Therefore, "Development without

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Destruction" is the only way for a sustainable solution of Global Harmony. Thus it may be safely be concluded that the role of tourism in the Darjeeling hill areas needs to be re-evaluated which should be followed up by judicious action by the locals and the authorities involved.

XI. Challenges of Tourism

Tourism has to a great part contributed to the excessive and unchecked development around shrines. Sustainable Tourism development can have both positive and negative impacts on destinations. Sustainable tourism development attempts to find a balance between these impacts to create an improved quality of life for the host community and the destination. The major attraction of the Queen of the Hill Station for the foreign tourists is the existing trekking route to Sandakphu and Phalut. But the existing facilities offered to trekkers are extremely limited and scheme had been undertaken under the Hill Development Programme in order to improve existing accommodation facilities at Tanglu, Sandakphu and Phalut.

In the past 30 years, the continual expansion of the population deeper into the hills has already left a passive trail of devastation - tourist hotels some as high as six-eight storey perch on cliffs, an expanding road network on unstable hillsides, commercial activity along new tourist routes, loss of tree cover, expansion of agriculture into forests, and a rain of garbage along hillsides.

In the past no organized effort has been taken for the promotion of tourism in Darjeeling Hills. Development of tourism in this region was taken in hand in the Fourth Five-Year Plan. The West Bengal Tourist Development Corporation and Bengal Tourism Department has undertaken various development schemes in order to provide better facilities to the tourists in the three hill towns of Darjeeling District (i.e. Darjeeling, Kalimpong & Kurseong) under the Accelerated Hill Development Programme. The problem of accommodation in Darjeeling has been solved to some extent by the construction of a 46-bed youth hostel and the extension of the Darjeeling Tourist Lodge during the Fifth Plan Period. Tiger Hill, the next attraction in the region now has a Tourist Lodge which had been undertaken during the Fourth Plan Period from where the tourists can enjoy the beauty of sunrise. In order to provide the cheap accommodation for the low budget tourists the repair and the renovation of Lowis Jubilee Sanatorium has been undertaken during the Fifth Plan Period. A Tourist-Reception Centre-cum-Tourist Office had been constructed at Darjeeling in order to provide the facilities to the tourists.

Tourist flows in Darjeeling has been increased in recent years due to the various developmental schemes which are undertaken under the Hill Development Programme. Generally the tourists are of two types: (i) Foreign Tourists and (ii) Domestic Tourists. In case of foreign tourists, Darjeeling captured only a smaller percent who visited India. After the Sinu-Indian border conflict in 1962, visit of foreign tourists has been restricted in this region. The actual figures about the foreigners are not available. But one thing is true, that their numbers are increasing every year. A large proportion of foreign tourists comes from Germany, Canada, U.K., U.S.A., Japan and Australia. Besides these foreign tourists, a large number of domestic tourists visit Darjeeling every year. Since there are no rules and regulations to record the visit of domestic tourists, it is very difficult to make any good estimate about them.

Excessive development of tourism in Darjeeling Hills especially in town areas has begun to destroy those attributes which attract the visitors. In order to alter this situation it is required to divert a portion of tourist inflow to different other areas of Darjeeling Himalaya by promoting successful tourism in those areas. Most of the tourists flock to Darjeeling during the months of April, May, June and October. During these four months Darjeeling gets 60 to 70 percent of its total tourist inflow. It is during these periods, Darjeeling has to bear enormous pressure of tourists. The transport fleet of the Tourism Department is providing valuable service to tourists during the seasons. They offer coach facilities to tourists from Bagdogra and NJP Railway station to Darjeeling and vice versa. In addition, conducted tours are also organized to Mirik and local sightseeing around Darjeeling.

Tourism in Hill Areas of Darjeeling District offers the greatest scope for development. It is roughly estimated by the Tourist Bureau of Darjeeling that approximately at present, more then four lakhs tourists from different parts of the world as well as the country visit Darjeeling every year and the Tourist Business occupies a prominent place from the view point of scenic beauty. Inspite of so many adverse effects of tourism in this tiny hill tract, there is no denying the fact that the economy still rests on its occupancy. The tourism potential, if properly planned can become a source of further income and regional development. Further expansions of tourist trade are immense if conceived on long-term perspective.

XII. Concluding Remarks

Tourism is the other important sector where Darjeeling Himalaya and its adjoining lowland have a comparative advantage. It is one of the important contributors to the regional economy. It is a growing sector and is growing relatively faster. This sector is, however, yet to be properly regulated and efficiently diversified. Of late massive mass tourism pouring across the urban spaces of the Darjeeling Hills coupled

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with weak regulatory mechanism and inadequate institutions have been the cause of serious environmental concern. In order to accommodate the influx of mass tourists many new hotels, buildings, roads and such other infrastructure facilities are constructed across the hills degrading the environmental situation therein. Diversification of the tourism into eco-tourism, adventure tourism, cultural tourism, religious tourism, nature tourism etc is a welcome step. Such ventures should, however, need to be rationally planned and scientifically managed.

Tourism is widely recognized as the world's largest industry. Yet tourism is also highly dynamic and is strongly influenced by economic, political, social, environmental and technological change. The flow of money generated by tourists' expenditure finds its ways into the overall economy through the effect of multiplier. Tourism has earned considerable recognition as an activity, generating a number of social and economic benefits like promotion of national integration and international understanding, creation of employment opportunities, removal of regional imbalances, augmentation of foreign exchange earnings etc. Tourism in Darjeeling Hills is essentially encouraged for economic reasons, as it promises cash-flows into remote mountain regions having little economic opportunity, generates local employment, holds back the procedure of depopulation in the marginal areas and finally corrects regional imbalance.

Tourism aims to meet higher social and environmental goals. It has been observed that communities located near the major attraction sites such as nature parks, reserves, historical sites, etc should have the opportunity to participate in tourism related activities. Local people can be employed in hotels, restaurants, shop, transportation, guide and escort service and other tourist facilities and services. The area is, however, ecologically fragile and under severe pressure due to the demands made on environmental resources by growing tourist traffic and rapid urbanization. Environmental stress is evident from the degradation of forests and deforestation due to an increased demand for fuel-wood and timber, air pollution because of an increasing reliance on motor vehicles, and lack of basic urban infrastructure such as water supply, sanitation, and solid waste management systems.

The overzealous and unplanned growth of tourism in the Darjeeling hills of India is identified and the following questions addressed: whether tourism development should be pursued at the cost of natural environmental decay through large scale deforestation; whether a large influx of tourists during the peak season, in excess of the carrying capacity of the region, is causing immense hardships for the local population in terms of unnecessary pressure on basic amenities and community services; and whether sustainable tourism development should be adopted to arrest further environmental decay and encourage a new approach to planning in the region. The evolution of tourism in the region is described, and a methodology for applying an environmental impact assessment introduced. In a bit to improve its tourism industry in Darjeeling, planners, managers, tour operators and the public should work collectively and effectively in various directions that are related to tourism.

XIII. Strategy for Sustainable Tourism Development & Suggestions

a) Tourism should support a wide range of local economic activities, taking environmental costs and benefits into account, but it should not be permitted to become an activity which dominates the economic base of an area.
b) The conservation and sustainable use of natural, social and cultural resources is crucial. Therefore, tourism should be planned and managed within environmental limits and with due regard for the long term appropriate use of natural and human resources.
c) Local communities should be encouraged and expected to participate in the planning, development and control of tourism with the support of government and the industry. Particular attention should be paid to involving indigenous people, women and minority groups to ensure the equitable distribution of the benefits of tourism.
d) All organisations and individuals should respect the culture, the economy, the way of life, the environment and political structures in the destination area.
e) All stakeholders within tourism should be educated about the need to develop more sustainable forms of tourism. This includes staff training and raising awareness, through education and marketing tourism responsibly, of sustainability issues amongst host communities and tourists themselves.
f) Research should be undertaken throughout all stages of tourism development and operation to monitor impacts, to solve problems and to allow local people and others to respond to changes and to take advantages of opportunities.
g) The industry has to organise training programmes and borrow the knowledge from experts to deal with all these issues, regular monitor and measuring the impact will indicate Quality level of achievement to protect environmental degradation. Environment protection should be the organisational culture.
h) Tourism being a highly labour intensive industry, there should be an integrated HRD system with both public and private sector participation to develop human resources to meet the requirements of the industry.

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i) There is also need for refresher training courses for the staff of the tourism industry. Proposals for running such courses by private institutions including non-governmental organizations should be encouraged and supported.

j) It is high time that the Government, after reviewing the growing tourist arrivals and the socio- economic benefits of the tourism phenomenon, accord it the status of a priority sector. The Government should also ensure more resource allocation for the overall development of this sector.

k) In view of the growing trends in the industry and the need for human resources, the Government should set up an Expert Committee comprising of human resource development (HRD) professionals, people from the tourism industry, prominent economists and intellectuals to study and assess various aspects of HRD and come out with a national policy on HRD in the tourism sector.

l) Forest cover has to be improved as per the National Forest Policy direction that hill station like Darjeeling should have 60%forest cover of its total geographic areas.

m) Wildlife depletion has to be checked and to be increased in its number by appropriate conservation programmers and improvement of other infrastructures as stated above at the earliest.

n) Seminars, conference and workshops, should be conducted to discuss the problems and prospects of tourism and development at the local, national and international level.

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Renewable Energy Context, Scope, Application and Green Business in Bangladesh

By Professor Dr. Kazi Abdur Rouf
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Abstract- Energy is inevitable for development and its demand is increasing day by day. Energy is essential and important for human life. However, energy from fossil fuel (coals, diesel, kerosene, wood etc.) generates carbon, carbon dioxide emissions, green house emissions that pollute air, and destroy environment resulted global warming that's harmful to living beings and nature. Hence energy scientists are looking for alternative energy resources uses that are environmentally friendly and good for human being. They are provoking for renewable energy (solar radiation energy, bio gas energy, wind energy, water wave energy, CNG energy and hydropower energy) use because PV technologies produce very small amount of CO2 compared to the emissions from conventional existing fossil fuel energy technologies. Therefore, renewable energy (RE) uses is less harmful to living beings and environment (air, water and land). This paper talks about fossil fuel energy and renewable energy use and their consequence and impact respectively in the nature and society.

Keywords: *Bio gas, climate change, fossil fuel energy, grameen shakti, green house gas emission, global warming, renewable energy and solar panel.*

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Renewable Energy Context, Scope, Application and Green Business in Bangladesh

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Abstract- Energy is inevitable for development and its demand is increasing day by day. Energy is essential and important for human life. However, energy from fossil fuel (coals, diesel, kerosene, wood etc.) generates carbon, carbon dioxide emissions, green house emissions that pollute air, and destroy environment resulted global warming that's harmful to living beings and nature. Hence energy scientists are looking for alternative energy resources uses that are environmentally friendly and good for human being. They are provoking for renewable energy (solar radiation energy, bio gas energy, wind energy, water wave energy, CNG energy and hydropower energy) use because PV technologies produce very small amount of CO_2 compared to the emissions from conventional existing fossil fuel energy technologies. Therefore, renewable energy (RE) uses is less harmful to living beings and environment (air, water and land). This paper talks about fossil fuel energy and renewable energy use and their consequence and impact respectively in the nature and society. In the paper, the author incorporates his working experience with Grameen Shakti (GS) and the collected data from different RE implementing organizations in Bangladesh during his visit to Bangladesh in 2014-2015.

The paper identifies different RE resources and different RE projects undertaken in the world particularly Bangladesh. The study explores RE resource utilization different business models, programs, and their benefits in Bangladesh. The study finds Bangladesh has developed a Government managed private apex organization named IDCOL (Infrastructure Development Company), which is involved in coordinating, counselling and financing to the RE implementing agencies in Bangladesh. The study discovers Grameen Shakti, a sister organization of Grameen Bank, is the largest RE implementing organization not only in Bangladesh, but also in the world. GS has developed a micro-utility RE financial model that has disseminated to the IDCOL partnered RE implementing agencies in Bangladesh. The RE implementing agencies apply the GS micro-utility financial model in their own programs in Bangladesh. However, RE resources like solar panels, biogas plants, wind pumps etc. are expensive for the low income people. The RE technologies need further improvement for to not only more handy at the micro level, but also valuable at the economic scale.

Keyterms: Bio gas, climate change, fossil fuel energy, grameen shakti, green house gas emission, global warming, renewable energy and solar panel.

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I. Introduction

It has been alarming the global warming is increasing because of fossil fuel CO_2 emission and other greenhouse gases consequences climate change. Now carbon emission, green house emissions are serious issues for environment pollution and climate change that have been forefront to the global community. Today's development in the advanced countries has resulted in global climate change and massive environmental damage. Many programs have already been initiated throughout the world in order to reduce GHG emission, which enhances mainly the utilization of renewable energy technologies. It is evident that the protection of climate and environment is only possible through complete reliance on renewable energy technologies. Environment and climate issues thus, have been significant considerations before many of the countries (EU countries, Japan) for the application of PV systems. So, large PV applications will have to be seen from the perspective of clean energy development and environmental protection. Bangladeshi people especially rural people and many industries are suffering from electrical power and energy. However, Bangladesh has huge renewable energy (Solar, biogas, and wind pump etc.) potentials because of its geophysical condition. Rural people of Bangladesh depend on biomass, crop residues, plant debris, animal dung and wood for fuel creating deforestation, flood, soil erosion and health hazards etc. to living beings. Women and children, on whom the burden of collecting fuel falls, suffer the most. They are the worst victims of indoor air pollution such as smokes in the kitchens. The combustion of non-renewable fossil fuels like petroleum, natural gas and coal produce the greenhouse gases up to the level which causes the rapid rise of global temperature. Research shows the renewable energy sources release very negligible amount of CO_2 to the atmosphere.

Many NGOs, private agencies and public institutions are involved in renewable energy green businesses and earn income by selling renewable energy products to people in Bangladesh. The paper studies the context of renewable energy in Bangladesh, its scope and applications there. The research also discerns renewable energy business models that exit in Bangladesh. In the paper, the author incorporates his working experience with Grameen Shakti (GS) and the

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collected data from different RE implementing organizations in Bangladesh during his visit to Bangladesh in September 2014-April 2015.

II. Environmental Issue

Green house gases (CO_2 Ch_4, and N_2O) emitted in burning of different types of fuel lead to air pollution, environmental pollution and global warming. GHG emissions factors are mostly due to CO_2 are shown below.

Table 1 : GHG emission factor

Item	GHG emission factor
Kerosene	2.5 ton CO_2/ton
Wood/straw	1.7 ton CO_2/ton
Diesel genset	1.3 ton CO_2 /MWh
Diesel	0.897 ton CO_2/MWh
Bangladesh grid (natural gas 90%)	0.452 ton CO_2/MWh
Natural gas	0.452 ton CO_2/MWh
Hydro, Solar, Wind	0

Source: SWERA, 2007

The gradual increase of global temperature and its consequences affect Bangladesh, risen the sea level of Bay of Bengal. It is because of climate change and because of radiant energy leaving the planet is naturally retained in the atmosphere. The concentration of the atmospheric gases slowly increases and helps to rise temperature. This issue is being termed as global warming, which accelerates the earth's climate change. The earth's average surface temperature, which has been relatively stable for more than, 1,000 years, has risen by about 0.5 degrees Celsius in the past 100 years. The nine warmest years in the 20th century have occurred since 1980 and 1990s were probably the warmest decade of the second millennium (IPCC, 2001). Carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) are naturally formed trace gases produced by the burning of fossil fuels, released by living and dead biomass, and resulting from various metabolic processes of microorganisms in the soil, wetlands and oceans. Along with these gases, chlorofluocarbons, bromofluocarbons including their hydrogenated forms (CFC, BFC, HCFC, and HBFC) have potential to accumulate heat from solar radiation, which are reflected from the earth's crust at longer wave length (Ahmed, 2005). The gas wave lengths are increasing due to both human and natural reasons, and contributing to global warming.

The anthropogenic activities include mainly the production and consumption of fossil fuels, as well as the intensification of agricultural activity changes in land use and land cover. Energy production and use, the largest sole source of CO_2 emissions and a large contributor of CH_4 and N_2O emissions, accounted for 81.7 percent of emissions in industrialized countries in 1998 (UNFCCC, 2000). Another estimate shows that the earth's atmosphere receives around 27,000 million tons of CO_2 in the recent years. As a country the USA is the largest CO_2 emitter in the world, which releases 5,729 million tons of CO_2 every year with 19.7 million tons of per capita emission, and the nearest contributor is China which releases 3,719 million tons with 2.9 million tons of per capita emission. Carbon dioxide, the greenhouse gas largely blamed for global warming, has already reached a record-high level in the atmosphere (Hanley, 2004). It has increased by 30% in the last 200 years as a result of industrial emissions, automobiles, and rapid forecast burning, especially in the tropics. Much of these have taken place since 1960. From 1973 to 2006, the emission of CO_2 has increased at a rate of 79.05%. Other pollutants (e.g. SO_2) are also released at high level from the combustion of coal.

III. World Energy Situation

Among the renewable sources, large hydropower all over the world plays an important role (approximately 80%) among renewable, and contributes around 20% of the total energy generation. But the use of hydropower is no longer increasing due to environmental limits throughout the world (Sorensen, 2005; European Commission, 1997). Hydropower is the largest (17%) renewable resource used for electricity generation. More than 150 countries are producing hydroelectricity by constructing dams. Nepal, India and China have a huge potential in hydropower generation. Among them, Nepal and India have economically exploitable hydropower potential of 84,000 MW and 34,000 MW respectively (Arya, 2001; Khera and Singh, 2001). Moreover, China has already installed a massive hydroelectric project known as Three Gorges Dam with an installed capacity of 18,000 MW and also plans to install larger plants in the near future (Kabir and Endlicher, 2012).

Many developed countries including some developing countries are adopting large scale investment in RETs since the global reserve of non-renewable sources like petroleum, gas, coal etc. gets reduced. Global renewable energy (wind power, solar hot water, geothermal heating, and off-grid solar PV capacity) increased at a rate of 15-30 percent annually during the period 2002-2006. Mass production of electricity using RE has recently been familiar throughout the world. UN predicts that 50% of the world's population now live in cities and this figure will be 60% in 2030. Over 75% of energy consumption is directly related to cities and per capita energy consumption is increasing fast in many cities especially in the developing countries (The world Watch Institute, 2007). The fasted growing energy technology in the world is grid-connected solar PV (growing capacity by 60% per year from 2000-2004), to cover more than 400,000 rooftops in Japan, Germany, and the United States. The average annual growth of PV market over the last 15 years is 30 percent. Table-2 shows World

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Energy generation, supply, consumption and CO_2 increasing trend from 1973 to 2006.

Table 2 : Comparison of World Energy related Data (1973 and 2006)

Category	Year 1973	Year 2006	Growth % 1973-2006
Primary energy supply	6,115 Mtoe	11, 741 Mtoe	92.00
Final energy consumption	4,672 Mtoe	8,8084 Mtoe	73.03
Electricity generation	6,116 TWh	18,930 TWh	209.52
Electricity consumption	439 Mtoe	1,347 Mtoe	206.83
CO_2 emission	15,640 Mtoe	28,003 Mtoer	79.05

Source: Prepared from International Energy Agency (2008).

Table -3 provides information on fossil fuel emission produced from different fuel sources.

Table 3 : GHG Emission Factor

Fuel mixed grid electricity production contains huge CO_2, CH_4, N_2O emission.

Fuel Type	Fuel Mix	CO_2 emission	CH_4 emission	N_2O emission	Fuel conversion efficiency	GHG emission factor
	%	Kg/GJ	Kg/GJ	Kg/GJ	%	(tco2/MWh)
Small hydro	4.9%	0.0	0.0000	0.0000	100.0%	0.000
Natural gas	90%	56.1	0.0030	0.0010	45.0%	0.452
Diesel (#2 oil)	5.1%	74.1	0.0020	0.0020	30.0%	0.897
Electricity mix	100%		-	-	-	-452

Note: Global warming Potential of GHG
1 ton CH_4= 21 tons CO_2
1 ton N_2O= 310 tons CO_2
The GHG emission from electricity production of 20062 MKwh in 2004 is 9 million tons. The emission is increasing with the years.

Source: RETScreen analysis in SWERA report 2007.

With availability of effective bright roof areas, satisfactory global irradiation and sunshine duration, the environmental concerns are very practical and pragmatic consideration for the installation of the photovoltaic systems. As a result, countries with capacity of technological innovation and strong economy have emphasized on harnessing energy from the renewable resources. The Kyoto Protocol prescribed that countries largely contributing to GHG emission could take part in emission trading, clean development mechanism and joint implementation to reduce their shares of GHG emission. Germany, Japan, Netherland etc. are some of the industrialized countries, which have been shown their obedience to the protocol since it was adopted.

IV. Energy Concern

a) Bangladesh Energy Concerns

Before 2006, only 40% people of the country are connected to grid electricity and the rest depend mostly on biomass energy, kerosene and diesel powered electricity. Remote villagers and coastal energy users are suffering from energy use. Most of the households do not have access to electricity as there is no power distribution network in the coastal areas. Kerosene is the most common fuel used by the households for illumination purposes. Price of kerosene is often subject to fluctuations with price going up in the event of scarcity of supply. The quality of light from kerosene lamps is poor and not adequate enough for all purposes. Besides, it pollutes the household environment through emission of smokes and is also hazardous. The households have to use dry cell for running different appliances like radio, emergency lighting. The price of dry cell is relatively high. This causes extra financial burden to the household budget. Recently there is a scarcity of biomass fuel for cooking in Bangladesh. The scarcity takes serious in the rainy season because biomasses are under water.

Small-scale private generators are in operation in some markets to provide electricity to the shops for limited hours, usually after the evening. The commercial shops in the non-electrified market places use kerosene lamps, candles, etc. which are not found suitable for their activities. The electrified shops face problems of load shedding, irregular supply of electricity and poor service by the utility agencies.

Most of the industrial units and irrigation pumps located in the coastal areas have no access to the grid-based supply of electricity. They are run by diesel. The diesel engines are facing many mechanical problems. The electrified industrial units suffer due to load shedding, non-cooperative attitude of the utility agencies and their poor service quality. Load shedding

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and frequent interruption in the supply of electricity affect the industrial units adversely causing a cut in production and revenue.

Although Bangladesh is also not a big contributor to global greenhouse gas emission, the imminent consequences of climate change in the country are likely to be higher due to sea-level rise and frequently occurring catastrophes. Meanwhile the country has experienced massive destruction due to severe cyclones in the south and frequent flood events, which are reported to be the result of global climate change. It is evident (experts' opinions) that due to the accelerated industrial growth of the developed countries, relatively low-lying countries (e.g., Bangladesh, Maldives) are getting more vulnerable to climate change.

b) Dhaka Mega City Energy Problem

The population of Dhaka City was 6.15 million in 1991. The number of inhabitants in the Dhaka Mega City rose to 14 million in 2008 (2015) now it is 17.9 million. Unofficially the number would be higher than formal statistics. With the dramatic growth of the size of the city population, the demand for energy consumption has also been increased manifold. However, the power situation is not satisfactory at all. The whole system of electricity distribution is poorly managed and continues with more than 30 percent system loss mainly through illegal connections (Alam et al. 2004). Power supply is quite inadequate compared to its peak demand in summer. Dhaka Megacity is supplied around 1, 000-1,200 MW, of electricity against the peak demand of nearly 2,000 MW. The country as a whole continues to have 1,500 MW of deficit, while Dhaka City lacks more than 500 MW.

In Dhaka, the total number of households is reported to be 1,796, 950 where 1, 6252,525 of them are identified as urban and the rest 144,425 are rural households (BBS, 2006). Electricity connections in these households are increasing over the decade. In 1991, the electricity connected households were 74% which increased to 88.76% in 2001. More than 10% households of Dhaka are still without electricity connection. The electricity demand of Dhaka Megacity is increasing at an alarming rate every year due to the rapid growth of population along with the growth of electricity connectivity. Currently the demand is around 1,500-2,000 MW, but DESA can supply a maximum of 1,000-1,200 Mw, which is not satisfactory to the existing demand. As a result the city experiences huge load shedding. The good news is the present government take huge steps to install nuclear plants for electricity generation and made agreement with India for quick rental electricity supply. Although the city has 0.8 million domestic gas connections, many of the households are still without gas connections including slums. Recently compressed natural gas (CNG) has drastically changed people`s transportation system and mobility in the city. Now all vehicles use CNG as their fuel. City dwellers are buying cars that contribute to air pollution in Dhaka city (Hosssain and Badr, 2005).

Nearly 40% of the population of Dhaka Megacity is the slum-dwellers. In 2005, the slum clusters identified in Dhaka Megacity was 4,966, which shared 3.4 million people out of city's nearly 9.1 million (CUS et.al. 2005). Slum population rises to 5.2 million out of total 14 million in 2009. Within the DCC wards (134.282 KM^2), their informal settlements have occupied nearly 10km^2. Nearly 96% of these slum communities are provided with grid electricity with obvious poor connection facilities. The entire households of the slum settlements 3-5 MW electricity can be generated from the off-grid SPV systems. Electricity crisis can immediately solve by nuclear power plant. But the problem would be with the disposal of highly radioactive wastes, although nuclear power would be increasingly important source of the world`s electricity mix (Doman, 2004).

V. Why Need Renewable Energy

Reduction of global greenhouse gas emission to seize global warming requires minimizing the use of fossil fuels. To achieve this, a large scale use of renewable energies must be made over the globe for production of electrical and thermal energy. World resources of oil, gas, and coal are limited and there is a global concern about this but, for Bangladesh the situation appears to be extremely unhappy as per capita reserve of fossil fuels is only 1/50th to 12/100th of world per capita.

According to a recent study by the World Health Organization, around 46,000 people die every year in Bangladesh from exposure to indoor air pollution caused by inefficient traditional cook stoves, with 70% of the victims being children under age of five years. Around 90% of the households in Bangladesh uses biomass fuels and low efficiency stoves for cooking resulting incomplete combustion and corresponding Indoor Air Pollution (IAP) through emissions of greenhouse pollutants and particular materials. It causes severely adverse health impacts which are particularly acute for women and children who are the most exposed groups to indoor air pollution.

The rapid growth of population, industrialization, urbanization and standard living of people demanded for energy and electricity lights. The production and consumption of global energy are still dominated by the non-renewable energies (petroleum, natural gas and coal). These non-renewable energies are mostly used for electricity generation. In 2005, electricity generation worldwide was 17,450 TWh, out of which 40% was generated from coal, 20% from gas, 16% from nuclear, 16% hydro, 7% from oil and only 2% from renewable sources such as geothermal, solar, wind and waste

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(Evans et al. 2008). The total electricity generation in 2006 was 18, 930 TWh in which the contribution of coal, gas, oil, nuclear, hydro and renewable was 41%, 20.1%, 5.8, 14.8%, 16% and 2.3 respectively. In 1973, oil (24.7%) and coal (38.3%) made the major contribution in electricity generation. The generation and consumption of electricity have both increased at a rate of more than 200% during 1973-2006 (International Energy Agency, 2008). Fadai (2007) reported that the exploitation of exhaustible non-renewable energy sources results in environmental deterioration, and the renewable energy sources are likely to serve the globe with negligible environmental threats compare to fossil and nuclear fuels.

CO_2 Emissions in Bangladesh

SWERA (2007) finds GHG (Green House Gas) emission from electricity grid (20,062 MKWh) is 9 million tons. By 2020 electricity demand should be doubled and CO_2 emission would be around 18 million tons.

The Table 4 : shows (IEA, 2003) CO_2 emission energy production in Bangladesh

Description	Quantity of emission
Energy-related Carbon Dioxide Emissions	32.9 million tons
Per capita energy consumption	4.0 million Btu
Per capita carbon dioxide emissions	0.23 tons

At least 89% of air emissions associated with electricity generation could be prevented if electricity from photovoltaic displaces electricity from the grid. Fthenakis et al. 2008 and Scheer, 2002 reported that the impending damage to the earth by fossil fuels can only be protected with a solar-based economy. Renewable energy emission of CO_2 is very low. Technologies on wind power generation have been reported as the lowest CO_2 emitter. Hydro and solar PV systems also have low emissions, with average reported values at less than 100g/kWh CO_2 (Evans et al. 2008).

a) Large Electricity Deficit in Bangladesh

The country had an initial installed capacity of 5,202 MW (current rerated capacity- 4,000 MW mainly due to ageing of infrastructures), while average electricity generation at present is around 3,700-3,800 MW against the present demand of over 5,000 MW (BPDB, 2009; World Bank and GTZ, 2009). Alongside; however, the country's electricity demand is increasing over 500MW each year (Stromsta, 2009).

Therefore, Bangladesh has been suffering from energy crisis. Huge load shading, lack of sufficient energy for agricultural irrigation is because of energy crisis. Heavy industries in Bangladesh cannot be developed because of energy crisis. Before 2000s, rural people use biomass fuel for cooking. 50% energy obtained from biomass energy in the rural areas. Indigenous gas (available within the field), oil (petroleum and coal (few from Bangladeshi coal mines and imported) are the major source of primary commercial energy in Bangladesh. Hydroelectric energy sources are managing by the public sector which is very limited and inefficient. The country's power is being mostly generated with conventional fuel (82% indigenous natural gas, 9% imported oil, 5% coal) and renewable sources (4% hydropower and solar). According to Bangladesh Bureau of Statistics (BBS, 2006), around 32% people of the country had electricity connection, and around 4% have natural gas supply. Currently around 40% people are connected with electricity grid. But still 60% people throughout country are still remaining without electricity (Kabir & Endlicher, 2012). However, the annual GDP growth of electricity is gradually rising (BBS, 2006). The electricity connection statistics show more disparity between urban and rural areas. In the urban areas, 70.32% households are connected with electricity, while only 29.68% of the rural households are having electricity connection (BBS, 2006).

The emission of carbon-dioxide in Bangladesh in 2004 was 37.17 million tons and the per capita emission was 0.25 tons. Nevertheless, traditional use of biomass, such as, burning wood, agricultural residues, dung, and livestock along with industrial emission, automobiles are the sources of GHG emission in the country. These gases cause indoor air pollution and health hazards to the people (Uddin et al. 2006). In the energy sector, the two largest greenhouse gas emitters are electricity generation and non-energy use (Urea fertilizer production). These sectors emit approximately 50% of the country's total GHG emission (Alam et al. ND.)

Bangladesh is one of the most disaster prone countries in the world, and is vulnerable to various devastating disasters like cyclone, tidal surge, sea level rise etc. The imminent consequences of global warming due to increase of GHG emissions will certainly affect the deltaic Bangladesh. The country has experienced with massive coastal cyclones and saline intrusion. It is predicted that in the near future, more severe impacts are likely to happen if immediate measures are not undertaken. This tremendous power shortfall and air pollution drives for alternative energy (solar home systems) exploitations in Bangladesh. Solar home systems (SHSs) has covered more than 2.2 million households providing at least some lighting (February, IDCOL, 2015).

b) Greenhouse Gas Emission Reduction in Dhaka

Dhaka is one of the most polluted cities in the world. The concentration of CO_2, other oxides of carbon, nitrogen, sulphur and other pollutants have already crossed the danger level in the sky of Dhaka Megacity.

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Emission from industries, brick kilns and automobiles are the major sources of the city's pollutions. In Dhaka, there are around 5,000 slum and squatter clusters where more than 3.5 million people live (CUS et al. 2006). In most cases, the slum dwellers burn crop residues, wood, furnace oil, kerosene for cooking and domestic power, which cause massive indoor air pollution and poisonous gases including CO_2. In order to reduce the emission from the automobiles, the two-stroke engine autos have already been banned from the city, but practically this is not enough to make the situation sustainable. Most of the non-renewable sources (petroleum, natural gas, coal) emit large extent of greenhouse gases. The renewable sources like solar PV system, wind turbines release very low greenhouse gases, which can play a significant role in improving the atmospheric condition of the Megacity of Dhaka. In order to reduce the greenhouse gases to global warming, there is an urgent need of the RETs utilization in Dhaka Megacity.

Table 5 : Fossil Fuel Reserves

Country/World	Gas Trillion cft	Oil million barrels	Coal million tons
Bangladesh	20	5.5	2295
World	5016	1,30, 444	10,967,373

One million ton of coal is to be extracted per year from Barapukuria coal mine in Bangladesh. This is equivalent to 0.03 tcft gas and should provide 240 MW generations by 2007. The following table 6 shows the coal deposits discovered so far in Bangladesh.

c) Conventional Energy Supply and Resources

Energy consumption per capita in Bangladesh is extremely low compare to neighbouring countries as shown in Table below Table 6

Table 6 : Per capita energy consumption (kgoe, 2003)

Country/Region	Energy Consumption	Country/Region	Energy Consumption
Bangladesh	157	India	520
Nepal	355	China	1094
Sri Lanka	422	World	1688
Pakistan	467	OECD	4588

Source: IEA (2008)

The consumption per capita is half of even Nepal and 1/10th of the world. A much higher consumption must be made to raise GDP and to alleviate poverty in Bangladesh.

India has already achieved a remarkable progress in generating power from different renewable energy sources especially solar PV systems, and a substantial amount to budget is allocated in this sector on regular basis to promote the RETs (Islam et al. 2006). The country has an annual capacity of electricity generations of 140 GW, in which 32.1% can be generated from renewable sources including large hydro-projects and the rest can be produced from non-renewable sources (REN21, 2007). The Government of India has recently decided to electrify 67 million remote rural households with solar home systems, where kerosene is used as the major source of energy (Chaurey and Kandpal, 2009). By the year 2020, India has a target of achieving 20 GW of PV generated power.

VI. Energy Status in Bangladesh

About 90% of the population in vast rural areas were practically without electricity. For the benefit of this vast rural people, REB (Rural Electrification Board) was established in 1977. It provides electricity to consumers in a selected area by forming a Rural Electric Co-operative called Pally Bidyut Samity (PBS). Activities of rural electrification co-operative are given below

Table 7 : PBS (Palli Bidyut Samity ctivities in Bangladesh

Description	Achievement
Area coverage/PBS	2000 sq. Kms
No. Of PBS	67
Number of villages energized	41,125
Number of 33/11 KV sub-station constructed	328
Length of power distribution lines	1,73, 125 Km
Number of population in programme area Category wise connection	9,25,13,296
Domestic	45,42,099
Commercial	6,06,666
Irrigation	1,38,869
Industry	95, 0559

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Others	12,043
Total	53,94,736

Source: SWERA, 2007.

Table 7 : Production and consumption of Natural Gas in Bangladesh

Category	2000-01	2001-02	2002-03	2003-04	2004-05
Gas Production Gas (109cft	372.16	391.53	421.16	454.59	486.75
Consumption (109cft)					
Electricity	175.27	190.03	190.54	199.40	211.02
Captive	0	0	0	32.03	37.87
Fertilizer	88.43	78.78	95.89	92.80	93.97
Industrial	47.99	53.56	63.76	46.49	51.68
Tea-garden	0.65	0.72	0.74	0.82	0.80
Brick field	0.44	0.53	0.52	0.12	0
Commercial	4.06	4.25	4.56	4.83	4.85
Domestic	31.85	36.74	44.80	49.22	52.49
CNG	0	0	0.23	1.94	3.62
Total Consumption	348.69	364.61	401.04	427.65	456.30

Source: BBS (2006)

a) Imported Fossil Fuels

Bangladesh transport system depends almost totally on imported liquid fuels, but good news is after 2008, CNG fuel is using from national source. Kerosene is used widely for lighting in villages while diesel generators are getting unavoidable. The amount of crude oil and petroleum products imported is shown above in Table 7.

Table 8 : Import of Petroleum Products and Crude Oil

Year	Crude Oil		Petroleum Products	
	Qty (Thousands Tons)	Value (Million US$)	Qty (Thousands tons)	Value (Million US$
2001-02	1225	220	2072	2536
2002-03	1331	289	2214	3319
2003-04	1252	314	2262	4015
2004-05	1063	364	2692	7214

Source: British Petroleum, (2005)

The Table 8 shows cost imported petroleum products is huge in Bangladesh. The good news is now Bangladesh is using less polluting local CNG fuel in vehicles and it is popular there. However, natural gas reserves in Bangladesh are likely to be depleted before 2020 and electricity production from gas may stop. Therefore, more energy supplies using RETs must be developed and utilized.

b) Electrical Energy

During financial year 2005-06, per capita consumption was 136kWh whereas per capita electricity generation was reported to be 167kWh (SEWERA, RERC, 2007). At present, the electricity supply situation little better than previous. The Government installed several nuclear plants for generating electricity power. However, during peak season (agricultural irrigation season) 5 am-10 pm 600 Mw of load shedding is required (CES, 2006). The World Bank (2007) estimates an annual loss of nearly 1 billion dollars in Bangladesh due to its unreliable power. Stromsta (2009) reported that the power demanded in Bangladesh is increasing at the rate of 500 MW per year. The maximum electricity generation was 4,130 MW in 2007 and 4,036.7 MW in 2008.

The availability of the most useful form of energy, electricity, is again extremely small as shown below Table 9.

Table 9 : Electricity Generation and Consumption in Bangladesh, 2005-2006.

Item	Quantity
Installation Capacity	5,275MW
Average demand	4,300-4,500MW
Average generation	3,200-3,300MW
Per capita generation	167 kWh
Per capita consumption	136 kWh

Figure 1 below presents the fossil fuel supply for electricity generation which shows that natural gas is the major energy source.

Natural gas	89%
Oil	7%
Hydro	4%

Figure 1: Generation pattern FY2004

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The shortfall in electricity generation continues till today mainly due to old inefficient generators requiring heavy maintenance.

The table below presents Bangladesh fossil fuel reserves. It is found Bangladesh gas reserve is around 1/250th while coal reserve is 12/5000th of the world reserves (SWERA, 2007). Per capita reserve of gas in Bangladesh is then around 1/5th and of coal 1/100th of world per capita. This situation is enough for Bangladesh. Fossil fuel reserves of Bangladesh are compared with world reserves in the Table 10 below.

Table 10 : Coal deposits discovered in Bangladesh

Coal Fields	Depth of coal seams in meter	Reserves in million tons
Jamalganj, Bogra	640-1158	1053
Barapukurias, Dinajpur	118-506	303
Khalaspir, Rangpur	257-451	147
Dighipara, Dinajpur	250	200
Phulbaria, Dinajpur	152-246	572

Source: Energy & Power, August 1, 2005 and May 1, 2006.

c) Coal

Bangladesh began its first significant coal production in April 2003 with the opening of the Barapukuria Coal Mine in Dinajpur area of north-west Bangladesh with an estimated reserve of about 300 million tons. It is planned that 85% of its annual production of 1 million ton will be utilized to produce electricity; the rest will be used as fuel for brick making and other purposes.

d) Oil

Bangladesh contains small oil reserves of 56.9 million barrels and produces around 7000 barrels per day (bb1/d) of which 6000 bbl/d is crude oil (Power Cell 2006).

Natural Gas: Natural gas is Bangladesh's only sizeable source of commercial energy with total production of 5.5 tcf. Estimates from Petrobangla put net reserves at 15.3 tcf as of mid 2004 (proven reserve is lower) (Power Cell, 2006).

e) Hydro

At present only 230 MW of hydro power is utilized in Kanarfuli Hydro Station, which is the only hydro-electric power plant operated by Bangladesh Power Development Board (BPDB). Apart from Kaptai, two other prospective sites for hydro power generation at Sangu (100 MW) and Matamuhuri (75 MW) river are identified by BPDB (BPDB, 2009).

f) Traditional Biomass Energy

Biomass is the most used energy source in Bangladesh which accounts for 76% of the total final energy consumption in Bangladesh. The main sources of biomass fuels are: Trees (wood fuels, twigs, leaves, and plant residues), agricultural residues (paddy husk, bran, bagasses, jute stick etc.) and livestock (animal dung). The biomass is used for mostly for cooking in rural areas and for rural industries. It forms 68% of total energy supply while 32% is supplied by commercial energy (including hydro power) (Kabir & Endliocherr, 2012). Inefficient cookers employed produce unhealthy oxides and particles from traditional ovens. Presently 12 million tons of coal equivalent biomass is consumed in the industrial and domestic sectors along with commercial energy. Fire wood forms only 10% of the fuel supply that indicates in the Table-11 below.

Table 11: Estimates of Energy Supplied by Traditional Biomass Fuels ('000 tons of coal equivalent)

Fuels	1999-00	2000-01	2001-02	2002-03	2003-04
Cow-dung	2441	2471	2471	2471	2502
Jute stick	922	966	1010	966	922
Rice straw	1375	1429	1409	12418	1218
Rice hulls	2810	2810	2854	2898	2854
Bagasse	314	340	366	366	392
Firewood	1166	1166	1219	1219	1272
Twigs and Leaves	1325	1378	1431	1484	1537
Other wastes	1186	1230	1273	1317	1361
Total	11539	11790	12033	12139	12258

Source: BBS (Bangladesh Bureau of Statistics, 2006)

g) Indigenous Fossil Fuels

According to BBS, 2006 there are 22 gas fields have identified in Bangladesh and total natural gas reserve is 20.5tcft of which 6tcft gas was produced by 2005 and 14.5 tcft gas was left while the annual gas production is around 0.5 tcft in 2005. 46% of natural gas is consumed for electricity generation and fertilizer production uses 21% of the gas while other consume the rest 33% as shown in the Table 11.

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VII. Renewable Energy Application in Bangladesh Until 1990s

Solar energy owns a share of more than 99.9% of all the energy converted on earth (Kaltschmitt and Wiese, 2007). The amount of energy sent to the earth from the sun each year is equivalent to almost 15,000 times of the world's commercial energy consumption and more than 100 times the world's proven oil, gas, and coal reserves (Islam, 2005). The continuous supply of the solar energy to the earth's surface is equivalent to a power of about of 100,000 TW (Kuhne and Aulich, 1992). Solar energy is inexhaustible and available throughout the year all over the world.

Despite the availability of enormous potential of renewable energy, there has not been any significant progress in the promotion and development of RETs by public sector and other sectors until 2010 (Kabir, 2011). It is because highly expensive installation devices, high maintenance costs and lack of strong political commitment. Till to date, the large part of the energy demand of the country (Bangladesh) is fulfilled by traditional biomass, which is predominating particularly in the rural areas. Biomass is the source of energy supply to the rural villagers, but it is unhealthy. Hence there is immense potential in solar energy utilization across Bangladesh because Bangladesh is rich is sunshine whole year. Wind and tidal energy generation potentials exist in the coastal areas. Now huge solar home system is installing across Bangladesh rural areas by NGOs, private sector even public sector promote SHS in Bangladesh.

a) Hydropower

Bangladesh is a flat country does not possess extensive potential in hydropower resource except some small hydro-projects. Karnafuli Multipurpose Hydroelectricity Project (KMHEP) is the first renewable energy development project in Bangladesh setup in 1957 (Islam, 2005). It has capacity to produce electricity 230 MW. This project contributes to 5% of the total national electricity generation in 2003 (Hossain and Badr, 2005). Apart from Kaptai dam project, the B Power Development Board (PDB) has identified two other prospective sites for hydropower generation. They are at Sangu (100MW) and Matamuhuri (75 M) rivers.

Non-renewable Energy Sources in Bangladesh.

The major sources of energy of the country are natural gas, coal and a limited hydroelectric capacity. The entire reserves of exploitative indigenous fossil fuels, with the exception of the coal reserve, are located in the eastern part of the country. This results in a gap of commercial energy supply between the east and the west (Hossain and Badr, 2005). This differentiation is because of indigenous gas fields are located in the Eastern part of Bangladesh and imported oil. In 2004, the shares of natural gas, oil, coal and hydroelectricity to total primary energy consumption were 70.8, 25, 24 and 1.8 percent, respectively (British Petroleum, 2005).

The Government of Bangladesh declared new gas connections shall be no more in Bangladesh (Daily Promothom Allo, May 04, 2015), it is because scarcity of gas in Bangladesh. The entire urea fertilizer manufacturing is based on natural gas. Power plants, fertilizer factories, other industries (e.g. brick kilns, tea processing plants, steel mills, and textile factories), commercial organizations e.g. offices and business centres) and the domestic sector are the end users of natural gas in the country. The gas consumption in the year 2004-2005 was 487 bcf, which on a daily basis is 1,334 MMcfd (million cubic feet per day). This indicates that there has been a large increase in gas consumption. Captive power generation and CNG refuelling are the two demand areas that are responsible for the large increase (Kabir & Endlicher, 2012).

Petroleum Oil is one of the most important sources of energy in Bangladesh. The country utilizes mostly imported petroleum from the OPEAC for mainly transportation, some electricity generation and industrial heating. The major coal deposits of the country are located at Jamalgonj in Jaipurhat, Baropukuria and Phulbari in Dinajpur and Khalispur in Rangpur. It is estimated these coal fields could have 2.55 billion tons of reserves in Bangladesh (Energy and Power, 2009).

VIII. Bangladesh Renewable Energy Sources and Technology Practices

Bangladesh though a small country it has numerous potential sources of renewable energy, for instance, biomass, solar energy, hydropower, wind and tidal energy. Rural people uses energy from traditional biomass- cow dung, domestic wastes, jute stick, rice straws, twigs, etc. Hydropower generates around 5% of the total consumption. So solar and wind energy is find a great potential source of energy in Bangladesh.

Table 12 : Renewable Energy Prospects in Bangladesh

RES Type	Capacity (up to December'08)	Theoretical Potential
Wind	1 M	2,000 MW
Hydro	230 MW	672 MW
Solar PV	15 MW approx	50,436 MW
Solar Thermal	3,000 m3	20<>106 m2
Biogas	.3 million m3	3,675 <>106 m3

Source: Based on Alam et al. (2003).

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In Bangladesh, although very few biomass gasification plants have been installed, many biogas Projects Undertaken in Bangladesh. For example, over 24,000 biogas plants have been installed all over Bangladesh (Energy & Power, 2007). Biogas plants in the rural areas are run mainly with animal dung and domestic wastes. The urban solid wastes include wastes from households, industries, hospitals are used in biogas production, but urban biogas production is very limited.

a) Solar Energy Technologies

Generation of solar electricity from solar radiation is basically made with solar cell, which is mainly a silicon–made solid device. A solar cell is defined as a device that directly converts sun-light into electrical energy through the process of PV systems. In order to generate electricity from solar radiation, an off-grid stand-alone or island system generally needs several devices, such as, solar panel, battery, inverter, charge-controller and necessary cables and tools. Energy is generated by the solar panels as direct current (DC), and converted to alternating current (AC) by the inverter. The battery is needed for the off-grid PV systems to store power, and the charge controller maintains the battery at the highest possible state of charge (Grameen Shakti, 2015; SWERA, 2010). Solar cells are electrically connected and placed between glass and tedlar plate, and framed by an aluminum frame. Number of solar-modules and other components (batteries, charge regulators, inverters) can form large photovoltaic systems.

Basic considerations of Solar PV Applications

The angle of the sun throughout the year is important for the assessment of solar incoming radiation. Moreover, extreme wind speed, lightening, moisture and dust can harm to the panels. The temperature of a certain place is a very important factor to receive the optimum amount of solar energy. Normally in a geographical area with 25° Celsius temperature, panels produce the maximum level of solar energy. The more and lesser the temperature than 25° Celsius, the less is the generation of electrical power. It is important to assess the temperature throughout the year. The geophysical features of Bangladesh favours installations of solar home systems everywhere in Bangladesh (Alam et al.(2004); Eusuf (2005); SWERA (2010). It is appropriate areas with more than 25° Celsius in most of the time a year, panels can be installed in the wall of the buildings so that enough wind to keep temperature close to 25° Celsius. Solar tracking system can be effectively used between 23° and 550 latitudes of both hemispheres (Kabir & Endlicher, 2012). Moreover site selection is very important for the installation of large-scale solar PV plants. Mounting of panels is essential to capture optimum level of electricity. The locations having more provision of having sun occurrence are likely to be most suitable areas.

b) Solar Energy

Solar PV generated lighting program in Bangladesh primarily includes on rural houses, small businesses, and income generation activities in the remote rural areas which is being implementing by Grameen Shakti, and other NGOs in Bangladesh. Many SPV aimed at providing income generating opportunities through running motors, permitting longer working hours and facilitating longer selling hours by rural traders.

In Bangladesh, the private sector, commercial as well as non-profit organizations have chosen at least an important renewable energy source for the economic realization. In the initial promotion of SPV, Rahimafrooz, a private battery manufacturing company in Bangladesh played an important role despite having it an unprofitable business due to high tariffs and duties. Rahimafrooz continued to emphasize manufacturing solar grade deep cycle batteries to go with the imported systems. Other private companies like Microelectronics, First Bangladesh Technology and Bangladesh Energy Advanced Studies have also looked for a market share.

The government sponsored organization infrastructure Development Company Limited (IDCOL) in Bangladesh has been involved to a large extent in the promotion of SPV systems and has already installed around 450,000 solar home systems all over the country through the partner NGOs (Haque, 2008; IDCOL, 2009). Grameen Shakti and Bangladesh Advancement Committee (BRAC) in Bangladesh initiated its solar program in 1997 to electrify remote locations too in Bangladesh. Many other NGOs have also involved in installing solar PV systems, biogas plants, wind turbines, hot box cookers and PV-diesel hybrid systems (Islam & Islam, 2005).

c) Solar Tracking System

Among the PV systems, solar tracking system is considered as the latest and most advanced system. It is also known as solar tree or solar concentrator. This system produces additional generation of electricity than the roof mounted system allowing for more efficient convertors for electricity generation (Kuhne and Alulich, 1992). With the movement of the sun, the solar concentrator moves to receive the maximum solar radiation. However, this tracking system is very expensive around E25, 000 (twenty five thousand Euros (Kabir & Endlicher, 2012).

d) Roof-top grid connected PV System

A 1.5 kW roof-top grid connected PV system has been developed and installed on the roof of Renewable Energy Research Center (RERC) in Bangladesh with the support of the Ministry of Science and Technology. It has carried out R & D activities on

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solar cookers, solar water heaters, solar dryers, SHSs, etc. (IDCOL, 2014; SWERA, 2010).

e) Roof Mounted Solar PV System

Compared to the solar tracking systems, roof-tied PV system is a cheaper option for the households. Grid connected roof-mounted system appears to be very profitable and secured, although the initial investment is high.

f) Building Integrated PV (BIPV) System

Building Integrated PV (BIPV) system is installed on the surface of the buildings combining solar electricity generation with other functions of the building structure (Bakos et al. 2003). Such systems usually consist of the PV module and waterproofing elements, a PV combiner, a grid inverter and an import /export meter. However, the application of PV systems on the urban building in Dhaka is absent.

g) Ground Mounted Solar PV System

Like roof mounted system, ground mounted grid connected PV system also produces satisfactory amount of electricity. However, here needs open space or land. However, this Ground Mounted Solar PV System is not popular in Bangladesh because scarcity land.

h) Stand alone or Island SPV Systems

Stand alone or Island SPV System is known as an autonomous system. This system is very much popular in Bangladesh, India, Sri Lanka, Ethiopia Indonesia and many other Asian and African countries. The capacity of the solar homer system ranges between 300-2,400 watts. Grameen Shakti and few other agencies in Bangladesh have been installing solar home systems in the remote rural areas of Bangladesh since 1997, which are basically stand- alone PV systems.

i) Wind Energy

Wind energy utilization in Bangladesh is still in the early stage. In the coastal areas, there is a very good potential of generating 20,000 MW of electricity (SEWRA/RERC, 2007). Recently in 2008, 50 wind turbines having capacity of 20kWh each has been installed in Kutubdia, a detached off-shore island of Cox's Bazar District with the self-funding of the BPDB (Kabir & Endlicher, 2012; The Daily Ettefaq, 2008). This wind-battery hybrid system has rarely helped in solving the electricity crisis in the island.

j) Tidal Energy

Tidal Energy is a form of hydropower that converts the energy of tides into electricity or other useful forms of power. Tidal power has the potential for future electricity generation although tide energy harnessing in the world is still very negligible. Tidal energy has an efficiency of 80% in converting the potential energy of the water into electricity. In the coastal part of Bangladesh, the normal tidal head rise and fall between 2 m and 8 m (SWERA, 2007). This tidal range can easily be converted into pollution free clean renewable energy by using the simple low-cost technology of a "tidal Wheel" in the sluice gates.

IX. Institutional Arrangement for Renewable Energy (RE) Exploitations in Bangladesh

The government has made its visionary statement to provide electricity to all by the year 2020 (MPERMR, 2008). In order to achieve this target, there are no so many options before the government except electricity generation through solar PV applications, proposed nuclear power plant and coal based power plants. SHSs can rapidly reach to rural areas with less infrastructure cost from the state. Nevertheless for electricity generation, even now, more than 80% indigenous gas is used, while the reserve is rapidly declining due to over exploitation and misuse (IDCOL, 2014; SWERA, 2007). The other uses of indigenous gas include domestic, industrial (e.g., fertilizer production) and transportation. As result the only abundant source of the country's fossil fuel is reducing at a rapid pace. After 2015, the fuel share of gas reduces from 85% to 61% and only 1% by the year 2030 (IDCOL, 2014; Kabir & Endlocher, 2012). It can be disavowed that after natural gas exhaustion, the country has to heavily depend on coal based generations. But the exploitation of coal often creates social and environmental problems. In such s situation, the government can only encourage investment and other supports for solar power exploitation although only solar PV systems cannot solve the power crisis. In order to provide lighting to the inaccessible areas, the government owned company IDCOL has been assigned to develop installations of solar home systems under the Rural Electrification and Renewable Energy Development Project (REREDP). Grameen Bank is working by the support of IDCOL in Bangladesh.

The public agencies like Bangladesh Power Development Board (BPWB) and the Rural Electricity Board (REB) both have been carrying out projects to promote renewable energy activities. Bangladesh Council for Scientific and Industrial Research (BCSIR), Bangladesh Atomic Energy Commission (BAEC), Local Government Engineering Department (LGED) and Infrastructure Development Company Limited (ICOL, a state-owned non-banking financial institution. These organizations are involved in Rural Energy and Renewable Energy Development Programmes (RERED) in Bangladesh.

a) Affords to increase Energy in Bangladesh

Government of Bangladesh has declared its vision to provide electricity for all by the year 2020. To fulfill this target, utilization of renewable energy

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technologies could play a vital role for off-grid electrification with minimum fiscal cost. Currently Bangladesh has made an agreement with Russia to build thermonuclear fusion energy plant for generating electricity and installed nuclear reactors plant at Rupur for 1000-2000MW, there could less risks associated with modern nuclear reactor technology. However grid connection all over Bangladesh is very expensive.

X. Scope of Renewable Energy use in Bangladesh

The recent rapid rise in the growth of solar PV and wind based power generation capacity is not only to gradually replace the conventional power supply system but also to meet the obligations of global climate protection. The developing countries (China, India, and Bangladesh) which are still struggling to produce enough power for their growing industrialization as well as other sectors are focusing on power supplement from the alternative sources. Given the rapid decline of conventional fuels, countries round the globe have devised supportive policy strategies in order to enhance RES exploitation. Among the new renewable (solar, wind, modern biomass, geothermal heat etc.), the installed capacity of wind based power generation is dramatically rising in some of the developed (e.g. USA, Germany, Denmark and developing countries (e.g. China, India). However, the installed capacity in solar PV systems (mainly grid connected systems) takes place mostly in the developed countries (e.g. South Asian countries of India and Bangladesh (Kabir & Endlicher, 2012). Until the end of 2008, the global capacity of solar PV systems is just less than 17 GW, while grid connected system accounts for 13 GW and off-grid system is 4 GW. Until now (2010, Germany alone has already achieved an installed capacity of 7 GW, which is more than the existing power demand (5-6 GW) of Bangladesh (Weiss et al. 1998; and Wengenmasyr, 2008). In Bangladesh until 2010, the exploitation of RES mainly apply solar home systems in the rural areas, a few wind based power generation plants and biogas plants.

Bangladesh has an enormous potential in solar energy, and therefore the installations of small and large-scale PV systems can help to reduce its current share of GHG emission. One family using a typical solar home system can save yearly 290 litres of kerosene by using solar lighting technology and can prevent the emission of 0.76 ton CO_2 per year (SWERA , 2007).

a) Energy demand Scenarios in Bangladesh

Two economic growth scenarios (Low Scenario and Reference Scenario) were considered to forecast future energy demands as presented in Tables 13 & 14. Projected demands for commercial energy and electricity up to the year 2020 under both the scenarios are presented in tables below.

Table 13 : Projected demand for energy (commercial and electricity) under Low economic growth Scenario (business as usual)

Year	1990	1995	2000	2005	2010	2015	2020
	Commercial Energy						
Population (million)	107	118	130	141	153	165	177
GNP Growth Rate (%)	4.44	5.25	5.24	5.24	5.24	6.65	6.65
Per Capital (GNP $)	190	214	242	276	3177	366	424
Energy Coefficient	1.62	1.37	1.37	1.37	1.08	1.08	1.08
Energy Growth Rate (%)	7.13	7.19	7.18	7.18	7.18	7.18	7.18
Per capita use (KgOE)	56	68	92	127	157	219	272
Total Energy (MTOE)	6	8	12	18	24	36	48
Total Energy (Pj)	256	342	512	769	1025	1537	2050
Energy Productivity (MJé$éGNP)	12.59	13.54	16.27	19.76	21.13	25.45	27.32
	Electricity						
Status in Energy mix (%)	35	37	39	37	33	33	33
Total GWh	8205	11584	18315	26063	30994	46491	61988
Per Capita kWh	77	98	141	185	203	282	351
Load factor (%)	55	57	57	57	58	59	60
Peak Load (MW)	1703	2320	3668	5220	6100	8995	11794

Source: SWERA, 2007.

Table 14 : Projected demand for energy (commercial & electricity) under reference economic scenario growth

Year	1990	1995	2000	2005	2010	2015	2020
	Commercial Energy						
Population (million)	107	118	130	141	153	165	177
GNP Growth Rate (%)	4.5	5,4	6.4	7.2	7.7	8.2	8.7

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Per Capital (GNP $)	190	214	254	318	416	560	774
Energy Coefficient	1.62	1.37	1.37	1.37	1.08	1.08	1.08
Energy Growth Rate (%)	7.34	7.4	8.77	9.86	8.32	8.86	9.40
Per capita use (KgOE)	56	72	94	131	194	269	384
Total Energy (MTOE)	6	8	12	19	31	46	72
Total Energy (Pj)	256	362	531	827	1314	1979	3055
Energy Productivity (MJé$éGNP)	13	14	16	18	20	20	21
	Electricity						
Status in Energy mix (%)	35	37	39	37	33	33	33
Total GWh	8207	12280	18971	28060	59858	46491	92402
Per Capita kWh	77	104	146	185	263	282	523
Load factor (%)	55	57	57	57	58	59	60
Peak Load (MW)	1703	2459	3799	5220	1158100	8995	17580

Source: SWERA, 2007.

Based on this estimation, the currently installed 450,000 solar home systems all over the country can save 130 million litters of kerosene and 342,000 tons of CO_2 annually (IDCOL, 2014). To consider as rural community based market (50 shops and a 10w florescent bulb each) with solar PV system for lighting that replaces diesel generator can mitigate 1.1 tons of CO_2 per year (Ibid, 2014).

The recently approved renewable energy policy sets targets to meet 5% of the total power demand by 2015 and 10% by 2020 (MPEMR, 2008). The Government of Bangladesh has a target of reducing 6.4 million tons of CO_2 emission through the generation of 2,200 Mw of electricity from renewable sources by 2020. SWERA/RERC (2007) calculated CO_2 reduction possibility with the applications of solar systems and wind turbines. Rahman (2009) reported that on an average 1.8 kWp solar PV system can reduce 900 kg of CO2 emission annually. According to this estimation, the applications of SPV systems on the bright rooftops of Dhaka (in the case of 1,000 Mw of electricity generation) will roughly reduce 500 million tons of CO_2 per year. Although the target seems to be ambitious and far-reaching given the country's RET application scenario, it can be treated as the positive indication towards the application of renewable energy technologies.

In Bangladesh, 60% of the total population still depend on biomass based energy. Agricultural residues (rice straws, jute sticks, rice husks etc.), cow dung, twigs etc. have been being used as fuel for cooking by the rural households since time immemorial. But the inefficient use of traditional fuel sources produces immense indoor air pollution causing massive health hazards particularly to women and children. At the same time, there has been a decline in the supply of biomass mainly due to the high population pressure on agricultural production (Grameen Shakti, 2015).

The major attention of the RE technology is still concentrated into the rural areas although the urban areas generate enormous solid wastes which can be used for power generation and to produce compost. By 2010, the renewable energy sources (especially hydropower) contribute only 4% of the total power generation (4,000 MW) (Hussain & Badr, 2005). The installed capacity of solar PV based power generation accounts for only 25 MW (by 2010) and the wind based generation capacity is still very insignificant (4MW) (IDCOL, 2014; SWERA, 2007). However, the geophysical characteristics (Global horizontal irradiation, sun shine duration etc.) of Bangladesh are fully favourable to solar photovoltaic application. But there has been a very significant progress achieved, mainly due to the absence of supportive policy, strong political will and people's awareness. In Dhaka City mentioned earlier there is massive gap between power supplies (1000-1200 MW) and the demand is 2000 Mw. As a result of this huge deficit, there has been a growing interest among people about the solar PV installations for power supplement.

The country has potential in wind power generation particularly in the coastal areas, although there is still lack of reliable wind speed data. Bangladesh being an agrarian country produces enormous biomass energy which can be used to generate biogas for clean fuel for cooking and electricity for lighting in the rural areas. However, in spite of enormous potential biogas technology has not been well accepted due to initial expenditure.

In Dhaka Megacity, the application of solar PV systems on the bright roof-tops can generate more than 1,000 MW of electricity (at 105 efficiency with 75 Wp modules) preferably through grid connected PV systems.

Practically the slums are reported to have least attention from electricity supply point of view. Electricity demand for the informal housing is comparatively very low. The roof-tops of these informal settlements can be effectively used for stand-alone PV applications, which are popularly known as solar home systems in the rural areas. Therefore, solar home systems can effectively generate electric power for these settlements. CUS et al. (2005) reported that each slum cluster has 10 households with at least 25 persons. If solar home systems are installed in each slum cluster depending on

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the demand, nearly 3-5 MW electricity (600-1,000 Watt in each slum cluster) can be generated through the application of stand-alone PV systems. The electricity demand of the slums can sufficiently be met-up through stand-alone PV installations.

b) Favourable Geophysical Situations in Bangladesh

The geographical location of Bangladesh on the globe, space availability (land availability, available bright roof surface etc.), global horizontal irradiance (GHI), sunshine hours etc. have been identified as the geophysical situation. The receipt of solar radiation depends on the latitude of the area. The geographical location of Bangladesh (between 20034' and 26038' north latitude and between 88001' and 92041' east latitudes) lies in one of the best locations, which is well-supportive to capturing enough solar radiation for electricity generation (Islam, 2005; Hossain and Badr, 2005). Bangladesh is grouped as the first category with best location for PV systems. However, due to lack of financial and technological support, political commitment, it fails to exploit the abundant solar energy at the optimum level.

c) Sunshine Hours and Solar Radiation

From solar energy generation perspectives Bangladesh being located in the suitable global position receives very effective duration of sunshine. The period from November to May has the maximum sunshine duration, and the period from September-October is reasonable satisfactory. Due to the availability of sunshine throughout the year the GHI of Bangladesh is also satisfactory for solar power production. It is calculated that the total yearly amount of solar radiation received over the surface of Bangladesh is at least 2.4X 1014 kWh, while existing electricity generation is 2.0X1010 kWh. Therefore, the availability of solar radiation is 10,000 times of electricity generation (SWERA, 2007). The daily average GHI in Bangladesh is 4.29 kWh/m^2 and the annual receipt of solar radiation of 31 locations of the country is 1,566 kWh/m^2. The SWERE project concluded that non-concentrating photovoltaic systems (stand alone or grid connected roof top) is feasible in the atmosphere of Bangladesh. Similar type of solar PV applications can be appropriate for the Megacity of Dhaka.

XI. Renewable Energy Applications and Businesses in Bangladesh

To achieve the target of making electricity for all citizens of Bangladesh by the year 2020, ensuring reliable and quality supply of electricity at a reasonable price is important. Many initiatives have being undertaken by public, private and NGOs. Nearly 2.5 million solar home systems have been installed in the remote off-grid areas all over Bangladesh through the government owned company IDCOL mainly with the financial assistance to local NGOs (IDCOL, 2014). Grameen Shakti is excelling in implementing solar home systems in Bangladesh. As of 2014, it has installed 1.7 million SHSs in Bangladesh. Like Grameen Shakti many NGOs are providing SHSs micro-loans to people for purchasing solar home systems in Bangladesh. More than 98% return on loan instalment has been made by the consumers as reported by IDCOL's partner organizations (GEF, 2005). Although the installation capacity of solar PV system based electricity (currently around 25 MW and 50 MW by 2 million SHSs installed in Bangladesh) is still very negligible. However, solar PV systems like solar lanterns, solar home system, solar market electrification system, solar water pumping, solar refrigerator, and grid connected PV system; solar-wind hybrid system and solar-diesel hybrid system get popular in Bangladesh.

a) Renewable Energy Service Promotions and Supports s by IDCOL in Bangladesh

Bangladesh government promote and support renewable energy, saving energy and GH emission reduction have been the goals. The legal framework for the support of the renewable energy sources of the country from the government is the Infrastructure Development Company Limited (IDCOL), a project of the World Bank Bangladesh. IDCOL is providing financial support, technological support to the implementing RE projects in Bangladesh. For example GS, BRAC, Rahimaforz etc. get solar panel installation support from IDCOl Bangladesh.

Until 2010, IDCOL has installed nearly 450,000 home systems (mostly off-grid systems) through the partner organizations having a total installed capacity of nearly 25MW (IDCOL, 2014). Grameen Shakti leads the installation process providing more than 60% of the systems alone. Solar home system normally used by the rural households consist of 4 florescent bulbs of 7 W each, 1 black-white TV of 15 W and a radio of 5W As mentioned earlier, one family using this small system can save yearly 290 litters of kerosene by using solar lighting technology and can prevent the emission of 0.76 ton CO_2 per year (SWERA/RERC, 32007). By installing 450,000 solar home systems all over Bangladesh can save 130 million litters of kerosene and 342,000 tons of CO_2 each year. However, the paper identifies has been identified that there is a large power deficit in Bangladesh, but there is a large untapped solar energy potential (favourable geographical situation geographical location on the globe, incidence of global horizontal irradiation, sunshine duration and day length, temperature, available bright roof tops) and the rising concerns of climate change. However CO_2 emission reduction can be done through clean energy (UNFCCC and Kyoto Protocol).

Wide scale used RETs in Bangladesh are shown in the following Table 15:

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Table 15 : Wide scale use of RETs (renewable Energy Technologies)

Technology	Number of Units (by 2007)
Solar Home System	Above 1000,000
Improved biomass cooker	3000,000
Biogas plants	25,000
Biomass bracketing machines	100

Source: SWERA, 2010.

RETS technologies demonstrated in Bangladesh are solar water heaters, solar dryers, solar cookers, water lifting wind turbine, wind electricity generators, hybrid generators-solar wind/diesel, grid connected wind turbine, micro hydro generator and LED lamps. IDCOL has invited proposals for developing a 1-2 MW solar panel assembly plant in Bangladesh.

XII. Barriers to Greater Utilization of Renewable Energy Technologies in Bangladesh

There are plenty of barriers hindering (as of 2007) widespread development of potential RETs in Bangladesh. The main barriers are lack of information among the public and policy makers about the renewable energy resources, technical/economic information about RETs; assembly of renewable energy technology components and equipment are currently limited and the high upfront cost at the end user level for renewable energy is a major barrier in Bangladesh. According to the Power Cell (2006) of the Government of Bangladesh, the tentative target for renewable energy utilization by 2020 is shown below Table 16 along with estimates for GHG reduction.

Table 16 : Power Cell targets for RETS

Tentative Target for RETs, 2020 and GHG reduction

Resource	Expected utilization	GHG reduction (million tons of CO_2)
Wind	1000 MW	5.0
Solar	300 MW	0.5
Biomass/Hydro	600 MW	0.6
Co-generation	300 MW	0.3
Total Renewable Energy	3200 MW	6.4

Source: Power Cell, 2006

GHG (Green House Gas) mitigation

The following results for CO_2 reduction have been found for various proposed applications of RETs.

Table 17 : Potential for electricity generation from solar and Wind energy technologies and the scope of CO_2 mitigation by 2020

RET	Indicative Potential	In place of conventional generation using Grid	CO_2 reduction potential ($MtCO_2$/year)
Hydr.o electricity (existing (230 MW)	300 MW	Grid1.4	
Solar Home system	50 W, 2 million	Kerosene & Grid	1.5
Solar lights for the poor	10 w, 2 million	Kerosene	0.6
Wind Diesel hybrid micro grids	100 kW.300	Diesel genset	0.1
PV Diesel hybrid micro grids	100 kW. 300	Diesel	0.1
Wind electricity generation (minimum)	200 MW	Diesel genset	2.1
Grid connected PV (if grid is stable)	200MW	Grid	0.8
Total			6.6

Source: SEWRA, 2007

Table 18 : Potential of thermal energy from Solar and the corresponding scope for CO_2 mitigation by 2020

RET	Application of RET	CO2 reduction potential (MtCO2/year
Solar Water Heaters	1 sq. Km	0.4
Improved biomass cookers 915% more efficient than conventional and biogas disasters	Biomass replacement	1.9
Total		2.3

Notes: Wood/straw produces 3.8 ton CO_2/ton fuel

Source: SEWRA, 2007

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XIII. IDCOL's Financing to Various Renewable Energy Programmes in Bangladesh

SHS is a convenient mode of supply power for small electrical loads such as lights, radio, and black & white TV. The supply has proved to be reliable and the systems can be managed in rural areas with little training. The main components of an SHS are a solar panel, a battery, and a charge controller.

IDCOL starts its solar program in January 2003 with the support from International Development Association (IDA) and Global Environmental Facility (GEF) to fulfill basic electricity requirements in the rural areas of Bangladesh. IDCOL provides both grant and refinancing for 50,000 SHS over a period of five-and – half years (January 2003-June 2008). The target was achieved in August 2006, three years ahead of the project completion period and US$2.0 million below estimated project cost of US$20 million. Therefore, the target was revised to finance a total of 200,000 SHS by the year 2009 with additional support from the World Bank, GTZ and KFW (IDCOI, 2014).

Table 19 : Progress with SHS's installation up to January 2007 PO wise installation of SHSs

Participating organization	Number of SHSs Installed
Grameen Shakti	61,309 *GS start its SHS distribution in 1997, before IDCOL support to GS. It is also supplying SHSs to people with its own resources.
BRAC foundation	22,115
Srizony Bangladesh	3,387
COAST Trust	1,270
TMSS	994
Centre for Mass Education and Science	1,263
Integrated Development Foundation	1,255
Shubashati	1,077
UBOMUS	1,620
BRIDGE	698
PMUK	61
RSF	1,600
PDBF	121
HF	139
Mukti Cox's Bazar	76
Other	77
Total	97,062

Source: SWERA 2007.

Many job opportunities have created through SHS program. Through GS, 11,230 people have employed in Bangladesh.

There are 2, 12,481handlooms units and 5, 14,456 handlooms exist in Bangladesh. Here is an opportunity to install SHSs and support handloom people. SHS units may use in the public and private hospitals in Bangladesh. Total numbers of hospitals are 1383 (public hospitals number is 671, and non-government hospitals number is 712) (IDCOL, 2014; SWERA, 2007).

To reduce GHG emission in Bangladesh, IDCOL has massively financing to NGOs for Solar Home System installations. A typical Solar Home System often consists of 4 fluorescent bulbs of 7w each, 1 BW TV of 15 W and a radio of 5W. Normally a home uses Kerosene for Lanterns and charges battery from grid supply at far away locations. Table 16 shows corresponding figures of saving kerosene and reducing CO_2 emission.

Table 20 : CO_2 reduction using Solar Home System

Total No. SHSs	Savings of Kerosene in litters/year	Tons CO_2/year
65,000	19 million	49,000
1,00,000	29 million	75,000

Source: SWERA, 2007

IDCOL renewable energy activities started in 2003 with the Solar Home System (SHS) program. IDCOI also has been implementing solar irrigation pump program, solar PV mini-grad project, solar-diesel hybrid power system for telecom BTS, biomass gasification project, biogas based power plant projects etc. Recently ICOL has launched Improved Cook Stove (ICS) program, with target to disseminate 1 million ICS by 2017.

IDCOL's Solar Home System Program is one of the fastest growing off-grid Renewable Energy Programs in the world. IDCOL, with support from the World Bank (IDA), Global Environmental Facility (GEF), German Technical Cooperation (GTZ), German Development Cooperation (KFW), Asian Development

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Bank (ADB), Islamic Development Bank (IDB), Japan International Cooperation Agency (JICA), The Department for International Development (DFID), USAID and Global Partnership on Output –Based Aid (GPOBA) is channelling both grant and credit to the program. As of March 2013, 2 million SHSs with generation capacity of about 100 MW have been installed covering 6% of the population (IDCOL, 2014).

Table 21 : IDCOL Program Benefits (2014)

Program achievement:	3 million SHS
Number of beneficiaries:	13.5 million people
Power generation:	150 MW
Fossil fuel saving:	216,000 ton/yr
CO_2 reduction:	503,000 ton/yr
Job creation:	60,000
IDCOL investment:	USD$ 500 million

Source: IDCOL, 2014.

IDCOL now has a target of financing a total of 6 million SHS by 2017. Till August 2014, more than 3 million SHSs have been installed across Bangladesh (IDCOL, 2014). Around 60,000 SHS are now being installed every month under the program. The total number of beneficiaries is 15 million rural people which is more than 9% of the total population of the country. The existing 2 million solar home systems have reduced consumption of approximately 230,000 tons of kerosene per year and hence, this contributed towards global drive of GHG emission reduction.

IDCOL provides three types of grant and concessionary refinancing support to its (POs): (a) the buy-down grant, provided to the customers to reduce the capital cost of HS; (b) the Institutional Development Grant, provided to Pos for their capacity development; and (c) the refinancing support (up to 80% of the total credit), extended to customers by the POs.

IDCOL follows a unique sustainable business model with commercialization objective for dissemination of SHS ensuring ownership of each stakeholder. Under the structure, customers are required to pay minimum 10% of the system cost net of grant as down-payment. The remaining 90% is financed by a loan from PO (partner organization), which the customers pay over 3 years in monthly instalments. Subsequently, the POs apply to IDCL for refinancing and grant. These subsidy elements of the program are gradually being phased out and more commercial financing are being introduced. Cost efficient standardized technical design, competitive market prices, development of local support industries, customer education, training, development of skilled manpower, stringent quality control & monitoring and services after sales services are other important features of the program. The grant and refinancing are disbursed to the POs. As of March 2013, IDCOL invested more than USD 365 million in its SHS program (IDCL, 2014).

Biogas produced from these plants is being used for cooking purpose in rural households; IDCOL has financed more than 34,000 biogas plants (till April 2014). Total number of beneficiaries under IDCOL program is 153,000. The program saves 82,000 tons of firewood and 1,088 tons of Kerosene every year. In addition, the slurry, by product of biogas plants, being a very good organic fertilizer is used as fertilizer and very good fish-feed. More than, 204,000 tons of organic fertilizer produced every year from these biogas plants and reduce use of 29,000 tons of chemical fertilizer. IDCOL is implementing the program through its 41 Partner Organizations. IDCOL also financed for Improved Cook Stoves (ICS) Program to NGOs in Bangladesh. IDCOL's target is to disseminate 1 million ICS in Bangladesh by 2017 (IDCOL, 2014).

Solar powered irrigation system is an innovative, economic and environmentally friendly solution for the agro-based economy of Bangladesh. ICOL has financed 38 and approved financing of additional 76 solar PV based submersible water pump in different locations of the country. IDCOL has a target to finance 1,550 pumps by 2016. IDCL provides subsidy, soft loan and technical support to ensure effective implementation of the program. IDCOL also financed to NGOs for biomass gasification based power plants

Table 22 : IDCOL Products and Services

Infrastructure Sector	Long-term local and foreign currency loans Debt and equity arrangement Agency services Corporate advisory services Short-term local currency loans
Renewable energy and energy efficiency initiatives	Concessionary credit and grant support Advisory services Technical assistance and quality assurance Capacity development of stakeholders Facilitation in availing CDM benefits
Training programs	Project finance Financial modeling Renewable energy

Source: IDCOL, 2014.

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IDCOL has financed a 400 kW biomass gasification-based power plant along with precipitation silica production plant and 250 kW biomasses gasification based power plant. These plants use locally available agricultural residues i.e. rice husk as fuel for power generation. By 2016, IDCOL has a target of financing another 30 biomass gasification based power plants. IDCOL has financed to five biogas power plant, with capacity of 400 kW, 50 kW and others with 6kW capacity, have been financed by IDCOL. Poultry litter is used as feed material in the biogas digesters for gas production and this biogas is used for electricity generation as well as cooking and per boiling system. Electricity generated from the plant is consumed for running poultry farms. Bio-fertilizer produced from the plant is used in crop production and fish farms. IDCOL has a target of financing 450 biogas based plants by 2016 (IDCOL, 2014).

IDCOL concessionary financing for energy efficient brick projects Thousands of traditional fixed chimney brick kilns emit an estimated 9.8 million tons of C_2O per annum, making it one of the worst green-house gas emitters in the country. IDCOL plans to invest around BDT 4,000 million in the energy efficient brick manufacturing sector in Bangladesh by 2020 (IDCOL 2014).

IDCOL Solar Powered Solution for Telecom BTS: IDCOL has financed solar powered solution for 138 telecom base transceiver stations (BTSs) in off-grid areas of Bangladesh. Solar powered solutions provide continuous power supply to ensure uninterrupted voice and data services. IDCOL has financed to Solar Mini-grid Projects in Bangladesh. IDCOL has financed one 100 kW solar mini-grid project in a remote island in the Bay of Bengal. IDCOL's participation in the Solar Mini-grid projects not only supported the efforts of the Government to address the growing infrastructure demand in Bangladesh but also played a catalytic role for attracting private investment in infrastructure projects. In 2013, IDCOL plans to invest further BDT 1 billion in a number of power, telecommunication, transport, social infrastructure and urban environmental projects (IDCOL, 2014).

Through IDCOL more than 70,000 direct jobs have created in Bangladesh. Due to SHSs, students now benefit from extended hours of studies at night in better lighting condition, small businesses enjoy extended operating hours and women feel more secured at night. The existing SHSs installed under the program reduces approximately 528,000 ton of CO_2 annually (IDCOL, 2014).

XIV. Grameen Shakti

Grameen Shakti is a non-profit organization established in 1996 to promote, develop and popularize renewable energy technologies in remote, rural areas of Bangladesh. Currently, GS is one of the largest and fastest growing rural based renewable energy company in the world. GS is also promoting Small Solar Home System to reach low income rural households. It enlighten houses by solar power, cook comfortably by bio-gas.

Table 23 : Grameen Shakti Programs at a Glance as of February, 2015

Description	This Month	This Year	Since Inception
No. of Solar Home System	16,594	33,184	1,583,319
No. of Biogas Plants installed	279	556	30,847
No. of Improved Cooking Stoves	9,767	19,299	910,204
No. of Branches	0	0	1,245
No. of Persons trained	124	238	44,252

Grameen Shakti is providing loans to SHS receivers both GB borrowers and to the non-GB members. Till February 2015, GS has alone installed 1,583,319 solar home systems covering 64 districts in Bangladesh. It is working at the grass roots village level and selling SHS to villagers with credit who pay their SHS prices at an instalment basis over three years. For the solar PV installation, GS selects areas where there is no availability of conventional electricity or areas with low coverage by Rural Electrification Board (REB) or areas with almost no possibility of the extension of rural electrification within 5-10 years period.

Grameen Shakti is working not as a charity rather follows social business model. It has successfully blended technology with social market forces to develop a market based approach to reach the rural people. It does not provide direct subsidies to RE users. It has developed an innovative micro-credit service to RE users to reduce costs and to reach economy scale.

a) Installations of SPV Systems b y Grameen Shakti

Within a period of one and an half decade, it has been able to develop a large number (2500) trained technicians, (mostly women) and altogether 7,000 employees for preparing, installing and taking care of the home systems. It has targeted to empower 75 million people all over the country through renewable energy technologies by 2015 (Grameen Shakti, 2009). It continues to provide solar home systems at a rate of 10,000 systems per month. The price of the SHS is still expensive for the rural poor; (Hackett, 2009). The application of solar PV systems by GS until now includes mostly stand-alone PV systems, SHSs to run CFL lights,

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black and white television, mobile chargers, refrigerators for vaccine preservation etc.

Grameen Shakti SHSs is used to light up homes, shops, fishing boats etc. People also used to charge cellular phones, run televisions, radios and cassette players. People also use for operating TVs cassettes, audios, VCPs etc., operational small fans and amplifiers, running computers and cellular phones, running computers and cellular phones and running DC motor driven equipments such as drill machines, soldering irons etc.

GS has introduced micro-utility model in order to reach the poorer people who cannot afford a SHS individually. GS has developed an effective strategy for reaching people in remote and rural areas with solar PV technology. It involves soft credit through instalments which makes SHSs affordable; community involvement and social acceptance; effective after sales service and blending Technology with Market Forces.

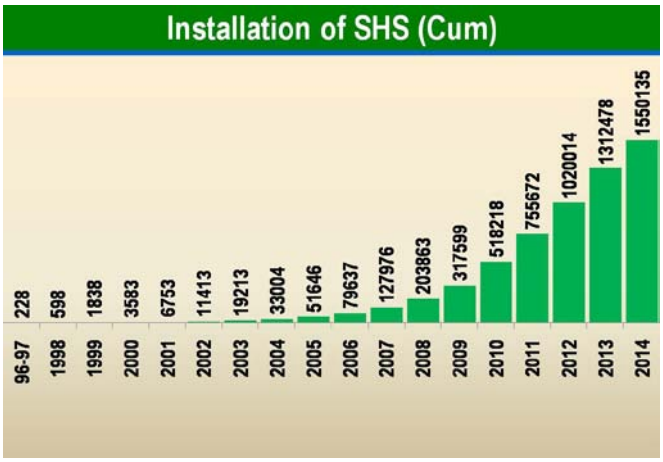


Figure 2

Source: Grameen Shakti, 2015.

Grameen Shakti SHSs users become the owner of an electric power generating and supply system. No need to pay monthly electricity bill in every month. SHSs life span is more than 20 years. There is no load shedding with SHSs. This technology is clean, safe and is environmental friendly & health hazards free energy.

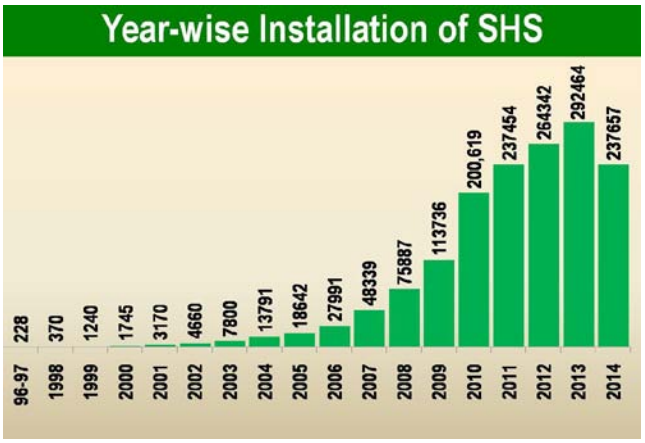


Figure 3

Source: Grameen Shakti, 2015.

b) GS PV Program Approach

Grameen Shakti's PV program targets unprivileged masses who live in remote rural areas of Bangladesh in order to make it easier for rural people to buy a system, GS has designed four soft financing options:

Table 24 : GS Financial Options

Option	Down Payment	Instalments	Service charge (flat rate)
Option-1	15%	36 months	6%
Option 2	25%	24 months	4%
Option-3	15%	36 months (with 36 post dated cheque)	5%
Option-4	1005 cash payment with 4% discount		

Source: Grameen Shakti, 2015

Table 25 : Grameen Shakti package price of LED Lamp solar home system 2014-2015 (price is changeable)

SL.	System Capacity (Watt)	Loads can be used	Equipments supplied by Grameen Shakti	Package price TK.
1	10	2X2.5 watt LED light	A 10 watt panel, 2X2.5 watt LED light, a 15 AH battery, a charge controller, a frame and cables	8,100
2	15	2X3 watt LED light	A 15 watt panel, 2X3 watt LED light, a 15 AH battery, a charge controller, a frame and cables	9,400
3	20	3X3 watt LED light	A 10 watt panel, 3X3 watt LED light, a 20/23 AH battery, a charge controller, a frame and cables	12,000
4	20	3X3 watt LED light	A 20 watt panel, 3X3 watt LED light, a 15 AH battery, a charge controller, a frame and cables	13,000
5	30	2x3 watt LD light and a	A 10 watt panel, 2X2.5 watt LED light, a 30 AH	15,500

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		15" LCD/LED TV	battery, a charge controller, a frame and cables	
6	40/42	3X3 watt LED light and a 15" LCD/LED TV	A 10 watt panel, 2X2.5 watt LED light, a 40/45 AH battery, a charge controller, a frame and cables	22,000
7	50	4X3 watt LED light and a 15" LCD/LED TV	A 50 watt panel, 4X3 watt LED light, a 55/60 AH battery, a charge controller, a frame and cables	27,100
8	60	5x3 watt LED light and a 15" LCD/LED TV	A 60 watt panel, 5X3 watt LED light, a 60 AH battery, a charge controller, a frame and cables	30,600
9	63/65	5x3 watt LED light and a 15" LCD/LED TV	A 63/65 watt panel, 5X3 watt LED light, a 70/80 AH battery, a charge controller, a frame and cables	31,600
10	75	6x3 watt LED light and a 12 watt fan and 15" LCD/LED TV	A 75 watt panel, 6X3 watt LED light, a 80 AH battery, a charge controller, a frame and cables	34,100
11	80	7x3 watt LED light, a 12 watt fan and a 15" LCD/LED TV	A 80 watt panel, 7X3 watt LED light, a 880 AH battery, a charge controller, a frame and cables	36,600
12	83/85	7x3 watt LED light, a 12 watt fan and a 15" LCD/LED TV	A 83/85 watt panel, 7X3 watt LED light, a 100 AH battery, a charge controller, a frame and cables	37,600
13	100	9x3 watt LED light, a 12 watt fan and a 15" LCD/LED TV and a 15" LCD/LED TV	A 100 watt panel, 9X3 watt LED light, a 100 AH battery, a charge controller, a frame and cables	41,600
14	130/135	7x3 watt LED light, two 12 watt fans and a 15" LCD/LED TV and a 15" LCD/LED TV	A 130/135 watt panel, 7X3 watt LED light, a 130 AH battery, a charge controller, a frame and cables	46,100
Warranty for different parts off LED Solar Home system Solar Panel: 20 years LED Lamp; 3 years 15 AH Battery: 3 years Change Controller: 3 years				

Source: Grameen Shakti, 2015.

The most popular demand Grameen Shakti's SHSs packages are serial number 3, 4, and 5 items in Bangladesh as mentioned items in the Table 25. In order to reach the poor, GS has introduced a financial model, known as Micro-utility. Till now GS installed more than 10,000 micro utility systems. GS also focuses on demonstration, quality products, and a reliable maintenance service to build awareness and trust of the rural people.

GS has been successful in promoting and constructing both domestic and larger sizes biogas plants to rural villagers. GS Biogas Program has a unique financial mechanism based on credit, which makes biogas plants affordable to the villagers. People use cow dung in their bio gas plants. Biogas technology can be also used with the home wastes. Grameen Shakti provides free services after sales including monthly visits by GS engineers for two to three years. People uses slurry of Biogas plant for organic fertilizer.

Key features of the GS biogas program are: a financial mechanism based on credit, which makes biogas plants affordable to the villagers, plants designed and constructed after one to one consultation with clients. GS provides free consultations after sales service including monthly visits by GS engineers for two to three years. GS uses local masons for constructing biogas plants in the villages. GS links biogas technology to emerging poultry, livestock and agriculture business. GS supported biogas is also using for cooking like natural gas.

Biogas protects women and children from in-door air pollution and related diseases such as coughs, asthmas etc. It helps keep the environment clean and stops the spread of diseases by transforming pollutants into clean energy. It saves fire woods resulted stops deforestation.

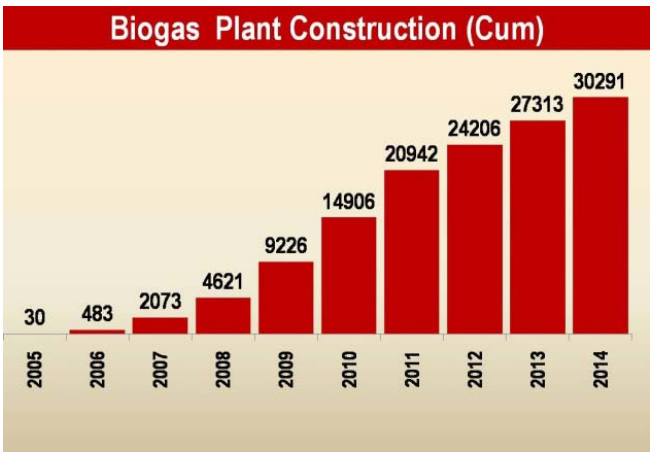


Figure 3

Source: Grameen Shakti, 2015

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c) *Bio-gas Program Financial Approach*

Grameen Shakti Bio-gas program has attractive financing system such as:

Option-1: 25% of the total cost is down payment. The remaining 75% is to b e paid in 24 monthly instalments with 8% service charges (flat rate) in 2 years.

Option-2: The buyer can also build his plant by himself, under the supervision of GS Engineers. In this case, half of the technical and supervision fee will be paid as down payment and the rest will be paid after the instalment.

d) *GS Wind Energy Program*

GS is also working in the field of solar thermal project, but it is still in pilot stage. GS installed 4 hybrid power stations (combination of wind turbine and diesel generator) in four cyclone shelters of Grameen Bank in the coastal areas in Bangladesh (Grameen Shakti 2015). The power generated from the wind turbines is connected to the four cyclone shelters. Appliances powered with this system are light, fan, water pump etc.

e) *Grameen Technology Centers*

GS has set up 45 Grameen Technology Centers (GTC). These GTCs are producing SHS accessories by manufacturing these locally. GTCs are also contributing to women empowerment by developing Solar Technicians in the villages. Women members of 5000 SHSs user families are also trained on proper repair and maintenance of their systems. Besides these, 10,000 school students gain awareness about the renewable energy technologies and the environment. GS also trained 300 engineers in order to implement this project smoothly. GS these technicians sign annual contracts with GS for after sales maintenance and become entrepreneurs in the future. Women technicians have already been trained, many of them are assembling SHS accessories at local GTCs, others are providing after sales service.These GTCs train renewable energy entrepreneurs and link them up with different technical and financial institutions.

Financing Solar Home Systems (Grameen Shakti 2015)

- The user has to pay 15% of the total price as down payment. The remaining 85% of the total cost is to be repaid within 36 months with 6% (flat rate) service charges.
- The customer has to pay 25% of the total price as down payment. The remaining 75% of the cost is to be repaid within 24 months with 4% (flat rate) service charge.
- Micro-utility: The customer has to pay 10% of the total price as down payment. The remaining 90% of the loan amount is to be repaid by 42 cheques. There is no service charge.
- 4% discount is allowed on printed price in case of cash purchase

GS research and development intents to develop and fabricate the solar accessories (charge controller, lamps, DC to DC converters etc.) locally in order to reduce the total system cost. Grameen Shakti has already developed Charge Controller, DC-DC Converter, DC Ballast for fluorescent lamp, Mobile phone charger products at low cost

f) *GS Improved Cooking Stoves contributes*

GS improved cooking stoves contributes to 50% less fuel cost, women protected from in-door air pollution, no blackening, no heat from stove. GS has become interested in ICS because it helps women and makes their lives easier. GS sees a potential market of at least 2 million ICSs in the first three years of the program. GS plans to depend on two types of local players for expanding Improved Cook Stoves - local technicians and local manufacturers. GS has already trained more than 1000 local youth especially women to make, sale and repair ICSs. GS plans to train more technicians in the next phase .These trained technicians train others as well as produce and commercialize improved cook stoves on behalf of Grammen Shakti. Many of them have started their own business in arrangement with GS.



Figure 4

Source: Grameen Shakti, 2015

g) *Bio-fuels*

India established the first biodiesel produce from Jatropha plant in Hyderabad of Andra Pradesh (GTZ, 2008). It is expected that at least 2.5 m. tons of biodiesel can be supplemented to the total demand of around 50 m. tons for Indian vehicles. Jatropha plants grow in the dry-arid part of the Indian State has promoted the local's income generation. Grameen Shakti has started to cultivate Jatropha on a plot basis in Dhaka in 2010, but it is yet not cultivate at mass scale.

h) *Social Business and Nabin Udoykta Program of Grameen Shakti- a new Dimension*

All the activities of the organization Grameen Shakti executes are fully related to social business

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perspective. It is a new category of cause-driven business. The company must cover all costs and make profit, at the same time achieve the social objective. In a social business, the investors/owners can gradually recoup the money invested, but cannot take any dividend (profit) beyond that point. Grameen Shakti follows all seven principles of social business.

Grameen Shakti has been attached to 'Nobin Udyokta Program' of Nobel Laureate Prof. Muhammad Yunus, a very promising project to bring new young entrepreneurs in the light. Prof. Muhammad Yunus has given permission to include the children (2nd generation) of Grameen Bank Borrowers from Birulia, Ahshulia and Dhamshona Union under Savar Upazilla of Dhaka district in the Social Business as well as Nobin Udyokta (New Entrepreneurs) Program.

The activity of investment in the different promising project of Nobin Udyokta has already been started in the Grameen Bank Area of above mentioned unions under Nobin Udyokta program executed by Grameen Shakti. Till now, 6 Nobin Udyokta projects have been presented in Executive Design Lab and approval for investing. Tk. 1.4 million has been invested by GS. Four Nobin Udyokta have received Nine Hundred Thousand Taka till now. These projects include tailoring, textile business, telecom service, grocery shop, dairy farm etc (GS, June 2014). Rest of 2 projects is now in the process to be invested as early as possible. Moreover, more than 10 promising project are in pipe line to be presented in Executive Design Lab in near future. There is a plan to invest 5 million Taka among 20 Nobin Udyokta (New Entrepreneur) by December, 2014 and 50 million Taka among 250 Nobin Udyokta by 2015 (Grameen Shakti, April, 2015).

Table 26 : Programs at a Glance February, 2015

Total Office	**1528**
Branch Office	1245
Grameen Technology Centre	34
ICS Production Center	67
D-Ionized Water Plant	1
Number of districts covered	Covered all districts
Number of Upazilas covered	508 Upazila
Number of villages covered	50,000 villages
Total beneficiaries	Around 17.67 million people
Total employees	11,230
Total installation of SHS	1,583,319
Total Number of Improved Cook Stove (ICS)	910,204
Total biogas plant constructed	30,847
Total installed power capacity	63.33 MWp
Daily power generation capacity	171.00 MW-hr
Installation rate	Over 20,000 SHSs/ month
Installation of micro utility systems	Over 9,605 system
Number of trained technicians (Mostly woman technicians)	22,822 technicians
Number of trained customers (Mostly woman)	839,725 users
Full Paid customer (ownership)	604,694 customers
User under maintenance agreement (After 3 Years)	44,759 customers
Future plan- total installation of SHS by 2015	2 million
Future plan- biogas plant construction by 2015	100,000
Future plan- Improved Cooking Stove construction by 2015	2 million
Green Jobs Creation by 2015	100,000

Source: Grameen Shakti, February, 2015

XV. National Energy Policy

The first National Energy Policy (NEP) of Bangladesh completed and gazetted in 1996 was adopted mainly with the aim of achieving sustainable economic growth and developing sufficient energy for different sectors (Islam et al. 2006; Islam, 2005). The guidelines of the renewable energy were mentioned in the NEP document. Later, the government adopted Private Power Generation Policy in order to promote private sector participation in power generation. In 1996, import duty and value added tax from solar PV and wind turbines were withdrawn by the government. In April 2004, Bangladesh Energy Regulatory Commission (BERC) was established and started functioning. The major objectives of the renewable energy policy mentioned in the NEP 2004 are targeted to provide energy for sustainable economic growth to meet the energy needs of different zones of the country, ensure environmentally sound sustainable energy development programmes causing minimum damage to environment, encourage public and private sector participation in the

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development and management of the energy sector, to bring entire country under electrification by the year 2020, to ensure reliable supply of energy to the people at reasonable and affordable price and too develop a regional energy market for rational exchange of commercial energy to ensure energy security (MPEMR, 2004).

The Renewable Energy Program in Bangladesh has emphasized on the exploitation of solar, wind, biomass gasification, biogas and hydro energy. The major objectives of the renew able energy policy aim to exploit potential RES and disseminate RETs in the rural, peri-urban and urban areas; to inspire private sector investment in RE; to promote clear energy for CDM etc. The policy has targeted to develop RES to meet 5% of the total power demand by 2015 and 10%by the year 2020 (MPEMR, 2008).

XVI. Recommendations

RETs along with technologies for energy conservation and energy efficiency can help overcome energy shortages and lead the country to progress provided necessary steps are taken now without delays. Solar radiation is excellent for all locations of Bangladesh. Large scale utilization of solar and wind energy should help energy security in the face of impending energy crisis from dearth of conventional energy supply. Renewable energy public education could be included in the formal and non-formal adult education in Bangladesh. On going SHS program should be strengthen to enable installation of 500,000 units by 2020

The program for biogas project and biomass cooking stove can solve rural firewood cooking problems so these two technologies can be promoted through public extension agencies, and green NGOs in Bangladesh. For power supplement, the roof-top application of solar PV systems could be promoted in urban areas of Bangladesh. The government sponsored Infrastructure Development Company (IDCOL) has to initiate financing (micro-credit) for solar home systems in the urban slums (like off-grid remote areas). In order to promote sustainable wind power generation, an efficient management system and strong coordination among the respective authorities have to be ensured. For biogas plant installation, village cooperatives can be created to promote the technology among the villagers. Funds for renewable energy projects have to make available along with additional resources for innovative activities of RETs.

Many problems are suffering by the coastal energy users. Therefore, the community institutions could be engaged and financed for developing Wind Pump Energy infrastructure facilities around the coastal areas in Bangladesh.

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The Atmospheric Warming and Homicides in India

By Ashutosh Mishra
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Abstract- Crime is an act against law and thus is a punishable offence. Crime varies over space and time. Among all crime types, murder is the most cruel and inhumane which do an irreparable damage to the society. The study attempts to examine how atmospheric warming may increase homicides. To achieve this, the paper analyses the trend pattern of homicides and various determinants. Social heterogeneity and weather- more specifically temperature, are considered to be most influencing in catalysing aggression and murder. The study tries to evaluate the linkages between these factors by examining the correlation between homicide and income and poverty level, level of urbanisation, and temperature in India over a 13-year span of time. The analysis is based mainly on the secondary data obtained from National Crime Record Bureau of India, India Meteorological Department and State and District Censuses. Results show that while poverty, urbanisation and income level do not affect the homicide significantly in unidirectional manner, temperature does affects the pattern of murder incidences. Interestingly the regions which have witnessed warming trend during the past decade, are also the areas of high and increasing homicide rates.

Keywords: *stressors; microdata; geographic resolution; ambient temperatures; precursors; relative deprivation.*

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The Atmospheric Warming and Homicides in India

Ashutosh Mishra

Abstract- Crime is an act against law and thus is a punishable offence. Crime varies over space and time. Among all crime types, murder is the most cruel and inhumane which do an irreparable damage to the society. The study attempts to examine how atmospheric warming may increase homicides. To achieve this, the paper analyses the trend pattern of homicides and various determinants. Social heterogeneity and weather- more specifically temperature, are considered to be most influencing in catalysing aggression and murder. The study tries to evaluate the linkages between these factors by examining the correlation between homicide and income and poverty level, level of urbanisation, and temperature in India over a 13-year span of time. The analysis is based mainly on the secondary data obtained from National Crime Record Bureau of India, India Meteorological Department and State and District Censuses. Results show that while poverty, urbanisation and income level do not affect the homicide significantly in unidirectional manner, temperature does affects the pattern of murder incidences. Interestingly the regions which have witnessed warming trend during the past decade, are also the areas of high and increasing homicide rates.

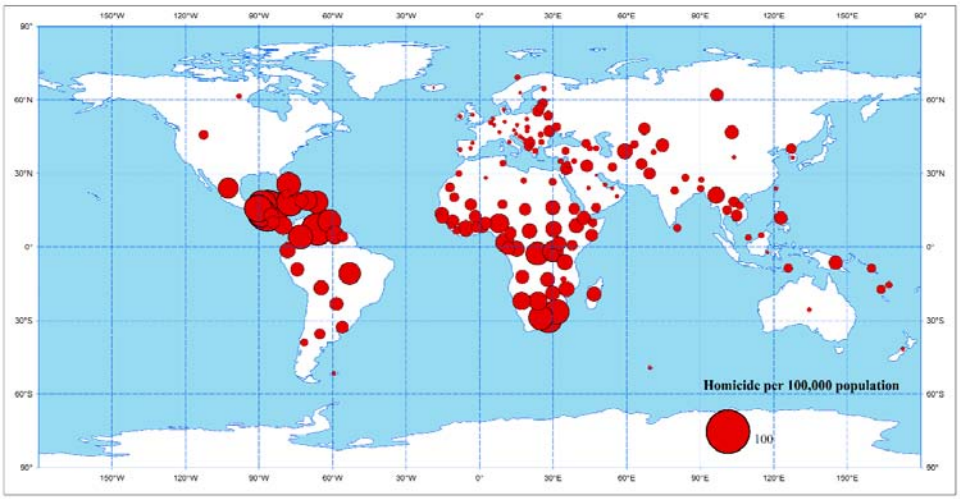
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I. Introduction

Man is the ultimate evolution of nature. As a social and physical creature he is governed by invariable laws. These laws are the necessary relations arising from the nature of things (Montesquieu, 1748). With the development of human society social laws emerged as a base to maintain social serenity. Gradual development of society filled a thirst for development in humankind. This desire whenever and wherever failed, generated frustration, depression and aggression. Lopsided economic development further strengthened these feeling by giving birth to poverty, unemployment and deprivation. These situations in combined ultimately produced crime. Among all the crime categories homicide is the severe most where society loses all the ethical bounds. It may be defined as "unlawful death purposefully inflicted on a person by another person" (UNODC, 2014: 21).

Homicide caused the deaths of almost half a million people (437,000) across the world in 2012. More than a third of those (36 per cent) occurred in the Americas, 31 per cent in Africa and 28 per cent in Asia, while Europe (5 per cent) and Oceania (0.3 per cent) accounted for the lowest shares of homicide at the regional level (UNODC, 2014).

The global average homicide rate stands at 6.2 per 100,000 population, but Southern Africa and Central America have rates over four times higher than that (above 24 victims per 100,000 population), making them the sub-regions with the highest homicide rates on record, followed by South America, Middle Africa and the Caribbean (between 16 and 23 homicides per 100,000 population). Meanwhile, with rates some five times lower than the global average, Eastern Asia, Southern Europe and Western Europe are the sub-regions with the lowest homicide levels. Interestingly most of the homicide is situated between 30° North to 30° South latitudes, which is the warmest region on the earth (Fig. 1).



Based on: UNODC World crime record, 2014

Figure 1 : World-wide pattern of homicide rate

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United Nations Office on Drugs and Crime (UNODC) data points out plausible relationship between climate (and especially temperature) and homicide. Crimes result from the interaction between individuals and environment, and the majority of the literature that has investigated the relationship between weather and homicide support the theory that weather does affect murder occurrences (Cohn, 1990). The literature pertaining to the effect of weather element on behaviour reveals two major biological theories. The first theory considers weather changes or extremes to be stresses. The theory states that if a person is highly stressed, or more sensitive to stressors, weather change may exhibit behavioural or mood changes to him. The second theory considers weather as a stimulus to the human organism which can have both physiological and psychological effects (Moos 1976). Researchers have found that weather is the production function for crime (Cohn, 1990; Agnew, 2012). Becker (1968) and Jacob et al. (2007) considered weather conditions as an input that affect the probability of successfully completing a crime and escaping undetected afterward.

Scientists have adopted different approaches and types of data sets to draw their results. While some studies have focused on measuring the short-term relationship between weather and crime using hourly, daily, or weekly microdata (Horrocks and Menclova, 2011; Bushman, Wang, and Anderson, 2005; Cohn and Rotton, 2000; Brunsdon et al., 2009, Jacob et al., 2007), others have used aggregate annual data to measure association between weather and crime (Anderson et al., 1997, Rotton and Cohn, 2003). While micro studies have noticed accountable influence of weather elements on homicide rate, the studies analysing bigger regions have found mixed results, possibly due to the lack of temporal and geographic resolution in their homicide and weather data.

Among all the climatic elements, temperature and precipitation are the most important determinants for weather conditions. And, therefore, variability pattern of these two elements may define the nature and degree of association between weather and homicide rate. On the basis of cost and benefit analysis, James Horrocks and Andrea Menclova (2011) found evidence that temperature and precipitation supported violent crimes. Michael and Zumpe (1983a, l983b) found a positive relationships between the annual mean temperature and annual mean homicide rate. DeFronzo (1984), also found positive association between year-total homicide data and the number of 'Hot Days' in their study. John Cotton (1986) suggest that aggressive behaviour increases above 90°F. An analysis by Harries and Standler (1988) suggests that there is no curvilinear effect between temperature and aggression, even during conditions of extreme heat. On the other hand Jacob et al. (2007) found that short term weather changes impacts weekly or daily rates of criminal activity but in the long run the correlation is not linear.

A series of experiments on the influence of high ambient temperature on aggressive behaviour by using two temperature conditions ('hot' being approximately 93°F and 'cool' being approximately 73°F) and two arousal conditions established a curvilinear relationship between aggression and heat (Baron 1972; Baron and Lawton 1972; Baron and Bell 1975, 1976; Bell and Baron, 1976). These experiments noted that aggressive behaviour increases with heat up to about 85°F, and then decreases. However, Anderson and Anderson (1984) proposed that the curvilinear effect may be an experimental artefact, because the temperature manipulations were extremely obvious to the subjects. Bell, Fisher, and Loomis (1978) concluded that extremely high ambient temperatures, especially when combined with other sources of irritation or discomfort, may become so debilitating that aggression is no longer facilitated and may well be reduced' (Bell, Fisher, and Loomis 1978). On the other hand, by using negative feedback technique Bovanowsky et al. (1981) found that aggression increased with heat.

Feldman and Jarmon (1979) found no significant correlations between ambient temperature and homicide. A ten year period trend analysis by Perry and Simpson (1987) recorded no significant relationship between the monthly homicide rate and the monthly minimum temperature. In his study Cohn (1990) could not establish a significant relationship between heat (temperature) and homicide rate, however he concluded that heat does affect crime in the areas of aggression and violence.

The review reveals that while the daily influence of heat on homicide is doubtful, there is evidence of long-term association of homicides with high-temperatures. However, this association could be mediated by a variety of cultural, regional, and historical factors.

The relationship between rain and crime appears to vary with the type of crime examined. While assault and other crimes show some notable association with precipitation, homicide does not associate very well. Feldman and Jarmon (1979) examined the association between rainfall and crime on a day-to-day basis and did not find any significant correlation between precipitation and homicide rate. In examining the relationship between rainfall and crime, DeFronzo (1979) considered the number of days on which amount of precipitation exceeded 0.25 mm. while in his study Perry and Simpson (1987) analysed monthly amounts of precipitation and month-wise crime rate. Like Feld and Jarmon, these two studies too could not establish notable relationship between precipitation and homicide rate. In his study of homicide and aggravated assaults, Pokorny (1965) found the similar results that homicide is not significantly related to rainfall.

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The results of these studies show both negative and positive outcomes, and they commonly suggest that while temperature (heat) have conflicting influences on homicide rate, rainfall does not seem to be a good predictor for the same.

Besides these researches suggesting influence of physical environment on homicide, there are number of studies explaining crime pattern on the basis of social interactions that occur during day- to-day life (Glaeser, Sacerdote, and Scheinkman, 1996; Rotton and Cohn, 2003). However, these studies too acknowledge the role of physical environment and believe that weather conditions that foster social interactions are likely to increase crime rates. World is passing through a phase of industrialisation and rapid urbanisation and these two have been regarded as precursors in bringing socio-economic development. However, many researchers consider industrialization and urbanization as an underlying causes of crime. Shaw & McKay (1969) were of the view that "due to constant influence of exogenous forces such as industrial invasion and migration, the process of industrialization and urbanization promotes crime". These exogenous forces disturb the traditional norms and values of the community, and continuous invasions of "foreign" cultures, and sprawling large urban settings, prevents the community from establishing shared norms and values. Crime rates are expected to be relatively low in societies characterized by a homogeneous population and simple technological development because social norms are relatively strong, unambiguous, and binding. In societies characterized by heterogeneous populations, perhaps as a result of rapid socioeconomic change (i.e., industrialization and urbanization), individuals are less likely to accept group-oriented discipline over personal desires due to confusion over norms and values (Tsushima, 1996).

It is said that human behaviour can be largely predicted by his socio-economic environment (Bonger, 1916: 75-76), and economic structure has a considerable impact on human activities such as crime, especially in terms of income level or poverty, economic inequality, and economic opportunity. Quetelet (1984) opined that crime is especially significant in areas with rapid social or economic change, rather than in areas where people are poor but are able to satisfy their basic needs. Poverty increases the probability of peoples` involvement in criminal activities. Philips (1991) says that economic independence for the poor is the single most crucial element in any plan to fight crime. Blau and Blau (1982) reports that economic inequality is positively associated with high rates of violent crime. In his study Bailey (1984) and Williams (1984) found that poverty is positively (insignificantly) associated with homicide rates, while Messner (1982) noticed that poverty has a negative (although insignificant) impact on homicide rate. Aronson (1988) argues that poverty leads frustration, which further leads to aggression. Aronson further stressed that "frustration is not simply the result of deprivation; it is the result of relative deprivation" (1988: 212-13). And, therefore, a society with the high level of economic inequality will have high crime rates (Bayley, 1991; Ladbrook, 1988; Tanioka & Glazer, 1991, Tsushima, 1996, Hartnagel & Lee, 1990).

Unemployment is also considered to be a major factor in incidence of crime. The unemployed people are more likely to be exposed to the lure of criminal subcultures because of their lack of involvement in conventional activities and close personal relationships with non-family members (Gottfredson & Hirschi, 1990; Kelvin & Jarret 1985: 53). Researchers have found mixed results on unemployment-crime association. Danziger (1976) and Jacob (1981) noticed a positive relationship between unemployment rates and homicide, while Spector (1975) found no significant relationship between unemployment rates and murder rate. On the other hand Crutchfield et al. (1982), and Kennedy et al. (1991) recorded a negative relationship between unemployment rates and homicide.

This study addresses mainly the association between atmospheric warming and homicides by taking India as a case. Meanwhile it also attempts to understand different underlying factors responsible for the murder incidences.

II. Data Sources and Methodology

Temperature is one of the most important determinant of weather conditions and most of the studies examining relationship between climate and crime are based on the variability pattern of temperature. Present study is also confined to this climatic factor to analyse the association between climate and homicide rate. The study is based on the month-wise data for 13 years period (2001-2013) at state and district level in India. The temperature data were obtained from India Meteorological Department, while district level monthly homicide rates were extracted from crime census records published by National Crime Record Bureau. World level crime pattern is based on the data of United Nations Office on Drugs and Crime. To map poverty, Human Development Report 2013, was used while population figures are based on Census of India, 2011.

Homicides occur more infrequently than other violent crimes, and this may, thus, seriously reduce the effectivity of the statistical tests employed. Therefore, the study examines the nature and level of association between weather and crime by using maps and graphs, however simple statistical techniques have also been employed.

III. Results and Findings

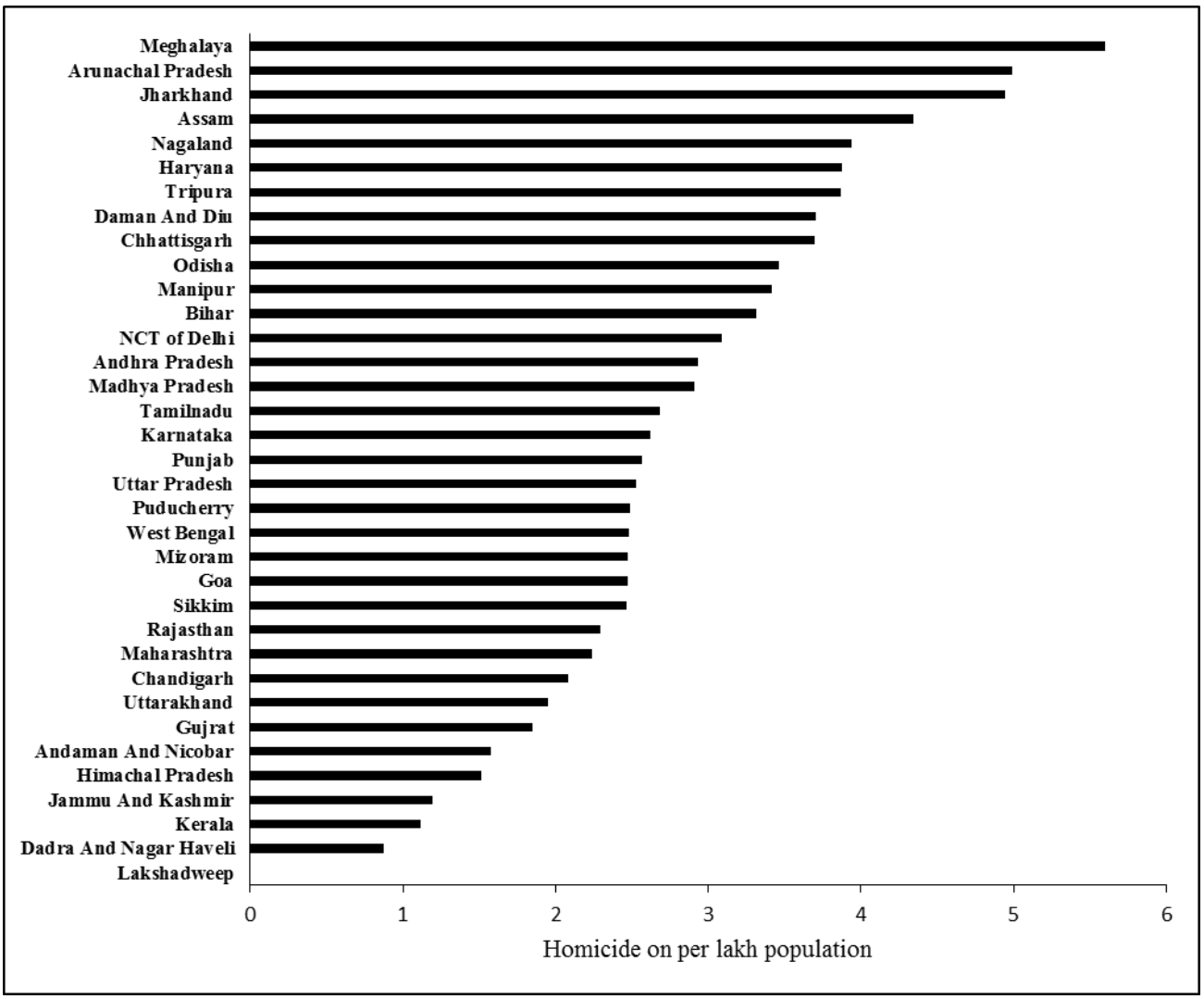
Trend of Homicide in India

Increased crime rates play a decisive role in hindering the growth of a nation as a unit, especially in

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the case of developing countries like India. India has recorded 33201 murder (3 per lakh population), 33707 rape (3 per lakh population), 65461 kidnapping & abduction (5per lakh population), 72126 riots (6 per lakh population), and 2647722 IPC crime incidences (219 per lakh population) in 2013 (NRBC, 2013).

Kerala State that tops in many development indicators, has the highest rate of crimes under the Indian Penal Code in India (NRBC, 2013). (Fig. 2). At 455.8 per lakh population, the crime figures for Kerala is more than double of the national average. Nagaland, according to the report, has the lowest crime rate that is only a tenth of that in Kerala. Among cities, Kochi reports 817.9 incidents of IPC crimes for every lakh population, the highest in the country. Indore comes second with 762.6 incidents.



Source: National Crime Record Bureau of India

Figure 2 : Incidence of homicide on per lakh population recorded in Indian states in 2013

Looking at the pattern of homicide at district level, Nadia district of west Bengal has recorded highest homicide cases (517). Nadia has also registered highest number of total incidences of IPC Crimes (80184). However comparing on absolute numbers does not seems very convincing because every state and district have different population size. To compare in real terms the study measures homicide rates on per lakh population. At per lakh population base, Dibang Valley district of Arunachal Pradesh records the highest number of homicides on per lakh population.

The urbanisation profile of India suggests that homicide is not significantly associated with the level of urbanisation. The North-Eastern districts of the country and especially the districts of boundary state-Arunachal Pradesh which are poorly urbanised, record the maximum homicide per year (Fig. 3). In general the less urbanised Himalayan states of India- Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Tripura, Nagaland, Manipur and Mizoram have recorded high homicide rates. However, some highly urbanised coastal districts also have registered the high homicide rate.

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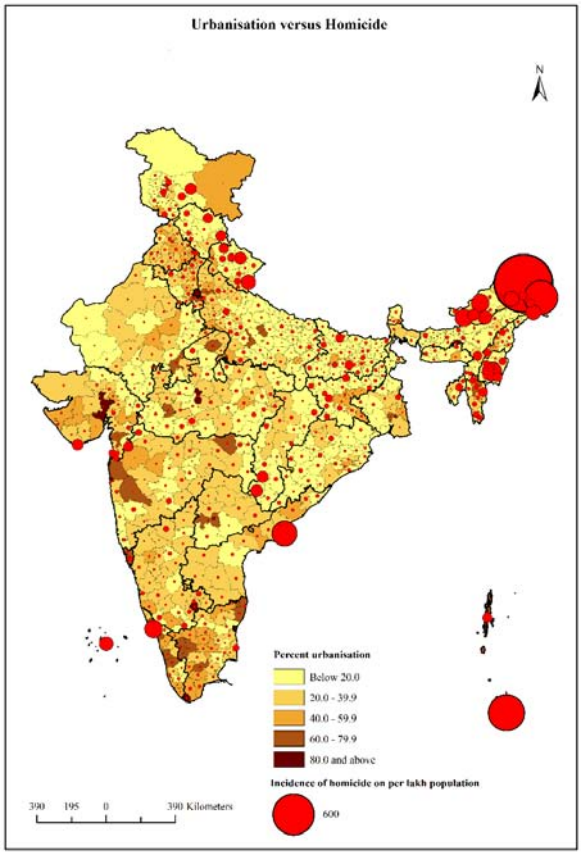


Figure 3 : Correlates of urbanisation and homicide

Table 1 shows some districts of India those have recorded the highest homicide rate and respective level of urbanisation there. It is clear that urbanisation and homicide are not very well correlated and the data of the table 1 produces very insignificant and negative correlation (-0.06) between homicide and urbanisation.

Table 1 : Districts having high homicide rate

District	State	Murder per lakh population	Urbanisation in per cent
Dibang Valley	Arunachal Pradesh	50	29.79
Bijapur	Karnataka	27	11.60
Nicobar	Andaman and Nicobar	22	0.0
Khunti	Jharkhand	20	8.46
Gumla	Jharkhand	19	6.35
Bijapur	Chhattisgarh	18	11.60
Kokrajhar	Assam	12	6.19
East Kameng	Arunachal Pradesh	11	23.32
Jaintia Hills	Meghalaya	11	7.20
Simdega	Jharkhand	11	7.16
Yanam	Puducherry	11	100

Source: National Crime Record Bureau of India, 2013

Studies suggest that socio-economic state influence the human behaviour and homicide rate significantly (Bonger, 1916; Quetelet, 1984; Philips, 1991; Blau and Blau, 1982; Bailey, 1984; Williams, 1984; Messner, 1982). Undoubtedly income and poverty are the two most important determinants of wellbeing but here in case of India, results suggest that regions above poverty line are also the areas having more homicide incidences with some exceptions like some poverty stricken districts of Bihar (Sheikhpura, Sheohar and Jehanabad) and Chhattisgarh (Bijapur and Narayanpur) have registered high homicide rates (Fig. 4).

Per capita income has not shown any significant relationship with homicide rate (Fig. 5). States like Haryana and Delhi which have recorded the highest per capita income are not the regions of high murder rates. While on the other hand almost all the districts of Uttarakhand and some districts of Telangana, Kerala, Gujrat and Maharashta have shown a significant and positive association between murder and income.

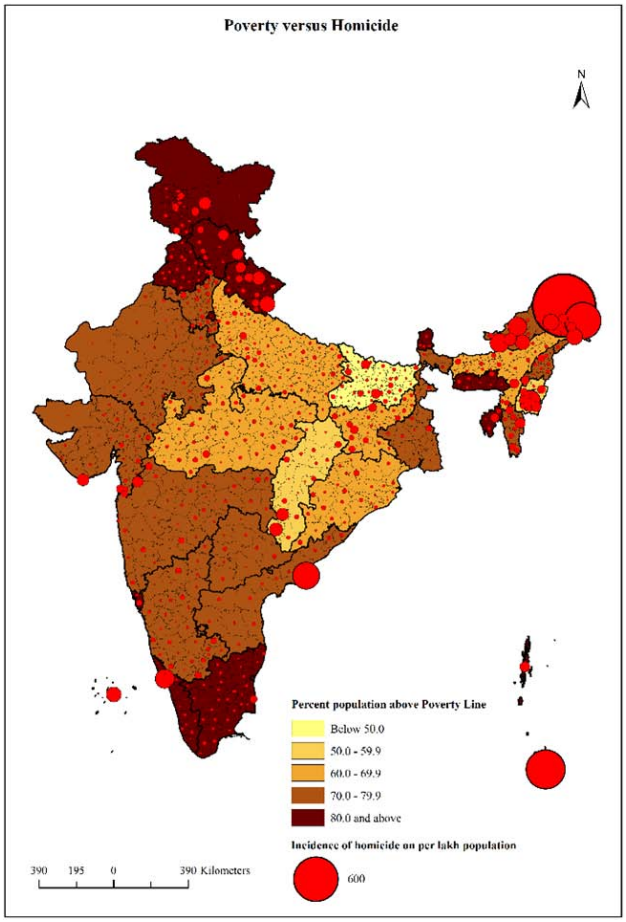


Figure 4 : Correlates of Homicide and Poverty, 2013

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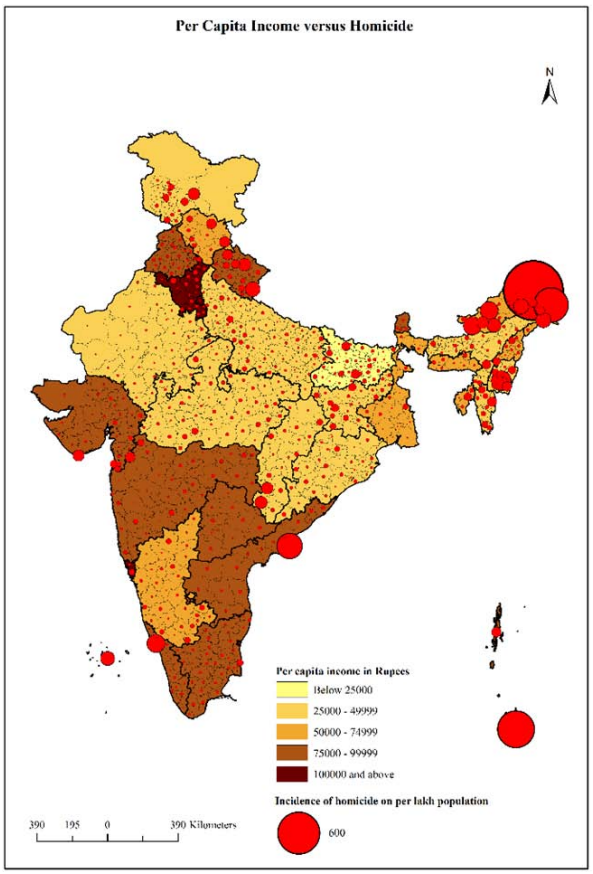


Figure 5 : Correlates of Homicide versus Income, 2013

Apart from socio-economic factors, physical elements seems having more striking connection with homicide pattern. The analysis of temperature-homicide association on the basis of average temperature data for the study period of 2001-2013 support the hypothesis that temperature does affect homicide rate, although exceptions are there. Average annual temperature over India varies between -1.86°C (Leh-Ladakh in Jammu & Kashmir) to 26°C (Kraikal in Puducherry) and while low temperature zones of Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh registered the maximum homicide, some high temperature regions of Kerala, Telangana, Maharashtra, Gujrat and Chhattisgarh states too have recorded high homicide rates (Fig. 6). However, figure 7 presents some convincing explanation of temperature-homicide association by comparing warming and homicide trends.

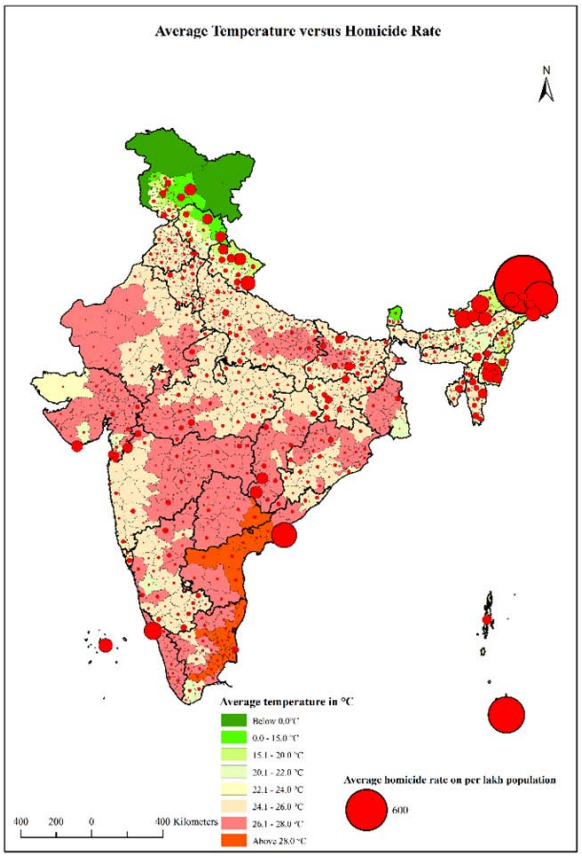


Figure 6 : Temperature versus Homicide

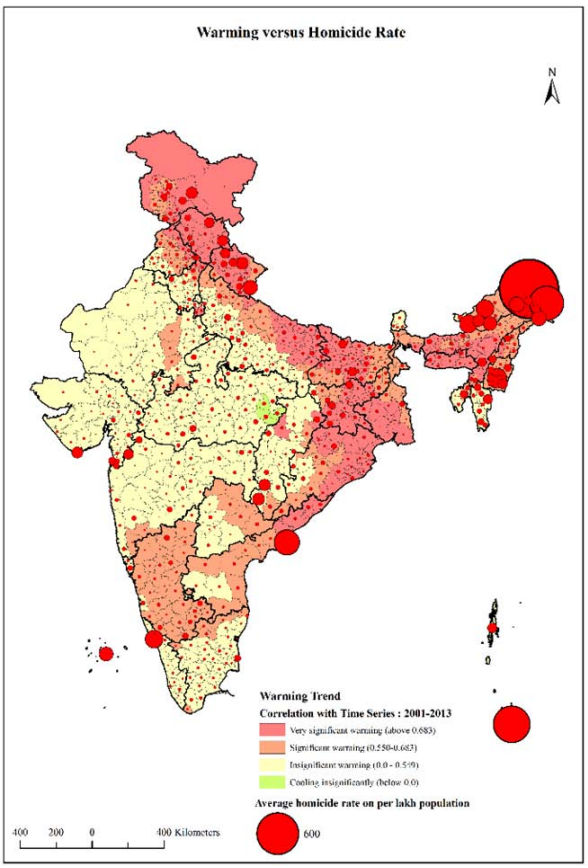


Figure 7 : Warming versus Homicide

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Evidently all the regions which have witnessed significant warming during the analysis period of 13 years (2001-2013), are also the areas of high homicide rates.

IV. Conclusion

Results suggest that social parameters like urbanisation, poverty and per capita income do not correlate very well with homicide trends. On the other hand regions of harsh climatic conditions–desert areas (districts of Rajasthan) and mountainous landscapes (districts of Jammu & Kashmir, Uttarakhand, Sikkim, Arunachal Pradesh, Tamil Nadu and Kerala) have a significant covariance with homicide rate. Districts of almost plain topography and mild climatic condition did not show any significant relationship between homicide and temperature trends. The regions which have shown the warming trend during the past decade have recorded the increasing murder incidences. Thus, while ambient temperature conditions, and heterogeneous landscape (physical as well as social) seems catalytic to increase the murder rates, warming trend also has a great bearing on homicide incidences.

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Land Tenure System, Land Settlement and Status of Legally Landless Communities in Koraput: A Case Study ofKapsiput Village, Odisha (India)

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Abstract- Land is the most critical factor of production for a myriad of economic activities for human settlement worldwide although it is in limited supply. It is therefore, essential that its allocation across different economic activities and uses should be based on sound theoretical premises, combined with the ground realities of multiple objectives -a few of which regularly exceed the narrowly defined goals of economic growth per se. For traditional communities, 'access to lands is directly associated with civilization paradigms and cultural ethos, which rather decide their 'economics', and not one other way round that could be true for modern, techno-centric civilizations. Most mainstream discourses of history have, however, tried to find the crisis in the 'absence of state interventions and a dig into the social history points to deeper roots of the crisis, which rather intensified after the entry of the 'welfare' state. In a predominantly, agrarian economy such as for example in India and Odisha, the entitlement to livelihood and access to the factors of production, especially land and forests, are essential objectives that require to ascertain allocation of land across different uses and users.

Keywords: landlessness, revenue land, waste land, land survey, land settlement.

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Land Tenure System, Land Settlement and Status of Legally Landless Communities in Koraput: A Case Study of Kapsiput Village, Odisha (India)

Dr. Rabindra Garada [α] & Pratap Kishore Mohanty [σ]

Abstract- Land is the most critical factor of production for a myriad of economic activities for human settlement worldwide although it is in limited supply. It is therefore, essential that its allocation across different economic activities and uses should be based on sound theoretical premises, combined with the ground realities of multiple objectives -a few of which regularly exceed the narrowly defined goals of economic growth per se. For traditional communities, 'access to lands is directly associated with civilization paradigms and cultural ethos, which rather decide their 'economics', and not one other way round that could be true for modern, techno-centric civilizations. Most mainstream discourses of history have, however, tried to find the crisis in the 'absence of state interventions and a dig into the social history points to deeper roots of the crisis, which rather intensified after the entry of the 'welfare' state. In a predominantly, agrarian economy such as for example in India and Odisha, the entitlement to livelihood and access to the factors of production, especially land and forests, are essential objectives that require to ascertain allocation of land across different uses and users. Our study reveals the allocation mechanism must not only address the requirements of economic activities or sectors including housing but additionally look into the specific needs of numerous ecosystems, regions and communities. A cursory look on the policies concerning revenue land in Odisha suggests that the ultimate authority lies with the state government to allocate land wherever necessity. Our study finds that sufficient care should be taken to engage the communities with the revenue laws in the state. In this paper, we have tried to unravel the critical issues of land and emphasised as to how communities can manage and allocate lands in a democratic, judicious and equitable manner. The case study also emphasizes the role of increased interface with revenue administration for creating an enabling environment for local action, participatory governance and policy dialogue.

Keywords: landlessness, revenue land, waste land, land survey, land settlement.

I. Introduction

In the context of prevailing land tenure systems and land settlement induced by government's intervention the status of legally landless people (LLP) has been complex and complicated in the resource rich regions of rural India. The legally landless people are mostly the tribal communities who have been customarily accessing forest and non-forest lands for their survival in India as elsewhere in the world for centuries. However, in course of time everywhere the nation-states have declared the customary access to, and use of lands as illegal access and instead, treat these lands as government lands for which the customary occupants lost their stake over it and became legally landless consequently. But without sustainable options the tribal continue to access these lands for their livelihoods in a country like India and state like Odisha mostly making their living in the remote forest areas. But in doing so, they grapple with many obstacles and stiff government opposition. For instance, in most of the tribal or "Schedule Area" of Odisha the landless poor suffer cultivating the government wastelands (Garada, 2014). They lack *de jure* ownership over these lands, and because of this, they keep on paying fines year after year and face the threat of eviction through legal cases as well. Addition to that in the context of demand of land for "development projects" the deliberately kept customary lands in the government record are easily alienated from their primary stakeholders- tribal in the state. Presently, though, the prevailing revenue laws like Odisha Private Land Encroachment Act (OPLE) and Odisha Government Land Settlement Act (OGLS) provide some space for providing ownership to the legally landless families but the legal inadequacies like insufficient procedures for compulsory settlement of wasteland for poor, rare scope of Gram Sabha for wasteland management and many other problems apart from the problem of non-implementation put the tribal communities at the receiving ends. Besides, these wastelands are leased out in the name of development to Industry, mining, contract framings, grass cultivation, plantation schemes, Trusts and Temples and host of such forged societies managed by the vested interests and political clout by alienating the customary rights of the poor farming communities without giving due compensation or having any negotiation in the plea of insufficient record of their land titles (Kumar, 2005). At present scenario of neo-liberalism and growth model of economic development the developing country like India is potentially facing serious challenges in safeguarding the farming communities and ensuring their agro-based livelihoods. As a result, the farming communities,

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especially the ecosystem people who still survive in the forests, make their livelihoods and find their cultural roots there over the years are fast losing their productive assets (lands) (Garada,2013). Many successive governments have taken initiatives in addressing such critical problem of landlessness, with legal and policy backup. However, the expectation envisaged has not been fully contented in the ground although there have been some impact realised on certain issues. In fact, the major proportion of land designed for distribution, lease or settlement for the poor landless families is the government wasteland. Hence, it is important to identify the gaps in provisions of the existing legislations that restrain the conferment of ownership or leasing rights to the legally landless families. Thus, this is high time to have a study which would help identifying such gaps in the existing legislations and policies so that suitable policy changes could be initiated. And that would benefit to wider section of the landless families in the state. However, in this regard most of the civil society groups, community members and Panchayati Raj Institution (PRI) representatives are not aware of simple provisions of existing laws/policies and government land distribution programmes. As a result, they fail to use the existing space in laws for facilitating ownership or leasing rights and devise effective advocacy strategies. Presently there is very little interface between the land administration system, farming communities and civil society groups. This has caused problems related to accountability, transparency, proper implementation of laws/policies, etc within the present governance pattern. Thus, the emphasis on increased interface with revenue administration will certainly help creating an enabling environment for local action, participatory governance and policy dialogue in this regard. In this backdrop this article exposes the tragedy of landlessness caused by government land settlements in the Koraput district of Odisha.

II. Review of Literature

The proportion of households operating without lands,whose livelihoods based principally on agricultural labour, was increased substantially after the widespread eviction of tenants from erstwhile landlord estates in the early 1960s in Odisha (Mearns and Sinha, 1999). Since the 1960s some have gained access to at least some lands, but around a quarter of all such households in Odisha still operate without any lands. In spite of land reforms and socio-economic and demographic change over the last half a century, the overall trends suggest that formidable obstacles continue to prevent the rural poor from improving their access to private arable land (World Bank, 2005). The biggest problems of the tribal of India in general and of Odisha in particular are their land alienations by non tribals and governments. In fact, while most of the scheduled tribes in rural area engaged in agriculture and allied sector activities a large section of the non-tribals are grabbing their lands to which the latter has been cultivating for ages. In addition to this, by manipulation, the non-tribals are also taking government land on lease in the tribal areas. It is surprising to see that there are many instances in Odisha where in actuality the land encroached by the tribals are also getting alienated in favour of the non-tribals (ibid). Thus, truly speaking the problem of land alienation for the tribals has become more critical day by day. In the scheduled areas of Odisha, three - fourth of land is owned by the state, and in districts like Gajapati and Kondhmal, only less than 10 per cent of land is owned by tribals. At the same time, the land ownership per tribal household is incredibly low at 1.12 standard acres in the state. The condition of ST marginal households (more than 50% of tribal landowners) is even more pathetic as their average landholding is only 0.44 standard acres. Thus, the extremely low level of land holdings might be an essential factor behind their extreme poverty in the state (Kumar, 2005). As per a report mentioned in the Economic Survey, Odisha, 2012-13 Odisha continues to maintain high percentage in her poverty line as against all India average from 1973-74 to 2009-10 (Economic Survey, Odisha,2012-13:264,Garada,2014). The head count ratio by social groups as per the Tendulkar Committee methodology for Rural Odisha as compared to OBC and others, the ST and SC people are still living in high poverty level in the state (Garada,2014). For instance, as per the Tendulkar Committee Methodology for Rural Odisha, 2004-2010 the Head Count Ratio (%) by Social Groups in poverty lines during 2004-05 the ST population account to have as much as 84.4 per cent against 67.9 per cent, 52.7 per cent and 37.1 per cent for SC, OBC and others receptively. Similarly during 2009-10 the ST population account to have as much as 66 per cent against 47.1,25.6 and 24.6 per cents for SC,OBC and others receptively (Economic Survey, Odisha, 2012-13:265). The average percentage of total private landholdings of total areas, average approximate percentage of landless (less than one standard land acre), average percentage of total government land and average percentage of forest land are 23.96 per cent, 75.826 per cent, 78.276 per cent and 46.124 per cent respectively found there in 10 districts of scheduled areas during 2006-07 in Odisha (Status Report on Land Rights and Ownership in Odisha, 2008: 29). The non-coastal districts mostly covered of tribal scheduled areas such as Gajapati, Kalahandi, Keonjhar, Kandhmal, Koraput, Malkangiri, Mayurbhanj, Nabarangpur, Rayagada and Sundergarh have less private landholdings, only 23.961 per cent of total areas than the government landholding and forest landholding which are as much as 78.27 per cent and 46.12 of the total areas respectively (Garada, 2014). In fact, after independence the land reform was not successfully

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implemented in the different regions of the state. The people of urban areas and coastal belt have taken most of its advantage comparison to those from the backward regions, because the former were educated and could pressurize the administration better than the latter's groups (ibid). Hence, the land reforms have been too timed to bring out any radical change in rural areas especially in the southern and western regions of Odisha (ibid). According to a Committee on Agrarian Reforms by MRD, Govt. of India (2009) there was a wide divergence between the revenue records and the actual situation; the margin of error was as high as 86 per cent in certain instances. More critically it is of the opinion that the impact of the land reform programmes in terms of change in ownership and operation pattern was not to the tune of even 4 to 5 per cent. According to a report provided by the Odisha Tribal Empowerment & Livelihoods Programme, Joint Review Mission: November 2-17, 2009 that about 75 per cent of the project households under OTELP are listed as BPL, of which 8 per cent are absolutely landless and 70 per cent own less than 1 standard acre of land. Taken together the report admits that in this neglected and vulnerable region almost 78 per cent population is landless which is alarming. According to the Comptroller & Auditor General Report 2012 the basic data such concerning public land allocation is not available and the statutory requirement under OGLS 1962 is not being followed in most of the cases. It also mentions since the state largely failed to maintain consolidated data bank on land (owned or leased or allotted) it hardly provide adequate information on utilization of existing land resources or justification acquiring private land (Comptroller & Auditor General Report 2012).

III. Objectives of the Study and Method of Data Collection

The main objective of this paper is to assess and explain the tragedy of legally landless tribal and their access to land in the context of land tenure systems and land settlement in the state. However, the other objectives included are (i) to understand the pattern of land settlement or leasing to individual landless families, (ii) to assess the status of wasteland cultivation by landless families and their eligibilities for ownership and leasing rights under existing legislations namely OPLE &OGLS and (iii) to identify the policy constraints in OPLE & OGLS and institutional practices for the land settlement in favour of poor landless families. The study has been carried out in Koraput district because it has been significant with regards to its area and indigenous population concentration. The methodology of the study includes analysis of secondary information, analysis of land record of individual households of selected villages and primary data collection, field survey of encroachments on wasteland, analysis of potential settlement of wasteland cultivation under various laws. The procedure of designing of research concepts and the methodology started from the process of district level consultation to the village level with the local community organizations and villagers. The district level consultation were involved researchers, retired revenue officers, civil society actors, land rights activists, NGOs and individuals in deliberations and discussion and their shared experiences. The major issues and challenges linked to land rights and settlements were identified during the consultation. In order to find out the facts firstly we have modestly tried to review the literatures available on such issues in the Koraput district as a whole and secondly in order to contextualising this dynamics we have conducted our field study at Kapsiput village situated in the same district.

IV. Background of Land Tenure System and Land Settlement in Koraput District of Odisha

The present Koraput district has been carved out of the larger undivided Koraput district (around 26961 sq kms) and the physical districts of Malkangiri, Nawarangpur and Rayagada. As per the last census, 2011 the district has recorded a total of 11, 77,954 population out of which 50.39 and 49.61 per cents male and female respectively. The district is numerically dominated by ST (50.66%) and SC (13.41%) population. The forest and forest based resources constitutes major proportion of the people's livelihood in the region. Out of 28 per cent of the recorded forest area only 12.8 per cent was dense forest and the others were degraded or open forests. All the open forest areas are under various types of cultivation since long. The genesis of the problems, referred backs to the historical processes of improper recording of land tenure rights of hill tribes during survey and settlement, exclusion of forest areas other than R.F and P.R.F from revenue as well as forest settlement process. The hill slopes beyond 10 degree slopes which were under shifting cultivation along with settled cultivation were included or categorized as government lands without any survey. Without proper settlement of rights of the cultivators, through forest settlement process, the lands were declared as RF, PRF, DPF, etc. The population's dependency on land and forest as their primary source of livelihood in the district (around 84% in 2001 census) was not visibly reduced (Odisha State Development Report, VI, 2001). Historically, Koraput district as a part of the Zamindari areas of the Jeypore Estate was governed by the Madras Estate Land Act 1908. Under this Act the tenants had only occupancy rights over their holdings. Two systems of tenancy prevalent during that period- *Mustajari* and *Ryotwari*. Under the former, the tenant pays rent to an agent or contractor appointed by the

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Estate and in latter case the tenant pays rent direct to the Estate officials. The *Mustajari* system has no legal recognition and varies from place to place in its practical application. It is the same origin as the *Gaontiahi* system of tenure in Sambalpur (Odisha District Gazetteer, Koraput, 1965). A *Mustajar* is merely an agent or contractor for collection of rent, who was remunerated certain piece of rent free land or percentage of rent realised. He brings the new cases of encroachment to the notice of the Estate ensuring that no assessed land remains unoccupied. As evidence goes, the Mustajars taking advantage of their positions took illegal extraction from tenants and more often harassed them. The tenants who had no record of their lands entirely used to live with the mercy of the *Mustajars* (Partially Excluded Area Enquiry Committee Report, 1940). In Roytwari villages the tenants were far better off. For securing the holdings to the Riyots, agreements are exchanged between landlords and tenants under this system. The receipts in proper form were granted to the tenants by the revenue establishment of the estate. For instance the Roytwari village shows each Ryot's land holding and rent, whereas a Mustajari village shows the demands from the Mustajar for the whole village which actually does not contain the names of a large number of cultivating tenants or their assessment. This system was abolished in the district with effect from 1st July 1955 under Govt. Resolution no. 4103-E.A., dated 7th June 1955, excepting the inaccessible Bonda areas in the Malkanagiri subdivision mostly inhabited by the aboriginals (Odisha District Gazetteer, Koraput, 1965 p. 287). The only interest of the British was to collect revenue from land and exploit the forest resources. In order to increase the land revenue they introduced many Acts but there was no attempt to simplify the land revenue system. With the increase in rent imposed by the British there was more pressure on the tribal tenants to pay more rent. The Madras Estate land Act which governed the relationship between the land holder and the tenant came into force in the district from the 1st July 1908 but it was not at all helpful for the tenants.

a) Land Holding Pattern

On the basis of the legal status of land under forest revenue department in Koraput there are estimated to be four per cent forest land, two per cent *Gocher* land, 46 per cent private land and 48 per cent other lands(Dept of Revenue & Disaster Management, Govt of Odisha, 2007). The social categorical operational land holding in the district is recorded as 64 per cent ST, 13 per cent SC and 23 per cent other. In case of operational land holding (all social groups) the marginal farmers, small famers, semi-medium farmers, medium farmers and large farmers are found to have14 per cent, 28 per cent,28 per cent,22 per cent and 8 per cent respectively in the district(ibid). Considering the availability of the land in the district the marginal and small farmers can be categorised under legally landless category, which holds less than one standard acre of land. The both marginal and small holding together constitutes 42 per cent of the total number of operational holding in the district, which can be treated as the legally landless category although the availability of government land is huge in the district.

b) Problems of Survey and Settlement in Koraput

The survey and settlement process and preparation of record-of-rights was started for the first time in Koraput district in 1938 and continued until 1964. The Government of Odisha adopted the Plain Table method of survey of Bihar and Odisha pattern against the chain survey method followed in Ganjam, the former was less costly. However, the plain table survey method became very costly for the tribals as hill slopes greater than 9 degree slope (their traditional agriculture land) were not recorded in their names due to unsuitable techniques. The landlords, feudal heads*, mustajars, amins, inamdars* had recorded the majority of land in their names because of their proximity to the surveyors and better knowledge (Behuria, 1965). Again, the tribals became marginalized because of their lack of knowledge and shy nature.

c) Lack of Systematic Records of Past Land Ownership

The survey and settlement process encountered lots of difficulties in Koraput district due to lack of adequate past records and systematic information for assessing the extent of ownership of lands. Various tenancy laws enacted by Government and other measures undertaken remained inoperative owing to the absence of land records. Especially the hill Ryots (most of them were illiterate tribal) faced lots of problem due to lack of any recording system as their occupancy rights was often terminated by the Estate employees arbitrarily in the past (*Major Koraput Settlement Report, 1938-64: 78).*

d) Improper Recording of Land Tenure Rights

Improper recording of Land Tenure rights and systematic process of alienation of Tribal/hill Ryots from their land had far reaching implication for survey and settlement process in Koraput. Many original poor Tribal/hill ryots got deprived of their land rights due to these processes during settlement periods. The Mustajars or the village headman responsible for rent collection, were not required to keep any written records of land holdings of Ryots in their villages (District Gazetteer, Koraput 1972). The only document available was the tenant's ledger which the Maharaja of Jeypore, was filing annually before the collector for cess valuation (Major Koraput Settlement Report, 1938-64). Thus, the records of Ryots'landholding were based on the reports and accounts of rents provided by Mustajars.

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e) Shifting Cultivation and Land Rights

Since most of the tribes in Koraput are hill cultivators i.e. shifting cultivators their right to *shifting cultivation is natural. But during colonial rule the lands under shifting cultivation was treated as forest lands and therefore, tribal's right to shifting cultivation was complicated at that time. In fact due to strong tribal revolt* the colonial government failed to implement *lands under shifting cultivation as forest lands in Koraput. However,* it could categorize large areas as reserve lands, protected lands and unreserved lands under provisions of Chapter III of Madras Forest Act, 1882. These categorizations did not require the rigorous settlement of rights which was done before declaring reserve forests and unreserved land too required no notification (Behuria, 1965:25). In Jeypore ex-state most of the reserve lands and protected lands were declared between1900-35. These declarations were not made known at local levels due to the remoteness of the areas. A provision was made that in "unreserved land" the tribal cultivators could clear lands for *Podu* cultivation after taking permission from the Collector. But in practice, *Podu* cultivation was extensively practiced on both reserved and unreserved land in the past. In the process of reservation for shifting cultivation land possession was continued after Independence (Sarangi, Mishra and Behera, 2005:60). In undivided Koraput district, during the first survey and settlements (1938-1964) the Board of Revenue ruled that since the shifting cultivators were not in continuous possession of land for 12 years, they could not be treated as Ryots as per Madras Estate Land Act, 1908, and therefore, these lands were not to be settled in their names (Behuria,1965).The Board of Revenue had taken a decision regarding the manner of recording the *Podu* lands and issued an order as all lands in continuous cultivating possession for 12 years prior to vesting of Jeypore Estate in State Government whether there are situated above or below 10 per cent slopes, may be recorded as Ryoti lands in favour of the person in actual cultivating possession of the same (Behuria, 1965). All the lands which are above or below 10 per cent slopes but unoccupied would be recorded as Government lands. But the concerned plot in the remarks column of the record of right (ROR) is mentioned that "'as it may be noted that so and so is in the forcible possession of the lands from such and such years"(ibid).

f) Discrepancy between Existing Law and Practices

The Madras Estate Land Act that governed the relationship between the landholder and the Ryots was largely ineffective in the district. There were also several instances where the law was directly transgressed and violated during the revenue administration of Jeypore Estate leading to violation of rights of original Ryots over land. Hence it was quite difficult to ascertain the rights of original landowners over lands in the area on the basis of which survey and settlement could be carried out.

V. A Case Study Of Kapsiput

Kapsiput is a revenue village of Bhitaragada Gram Panchayat coming under Kakiriguma R.I Circle, Laxmipur Tahasil of Koraput district. It is extremely tough to express about the precise history of the establishment of the village Kapsiput. However, a number of the older persons namely Burju Jani, Aged 70, Sambru Saunta 64 and Dama Saunta 62 who had oral history of the village narrated that the village was established for approximately more than three generations. There have been first 6 families from village Sanka of Laxmipur came and settled in present Kapsiput, which was first referred to as Agyanpada. These were namely Bandu Jani, Nandu Jani, Rigidi Saunta, Dagera Saunta, Bastu Saunta and Dekina Saunta. As per the villagers' memories there was a big Mango tree in the village where these six families had collected a lot of Mango fruit (*Phal*) and named the village as Phalka Ambaguda. After few days another 12 number of families from a nearby a place close to Bhittargada (originally known as Kapsiput) came to Phalka Ambaguda. In subsequent period, the village was named as Kapsiput.

Table 1 : Household Profile of Kapsiput Village

Sl.No.	Households	Total
1	STs	146(99.32)
2	SCs	01(0.68)
	Total	147(100.00)
3	Female Headed Households	13(8.84)
4	Households Size	4.17

NB: Figures in Parenthesis denote percentage.
Source: Household Survey, 2010-11

There are 147 households out of which 99.32 per cent and 0.68 per cent are belonging to STs and SCs households respectively in Kapsiput village at present. Except one SC household all are scheduled tribes living in the village. But interestingly our study finds that out of total 147 households 13 households headed by women of them 12 are widows. The household size is about just only 4.17 which are akin to the average family size of the district. There is a total of 613 population comprising 99.19 per cent ST and 0.81 per cent SC population in the village at present.

Table 2 : Demographic Profile of Households in Kapsiput Village

Sl.No.	Population	Male	Female	Total
1	STs	322	286	608(99.19)
2	SCs	3	2	5(0.81)
	Total	325(53.02)	288(46.98)	613(100.00)
3	Sex Ratio	886.15		

NB: Figures in Parenthesis denote percentage.
Source: Household Survey, 2010-11

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Out of total 613 populations there are only 46.98 per cent female against 53.02 per cent male in the village. Thus, the sex ratio of the village is 886 only (females per 1000 males) which is quite far below the sex ratio of the district. The elder members argue that the family planning programme and premature death of female members due to malnutrition as might be the prominent cause led to this low sex ratio in the village. The elders also argue that earlier the some tribal families used to marry more women since they were in position to carry them for household and agricultural activities in the village. But without more agricultural activities now they cannot afford to marry other women even after early death of their wives in the village. Even now their family income is not up to the mark to support them in this regard. As per the Table-3, nobody is found to have more than10000 rupees as annual income. About 74 per cent households do have annual income in between 2 500 to 5000 rupees. It is only 16 per cent households' annual income found in between 5000 to10000 rupees in the village.

Table 3 : Income Profile of Households

Sl.No.	Income	HHs
1	Below 2500	15(10.20)
2	2500 to 5000	23(74.15)
3	5000 to 10000	109(15.65)
4.	More than 10000	0(0.00)
Total		147(100.00)

NB: Figures in Parenthesis denote percentage.
Source: Household Survey, 2010-11

Our study also reveals that only one person has got the annual income- just one thousands rupees. The Aeverage annual income of the village per households comes around Rs. 4000/-.Thus, with this minimum annual income the villagers live in an abysmal poverty condition. The Table-4 clears the status of poverty with some social indicators. As per the Table-4 out of total families as much as 74.83 per cent belongs to BPL (Below Poverty Line) category including 11 widows. And only 10 households (6.80%) are covered under AAY (Antyodaya Anna Yojana) and only 18.37 per cent belong to APL (Above Poverty Line) families including one SC family.

Table 4 : APL & BPL Profile of Households

Sl.No.	Social Indicators	STs	SCs	Total
1	AAY	9	1	10(6.80)
2	APL	27	0	27(18.37)
3	BPL	110	0	110(74.83)
Total		146	1	147(100.00)

NB: Figures in Parenthesis denote percentage.
Source: Household Survey, 2010-11

a) History of Land Tenure System in Kapsiput Village

The memory of the villagers goes in saying that there have been only 18 numbers of families living in the village. Agriculture was the main source of livelihood. The land was used as communal property, customarily cultivated and used by the individuals. There is no record of rights of the individual cultivators over those lands. During the regime of Jeypore King/Estate the farmers were cultivating agriculture lands and in turn they were paying agriculture produces as revenue to the Mustajars. The Mustajars were also involved in assortment of revenue during British period. In Kapsiput village three men among Mustajars appointed by the British government were namely Rupuna Jani, Linga Saunta and Dambu Saunta. They were responsible for assortment of revenue at village level and deposit with the Sahukar/ Mahajan. Sri Renu Bisoi, Rama Chandra Bisoi of Kakiriguma village (8 kms from Kapsiput), Bhabani Naik of Goudaguda village and Shama Bisoi and Raghu Bisoi of Matuguda (5 kms from Kapsiput) village were the Mahajans during that time. The villagers were paying Rs. 107.25 only towards revenue to the British government. If the Ryots were unable to pay the revenue, they were forced to provide some portion of their lands to the Sahukars/ Mahajans. In this process, the Sahukars accumulated more land from poor tribals. The Mahajan/ Sahukar were cultivating such lands by utilizing other people. Of the total 426.21 acres of agriculture land of different *Kisam's* privately recorded in Kapsiput Mauza only 22.23 acres seems to be the class one category. Rest of the land belong to 2nd and 3rd category as per the standard acres calculated. Dhana 1, 2 and 3 is the types of land used for paddy cultivation and Dangara category is usually the hill slopes used for cultivation of cereals, pulses, oil seeds, etc. One Muslim tenant who is actually not residing in the village has purchased the land and did plantation of the coffee (Major Settlement, Kopraput, 1938-64).

b) Survey and Settlement Process in the Village

The survey and settlement process and preparation of record-of-rights was started for the first time in Koraput district in 1938 and continued until 1964 as stated earlier (Major Survey and Settlement Report of Koraput District, 1965). Particularly, in village Kapsiput the survey and settlement process was carried out during 1957-61. Before that the entire area was un-surveyed and there was no record of rights (RoR) was granted in the name of the tenants over the lands they had been cultivating. The survey and settlement process was started in 1960 and most the agriculture land settled in the names of families who were cultivating the lands. However, the homestead lands were not surveyed and no record of rights was issued to the villagers on such lands. During the time of survey there were about 60 families were living in the village. The first survey and settlement in the village was conducted during the year 1957-58. During the period of survey and settlement in Kapsiput the demarcation of individual land process, reservation and classification of

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government lands including Gochar, Road, *Bijesthali*, burial places, etc was conducted. As per the memory of the villagers, no individual was deprived to get record of rights during the survey and there was no conflicting situation occurred. However, due to a mistake committed by the settlement/ revenue officials while drawing the traverse boundary of the village. The traverse line did not cover the agriculture land of 18 families close to Bhittaragada Mauza at that time. In the process of survey and settlement simultaneously undertaken in Bhitaragada had included these lands within Bhittaragada Mauza. The people of Bhitaragada demanded to settle the lands in their names instead of the actual cultivators of Kapsiput village. A boundary conflict was occurred between Bhittargada and Kapsiput village on which legal battle was going on. Till now the conflict is continuing for the government land which is under process to be settled the *dafayati r*ights over Coffee plantation with the landless, marginal farmers and poor families for their sustainable livelihood. However, the Kapsiput villagers finally won the case in 1964-65 and those lands were settled in their names but remain within the boundary of Bhittargada Mauza.

c) Status of Revenue Land in Kapsiput Village

Table 5 : Category of Government Lands

Sl.No.	Category of Government land	Area in Acre.
1	AJA (Abada Jogya Anabadi)	8.31(1.32)
2	AAA(Abad Ajogya Anabadi)	581.82(92.10)
3	Sarbasadharan (Village Common)	3.31(0.52)
4	Rev. Dept.	4.82(0.76)
5	Railway Dept.	5.57(0.88)
6	Raskhita	25.71(4.07)
7	Welfare Dept.	2.17(0.34)
Total		631.71(100.00)

NB: Figures in Parenthesis denote percentage.
Source: Tahasil Office Record, Laxmipur Tahasil, Koraput, 2011.

The information given in the Table-5 clearly shows that there is no legally classified forest land available in the village. There is an area of more than 581acres of land which is classified as Pahad kisam of uncultivable waste category. As per the information of the people those areas were considered as forestlands in their customary classification. But now they are not considered as legally forestlands for which their application under Forest Rights Act has not been processed for the land title. As per the Table-6 a total number of 90 tenants own lands within Kapsiput revenue village of which Joint Patta holders (house site) are only 73.33per cent and Joint Patta (Agr.Land) holders are only 24.44 per cent. Our study also reveals that of the total households there are 30 completely landless households out of which 29 belong to ST families and one belongs to SC family. Of the 29 STs landless families four are headed by women households and the Table reveals about the land ownership of two women in the village.

Table 6 : Type of Ownership of land at Kapsiput Village

Sl.No.	Ownership Type	No. of Tenants		Total	Area in Acre
		ST	SC		
1	Joint patta (House site)	65	1	66(73.33)	1.32(5.72)
2	Owned by Women	2	0	2(2.22)	0.04(0.17)
3	Joint Patta (Agr.Land)	22	0	22(24.44)	21.71(94.10)
Total		89	1	90(100.00)	23.07(100.00)

NB: Figures in Parenthesis denote percentage.
Source: Laxmipur Tahasil, Koraput

d) Cultivation over Government Wasteland

The main source of livelihood of the villagers is agriculture and wage earning. Most of the landless families and marginal farmers are working as daily labour in the NALCO (National Aluminium Company Limited) mining project. The villagers are deriving their livelihood from the customarily cultivated land, categorized as government wasteland as stated earlier. But, they do not have legal ownership over those lands. Although government has taken initiatives for the settlement of those lands against them, it has not actually realized in the ground. Due to faulty classification of lands the majority of those lands are not settled by the revenue officers, taking the plea that those lands are objectionable categories or non-cultivable waste lands, without taking genuine recommendation for change of *kisam* and settlement. As per the information collected through trace maps and measurement of the lands under occupation, presently, there are 71 households of the village cultivating over uncultivable waste land. Interestingly, there is availability of 8.31 acres of cultivable wasteland in the village over which no single household has possession and cultivation. This means people are not aware about the legal Kisam/character of land, when they go for cultivation the only criteria they see is the land which has cultivable character. The legal classification does not have much sense for the poor farmers.

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e) Impact of Mining on Agriculture in Kapsiput Village

The village Kapsiput has been directly affected by the Panchbatimali mining area. It is one of the most affected villages of Laxmipur Block due to NALCO mining project. The mining activities have reduced the agriculture productivity affecting the water level. The water bodies available earlier have been dried which resulted in decreasing cultivation of summer crops drastically. The quality of drinking water is seriously affected. There were six number of perennial water streams flowing from the Panchbatimali to the village sides. With the impact of continued mining and blasting activities five natural streams such as Pokamari Jhola, Sara Jhola, Betamunda Jhola, Karindi Jhola, Keeda Jhola and Katuni Jhola originated from the Panchbatimali hills have already been dried. The agriculture was solely depending upon those water streams in the past. Our study also reveals that here has been diminishing water flows from Katuni Jhola, the only water stream exists. The villagers said before mining they were yielding paddy and vegetables sufficiently in summer season. However, at present, due to scarcity of water the quantity of summer paddy cultivation has been drastically reduced. It also became very problematic for drinking of domestic animals. Thus, it being the chief cause of low agricultural production largely affects food security in the village.

f) Impact of Blasting and Mining

At the time of interaction with the villagers about the impact of mining and blasting they said that the company has been conducting blasting at the day time without notice and any signal. After blasting the chips and stones frequently falls on the village site and resulting injuries or death of cattle and human beings because at that time people used to engage in cultivation on their own land and busy with such auxiliary agricultural activities. In the year 1995, Timili Saunta, a woman aged about 30, was working in her agricultural land. Suddenly, due to blasting a stone was fallen in her hand in which she got serious injury. After few days, she succumbed to death. The villagers said after coming of the mining project the increasing content of iron and other mining wastes in the streams have seriously affected the quality of drinking water.

g) Present Land Issue due to Mining

The NALCO had planned to acquire the forest and private lands surrounding villages of the Panchbatimali mining area. It had also constructed some pillars in this village covering the forest and private agriculture land which is occupied by the individual tribal family since long. The NALCO authorities hoodwinked the villagers by saying that they are simply having the pillers but not acquiring their lands. Subsequently, the Block Development Officer, Laxmipur issued a letter (2012) to the Gram Panchayat, Bhitaragada to arrange Gram Sabha for acquisition of forest land of 1294.283 ha. Then Panchayat had issued a notice to the villagers of surrounding villages of Panchabatimali to attend the Gram Sahba for the purpose of forest land acquisition for NALCO. The Kapsiput villagers were served notice to attend the Gram Sabha for the said purpose, on 25th June 2012. So on 24th June the villagers organized a village meeting and decided to not to cooperate with Sarapanch and panchayat functionaries to organize Gram Sabha. When the panchayat extension officer and Sarapanch came to the village to organize Gram Sahba the villagers strongly opposed to organize Gram Sahba for the purpose of forest land acquisition for NALCO. Then Gram Sabha was postponed due to the people's voice against land acquisition.

VI. Conclusion

The study brings forth the critical aspects of the land survey and settlement process in the tribal dominated district Koraput situated in the eastern ghat zone of Odisha. It exposes that how the land survey and settlement process were conducted without accounting the ground realities of the villages and the villagers neglecting their collective voice and actions. It also raises questions as to how the very principle of democracy, human right, justice and equity has been thoroughly violated in the process. While allocating land sufficient care has not been taken to ensure that leasable categories of lands should have been kept reserve for subsequent requirement and future use in the district. In such a scenario there is also dire need of amending the existing Odisha Government Land Settlement Act. Since the entire domain of settlement process is a one sided affair with little or no say of the community and community institutions, people have no idea as to which category or kissam of revenue or Govt land they have encroached upon. In this context, the tribals in Kapsiput villages are worst sufferers. Hence, the steps should be taken to ensure the awareness of laws related to revenue land to all stake holders. One important change taking place throughout Odisha is the acquisition of land by non cultivating agents. Corporate bodies across the state have been purchasing and holding fertile land for non-agricultural purposes, including speculative purpose. If unchecked, this trend can have severe repercussions on agricultural growth and the ecological security as well. In the area of land utilisation, there is no single approach currently being followed across the country. Various sectors at central level such as urban, rural, industrial, transport, mining, agriculture etc. follow their own approaches. For example, in the case of rural sector, since nearly 50 per cent of India's population is dependent on agriculture, the sector lays focus on reforms on land acquisition and resettlement & rehabilitation, watershed management and modernisation of land records, and there is not yet an approach in place for planning and management of

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land resources in rural areas. Proper planning of land and its resources allows for rational and sustainable use of land catering to various needs, including social, economic, developmental and environmental one. Proper land use planning based on sound scientific, technical procedures and land utilisation strategies supported by participatory approaches empowers people to make decisions on how to appropriately allocate and utilize land and its resources comprehensively and consistently catering to the present and future demands. There is a need for scientific, aesthetic and orderly disposition of land resources, facilities and services with a view to securing the physical, economic and social well-being of communities.

Notes

OPLE- *Odisha Private Land Encroachment Act, 1972. It is an Act to provide for prevention of unauthorized occupation of lands which are the property of Government.*

OGLS- *Odisha Government Land Settlement Act. It is an Act to provide for settlement of Government Land in the State of Odisha.*

PRI- *Panchayati Raj Institutions are the lowest of the three tier structure, incorporated through the 73rd Amendment of Indian constitution for local self governance.*

RF, PRF, DPF- *Reserve Forests, Protected Reserve Forest and Demarcated Protected Forests are different categories of forests, generally governed and managed by the Ministry of Environment and Forests, Govt of India. Until recently and before the enactment of Forest Rights Act, human settlement and cultivation within these forests were neither allowed nor recognised by the ministry.*

Gaonti Tenure- *Gaonti is a colloquial term used for a village headman who used to collect land revenue during the British regime in India.*

AAY- *Abad Ajogya Anabadi is a category of revenue land which a type of waste land within a revenue village which cannot be leased out for cultivation purpose as per the Odisha Land Settlement Act, 1962.*

Pahad - *Pahad is the equivalent of hill or mountain.*

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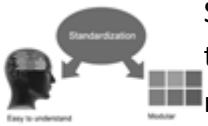


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4. Manuscript's Category,

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.



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Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.



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Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

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- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.



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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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