Prospect of Wind Energy in the Coastal Belt of Bangladesh.

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ABSTRACT

Energy is the prime requirement of modern civilization. As a developing country, Bangladesh uses energy for its needs, but she is encountering difficulties in supplying energy to maintain its economic growth. The current demand for energy exceeds the available resources and this gap is projected to increase significantly in the near future. In the case of the emerging energy problem in Bangladesh, wind energy holds good prospects. The wind speeds of the coastal regions of Bangladesh have been considered in the present paper. This data shows a prospective source of wind energy in coastal regions in Bangladesh. Proper types of wind turbines may be designed and fabricated for the purpose of extracting wind energy from this area. The wind speed in some regions is satisfactory for operating pumps and also for generation of electricity. Wind turbines may also be useful to drive hand pumps used for irrigating agricultural lands.

(Keywords: Bangladesh, Coastal region, Wind energy, Wind data, Velocity duration)

INTRODUCTION

Bangladesh is situated between 20°34' and 26°38' N latitudes and 88°01' and 92°41' E longitudes with nearly 150 million people living on 144,000 sq. km area [1]. The high growth of her population makes it difficult to keep up with its growing energy demand. Presently, there are no sufficient common sources of energy in Bangladesh. To overcome this situation, expanded searches of energy sources are needed. The prospect of wind energy as an alternative energy source in Bangladesh needs to be examined because the oil and gas reserve of the country is very small.

Bangladesh is an agricultural country and its agriculture sector needs a reliable supply of water for land irrigation. A recent study [2] shows that there is surface water potential for a total of 54,700 pumps of 0.066 m^3/s capacity. About 50% of these pumps are to be operated at a head of 6m or less, considering the terrain of the country. Either diesel engines or electric motors are used to drive these pumps. Future pump applications can be driven with the help of windmills. For selecting the size and type of wind machine, information about wind speed, direction and its duration should be known.

In this paper, an attempt has also been made to investigate the application of wind energy for irrigation and the generation of electricity in coastal region of Bangladesh.

WIND DATA

Bangladesh is situated in the sub-tropics and its climate, which is warm and humid, has two pronounced monsoon seasons. It is observed that the shape of the coastal belt of Bangladesh is like a funnel. Due to this shape, intensity of the cyclones approaching the coastal areas of Bangladesh is usually increased substantially.

This fact also plays an important role in the case of the normal trade winds blowing over the coastal areas of Bangladesh. If proper investigation and analysis have been performed to evaluate the wind energy prospect in coastal areas of Bangladesh, it can play an important role in solving the energy crisis in Bangladesh. In this

paper, wind data [3] of the coastal region in Bangladesh such as, Teknaf, Kutubdia, Sandwip, Kuakata, and Mongla have been considered to evaluate the wind power availability.

WIND ENERGY POTENTIAL

In Bangladesh, winds are available mainly during the Monsoons and around one to two months before and after the Monsoons [4]. During the months starting from late October to the middle of February, winds either remain calm or are too low to be of any use by a traditional windmill. Except for the above mentioned period of four months, a windmill if properly designed and located, can supply enough energy to be marketable.

The wind energy distribution during the year is such that about 55% is available during the time when the need for water pumping is low and about 25% is available in the season when the need for water pumping is at its peak [5]. However, the wind speed of the coastal area holds good prospect to make the best use of wind energy.

Peak rainfall occurs in the country during the months of June, July, and August. But the peak wind speed occurs one to two months, and in some cases, three months before the peak rainfall occurs. The average wind speed in Bangladesh is available from the month of March, April, and May and highest wind speeds are found in Coastal areas of Bangladesh.

The wind speed data from March to September are hereby considered for the analysis. During this period windmills may be used for pumping water for irrigation (if it had been previously stored in a reservoir). Wind power can be conveniently used economically for lifting water for irrigation in regions, where the mean monthly wind speed exceeds 2.22 m/s [6].

Rain water is available in this country from May to October. During the operating seasons, subsoil water from shallow wells can also be pumped by low lift pumps run by windmills. Wind power can also be incorporated into the electricity grid on a substantial basis and could add reliability and consistency to the electricity generated by the Kaptai Hydroelectric Power Station during the dry season.

In dry season, the required water head becomes rather low for total utilization of the entire generating capacity of the Kaptai Hydroelectric Power Station. Thus, power generation has to be curtailed during this period. So this deficit power could be augmented with the help of wind power plants. Characteristics of the wind speed data of the above mentioned coastal region have been studied from the months of March to September, 2003.

This data has been used to compute the monthly average wind speed as shown in Table 1 and the energy availability for the stations are presented in Table 2.

Table 1: Average wind speed in m/s at different locations in coastal region of Bangladesh (2003).

Locations	Month						
	Mar	Apr	May	Jun	Jul	Aug	Sep
Teknaf	2.85	2.56	2.39	4.71	2.83	4.14	3.11
Kutubdia	3.78	12.02	2.37	4.71	5.73	4.78	2.92
Sandwip	6.23	8.34	2.28	3.93	5.44	4.44	5.18
Kuakata	3.07	5.26	3.10	3.69	4.28	3.37	2.03
Mongla	3.07	2.41	2.94	4.23	4.34	4.44	2.92

Table 2: Theoretical available power of different locations in coastal region of Bangladesh (2003),

Locations	Months	Avg. wind speed (m/s)	Theoretical Available power (W/m^2)
Teknaf	March to Sep.	3.23	20.17
Kutubdia		5.19	83.74
Sandwip		5.12	80.53
Kuakata		3.54	26.68
Mongla		3.48	25.26

In Figure 1, hourly wind speeds of the locations were plotted against the hour of day and it was found that for all the locations, the speed has a regular variation along with some fluctuation, and it attains a maximum value at around 10 am-2 pm local time. In all cases, there appears to be a seasonal effect and a stable wind speed is found for the month of June.

Velocity duration is an important parameter for a location to identify the wind energy prospect. Higher velocity duration means higher fruitfulness. The velocity duration of each selected coastal region of Bangladesh is presented in Figure 2**.**

To evaluate the highest potential energy site, it is necessary to compare these locations for a definite criteria. Hence, the velocity duration for each location are presented in Figure 3.

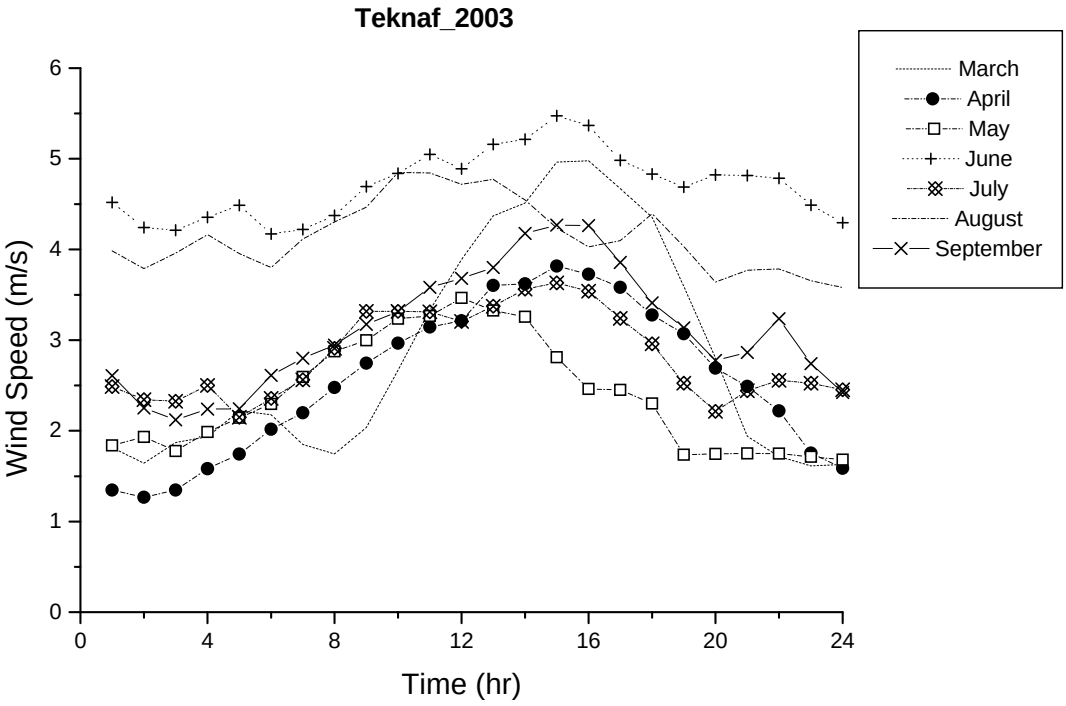

Fig.1(a) Mean hourly wind speed at Teknaf

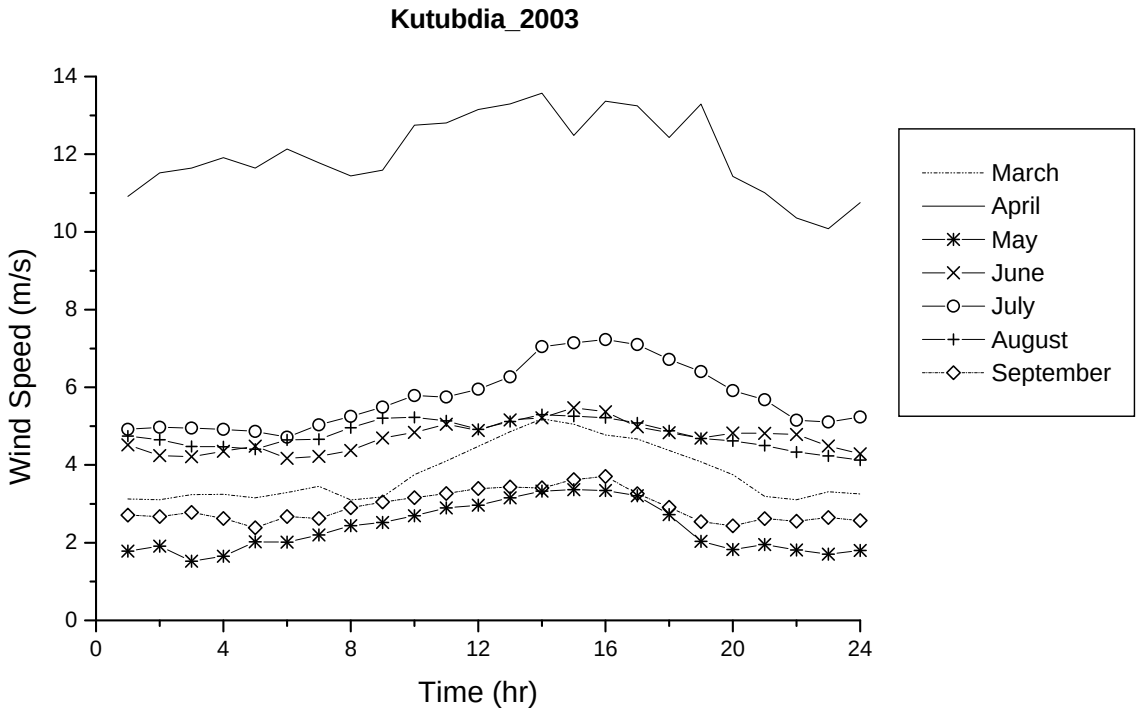

Fig.1(b) Mean hourly wind speed at Kutubdia

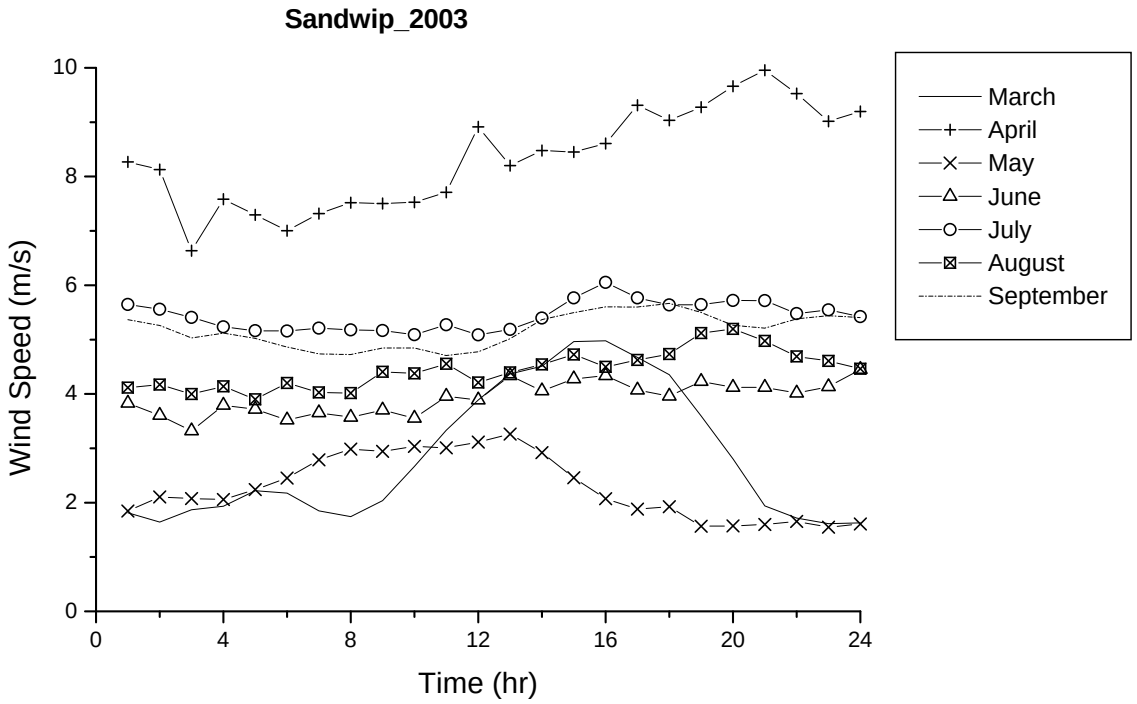

Fig.1(c) Mean hourly wind speed at Sandwip

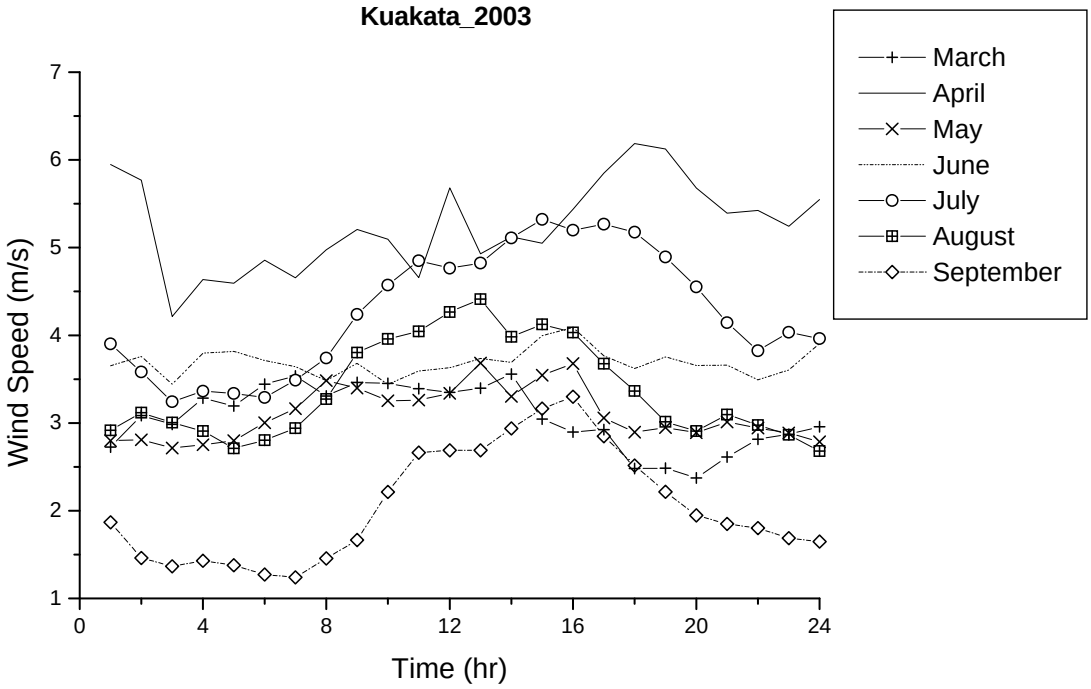

Fig.1(d) Mean hourly wind speed at Kuakata

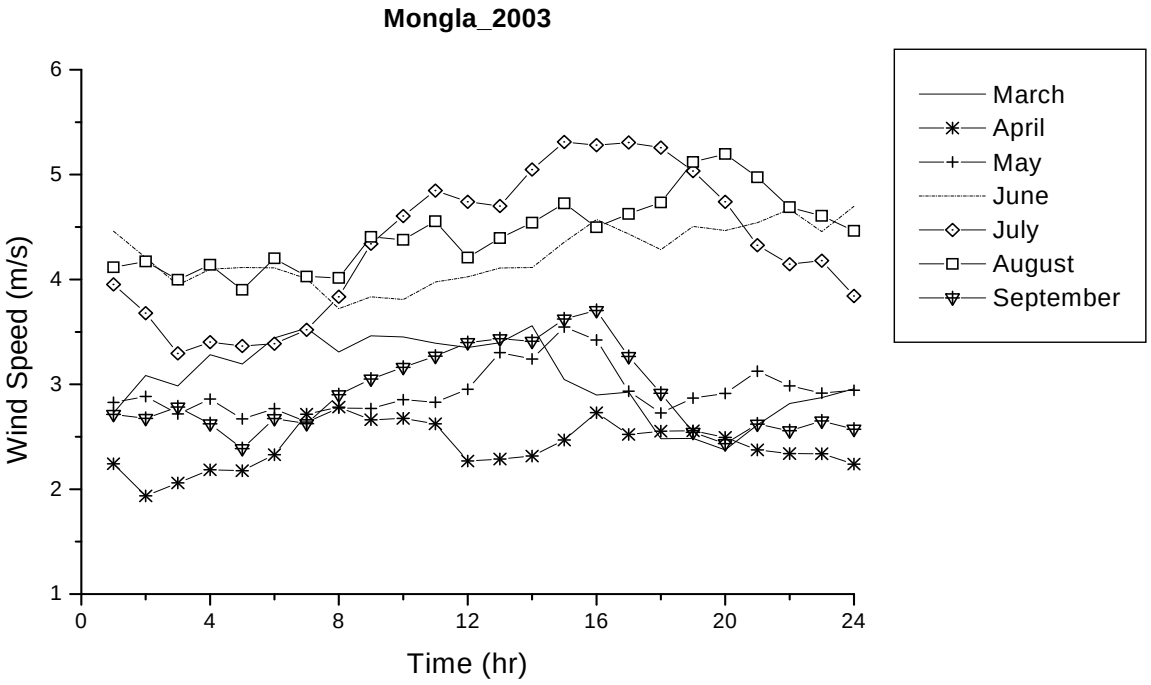

Fig.1(e) Mean hourly wind speed at Mongla

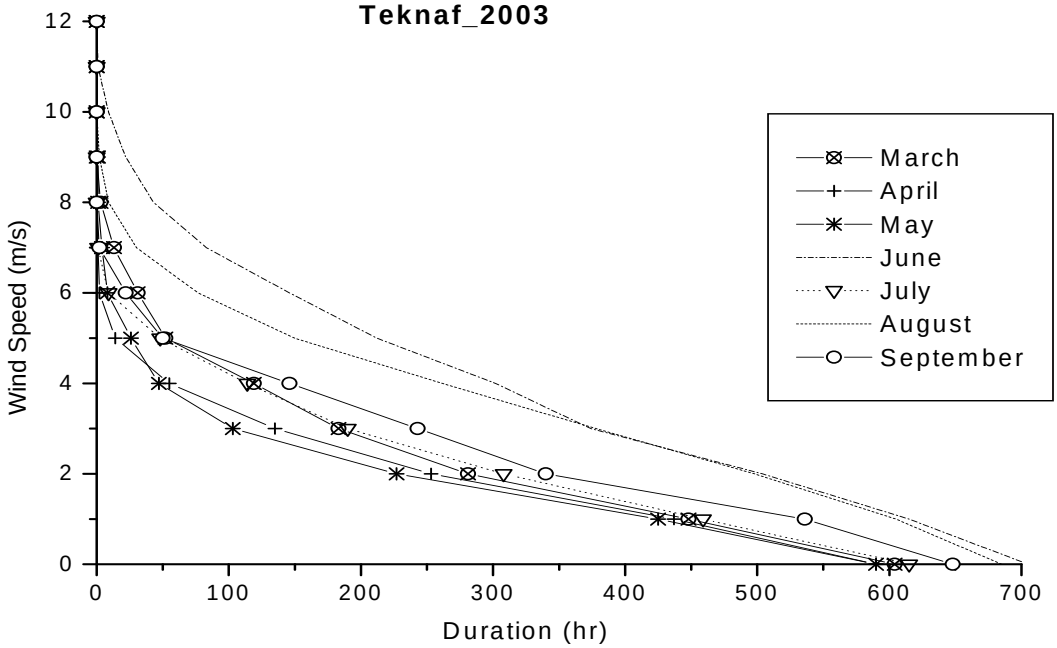

Fig. 2(a): Monthwise velocity duration for Teknaf

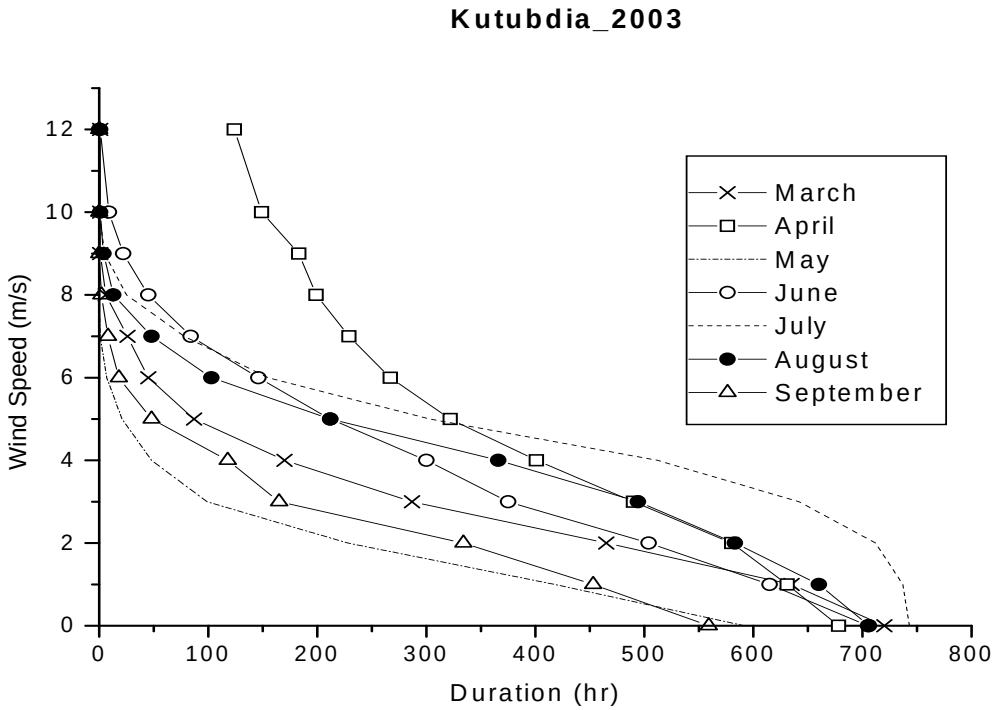

Fig. 2(b): Monthwise velocity duration for Kutubdia

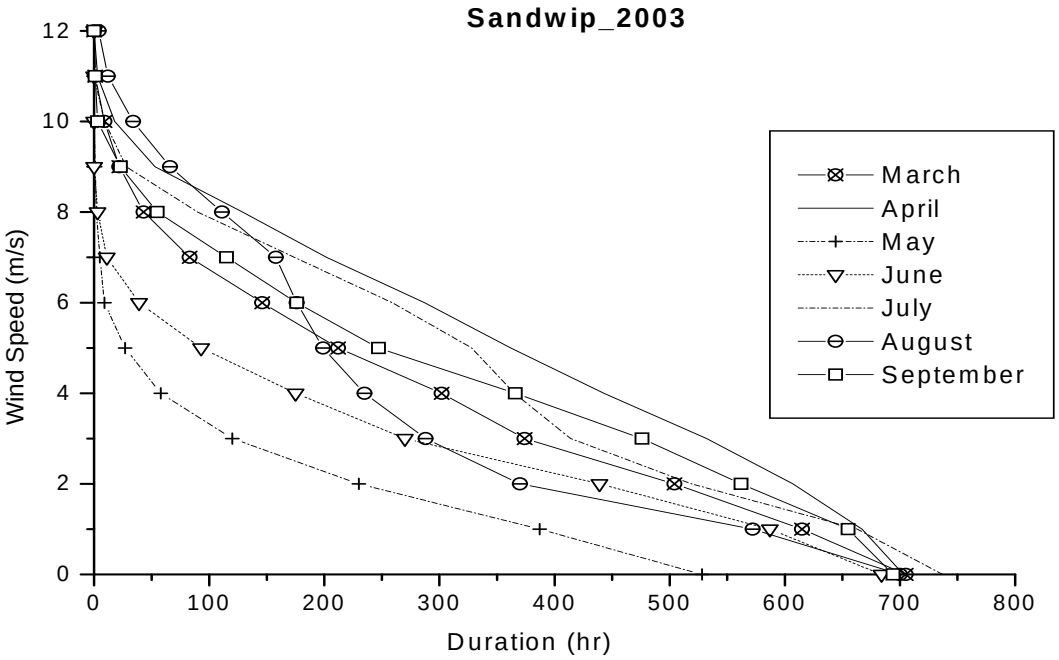

Fig. 2(c): Monthwise velocity duration for Sandwip

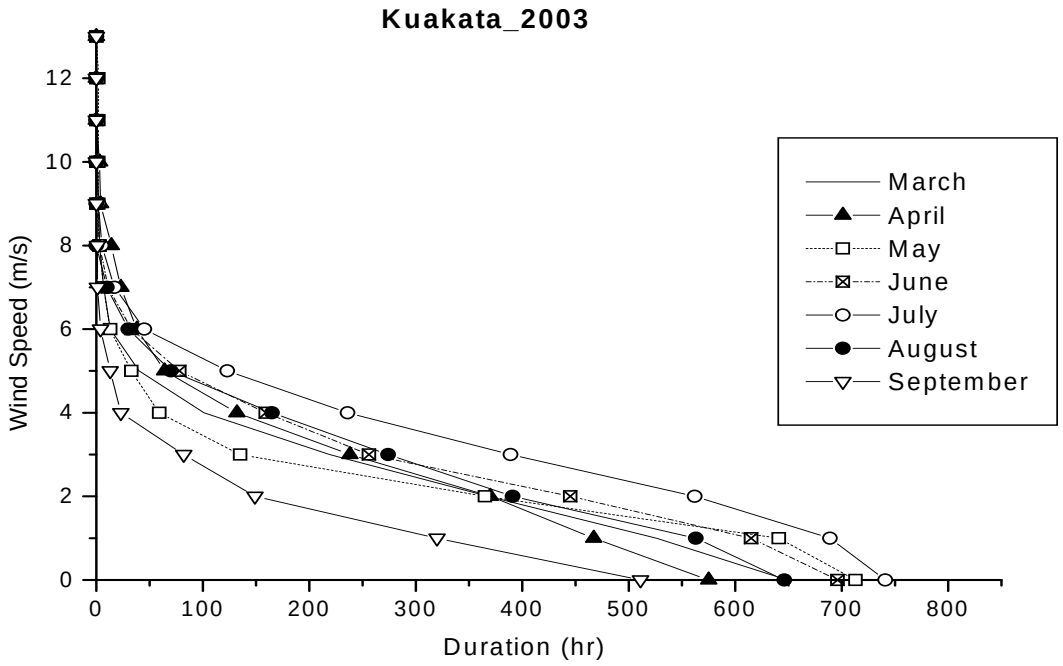

Fig. 2(d): Monthwise velocity duration for Kuakata

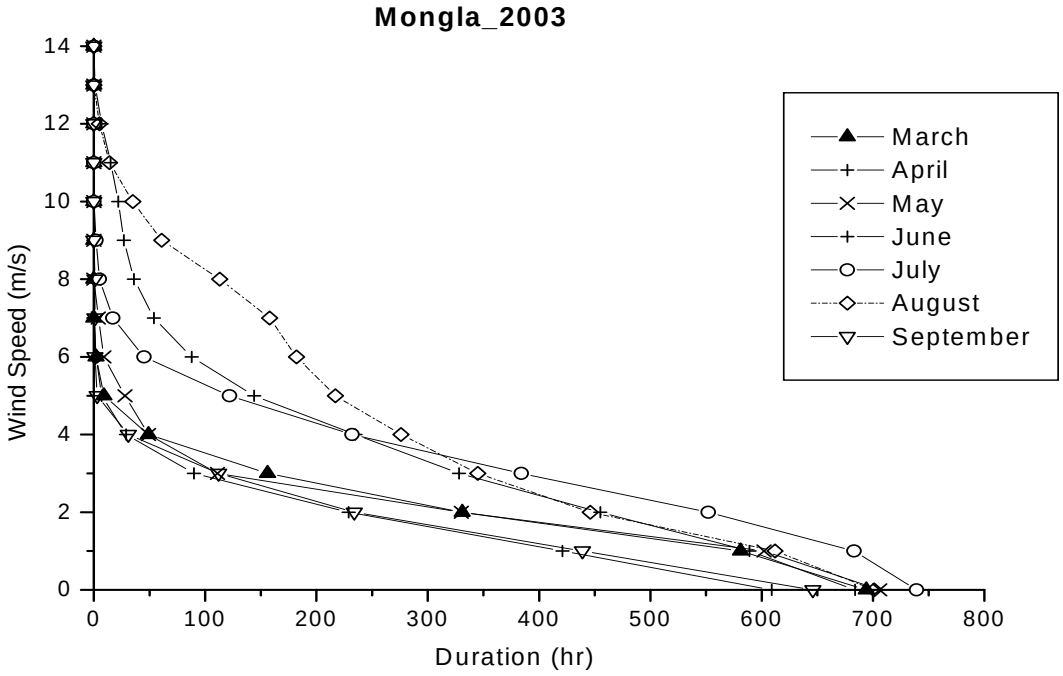

Fig. 2(e): Monthwise velocity duration for Mongla

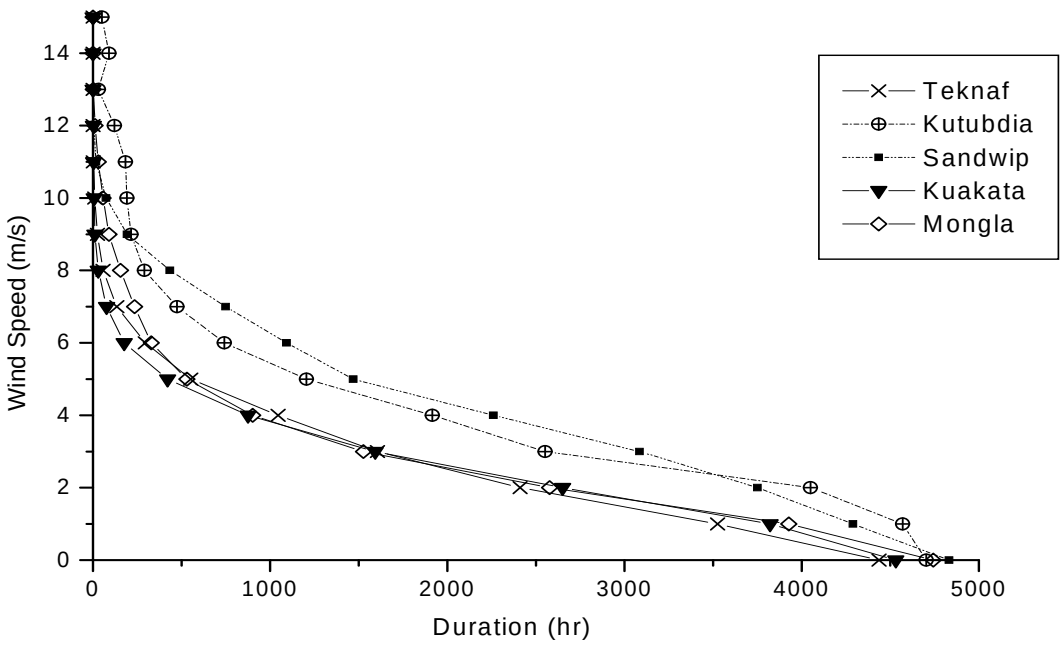

Fig. 3: Velocity duration for different locations

From Figure 3 and Table 2, it is found that the average wind speed in Kutubdia and Sandwip are above 5m/s (March-September) and about 2.57m/s for 2500 hrs. At this available speed, these locations may be recommended for water pumping purpose [1].

In Kutubdia, the average wind speed is 5.19 m/s, but the wind speeds are not stable in this location as sometimes higher peaks are obtained (as much as high 40m/s), and such unstable wind speed is not fruitful from the point view of wind turbine performance. On the other hand, in Sandwip the average wind speed is 5.12 m/s which is relatively stable compared to Kutubdia. Although many factors are required in consideration of the Wind Energy Conversion System (WECS), a rule-of-thumb is that a site with an average wind speed of above 5 m/s will be cost effective with modern wind turbines [7]. So, the site having wind speed higher than 5m/s can be effective for extracting wind energy for electricity generation and water pumping purpose.

Again, as the average wind speed of all the location considered is more than 3.2 m/s, sailwing rotors may be recommended for pumping purpose as its starting speed is around 2 m/s [6].

The wind power per unit area of approach [8] is proportional to the cube of wind speed and it can be expressed as $P/A = 0.6\ V^3$, where P/A is in W/m^2 and V is in m/s.

This wind power represents the strength of wind, and theoretically maximum 59% of this power can be extracted. The wind power, P/A is plotted in Figure 4 to show the strength of wind in different locations. Figure 4, also shows that in Kutubdia the average wind power is about 83.74 W/m^2 and that of Sandwip is 80.53 W/m^2, of which are higher than other location.

CONCLUSION

The wind data presented here may be helpful for lifting water and electricity generation in the coastal region in Bangladesh, which may solve energy problems throughout the country to some extent. In some location, like Sandwip in coastal region, the wind speed is expected to be reasonably sufficient for installing wind power plant than other studied locations. In these areas, the transmission of electricity is either expensive or impossible. The installation of wind power plant for generating electricity will be very useful for such areas.

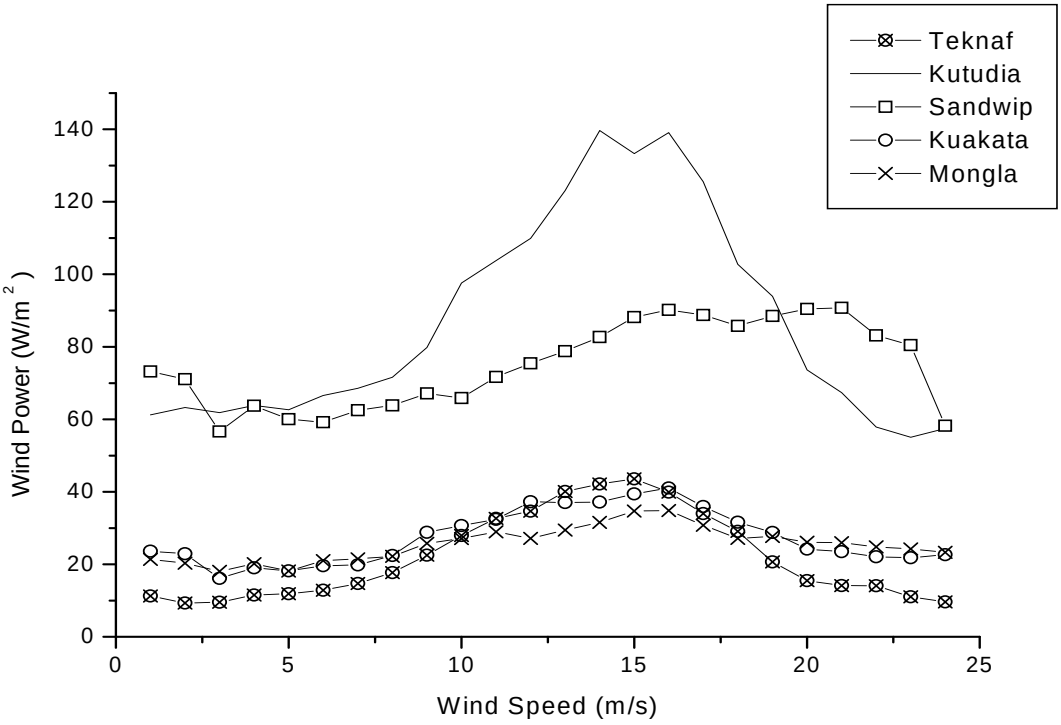

Fig. 4: Wind power in different locations in coastal region

Again, by using wind power to drive water pumps, can potentially solve the watering problem in the crop lands to a great extent. Wind plants should be made popular to the users, and the owners should be encouraged to construct them with locally available materials.

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