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# Wind Assessment for Disaster Risk Management in Cox's Bazaar District

## Cox's Bazar | May 2020

### Introduction:

UNDP has undertaken a Wind modelling assessment exercise for disaster risk management in the Cox's Bazar District and Kutupalong Rohingya Refugees Camps in Cox's Bazar District, Bangladesh. The risk assessment is based on three case scenarios of wind hazards, namely: cyclone, monsoon wind, and pre-monsoon wind- *Kalbaishakhi* (Nor' Western) - common in the region. The Cox's Bazar District and Kutupalong Rohingya Refugees Camps in the District are prone to these wind risks therefore, wind risk was examined in this study. Potential impact of three hazardous wind regimes, namely: 1. a category I cyclone on the Saffir-Simpson scale, 2. strong monsoon winds and 3. a pre-monsoon season storm, were assessed.

The map displays simulated wind velocities based on the three hazardous wind regimes known to occur in the region. Historical meteorological records were used to determine regional wind speeds and directions and input into the model. The table below displays the historical date/time intervals and maximum wind speed for each scenario. The study area considered is the region in which the current Kutupalong Balukhali Expansion site is located.

Scenario	Date/Time	Maximum Wind Speed (km/h)
Cyclone	25 March 1995 (0300-1200 hrs.)	219.5
Monsoon	16-19 June, 2011	140.8
Pre-Monsoon	03-08 March, 1995	84.4

A standard wind modelling assessment software, OpenWind, was used for wind speed analysis. However, this software was not able to capture the meteorologically induced energies during periods of extreme winds. Instead, a much more elaborated model chain which combines the WRF meso-scale weather model with the CALMET boundary layer model was used. Selection of these models ensure high quality standards and apply latest scientific knowledge. The WRF weather model is used by a large scientific community and many national weather services to perform weather fore-cast and hind-cast. The CALMET model is an approved model of the U.S. Environmental Protection Agency for air quality modelling of time varying studies in complex terrain. Modelling of extreme winds requires representation of the full physics of the atmosphere to reproduce the details necessary for risk assessment. The used model chain comprises the large-scale atmospheric processes that develop over the continent and Northern Indian Ocean and includes the impact on the local level in the Cox's Bazar District and Kutupalong Rohingya Refugees Camps in the District.

### Cyclone:

Based on the IBTrACS database, a case study was conducted identifying a category I cyclone in November 1995 which was reproduced using the model. Landfall of the cyclone was north of and close to Kutupalong Rohingya Refugees Camps. However, the circular air stream around the center of the cyclone rotated above the Kutupalong Rohingya Refugees Camps with strong southern winds hitting the Camps. Within the Kutupalong Rohingya Refugees Camps the air flow underwent violent modulation due to unidirectional cyclone winds guided by topography and locally adapted to varying surface characteristics.

The maximum resulting wind-speed at each pixel was extracted for all the hourly results (0300-1200) and mapped to represent the maximum wind speed impacting all locations throughout the duration of the cyclone.

The results show that the wind speed reached up to 220 km/h or more at the peaks of the hills and the troughs at the bottom were calm at the Kutupalong Rohingya Refugees Camps. Local wind speed inside the Kutupalong Rohingya Refugees Camps overtop the offshore wind speed recorded from the cyclone because of the topographically induced speed-up phenomena; and during a cyclone event it may cause unexpected high winds.



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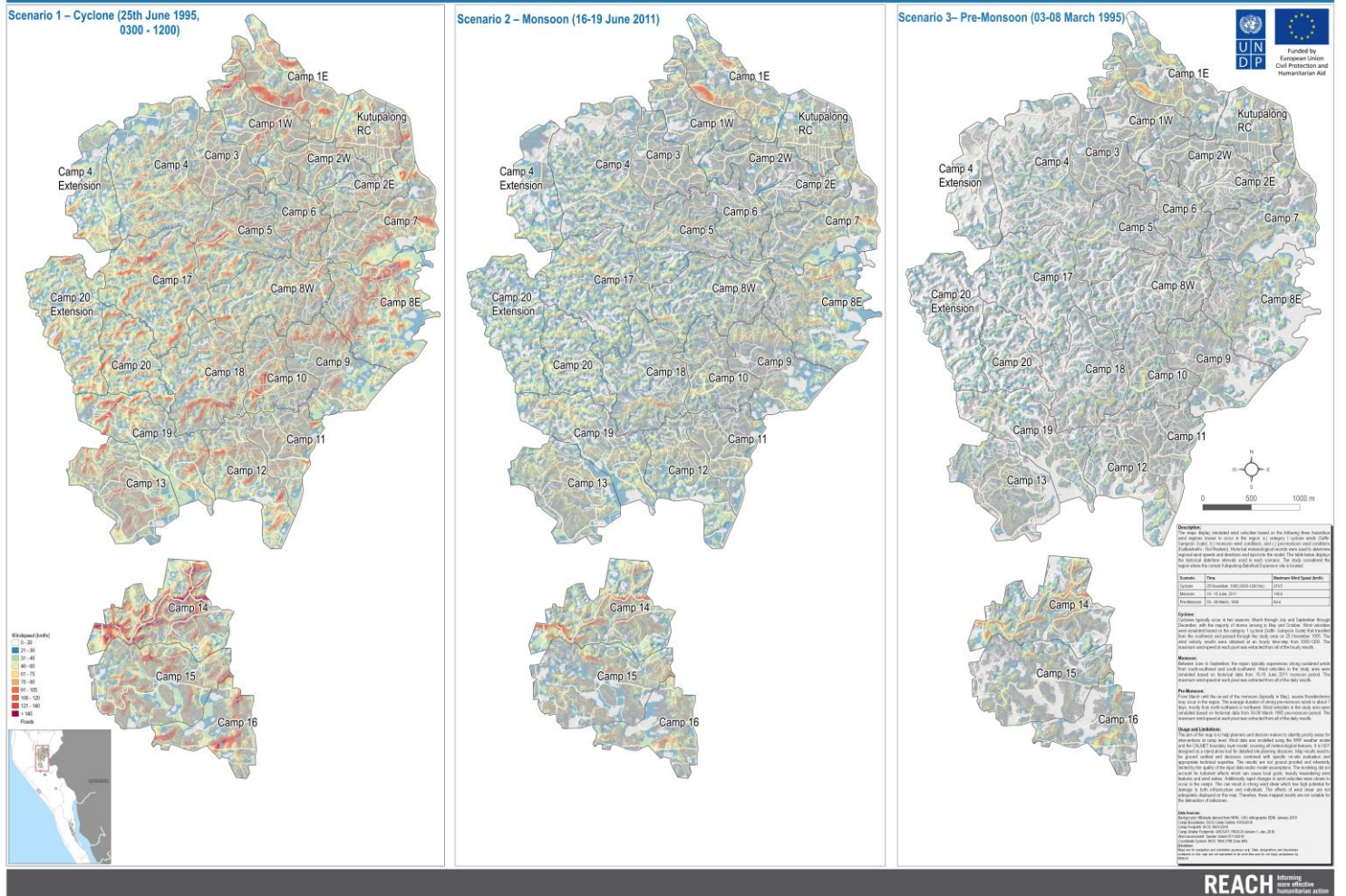
## Monsoon Wind:

The ERA-5 global re-analysis was considered to analyze the monsoon climatology in detail for strong monsoon wind scenario. During episodes of strong monsoon wind, the wind directional changes are small, and the general wind direction is from the south. Monsoon winds blow approximately three or four times a year lasting ten days in average during which extreme winds last for about 135 hours. Strong monsoon winds analysis was conducted for the period of 16 - 19 June 2011 which corresponds to the peak wind. The results indicated that the extreme monsoon winds can reach up to 30 m/s (above 108 km/h) and the difference exceeds 20 m/s (above 70 km/h) within radius of 100 m at exposed locations in the Kutupalong Rohingya Refugees Camps. The locations of high wind speeds are persistent and do not change much during a storm event because the general wind direction during the storm is nearly unidirectional.

Wind velocities in the study area were simulated based on historical data from 16-19 June 2011 for monsoon period. The maximum wind-speed at each pixel was extracted from all the daily results to come up with the map.

### ISCG Bangladesh – Cox's Bazar District - Kutupalong Balukhali Expansion Wind Hazard – Maximum Wind Speed From 3 Historical Simulations

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## Pre-Monsoon Wind

The pre-monsoon storm scenario shows similarities with the well described meteorological phenomena of "derechos". These winds are induced by meso-scale convective events resulting in disastrous vertically falling winds. The literature describes wind gusts above 30 m/s (108 km/h) are a common feature. Usually monsoon winds and pre-monsoon storm show similar wind speed patterns, but extreme hourly pre-monsoon storm speed observed in the past 30 years is about twice the wind speed of the extreme monsoon wind indicating that pre-monsoon storm could be dangerous occasionally.

The modelling considered ERA-5 data for pre-monsoon storm during March, April and May of the last 30 years, 29 events were identified since 1988 and the results revealed the wind direction between 180° - 360°, all directions except east. On average



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they lasted for seven days with strong winds during 66% of the time, however, these pre-monsoon storms do not appear each year, while in some years they returned twice. A period from 8 - 16 June 1995 was considered for the analysis because during these days a strong unidirectional wind blew from the north. Wind direction was opposite to the monsoon winds investigated which allows to estimate the influence of wind direction on the location of areas affected by extreme winds. Results concluded that the peak pre-monsoon storm speeds are higher than peak monsoon wind. Inside the Kutupalong Rohingya Refugees Camps, the high wind speed is at the crests, however smaller hills may or may not fall into the slipstreams of neighboring hills.

Wind velocities in the study area were simulated based on historical data from 03-08 March 1995 pre-monsoon period. The maximum wind-speed at each pixel was extracted from all the daily results to come with a map.

### **Discussion and Conclusion:**

Some common features concerning risks were identified: - the major characteristics of the winds inside Kutupalong Rohingya Refugees Camps was topographically induced. A change in general wind direction causes variation of the location where severe wind blows. The highest wind speed occurs on the crests of the undulating topography. Highest hills are most affected by strong winds whereas smaller hills are in the slipstream. Risks do not only occur because of the high wind speeds but also rapid change of wind speed within the Rohingya Refugees Camps generating strong wind shear with possibilities of exposing people or property at risk way. Maximum wind speed inside the Kutupalong Rohingya Refugees Camps could be up to 220 km/h during a category I cyclone on the Saffir-Simpson scale and the most vulnerable Camp is Camp No 14 and the least are Camps No. 4 Ext and Camp No. 4 with the spatial resolution of 10m.

Standard WMO rules suggest that wind gust can be calculated from sustained winds multiplying with a factor of 1.4, however, at the Cox's Bazar District, a factor of 1.8 or above was found from wind mast observations. The maximum wind speed was 4.3 - 4.6 times higher than the regionalized wind speed provided by the weather forecast at Kutupalong Rohingya Refugees Camps, which indicated that at the Cox's Bazar District the wind gusts are stronger than elsewhere; therefore, severe wind gust risk is expected.

Monitoring the wind speed outside or inside the Camps is very important for ground truthing and getting actual field measurements for robust science-based decision making therefore, it is highly recommended to continue the monitoring process. Collection of observations without interruption with the same instrument is important for analysis of the local climatology. If new observation stations are set-up, it is recommended to install instruments which record wind speeds every 10 minutes with an accuracy of 1 m/s, and record wind directions in degrees in-line with the international instrument standards. Other parameters worth monitoring are wind gust, temperature, humidity and air pressure.

### **Usage and Limitations of the Map:**

The aim of these map is to support planners and decision makers to identify priority areas for interventions at macro-level and potentially camp level. Wind data was modelled using the WRF weather model and the CALMET boundary layer model, covering all meteorological features. The results have not been verified and should be considered as indicative only. The modeling did not account for turbulent effects which can cause local gusts, heavily meandering wind features, and wind wakes. Therefore, these mapped results are not suitable for the delineation of safe areas.

### **Data Sources:**

Camp Boundaries: ISCG Camp Outline 10/03/2019

Camp Footpath: ISCG 19/01/2019

Camp Shelter Footprints: UNOSAT / REACH Version 1, Jan. 2019

Wind assessment: UNDP (Sander GmbH 07/11/2019)