The First Steps Towards The Realization Of Energy From Oceanic Waves In Jamaica

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Jamaica a medium-sized island of 1022km with ~2.89 M inhabitants located in the Greater Antilles Arc of the Caribbean has made significant strides in achieving its goal of 50% renewables on the electricity grid by 2030. Presently, the renewable energy sources harnessed by the country include wind, solar and hydro. Despite the influx of these green energy sources they only represent 13% of the electricity production islandwide and as such the island still has additional work to do. Since 2015 some consideration has been given to exploiting the power from the waves that constantly wash ashore the island's coastline. Harnessing this energy involves taking advantage of the vertical and horizontal wave motion which can then be converted to electrical or pneumatic energy. Extracting this energy not only provides clean energy but also contributes to the preservation of some fragile zones of the coastal area. The dual benefits provided by this energy sources make it as attractive as its clean energy partner previously mentioned. To reap the benefits of this energy source it is paramount that the sea state of the surrounding waters is understood. This study aims to highlight the sea state of the water mass surrounding this tropical island situated in the wake of Cuba and Hispaniola. Access to this information should allow officials and investors to make a more conscious decision on the applicability of this low fluctuating green energy source.

The sea state is defined as the behaviour of the surface of a large portion of the open sea, ocean or lake due to the effects of wind waves, swells and surface currents. The generic variables associated with the sea state includes:significant wave height , wave direction, wave period and the wind speed at 10m. Compared to other areas such as Puerto-Rico or Lesser Antilles arc the density of in-situ measurements (number of buoys per square kilometer) around Jamaica vicinity is quite low. These values are 10,000 and 100 times less than the aforementioned. This lack of data has resulted in the use of a combination of distant in-situ measure (NOAA/NDBC buoys), remote measure (Jason Series/altimetric data) and numerical simulation (NCEP/NOAA/WW3) to develop an understanding of the behaviour of the main wave features: significant wave height (H_s), wave period (T_p) and wave direction ($\square_m$) both spatially and temporally. Wave energy (E_w) is defined as the product of the square of the significant height and the peak period, hence, the consideration for these wave features.

Spatial distribution of the measurements available show a strong relationship between trade winds and wave energy potential [2]. This link is reflected in the decline of wave energy potential from East to West for all the sources due to the weakening of the wind speeds. Wind seasonality is visible in the monthly values for the wave measurements and simulation. September and October show lower values of wave height (0.8-1.7 m) and period (6.1-6.9 s) in the area. Contrary to those months May and January, July and December provide higher wave conditions and consequently higher wave energy, with Hs up to 2.3 m and Tp up to 7.7 s. The simulation carried out using WW3 over a complete year (February 15, 2016, to February 14, 2017) shows a very good correlation between simulation and in-situ measures for Hs. The same could not be said for Tp and □m. Gaps are visible only during extreme conditions (hurricane passage or strong North swell).

Based on that validation computation of the wave energy can be done using the equation

□□ = *1/2* □□*2* □ □□

The results show that the SE coast of the island produces the best wave conditions (Hs > 1.5m and Tp < 7.5s) equivalent to 10.089kW/m or 5 householders per meter. The best periods for production are in the order May-July, February-April and November-January, with May-June affected by tropical storms and hurricanes (Fig 1(b)). A 30 MW Wave Energy farm is proposed for this favourable sector (SE) nearby the parish of St. Thomas. This farm should consist of 30 to 40 WEC with rated power ranging from 750 kW - 1 MW. The energy cost of this farm can be estimation to 7.6 c/kWh 10.8 c/kWh with Oyster device, which has a lifespan of 20 years.

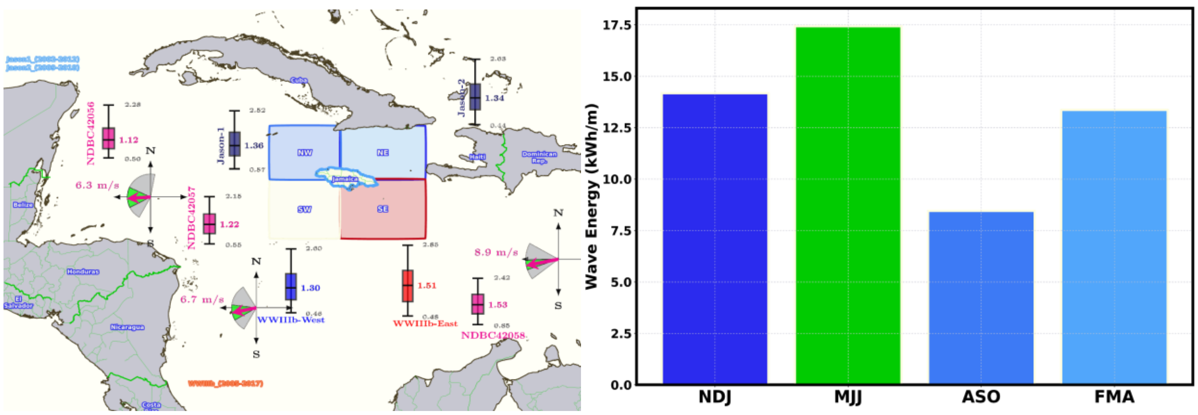

Fig. 1 . (a) on the left Map wave (Hs, Tp) and wind (Wspd, Wdir) parameters (b) on the right Seasonality of the Wave Energy in Jamaica vicinity using WW3 data (1999-2018).

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