

Sustainability of wave energy potential in Japan

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Marine renewable energies and especially the wave energy, as an alternative to fossil fuels, are sensitive to changing climate. In addition, considering both short-term variations and long-term changes in the available resources is necessary for sustainable development. Wave energy potential has been less investigated in Northeast Asia and Japan in long-term and the previous works are limited to three decades at the most and mainly in limited locations and based on wave records or satellite measurements [e.g., 1-5]. This study focuses on the estimation of wave energy resources in Japan using five decades of modeled wave characteristics. For this purpose, SWAN Cycle III version 41.31 (by the Delft University of Technology) [6] was utilized in order to model the wave characteristics in Northeast Asia. The input wind was JRA-55 re-analysis developed by the Japan Meteorological Agency (JMA) [7]. The spatial and temporal resolutions of the wind field are 60 km and 6 hrs, respectively and it is available for the period of 1958-2012. The boundary condition for the model was also obtained from a global performance. The model was validated against satellite measurements and the bias was calculated on a monthly scale showing the similarity between the monthly mean values in the domain. The validated model was performed to generate the wave climate for five decades. The decadal change of wave climate was assessed in 10-yearly periods, i.e., 1961-1970, 1971-1980, 1981-1990, 1991-2000, 2001-2010. The analysis was performed for wind and wave characteristics as well as wave power parameter and the relationship between their change was discussed. The results indicate the difference between the changing pattern in various decades. However, in general, wave height and wave power have been decreased in the Pacific side of Japan during the two latter decades, while the parameters did not change considerably in the Sea of Japan. In addition, the share of swells in the whole wave energy potential has been discussed and the results indicate that almost fifty percent of the total wave power is provided by swells in the Pacific side of Japan while this value reaches around 40 percent in the Ryukyu Islands. In the Sea of Japan side of Japan, the percentage of wave power obtained from swells varied between 15 and 25 percent of the total wave power. Further analysis will be discussed regarding the sustainability of wave energy resources in different time scales.

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