Multi-approach ocean wave energy resource assessment in Siargao

Rexmelle Decapia Jr.[1*], Enrico C. Paringit[2]

[1]Energy Engineering Graduate Program

University of the Philippines Melchor Hall, Osmeña Avenue, Diliman, Quezon City,

National Capital Region, Republic of the Philippines,1101.

[2]Geodetic Engineering Department, University of the Philippines, Melchor Hall, Osmeña Avenue,

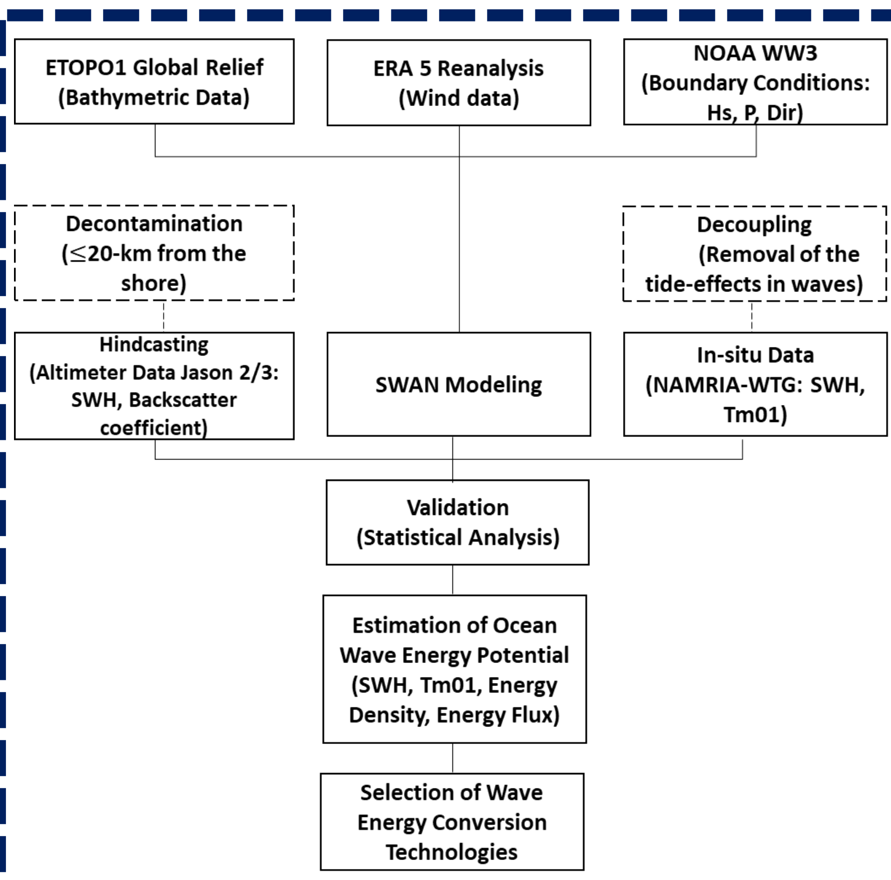
Diliman, Quezon City, National Capita Region, Republic of the Philippines,1101.

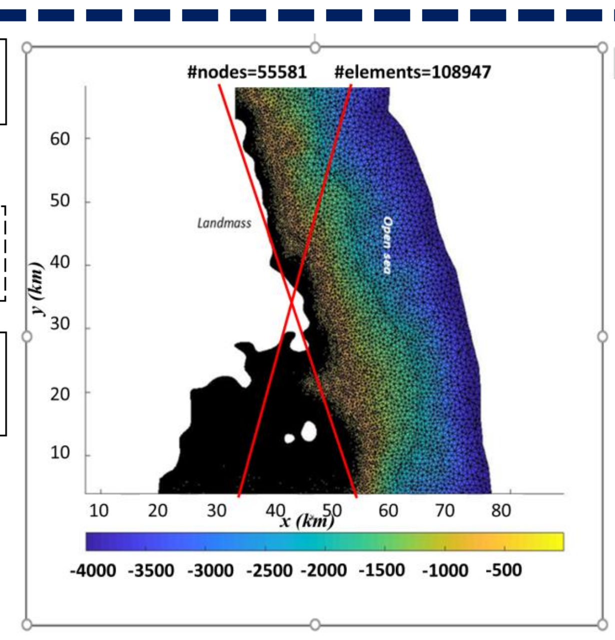
[a]rexdecapia@yahoo.com.ph, [b]paringit@gmail.com

ABSTRACT

This study aims to assess the ocean wave energy potential in the Siagao using three major approaches: (1) a 9-year hindcast covering 9.5°-10.5°N and 125.9°-126.9°E using Jason 2 satellite altimeter data, (2) numerical model using Simulating Wave Nearshore (SWAN), and (3) in-situ measurement from wave-tide gauge. In situ data was processed and decontaminated using moving average and Fast-Fourier Transform methods to eliminate the effects of tide. Result showed that the northern and eastern coast has greater ocean wave energy potential with lower variability than other sites. SWAN model was able to estimate ocean wave energy potential and indicates a strong relationship with altimeter data. Result also showed that Wavedragon and Wavestar are the two most suitable wave energy conversion devices in both nearshore and deep-water ocean energy harnessing.

METHODOLOGY





Unstructured grid used in the study showing the Jason 2-satellite track.

This study used three basic approaches. A 9-year hindcast using data from Jason 2 satellite altimeter covering 9.5°-10.5°N and 125.9°-126.9°E and is decontaminated based on a minimum of 20-km from nearshore. Second is one-year one hour step simulation using SWAN model using unstructured grid covering 9.4979° – 10.1220° N latitude and a longitude of 125.8917° –126.5083°E. The entire domain is approximately 4900 km². The maximum depth considered in the study is about 4000 m to cover larger area. The maximum grid size is 4 x 4 km² and the minimum grid is about 100 x 100 m². Grid size decreases as from the open sea towards near the coast for better resolution. There are 55581 number of nodes and 108947 number of elements. Lastly, an on-point 33-day in-situ measurements using wave-tide gauge gathering significant wave heigh and period data.

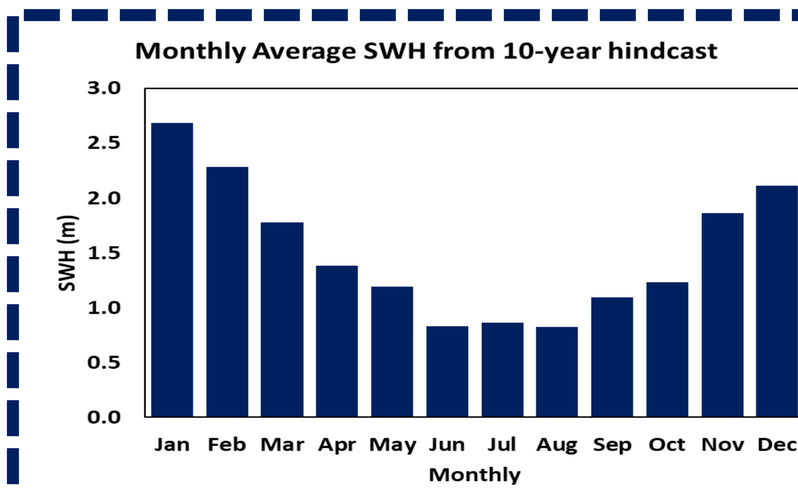
CONCLUSIONS

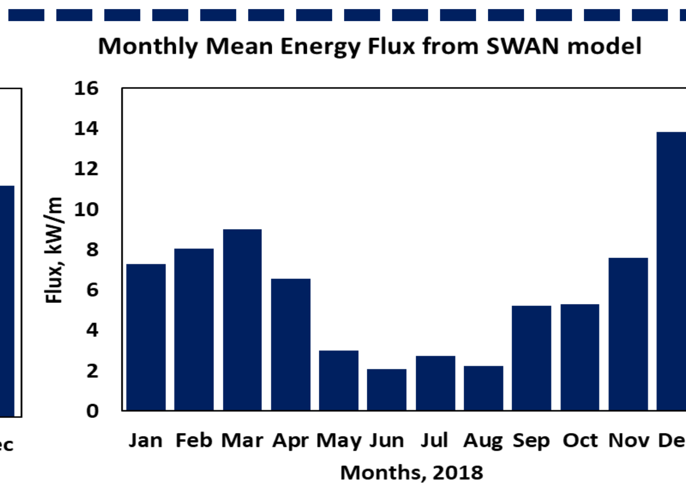
The 9-year hindcast using Jason-2 altimeter data was able to estimate the potential ocean wave energy in Siargao. Despite its limitations, altimeter data can be used as a potential basis for initial ocean wave resource assessment, and it also depicts the variability of the SWH along the region and the effect of seasonal and interannual changes. Considering high correlation between SWAN and altimeter data, SWAN model effectively calculated various wave characteristics necessary for ocean wave energy assessment. This has overcome the limitations of the altimeter data as it can calculate data in both deep and shallow water. However, the capability of the model to capture the actual ocean condition mainly depends on the accuracy of the input parameters. The result recommends the use of Wavestar and Wavedragon as a suitable device to harness ocean wave energy in this. On the other hand, the country must also consider developing WEC that will be able to harness ocean wave energy with lower SWH and wave period to maximize the use of this potential energy resource. Further studies should be conducted in some other potential sites using other models and satellite altimeters as well establish the in-situ data by acquiring and deploying wave buoys.

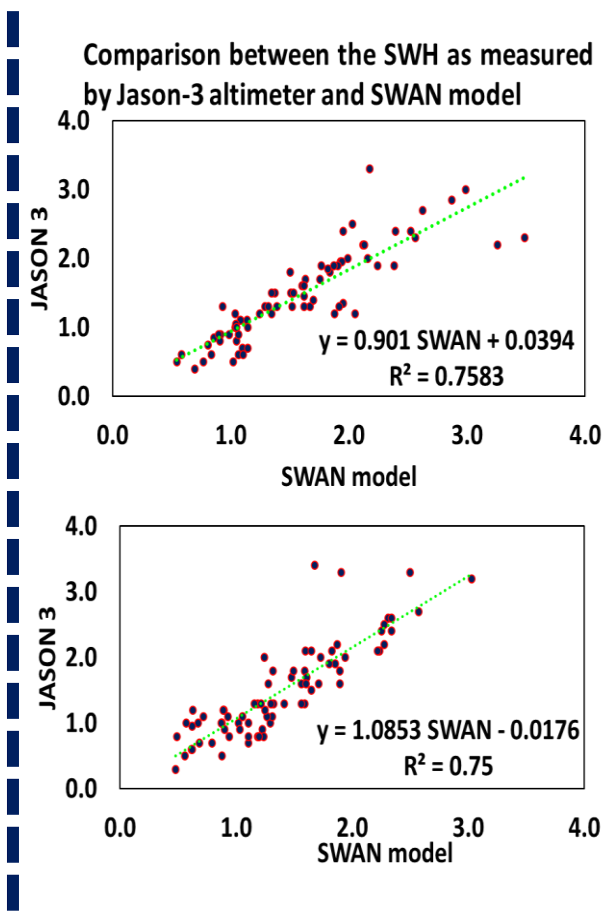
INTRODUCTION

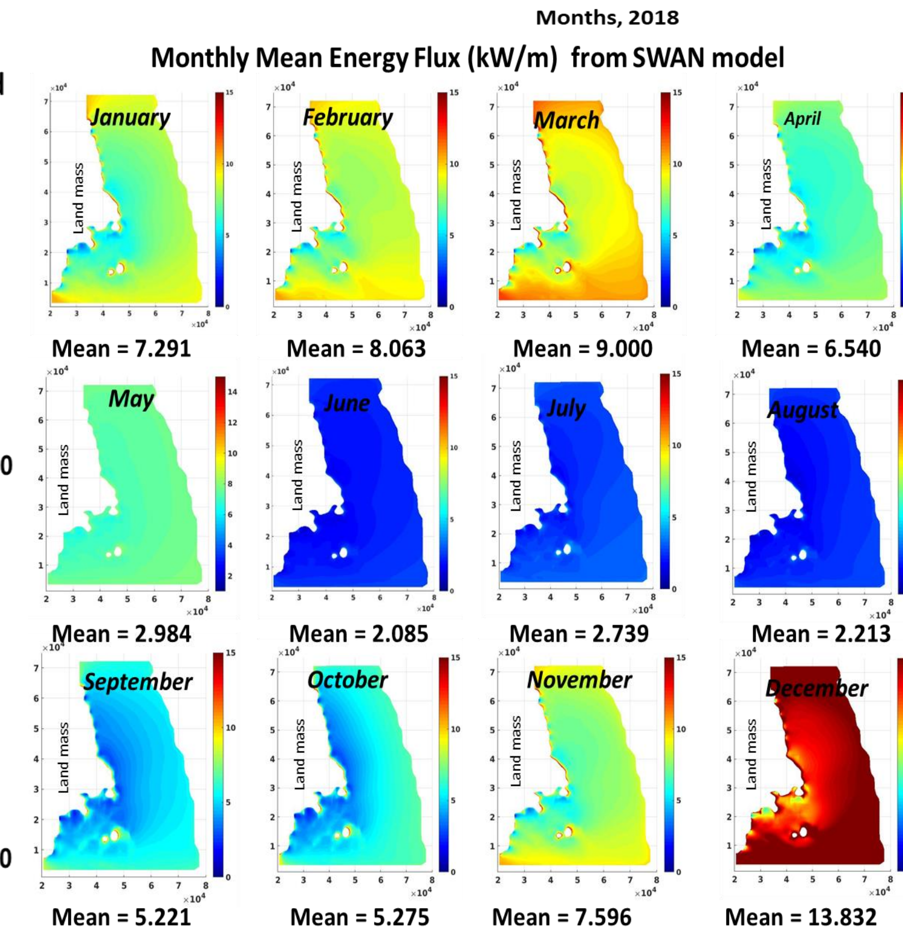
The implementation of RA 9153; an act that aims to promote the development, utilization, and commercialization of renewable energy resources has resulted to the introduction of the Philippine Renewable Energy Plan (NREP). One of the potential renewable energy sources identified in the NREPs Renewable Energy Plans and Programs (2011-2030) was the ocean wave energy. In 1996, the DOE together with the OCEANOR investigated of the ocean energy and assessed the potential wave energy in some sites (which includes Siargao) in the Philippines, but the data were limited. Similarly, several studies were conducted to assess the potential of this energy source (Cornet, 2008; Mork et al, 2010; Duy et al, 2015; Quitoras et al, 2018) which estimated that there is about 10-20 kW/m energy potential in the North Luzon and less than 5 kW/m elsewhere. However, due to several challenges such as the limited availability of in-situ data and equipment, most of these studies made used of secondary data from various weather forecast models with coarse resolution of about 0.5° latitude and longitude. To promote and establish the use of this energy source, in 2014 the ADB recommended to conduct a more comprehensive assessment study at various sites with finer resolution specifically at the nearshore where most of the currently designed wave energy devices operates.

RESULTS AND DISCUSSIONS









Both the 9-year hindcast and the simulation showed the ocean wave energy are generally higher during the Amihan season (Sept-Apr) than Habagat with higher variability during the south-west monsoon similar to the previous studies conducted by Mork, et.al [9] . Result showed that the mean annual energy flux in Siargao is about 6.123 kW/m which validates the previous claims considering the northern part of the Philippines with greater potential <5 kW/m [9] and 4-6 kW/m by Duy, K. et.al [10]. However, the model underestimates the WW3 model, 10-20 kW by Quitoras, M. et.al [11] and the Surf forecast by Quitoras, M. [11]. There is a strong relationship between the Jason 3-altimeter data and SWAN model (correlation value of 0.87, bias of 0.11 and SI of 21). There is a weak relationship between the wave-tide gauge data and the simulation, however, smoothing using 1-day moving average and decoupling tide data using Fast-Fourier transform enhances the relationship. The study recommends the use of Wavedragon for deepwater similar to the findings of Quitoras,M. et.al [11] and Wavestar for nearshore application.