IDENTIFICATION AND MAPPING A POTENSIAL WAVE ENERGY LOCATION IN INDONESIAN WATERS

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ABSTRACT

Territorial waters of Indonesia can be potential which utilized to maximum for generating electrical energy from renewable energy sources. That energy can be created from the Tidal elevation, temperature difference (Ocean Thermal Energy Conversion), currents, waves, and wind up on the shores of Indonesia. Wave energy is a potential energy source that has not been much developed, although some inroads have been made. For the energy of ocean waves in Indonesia, southern parts of West Java and parts of Sumatra are the place where the potential waves large enough to be developed because of its territory directly overlooking the sea, namely Indian Ocean and North parts of Papua is the other place that can be developed for wave energy because its directly overlooking the sea, namely Pasific Ocean. This research aims to identify locations that potentially has the energy of ocean waves in the Indonesian waters. The method used is inverse distance weight (IDW) method which is one of the methods in geographic information systems (GIS). The results of the identification of the location on this research can be used to provide the initial prediction of the area that has potential wave energy.

Keywords: *Indonesian Waters, Wave Energy, Geographic Information System.*

INTRODUCTION

Potential energy is the quantity of energy that is contained in an entity of natural resources, that we known as the energy resources. Information or the scale of the magnitude of the potential energy can be a consideration in the assessment of whether the potential is quite sufficient to be developed or managed to produce energy. Ocean energy development efforts require the support of increased exploration activities through marine energy resources survey to obtain data and information on how big the energy content of the resources in the sea (Mukhtasor, 2014).

According to the Wave Energy Centre team up with the Implementing Agreement on Ocean Energy Systems (OES), defines that the Ocean energy is energy that generated from some technologies use energy from the power source of waves, ocean currents, tides, Ocean heat differences (Ocean Thermal Energy Conversion) and the difference in salinity (salt levels) to produce electricity. Wave energy has long been considered one of the most promising renewable technologies. It is a potential renewable energy source that has not been adequately developed, although some breakthroughs are underway. Not only is the energy resource vast, but it is more dependable than most renewable energy resources (Maulud et al, 2008).

Geographical Information System (GIS) is the combination of skilled persons, spatial and descriptive data, analytical metods, and computer software and hardware – all organized to automate, manage and deliver information through geographic presentation. GIS is a set of tools for collecting, storing, retrieving, transforming, and displaying spatial data from real world for a particular set of purposes (Burrough, 1986).

Some of this year, the Ministry of eksploration human resources (ESDM) Indonesia in cooperation with several research institutions in Indonesia has been conducting surveys and research to find out about the potential of ocean energy in several locations in Indonesia. This is evidenced by the presence of Ocean Energy Potential Reports published in 2014. However, these results have not been assessed fairly represent the whole ocean energy potential locations in the waters in Indonesia.

Table 1 Potential Ocean Energy in Indonesia (ASELI, 2011)

Type	theoretical potention (MW)
Ocean thermal	57.000
Current	160.000
Waves	510.000
Total	727.000

Based on the consensus of experts in Indonesia, the potential energy of the ocean is divided into several categories by adopting categories that have been used in Ireland (Marine Institute and Sustainable Energy Ireland, 2005) :

- *Theoretical Resources* : the gross energy content of the resource.
- *Technical Resources* : theoretical resource that limited by the efficiency of the technologies available.
- *Practical Resources* : technical resources that limited by physical factors which are not compatible.
- *Accessible Resources* : practical resources constrained by institutional and regulation.
- *Viable Accessible Resources* : resources constrained by economic feasibility.

This research aims to identify locations that potentially has the energy of ocean waves around the waters of Indonesia (theoretical resources), so it can be the advice for the Ministry of eksploration human resources as well as institutions in conducting the next research studies survey more detail.

EXPERIMENTAL SET UP

Design of Experiment

There are two types of wave data were considered to achieve the objectives of this research, i.e : satellite altimetry data and ECMWF data. The satellite altimeter is the

main source of wave data to validate the waves model from ECMWF data and assess the potential of wave energy in Indonesia.

The wave data were download from the website of satellite altimetry with the resolution of 1^0 x 1^0 within the time range from Januari 2012 to December 2016, and the website of ECMWF for the waves model.

Wave power unit crest length, P (kW/m), is calculated using the formula :

$$P \approx \frac{\rho g^2}{64\pi} H_S^2 T_e \quad (1)$$

Hs : Significant wave height (m)
Te : Energy mean period (s)

However, the altimeter is unable to provide direct measurement of wave period. Numerous researchers proposed wave period algorithms relating the altimeter significant wave height, Hs, wind speed, U and rada backscatter coefficient, σ_0 to the wave period. However, according to Fu and Cazenave (2001), the research are in early stages and could be improved in accordance with the technology improvement. The final algorithms were selected according to the highest value of the correlation coefficient, R and minimal mean absolute error (MAE) (Hashim et al, 2016).

$$T_z = 1.299a - 1.127$$

$$a = 2.247 + \frac{4.947 + 25.399\, H_s}{7.562 + H_s + U} \quad (2)$$

RESULTS AND DISCUSSION

Figure 1 illustrates the mean theoretical wave power of Indonesian waters at December 2016. The map clearly shows that the most energy rich areas in the South Java and part of Sumatra (38 kW/m) and also the North of Papua almost has the same energy resources (16 kW/m). The wave power decreases gradually in the java sea because the significant wave were not high in that area (3,8 kW/m). The factor why the waves energy was high in South Java and North Papua because it is directly face the open ocean (Hindia − Pasific) that has big significant wave hight with high wind speed.

Figure 2 present the monthly climatology of wave energy in Indonesia waters at 2016. It can be noticed that the highest wave power estimed during the months of June and July. There are several potential locations in the Indonesian waters having large wave power. However, these locations are located offshore, therefore less accessible for the installation and operation of wave energy farm and likely will add up the cost of project.

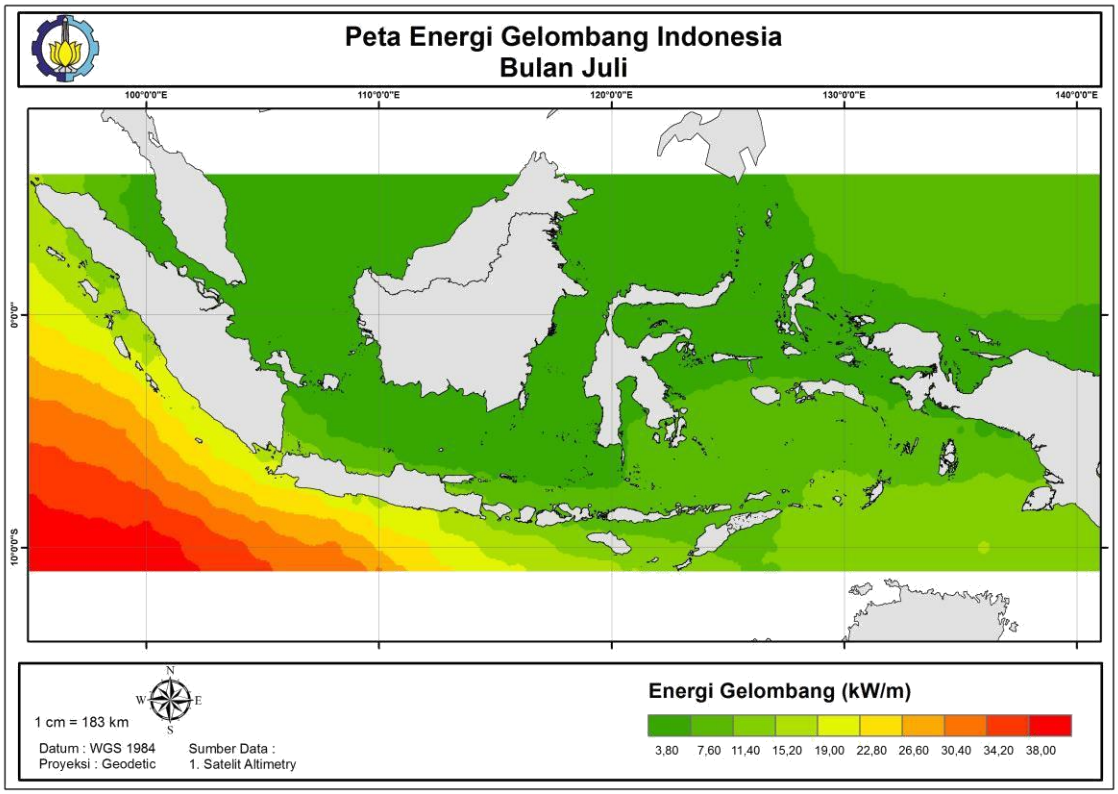

Figure 1 Mean theoretical wave energy in kW/m July 2016

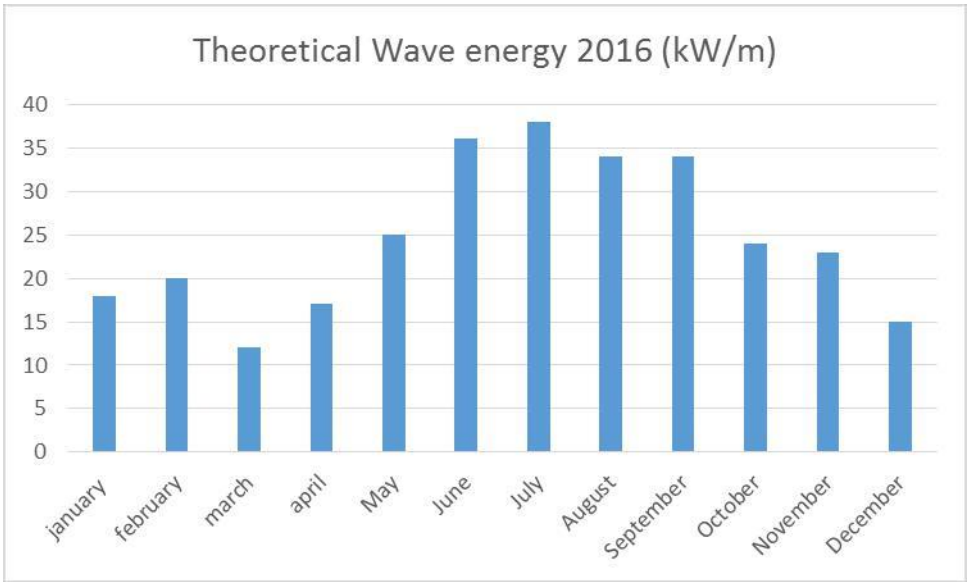

Figure 2 Monthly Mean theoretical wave energy in kW/m 2016

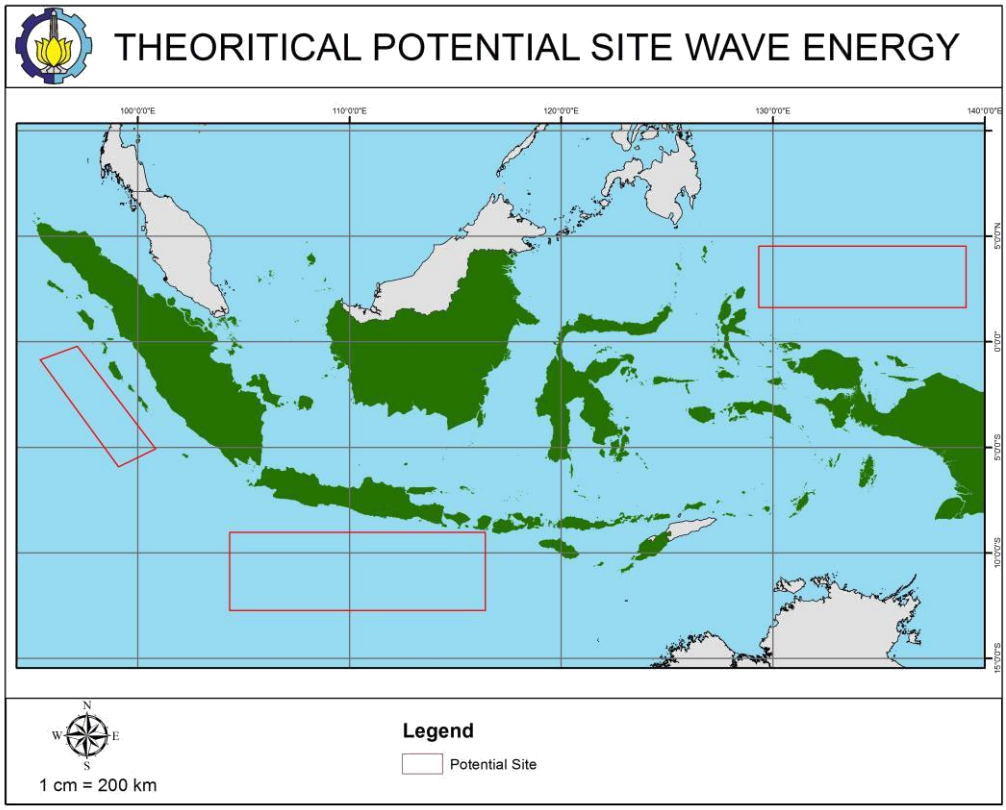

Figure 3 Theoretical wave potential energy location in Indonesian Waters

CONCLUSION

This result is the beginning phase for potential energy mapping. There are some place in Indonesian Waters that potential for Wave energy, althought almost all of the site were offshore, but we can mapping all of the waters of Indonesia. So it can be an advice for the government (ministry of ESDM) and other constitutions in Indonesia to do the next survey studies for waves energy. The location that has potential for waves energy are the site that directly face the open ocean (Sumatra, Java, Bali, NTT, NTB, Papua).

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