IDENTIFICATION A POTENTIAL WAVE ENERGY LOCATION IN MALAYSIA USING GIS

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Abstract: - Our current living standard could not be maintained without energy. The provision of energy or – more precisely- of the related energy services (e.g. heated living spaces, information, and mobility) involves a huge variety of environmental impacts which are increasingly less tolerated by the society of the 21^{st} century. The development of a nation needs support not only from sustainable energy generation system but also clean, safe and renewable energy. No doubt in the near future, the world still needs fossil fuel because most of the primary existing technologies depend on it. Dependence on depletable sources of energy cannot guarantee the sustained development of any nation. Renewable energy is the best alternative as the source is free of such impact. The aim of the project is to conduct a preliminary study to find out potential wave energy generation for use in Malaysia by looking at a few aspects and factors related in hydraulics and hydrology. This research in Malaysia investigates potential wave energy sources including the land, the island and the sea. The data about climate information and forecast of sea condition may be derived from the Malaysia Meteorological Department used to study the wave height and wave period, wind speed and sea surface temperature around Malaysia. Finally the results from analysis are the index as a reference to summarize a grade and potential levels of locations selected. By looking forward that the technology like wave energy has great potential for future energy generation in Malaysia, the pursuit of clean, safe and sustainable renewable energy generation system requires society effort and a paradigm shift. This paper is a beginning of the research about potential of marine energy in Malaysia, focusing on mapping the potential area and location for wave energy in Malaysia.

Key-Words: - Geographical Information System (GIS), Marine Energy, Wave Energy, Renewable Energy

1 Introduction

Energy resource use is one of the most important and contentious issues of our time. Renewable energy refers to energy resources that occur naturally and repeatedly in the environmental and can be harnessed for human benefit. Examples of renewable energy systems focus in Malaysia include wave and tidal. Renewable energy encompasses many different types of technology at different stages of development and commercialization.

The Renewable Energy Atlas of the Malaysia is design as a resource for policy makers, developers and others interested in furthering the production of electricity from renewable wave and tidal resources. Utilizing state of the GIS technology, the Atlas brings together the best existing renewable resource maps and data into a single comprehensive, publicly available document and interactive digital maps. While the maps contained in this atlas do not eliminate the need for on-site resource measurement, they do provide an estimate of the available resource.

Malaysia is one of the fastest growing states in Asia. This growth will greatly increase demand for electricity over the next decade. Renewable resources can play an important role in helping to meet this demand.

2.2 Geographical Information System (GIS)

Geographical Information System (GIS) is the combination of skilled persons, spatial and descriptive data, analytical methods, 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) said that GIS is a set of tools for collecting, storing, retrieving, transforming, and displaying spatial data from real world for a particular set of purposes. Bernhardsen (1999) said that all of the data in GIS are georeferenced and linked to a specific location on the surface of the earth through a system of coordinates.

GIS is a tool for resolving problems where the data is dependent on geographical position. It provides the functions and tools needed to store, analyze and display information referenced geographically. A GIS commonly manages the data by dividing the information into thematic layers (Figure 1)

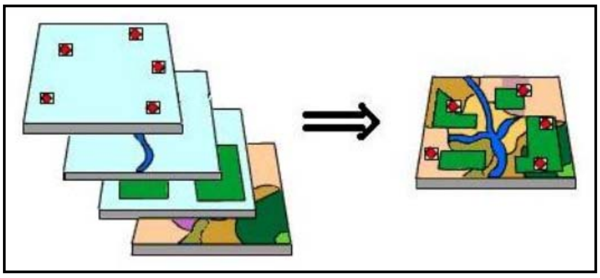
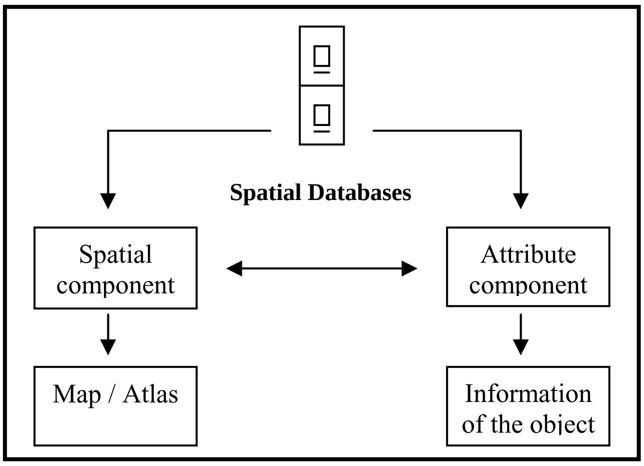


FIGURE 1 Data layers forming a map in a GIS

Antenucci (1991) describe that GIS databases divide by two which is spatial data and non spatial data (attribute). Figure 2 show the flow of GIS database.



Source: Antenucci (1991)

FIGURE 2 GIS Database

According to Shekhar (2003), Spatial Databases Management System (SDBMS) provides simpler operations on a set of objects and sets of layers. SDBMS are designed to handle very large amounts of spatial data stored on secondary devices, using specialized indices and query processing techniques

2 Wave Energy

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.

Winds are generated by the differential heating of the earth and as they pass over open bodies of water, they transfer some of their energy into the form of waves. Extraction of energy from the waves is more efficient than direct collection of energy from the wind due to the fact that waves are a more concentrated form of wind energy. However, the practicality and economics of harnessing wave energy is dependent on many factors, particularly geographic location, season, storm frequency, and storm location. The concept of extracting energy from waves is not recent.

2.1 Resource potential

Ocean waves represent a form of renewable energy created by wind currents passing over open water. Compared with other forms of offshore renewable energy, such as solar photovoltaic (PV), wind, or ocean current, wave energy is continuous but highly variable, although wave levels at a given location can be confidently predicted several days in advance.

The common measure of wave power, P, is

$$P = \frac{\rho g^2}{32\pi} H^2_{mo} T \approx \left(1.0 \frac{kW}{m^3 s}\right) H^2_{mo} T$$

where:
ρ = the density of seawater
g = acceleration due to gravity = 9.8 m/s/s,
T = period of wave (s), and
H_{mo} = wave height (m).

The formula above can be simplified as:

$$P \approx H^2_{mo} T$$

Waves are also efficient transporters of solar energy. Storm winds generally create irregular and complex waves. In deep water, after the storm winds die down, the storm waves can travel thousands of kilometers in the form of regular smooth waves, or swells that retain much of the energy of the original storm waves. The energy in swells or waves dissipates after it reaches waters that are less than ~200 m deep. At 20-m water depths, the wave's energy typically drops to about one-third of the level it had in deep water.

3 Analysis of Wave Energy

The wave data are obtained from Malaysia Meteorological Department.

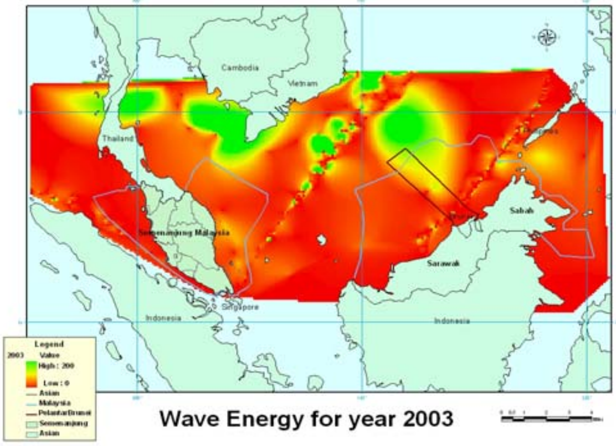


Figure 3 Wave power generation for 2003

The wave energy for year 2003 indicates that the highest wave power at Peninsular Malaysia is 8 kW m at 5^{o} 00$^{'}$N and 104^{o}E, on the eastern boundaries of beach. For coastal of Malaysia (Sabah) the highest wave power is 20kW/m indicates within 7^{o} 30$^{'}$N and 116^{o}E.

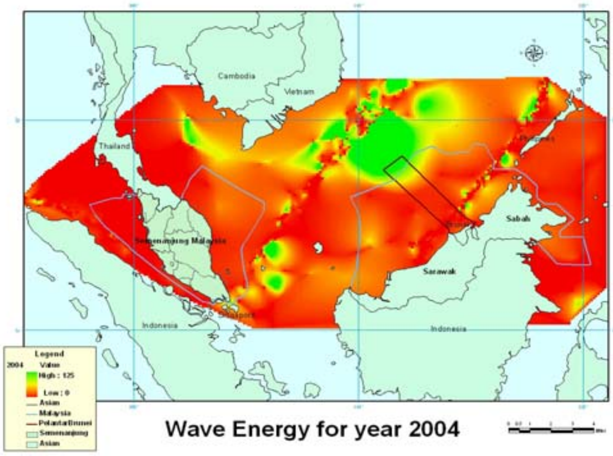


Figure 4 Wave power generation for 2004

For year 2004 it show that the highest wave power at Peninsular Malaysia is 13kW/m at 1^{o} 10$^{'}$N and 104^{o}E within coastal of Johor. Coastal of Malaysia (Sabah) shown that the highest wave power is 45kW/m at within range 6^{o} 40$^{'}$N and 115^{o}E

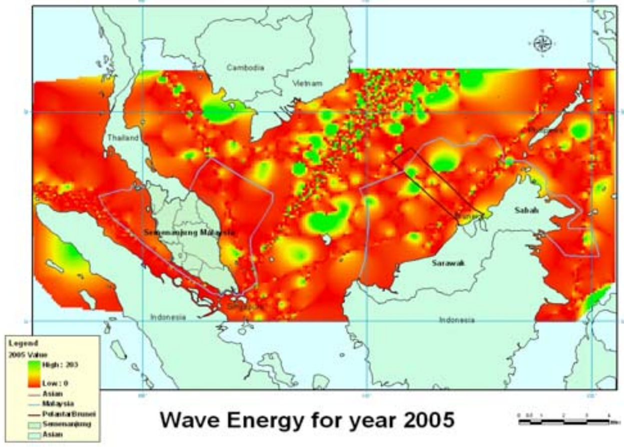


Figure 5 Wave power generation for 2005

As we can see the highest wave power for year 2005 for Peninsular Malaysia is 112kW/m within 2^{o} 00$^{'}$N and 105^{o}E. Mostly it indicates within east coastal beach. For coastal of Malaysia (Sabah) the highest wave power is 160kW/m indicates within 7^{o} 30$^{'}$N and 115^{o}E.

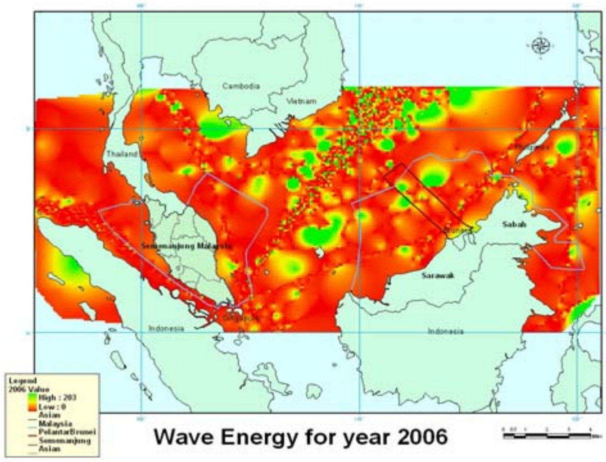


Figure 6 Wave power generation for 2006

The figure shown that the highest wave power for year 2006 for Peninsular Malaysia is 112kW/m at latitude 2^{o} 00$^{'}$N and 105^{o}E. Another part for coastal of Malaysia (Sabah) the highest wave power is 160kW/m at latitude 7^{o} 30$^{'}$N and 115^{o}E.

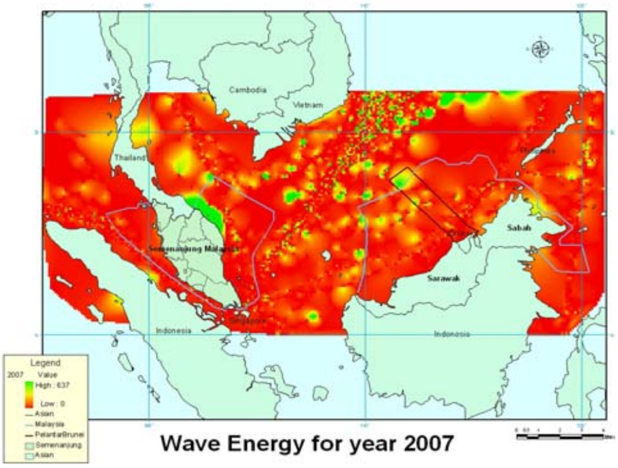


Figure 7 Wave power generation for 2007

According to the figure above, the highest wave power for year 2007 is 150kW/m at latitude 6^{o} $00^{'}$N and 103^{o}E. Mostly it indicates within east coastal beach and west coastal beach. For coastal of Malaysia (Sabah), we can see that the highest wave power is 81kW/m at latitude 7^{o} $20^{'}$N and 115^{o}E.

4 Potential location

The greatest potential for wave energy exists in Malaysia with the northern portion of the island of Borneo, Sabah having particularly high potential. Based on the analysis, wave energy devices could generate up to 160kW/m within Sabah area and 150kW/m for Peninsular Malaysia. The economics of wave energy power, though not yet competitive with fossil fuels, are promising, and the situation is improving with more advanced technology.

5 Environmental impacts

Small-scale wave energy plants are likely to have minimal environmental impacts. However, some of the very large-scale projects that have been proposed have the potential for harming ocean ecosystems. Covering very large areas of the surface of the ocean with wave energy devices would harm marine life and could have more widespread effects, by altering the way the ocean interacts with the atmosphere.

The following environmental considerations require monitoring.

Visual appearance and noise are device-specific, with considerable variability in visible freeboard height and noise generation above and below the water surface. Devices with OWCs and overtopping devices typically have the highest freeboard and are most visible. Offshore devices would require navigation hazard warning devices such as lights, sound signals, radar reflectors, and contrasting day marker painting. However, Coast Guard requirements only require that day markers be visible for 1 nautical mile (1.8 km), and thus offshore device markings would only be seen from shore on exceptionally clear days. The air being drawn in and expelled in OWC devices is likely to be the largest source of above-water noise. Some underwater noise would occur from devices with turbines, hydraulic pumps, and other moving parts. The frequency of the noise may also be a consideration in evaluating noise impacts.

Reduction in wave height from wave energy converters could be a consideration in some settings; however, the impact on wave characteristics would generally only be observed 1 to 2 km away from the wave energy conversion (WEC) device in the direction of the wave travel. Thus there should not be a significant onshore impact if the devices were much more than this distance from the shore. None of the devices currently being developed would harvest a large portion of the wave energy, which would leave a relatively calm surface behind the devices. It is estimated that with current projections, a large wave energy facility with a maximum density of devices would cause the reduction in waves to be on the order of 10 to 15%, and this impact would rapidly dissipate within a few kilometers, but leave a slight lessening of waves in the overall vicinity. Little information is available on the impact on sediment transport or on biological communities from a reduction in wave height offshore. An isolated impact, such as reduced wave height for recreational surfers, could possibly result.

Marine habitat could be impacted positively or negatively depending on the nature of additional submerged surfaces, above-water platforms, and changes in the seafloor. Artificial above-water surfaces could provide habitat for seals and sea lions or nesting areas for birds. Underwater surfaces of WEC devices would provide substrates for various biological systems, which could be a positive or negative complement to existing natural habitats. With some WEC devices, it may be necessary to control the growth of marine organisms on some surfaces.

Toxic releases may be of concern related to leaks or accidental spills of liquids used in systems with working hydraulic fluids. Any impacts could be minimized through the selection of nontoxic fluids and careful monitoring, with adequate spill response plans and secondary containment design features. Use of biocides to control growth of marine organisms may also be a source of toxic releases.

Conflict with other sea space users, such as commercial shipping and fishing and recreational boating, can occur without the careful selection of sites for WEC devices. The impact can potentially be positive for recreational and commercial fisheries if the devices provide for additional biological habitats.

Installation and decommissioning. Disturbances from securing the devices to the ocean floor and installation of cables may have negative impacts on marine habitats. Potential decommissioning impacts are primarily related to disturbing marine habitats that have adapted to the presence of the wave energy structures.

5 Conclusion

Ocean waves have the potential to contribute up to one TW to the global energy supply. The problems associated with the intermittence of wave energy can be smoothed by integration with the general energy supply system. Many different wave power plants, some of them multi-purpose, have been proposed, assessed, and cost-estimated. With the development of large-scale demonstration and commercial power plants underway, wave energy will begin to play an increasing role in complementing other renewable and conventional energy technologies to meet global needs. GIS analysis has been carried out to determine suitable sites for new marine energy. GIS can produce an interactive digital and hardcopy maps. Malaysian government and related agencies can used the output from this research to plan a next step of new energy in Malaysia especially in Marine Energy

Acknowledgement

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