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A Review on Environmental Impact Assessment on Wave Energy Converter in Pulau Mantanani Besar, Kota Belud, Sabah

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Abstract

The exploitation of Wave Energy Converter (WEC) with a large number of devices may have a major impact on wave in coastal areas. Environmental Impact Assessment (EIA) is a global environmental management tool. The progression of WEC has affected environmental research in EIA. In Malaysia, the activities specified in the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) order 1987 is under the requirement of EIA. The objective of this paper is to establish the list environmental possible threat and to investigate the environmental impact of WEC construction project implementation in Pulau Mantanani Besar and identify which suitable method for this WEC project. . The research method is a descriptive analysis. Field surveys, case studies and surveys were conducted to collect data from local, community, marine and government agencies, as well as expert interviews with Jabatan Alam Sekitar, Jabatan Laut Sabah and Sabah Park. The expected outcome of this project is conduct list of environmental impact assessment of WEC project during the construction phase. There will be a proposed investigation steps to overcome this project.

1. INTRODUCTION

Wave energy is considered clean and renewable energy. Wave power equipment does not produce any atmospheric pollution and greenhouse gas emissions, such as fossil carbon dioxide, usually associated with burning fuel power generators. However, most, if not all, types of power generation, had affected the environment in some form, be it renewable or traditional power generation. However, it is highly believed that wave Energy is a type of clean energy source that will be replenished naturally in a short period. Time reduces environmental impact compared to other forms of renewable energy generation Wave energy, which is another name for ocean wave energy, is a kind of energy source that can be renewed despite ocean-based. Wave energy creates the periodic movement of waves that arise in the ocean up and down along the electricity located on the surface of the oceans.

Before, EIA is known as the method or process of measuring the anticipated environmental impact of a proposed development. To prevent out comings that are deemed unsuitable, necessary modifications and design measures are required to be done. The process of inspecting the environmental impact of the development or project that has been proposed is known as EIA, while not omitting the positive contributions and unfavorable interrelated socio-economic, cultural and human health impacts. The International Association for Impact Assessment (IAIA) defined EIA as the process of identifying, evaluating, forecasting, modifying social, biophysical and other factors that can influence the recommendations of the development before any decision and commitments are made. The aim is to anticipate the impacts of the environment in the beginning stages of project planning and design, finding out other methods to decrease the adverse impacts, identifies a project that is deemed suitable to the local environment, and provide predictions and possible solutions for decision making.

For this project, to solve the issue of deficiencies in the implementation and reporting on EIA, the development and implementation of a Rapid Impact Assessment Matrix (RIAM) are created. The knowledge that bases the whole system is the certain specific criteria are common to all impact assessments, and the values such as estimates, are made possible to be written down, due to the scaling of these criteria.

Currently used to determine the effect of the develop-

ment strategy or project may have many of the standards is well-known, and most efforts in the field of environmental impact assessment are acceptable. For example, in any environmental impact assessment, an area that can affect the degree or degree of impact is always a priority to be taken into consideration, whether the impact is permanent or temporary, whether the impact can be reversed, whether the impact can be saved, and whether it affects. There may be a synergistic effect and may lead to an effect that will accumulate in the long run. All of these standards form a common area of judgment common to most environmental impact assessments today, but most evaluators have developed metrics to describe their judgments about the impact of these standards on a "temporary" basis.

This study will be used for construction projects for WEC and mooring systems. The WEC fine-tuning system needs to be integrated into the design to maintain the equipment in optimum relative direction with the waves and can also be part of the optimum control system for the WEC unit-specific power bandwidth. The WEC platform will be to be planted at Pulau Mantanani Besar, Kota Belud Sabah. A mooring system will also be constructed in this project. Many difficulties will ocean for the environment during construction, maintenance, and operation. Therefore, the study intends to investigate the environmental impact on the island due to WEC device development and construction. , this project is a government initiative to further develop the green technology sector by using renewable energy. Furthermore, this project has been getting funds from the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC). This project is planned to be developed and installed at Pulau Mantanani Besar, Kota Belud in Sabah.

2. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Environmental Impact Assessment (EIA), which aims to determine the impact of development, sepsis, biological and physical processes; despite noting that testing sites and small-scale demonstration projects might be redundant for a comprehensive environmental impact assessment. The effect will follow the project phase (construction), operations, and decommissioning whereas the scale will depend on the location and surrounding of the area shown in Table 1.

3. RAPID IMPACT ASSESSMENT MATRIX (RIAM) FOR EIA

Rapid Impact Assessment (RIAM) which was introduced by Pastakia in 1998 [4] is a technique that can be used for evaluating many categories of environmental impacts. Other than that it allows the independent classification for each analyzed item. This also allows for the revaluation of each item later during the process [5]. The importance of this approach is that the standards define the importance of assessing the impact of the criteria, and for each semi-quantitative value collected by the standard, different conditions are allowed to obtain an independent and precise classification.

Table 1. Prediction Environmental Impact of project and explanation

No	Environmental Impact	Explanation
1	Water quality interference	The large and rapid marine fouling increment of wave energy device [1].
2	Artificial reef effects	Artificial marine reef effects the extensive marine energy structure is also established by microbenthic communities, especially in coastal sands area. It is important to determine if this change is beneficial to exist in local conditions [1].
3	Visual impact	Manpower waves can affect several forms of response such as water skiing, snorkeling, diving, sailing and windsurfing. in addition to the visual effects, as the WEC near the coast can sometimes be seen from the coastal area [2].
4	Fishing industry	The device area which is considered as an exclusion zone is highly impacting the fishing area. Other devices such as power cables, anchor lines and tethers can be limiting the use of nets. The floating devices can restrict fishing access to that area [3].
5	Navigational hazards	Repair and maintenance of boat may affect the water quality due to oil spills from the particular work [3].
6	Device construction	The dredging and polishing work of the sea bed during the installation of a submarine cable may employ the ocean bed system [3].
7	Collision risk for marine mammals	The risk of collision of marine mammal species with the installed WEC device can produce greater ambient noise which can disturb the marine life [2].
8	Sedimentary flow	The velocity of water could change and affect the sediment transport, erosion of coastal area and deposition of pebbles or rock on the seashores [2].
9	Electromagnetic fields	The electromagnetic field produced by the WEC and the sub-sea cables will affect the marine animals since these animals depend on the magnetic field of the Earth for navigation [2].
10	Environmental	The debris from rams, biofouling paints, power trains engines, lubricating oils, and other maintenance materials may increase the potential impact on the nearby coastal area [2].

4. ENVIRONMENTAL COMPONENTS RIAM

Physical and chemical composition related to case studies Climate, groundwater quality, air quality, soil conditions, noise levels, desilting, surface water quality, vibration, land use/recovery, and they are measured from secondary data. Social and economic factors include strengthening social and cultural development, economic development, employment opportunities and ecotourism, and evaluating and scoring them based on surveys conducted. Therefore, the component environment impact RIAM method is suit-

able for implementation at the Pulau Mantanani Besar, a WEC project in Sabah.

RIAM requires the definition of specific evaluation components through a scoping process. There are four categories of environmental components [5], [6] as stated below.

i. Physical or Chemical (PC)
   - Depleting (non-renewable) natural resources (non-biological).
   - Degrading physical environment due to pollution.
   - Including water resources and quality, climate air quality, soil and geophysics, noise, solid waste, rainfall, and degrading forest cover [5], [6]

ii. Biological or Ecological (BE)
   - Altogether biological aspects of the environment
   - Preservation of biodiversity, interaction among pollution, and species of the biosphere.
   - Instance sewage intrusion, sewage sanitation, flora, vegetation proper sewage connection, fauna, foul smells, and vegetation [5], [6]

iii. Sociological or Cultural (SC)
   - The social issues affect the populations and individuals
   - For example medical services, education, house flies, mosquitoes, science, and development due to technology [5], [6]

iv. Economical or Operational (EO)
   - Identify the economic consequences of ecological transformation
   - The difficulties of project organization surrounded the context of the project events
   - Gradation of understanding and element of the system can be measured by the selection and classification process for these economical components [5], [6]

Imperative to apply the fore declared estimation arrangement; a matrix is generated for respectively project option. The condition includes a set for each defined element, giving the standard used, whereby individual normal scores are set within each cell. Calculated and recorded according to the formula given for each ES number. After setting the ES score to the range band (Figure 1), that is, $-108 \leq ES \leq 108$. Relevant scores are displayed separately or grouped by component type and displayed numerically shown in Figure 1.

The vital assessment conditions reduction into two groups:

i. The category that is respected to the condition and situation, but should not separately be capable of changing the score.
ii. The category is imperative to the condition that separately can changing the score

$$(a1) * (a2) = aT \tag{1}$$

Environment classification (EC)	Value of the class	Value of the class numerical	Description of class
72 to 108	E	5	Major positive impact
36 to 71	D	4	Significantly positive impact
19 to 35	C	3	Moderately positive impact
10 to 18	B	2	Positive impact
1 to 9	A	1	Slightly positive impact
0	N	0	No alteration
-1 to -9	-A	-1	Slightly negative impact
-10 to -18	-B	-2	Negative impact
-19 to -35	-C	-3	Moderately negative impact
-36 to -71	-D	-4	Significantly negative impact
-72 to -108	-E	-5	Major negative impact

Figure 1. Range bands used for RIAM [4], [7], [8]

$$(b1) + (b2) + (b3) = bT \tag{2}$$

$$(aT) * (bT) = ES \tag{3}$$

Thus, for group (A); (a1) (a2) is the single category scores. While for the group (B); the single category scores are (b1) (b2) (b3), aT is the multiplication of all (A) scores. bT is the addition of all (B) scores. Then, ES stands for the environmental score for the condition [4].

The significance and magnitude principles for impact are specified in the first category of a1 and a2, reversibility, respectively, accumulation and persistence category are listed in the second category of b1, b2, b3 (Figure 2). From Figure 2 Environmental Score (ES) values and range are used in RIAM as of the present. The concluding assessment of each component is then computed in an arrangement to these range bands. Originally, it should be determined whether the result is either positive or negative and the score will be concluded as shown in Figure 2.

5. DISCUSSION

The above RIAM method applies to the Pulau Mantanani Besar, a WEC project in Sabah. RIAM is suitable for EIAs that use a multidisciplinary team approach because it allows for the clear assessment of key impacts by analyzing data from different departments based on common criteria in a common matrix. By using matrix-imposed discipline allow assessors to note their judgments in a short period. Objectivity is ensured by a standard scale set these standards provide digital determination made. Multiple Matrices can be established to relate different plans and enlargement choosing, set apart main positive or negative impacts, classify impermanent and permanent impacts and illustrate where modification can effectively reduce negative impacts.

Category	Crisp scale	Fuzy scale	Description
A1 Importance of condition (1)	4	(3,4,5)	International importance
	3	(2,3,4)	National importance
	2	(1,2,3)	Outside of local condition
	1	(0,1,2)	Local condition
	0	(0,0,0)	Not important
A2 magnitude of change-effect (M)	+3	(2,3,4)	Major positive benifit
	+2	(1,2,3)	Significant improvement
	+1	(0,1,2)	Improvement in "status quo"
	0	(0,0,0)	No change / "status quo"
	-1	(-2,-1,0)	Negative change to "status quo"
	-2	(-3,-2,-1)	Significant negative effect
	-3	(-4,-3,-2)	Major negative effect
B1 permanence	1	(0,1,2)	No change / not applicable
	2	(1,2,3)	Temporary
	3	(2,3,4)	Permanent
B2 reversibility	1	(0,1,2)	No change / not applicable
	2	(1,2,3)	Reversible
	3	(2,3,4)	Irreversible
B3 cumulative	1	(0,1,2)	No change / not applicable
	2	(1,2,3)	Non-cumulative / single
	3	(2,3,4)	Cumulative / synergistic

Figure 2. Description of the evaluation assessment criteria for RIAM [4], [7]

We choose the RIAM method for the WEC project because it is suitable to solve the actual problem we had been facing. In Table 1, it had been discussed in detail in regards to the problem of environmental impact in WEC project Pulau Mantanani Besar in Sabah. Thus, this project is suitable for the development and implementation of RIAM as a pioneer in this country, to solve the WEC project at Pulau Mantanani Besar in Sabah.

6. CONCLUSION

There are many difficulties that will ocean for the environment during construction, maintenance and operation. Therefore, the study intends to investigate the environmental impact on the island due to WEC device development and construction. Environmental Impact Assessment of the Wave Energy Converter project has been conducted by using the Rapid Impact Assessment Matrix method. The RIAM, in general, presented the result of the EIA study easily and transparently.

The aptitude of RIAM to transparent, permanent record decision in Environmental Impact Assessment is a vital improvement in improving the use of Environmental Impact Assessment. With full of hope that in all development stages of planning and management, the ease of use of RIAM concepts and method will be more widely accepted in impact assessment.

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