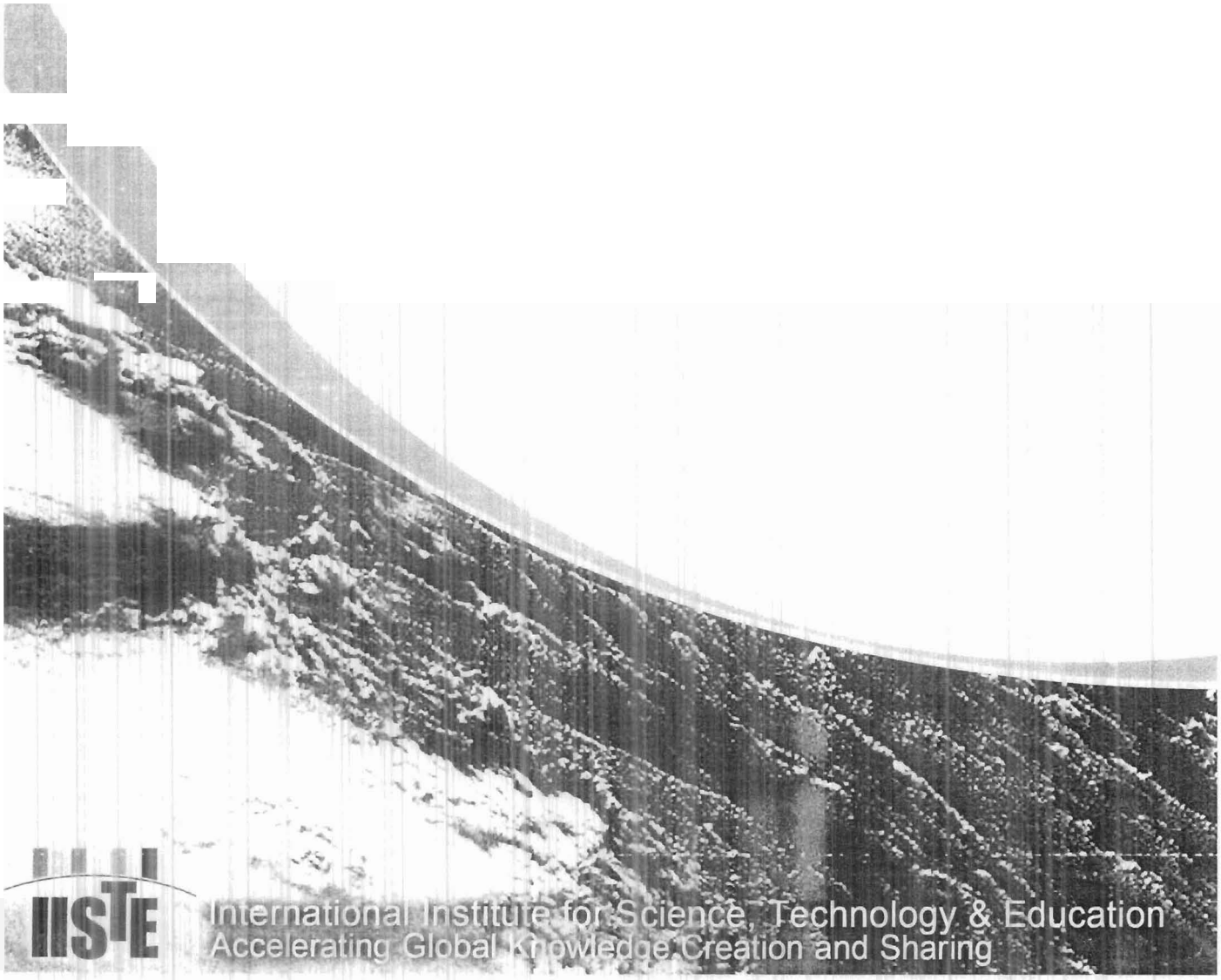
Journal of Environment and Earth Science



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The Strategic Model of Tsunami Based in Coastal Ecotourism Development at Mandeh Regions, West Sumatera, Indonesia

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Abstract
The aim of this research is to formulate the strategic model of tsunami based in coastal ecotourism development. The danger zones of tsunami formulation was using the analytical method of Geography Information System (GIS) through GIS analysis equipment-GLOBAL MAPPER to modify and stimulate the contour through the height of tsunami's wave 10-20 m, while to formulate the danger zones of this was conducted by using GIS-ERDAS 9.1 and GIS-ArcGIS 9.1 (Hermon, 2012[b], Hermon 2014[c]; Hermon 2015). This strategic model formulation of ecotourism development through tsunami based was conducted by A'WOT method, that is a mixture analysis of Analytical Hierarchy Process (AHP) and SWOT analysis (Kanges et al., 2001; Hermon, 2010[a]; Pelz, 2014; and Hermon 2014[d]). Generally, Mandeh regions are included in the risk zones of high tsunami and medium zones. The risk zones of high tsunami are included coastal region of Marak Island, west coastal region of Sironjong Kecil Island, north coastal region of Carocok Tarusan Bay, west, north and south coastal region of Cubadak Island, and west coastal region of Pagang peninsula. Meanwhile, the risk zones of medium tsunami are included east coastal region of Sironjong Kecil Island, east coastal region of Cubadak Island and west Sironjong Gadang, Setan Kecil and Gadang islands, Pagang islands and south coastal region of Carocok Tarusan Bay. The strategic model of tsunami based in ecotourism development showed that IFE (Internal/Strength Factor and Weaknesses Evaluation) had a score of 1,678 and EFE (External/Chance Factor and Threat) had a score of 2.371. EFE score is higher than IFE. It showed that tsunami based of ecotourism development of Mandeh regions has a big strengths and chances to be done.
Keywords: Ecotourism, Region, Coastal, Tsunami

1. Introduction

Coastal ecotourism is a marine tourism object which depended on the benefits of this region which have to have an environmental knowledge by using the principles of sustainable tourism as the priority. These principles are hoped to maintain the quality of coastal environment as well as the culture of coastal society, empower this society and give a financial benefit to all coastal society and also the government (Fandeli, *et al*, 2005). Fennel and Eagles (1990), Damanik and Weber (2006), and Primadany (2010) explained that the richness of coastal natural resources potential can be the new and priority aim for the national development. The construction of coastal region for ecotourism development should be basedd on the ecosystem and culture of its society. Because of this industry is one of the resource of the regional incoming (PAD), if it is not managed well and use the environmental knowledge, can cause a serious damage of ecosystem and environment of this coastal region.

Gun (1994); Fandeli and Nurdin (2005) said that ecotourism has an important point for coastal ecosystem conservation, it is caused by several reasons such as: (1) giving an economical value for a region whose aim to have conservation in protected area, (2) giving an economical value which can be used for conservation's program in protected area, (3) increasing the income of those society who live near to the location directly or indirectly, (4) encouraging the use of natural resources continuously, and (5) reducing treats toward biodiversity.

Mandeh regions are one of the tourism objects which are located in Tarusan, Pesisir Selatan District that bounded directly to Padang City. This location has 18.000 ha included 7 villages in 3 nagari which have 9.931 society. Most of the society are farmers, stockman, and fisherman. Mandeh regions consist of Carocok Tarusan Bay, Marak, Cubadak, Setan Gadang and Kecil, Sironjong Gadang and Kecil, and also Pagang Islands. These regions have a big development potential as a coastal ecotourism. Considering that these locations have a big threat of getting Tsunami because of the big earthquake potential (>8 SR) at Siberut block (Hermon, 2012[a]). Tsunami is predicted to destroy Mandeh Regions and the coastal area of West Sumatera whose height 10-20 m (Hermon, 2014[a]). This potential need to be examined more before developing Mandeh Regions become an ecotourism object, even though this regions has a big potential and also has positive effects on economic factors for the society as well as the regional government (Hermon 2010[b] and Hermon 2014[b]). Therefore, a strategic model of tsunami based in Mandeh Regions development into an coastal ecotourism object is needed, so that the sustainability of environmental knowledge ecotourism can be realized.

2. Research Method

2.1. Spatial Model of Tsunami Risk in Mandeh Regions

This research was conducted at Mandeh Regions, Pesisir Selatan District, West Sumatera. Risk zones of tsunami

of these area are analyzed by using topography map 1:250.00 with GIS-GLOBAL MAPPER 5.1 analysis equipment to arrange contour modification and simulation for tsunami which has 10-20 m height. Meanwhile, GIS-ERDAS 9.1 and GIS-ArcGIS 9.1 (Hermon, 2012[b], Hermon 2014[c]; Hermon 2015) are used for arranging the risk zones of tsunami.

2.2. Strategic Model of Tsunami Based in Coastal Ecotourism Development at Mandeh Regions

The strategic model formulation in coastal ecotourism development with systemic approach was done by using *A'WOT* (Kanges *et al*., 2001; Hermon, 2010[a]; Pelz, 2014; and Hermon 2014[d]). *A'WOT* is a mixture analysis between AHP (Analytic Hierarchy Process) and SWOT Analysis. This analysis was done after internal factor (IFE /Internal Factor Evaluation) and external factor (EFE/ External Factor Evaluation) were arranged in tsunami based of ecotourism development so that, quality and rate of each factors are determined. Each quality is given from the most important (1.0) until the least important (0.0). After the quality is determined then the rate is known by the effect. Rate has range of values from 1-5. Rating 1 means the least influence while 5 means the most influence one.

3. Result and Discussion

3.1. Spatial Model of Tsunami Risk in Mandeh Regions

Generally, Mandeh Regions are located in a risk zone of *high* and *medium* tsunami. The risk zones of *high* tsunami are included coastal region of Marak Island, west coastal region of Sironjong Kecil Island, north coastal region of Carocok Tarusan Bay, west, north and south coastal region of Cubadak Island, and west coastal region of Pagang Peninsula. Meanwhile, the risk zones of *medium* tsunami are included east coastal region of Sironjong Kecil Island, east coastal region of Cubadak Island and west Sironjong Gadang, Setan Kecil and Setan Gadang Island, Pagang Islands and south coastal region of Carocok Tarusan Bay.

A large earthquake (M 8.8) and tsunami are likely sometime in the coming decades in West Sumatra Province, though scientists cannot predict the exact day, month, or year when this may happen. The earthquake itself would damage or destroy many existing buildings and bridges; people can protect themselves by using earthquake-resistant construction techniques for new buildings and reinforcing existing buildings. The tsunami would reach the shores of the Mentawai Islands within 5-10 minutes and would reach the mainland West Sumatran coast, including Padang and Mandeh Regions, within 20-30 minutes of the earthquake. The earthquake is likely to cause power and mobile phone networks to stop working, so warning messages may not reach the public. The sea water may or may not recede before the tsunami arrives, and would recede only a few minutes before the tsunami. This means that people living near the coast should evacuate to high ground immediately after feeling an earthquake that is strong or lasts longer than one minute. In most areas, there is not enough time to wait for official warnings or to see receding water or the tsunami itself.

Figure 1. Zone of Tsunami Risk in Mandeh Regions

A combination of paleoseismic and geodetic evidence indicates that a great earthquake (MW ~8.8) and its tsunami are likely in the coming decades in the northern portion of the Mentawai patch of the Sunda megathrust. The potential source of this great earthquake underlies an area offshore of Mandeh Regions, around the Mentawai Islands of Siberut, Sipora, and North Pagai. Strong shaking would devastate settlements across the Mentawai Islands, Mandeh Regions, Padang, and surrounding areas near the West Sumatra coast; a tsunami, likely to be devastating in size, would reach the coastlines of the Mentawai Islands within 5-10 minutes and would reach Padang and neighboring areas of the West Sumatra coast within 20-30 minutes of the earthquake (Hermon, 2014[b]; EOS, 2015).

Recent local earthquakes and tsunamis have heightened local motivation for disaster risk reduction. The 2009 Padang earthquake caused extensive building damage and more than 1000 casualties. In the Mentawai Islands, nature has been a capricious teacher: the September 2007 MW 8.4 earthquake in the southern Mentawai patch generated strong shaking but a relatively small tsunami. When the October 2010 MW 7.8 earthquake generated much less shaking, it is not surprising that many people chose not to evacuate. Yet this earthquake produced a surprisingly large tsunami with maximum run-up heights of more than 16 m (Hill et al., submitted), ultimately killing 509 people and displacing some 11,425 (Mentawai Response). After one year, many survivors are still in temporary housing and struggling to re-establish their livelihoods far from their original villages (Ramsay, 2011). People throughout the Mentawai still feel this tragedy deeply: because the cultures of these isolated villages are different from one another, they feel that not only the people but also entire cultures were washed away. Their sense of shared responsibility for preventing future tragedy motivates disaster risk reduction: now is a critical time to support their efforts (EOS, 2015).

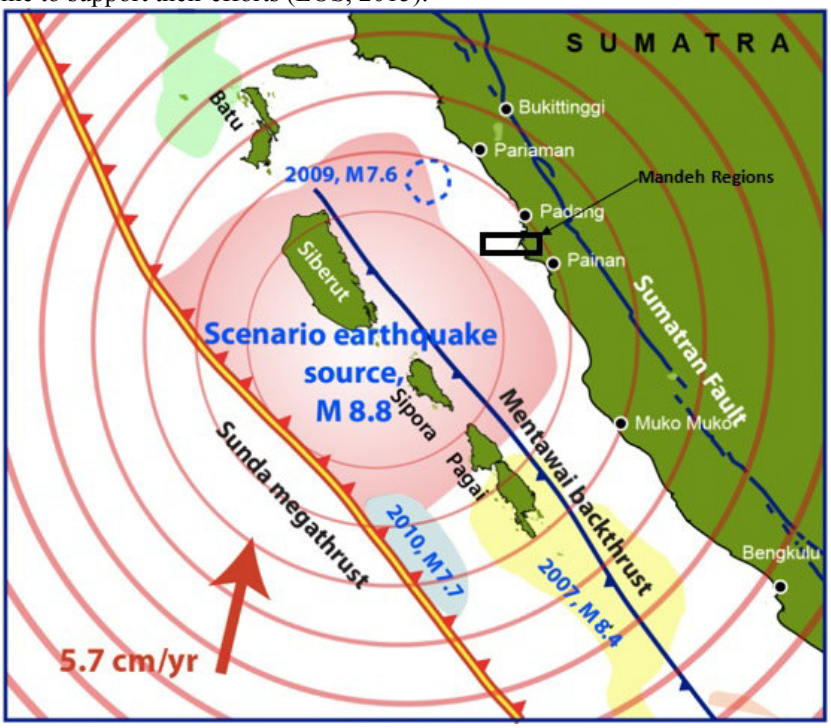

Figure 2. Earthquake Forecast on the Mentawai Patch of the Sunda Megathrust
(EOS, 2015)

Robert *et* al., (2010) explained that Laem Khruat, one of the rural villages in Krabi Province affected by the 2004 tsunami. The 2004 Indian Ocean tsunami devastated the Andaman Coast of Thailand. The surge killed over 8000 people and caused an estimated 32.7 million dollars in damages to fish farms. Rural villages on the coast, whose livelihoods rely on the fishing industry, suffered major economic setbacks. Many of these villages have turned to tourism to compensate for their lost income.

3.2. Strategic Model of Tsunami Based in Coastal Ecotourism Development at Mandeh Regions

The damage that is caused by tsunami in Mandeh Regions will be large, so that tsunami based is needed to develop ecotourism of this object in order to keep the sustainable of ecotourism and ecosystem. Analysis result of internal factor evaluation (IFE) and external factor evaluation (EFE) (Figure 2), showed that IFE gave a significant variation into each factor. In *strength* category, an interesting tourism object factor had IFE about 0,537, followed by an unique ecosystem (0,279), an interesting social culture (0,085), open minded society (0,055), and an unique melayu culture (0.043). Meanwhile, in *weakness* category, tsunami threat factor had IFE about 0,547, followed by less cultural attraction (0,279), complicated accessibility (0,091), and small amount of

facilities (0.082).

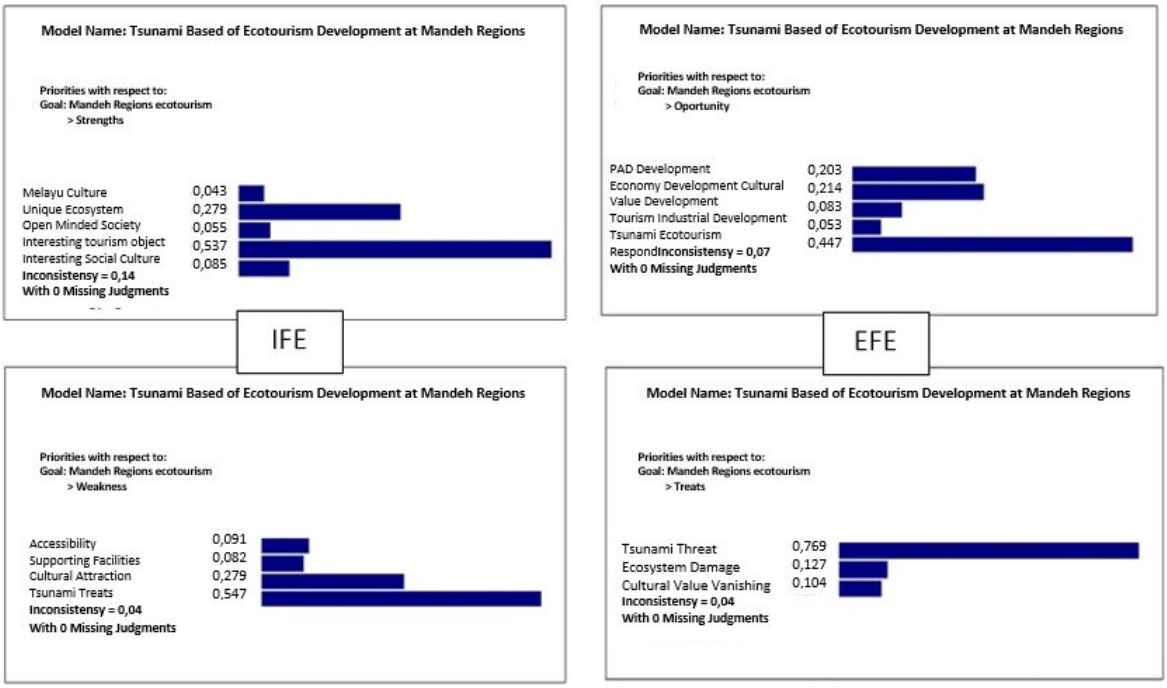

Figure 2. IFE and EFE Score of Tsunami Based of Ecotourism Development at Mandeh Regions

EFE score is varied for each factor where in *opportunity* category, tsunami ecotourism respond factor had the highest EFE score, that was 0.447, followed by a fast economy development (0.214), PAD development (0.023), cultural value development (0.083), and tourism industrial development (0.053). Besides that, in *threats* category, tsunami *threat* factor had the highest EFE score, which was about 0.796, followed by ecosystem damage (0.127), and cultural value vanishing (0.104).

Table 1. Total Score IFE and EFE for Tsunami Based Ecotourism Development at Mandeh Regions

Ecotourism Development Factors	Quality	Rating	Score
A. Internal Factors (IFE)			
1. Strengths			
a. Unique Ecosystem	0.279	5	1.395
b. Interesting Tourism Object	0.537	5	2.685
c. Open Minded Society	0.055	3	0.165
d. Interesting Social Cultute	0.085	4	0.340
e. An Unique Melayu Culture	0.043	4	0.172
2. Weakness			**4.757**
a. Accessibility	0.091	3	0.273
b. Supporting Facilities	0.082	4	0.328
c. Cultural Attractions	0.279	3	0.837
d. Tsunami Threat	0.547	3	1.641
			3.079
IFE Total Score			**1.678**
B. External Factors (EFE)			
1. Opportunity			
a. PAD Development	0.203	4	0.812
b. Economy Development	0.214	5	1.070
c. Cultural Value Development	0.083	4	0.332
d. Tourism Industrial Development	0.053	5	0.265
e. Tsunami Ecotourism Respond	0.447	4	1.788
			4.267
2. Threat			
a. Tsunami Threat	0.796	2	1.538
b. Ecosystem Damage	0.127	2	0.254
c. Cultural Value Vanishing	0.104	1	0.104
			1.896
EFE Total Score			**2.371**

Source: Analysis Result (2016)

Analysis result showed that IFE score and EFE score are positive and EFE score (2.371) is higher than IFE score (1.678), therefore Tsunami based is needed to develop ecotourism in Mandeh Pesisir Selatan District West Sumatera. It has a big potential to be developed and improved. The relationship of IFE score and EFE score can be seen in Figure 3.

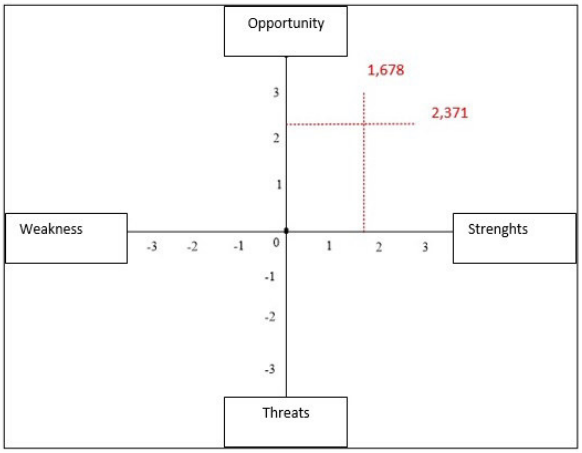

Figure 3. Tsunami Based Ecotourism Development of Mandeh Regions Quadrant

Having this tsunami based ecotourism development in Mandeh regions in Pesisir Selatan District West Sumatera succeeded, the efforts had been done optimally by applying an effective mitigation and adaptation patterns toward the tsunami threat. Gold (1980), Hidayati *et al*., (2003), Dirawan (2006), Hermon (2012[a]), dan Hermon (2014[d]) explained that the sustainable management of ecotourism has the same concept as well as a sustainable development therefore, a sustainable ecotourism supposed to has these categories: (a) ecologically sustainable, which means ecotourism development does not have a negative effect toward the local ecosystem. The conservation of Ecotourism object must be conducted maximally to protect natural resources and environment from the negative effect of ecotourism activity, (b) can be accepted socially and culturally, which refers to local society ability to use ecotourism without causing any social conflicts, (c) economically, the benefits received from ecotourism activity can improve the income of local society, and (4) considering the space, it also needed to discuss the effect of a disaster toward the sustainable of this ecotourism.

4. Conclusion

Mandeh regions has a big potential to be developed and improved into a coastal ecotourism object, because it has a good economic and social potential to improve the society's income. Ecotourism development of Mandeh coastal regions should consider the tsunami threat and coastal ecosystem damage. The dangerous threat of tsunami can be solved by applying an effective mitigation patterns to maximize adaptation process.

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