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How Can We Mitigate Coastal Hazards? Tarakan Island Case Study

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ABSTRACT

Intensity of coastal hazards driven by changes in climate and land use have been increasing in many parts of Indonesia, including Tarakan City, where 36% of the population lives near the coast. The purpose of this study is to determine the value of the WTP and identify the factors that affect the WTP of coastal communities in an effort to overcome the impact of beach abrasion in Tarakan City. The analytical methods used in calculating people's willingness to pay in an effort to overcome the impact of beach abrasion are the Willingness to Pay (WTP) method and multiple linear regression. The results of this study are known to mean that the public's willingness to pay is IDR 61,075. Based on the results of multiple regression analysis, the income variable has a significant effect on the WTP of coastal communities, namely income, age, and education variables, while the number of family members has no significant effect. Also, the coefficient of determination (R2) is 0.2718, or 27.18%, where this value indicates that the variables of income, age, education, and number of family members are able to explain the WTP of coastal communities of 27.18%. While the remaining 72.82% is explained by other variables not included in the regression model. Our findings highlight the value of the community's willingness to repair coastal hazards through the several scenarios offered. The results indicate an overview of local participation in preserving coastal areas.

INTRODUCTION

Climate change is a change in climate that is caused directly or indirectly by human activities, causing changes in the composition of the global atmosphere, and besides that, it is also in the form of changes in natural climate variability that are observed in comparable time periods (Law No. 32 of 2009). Climate change is a major disaster for mankind because the impact of climate change on human life is very detrimental (Kim et al., 2014). Among them are infrastructure damaged by disasters, outbreaks of disease, drought and lack of water sources, natural disasters, increasing food prices, increasingly unhealthy air, and others (McMichael et al., 2004; Luber, 2014; Patz et al., 2014).

The increasing population accompanied by increased human activities, especially in the fields of transportation and industry, will indirectly trigger an increase in temperature throughout the earth's surface, which is known as global warming (Rukaesih, 2004). Along with rapid growth, coastal areas have greater vulnerability, which automatically increases the potential risk of abrasion hazards on beaches or coastal areas (Samson et al., 2011; Rhein et al., 2013). This is also supported by the ineffectiveness of mitigation efforts by communities and governments (Bhat, 2000; ADPC, 2001; EPA, 2016). This can have a negative impact in the form of physical, social, economic, and environmental losses if it occurs. In this regard, efforts are needed to reduce the level of disaster risk (Arkhurst, Poku-Boansi, & Adarkwa, 2022).

Hallegatte (2015) stated that the average loss due to flooding in major world cities increased from $6 billion per city per year in 2005 to $52 billion per city per year in 2050, taking into account social and economic factors including population growth and property values. If the world's cities do not take steps to reduce the risk of

flooding and sea level rise, according to the World Bank, global losses due to sea level rise, submergence, and flooding will reach $1 trillion per year. Environmental conditions and vulnerable coastal natural resources have an impact on the socio-economic aspects of the population. The loss of agricultural land, plantations, and ponds results in a loss of livelihoods and reduced income. In an effort to overcome the impact of coastal abrasion, it is hoped that the public's willingness to pay will prevent a decrease in these environmental conditions. In deciding the amount of value that is willing to be paid, it is influenced by several factors of socio-economic characteristics, which will later be known which factors have the most influence on the willingness to pay the community.

The vulnerability of climate change that occurs in the Southeast Asian region is mapped with GIS by Yusuf and Fancisco (2010). The result is the occurrence of vulnerability to climate change in the study area, especially in areas with low regional income.

Dell et al. (2009) used panel data to analyse long-term climate change impacts. This study states that the impact of climate change will result in poor economic growth in poor countries. Methods The experimental choice method (CE) was used in a study conducted by Chaisemartin & Mahe (2009) to determine a person's awareness of paying for additional trees to be planted as an effort to reduce climate change.

RESEARCH METHOD

Metode Analisis

Valuation is basically giving monetary value to natural resources and the environment. Valuation techniques are needed because of the unavailability of prices for natural resources and the environment in the market (Fauzi, 2006). The technique used for economic valuation in this study is the contingency extent method.

The contingent valuation method (CVM) is a survey-based methodology for estimating how much a person or society values goods, services, and convenience. This method is widely used to estimate the value of something that is not traded in the market, while the revealed preference method cannot be used.

The model to be estimated is indicated by the following equation:

WTP = f (socio-economic, community resilience, management of coastal resources) where socio-economics, community resilience, and management of coastal resources are the vector variables in the model. When there are numbers indicating zero observations, OLS regression can produce parameter estimates that are biassed and inconsistent. In addition, the OLS model can predict WTP lower than zero.

RESULTS AND DISCUSSION

Characteristics of respondents

Respondents in this study were coastal communities living in Pantai Amal Village, Juata Laut Village, Karang Anyar Pantai Village, and Selumit Pantai Village. The characteristics of the respondents are very important in this study because, by knowing their characteristics, they will know the object of research better. The number of respondents in this study who became objects was 100. There are certain criteria for describing the characteristics of respondents, namely as follows:

Table 1. Demographics and characteristics of respondents (n=30)

Characteristics	Majority	Percentage
Gender	Man	71
	Woman	29
Age	<35	52
	36 – 55	45
	>55	3
Education	SD	13
	SMP	23
	SMA	49
	S1	15
Income of Family Members	2 – 4	43
	5 – 7	52
	>7	5
Income	<IDR 1.000.000	43
	IDR 1.100.000 – IDR 3.000.000	52
	>IDR 3.100.000	5

Offered Willingness to Pay (WTP) Value

Based on the results of previous surveys, it is known that various efforts have been made by the government and the Environmental Service (DLH) to prevent damage to coastal areas due to abrasion. The effort referred to by the researcher has been listed as a type of option or as a respondent's choice based on their ability to pay.The amount of money that respondents are willing to pay to deal with the impacts of beach abrasion in Tarakan City varies widely, ranging from Rp. 0 to Rp. 250,000 per year, depending on the type of option or type of prevention effort chosen. The WTP value for overcoming the impact of coastal abrasion that was most chosen by the respondents was the WTP value of IDR 0 per year with the Status Quo option of 33%, while the other WTP values chosen by the respondents varied greatly. Respondents who are willing to pay around IDR 40,000–IDR 60,000 per year with the type of vegetation option of 29%, around IDR 40,000–IDR 60,000 per year with the type of mangrove maintenance option of 15%, around IDR 180,000–IDR 250,000 per year with the type of vegetation option, building design, and breakwaters by 13%, around Rp. 100,000–Rp. 135,000 per year with the type of vegetation and mangrove maintenance type of option by 5%, around Rp. 75,000–Rp. 100,000 per year with the type of breakwater option by 4%, and around Rp. 100,000–IDR 135,000 per year with the type of 1% of the total 100 respondents.

Table 2. Distribution of Respondents Based on WTP Value

Option Type	Option Value (WTP) in Rupiah	Percentage
Status quo	0	33
Vegetation	40.000 – 60.000	29
Maintenance of mangroves	40.000 – 60.000	15
Breakwater	75.000 – 100.000	4
Vegetation and maintenance of mangroves	100.000 – 135.000	5
Vegetation and breakwaters	100.000 – 135.000	0
Maintenance of mangroves and breakwaters	150.000 – 200.000	1
Vegetation, building design and breakwaters	180.000 – 250.000	13

Source: Primary Data, 2022

Willingness To Pay (WTP) Average Value

Based on the results of research conducted on 100 respondents, it is known that the average maximum willingness to pay for coastal communities is IDR 61,075 per year. This value is obtained from the number of PAPs divided by the number of existing respondents. So, if the government implements a prevention plan in an effort to overcome the effects of coastal abrasion, then the average price people are willing to pay is Rp. 61,075.

Table 3. Average Maximum Value of PAPs for Coastal Communities in the City Tarakan

WTP Value in Rupiah	Frequency	WTP Total
0	33	Rp0
50.000	44	Rp2.200.000
87.500	4	Rp350.000
117.500	5	Rp587.500
175.000	1	Rp175.000
215.000	13	Rp2.795.000
	100	Rp6.107.500

Source: Primary Data, 2022

Table 4. Efforts to Prevent Damage Due to Coastal Abrasion Impacts

Upaya Pencegahan	Biaya (Rp)
Vegetasi	50.000
Pemeliharaan Mangrove	50.000
Pemecah Gelombang	85.500

Source: Primary Data, 2022

The survey results show that the cost of prevention by means of Vegetation and Mangrove Maintenance is Rp. 50,000 less than the average value of the community's maximum willingness to pay (Average of Maximum Willingnes To Pay) in an effort to prevent the impact of coastal abrasion of IDR 61,075. These results indicate that the public's awareness and willingness to pay for efforts to prevent the effects of coastal abrasion in Tarakan City is quite high. As for the prevention efforts by means of a breakwater of Rp. 85,500 which is greater than the average

value of the community's maximum willingness to pay (Average of Maximum Willingnes To Pay) in an effort to prevent the impact of coastal abrasion of IDR 61,075. This shows that the public's awareness and willingness to pay for efforts to prevent the effects of coastal abrasion in Tarakan City is quite low. In addition, with a low average value of the maximum willingness to pay, this will involve the allocation of government funds to realize efforts to prevent coastal erosion (Cass, Shao, & Smiley, 2022). Communities are not only victims but also actors in coastal damage. The role of the community is very important in efforts to prevent the effects of abrasion and damage to the coast (Yulianti, Zulfan, Zalmita, Irawan, & Diah, 2022; Awuni, Adarkwah, Ofori, Purwestri, Huertas Bernal, & Hajek, 2023).

Multiple Regression Analysis

The results of the analysis are shown in the following table.

Table 5. Regression Analysis Result

Variable	Coefficient	Prob.	Information
Income	0,379	0,06	Significant
Age	0,598	0,02	Significant
Pendidikan	0,900	0,00	Significant
Number of family members	-0,208	0,32	Not significant

Source: Primary Data, 2022

The results of the regression analysis showed that only the number of family members had a significant effect. While other variables have a significant effect. F_{hitung} value of 8.864739 The significance level is 10% or 0.1; to determine the real level and the F_{table} value, it is necessary to determine the df quantifier, namely k-1 = 4-1 = 3, while the denominator df is n-k = 100-4 = 96, then the F_{table} value is 2.141. From the results of the calculation above, it is known that the F_{hitung} value is 8.864739 > F_{table} 2.141 and the F_{hitung} probability value is 0.000004 0.1. So that H_0 is rejected and H_a is accepted, meaning that income, age, education, and number of family members simultaneously have a significant effect on willingness to pay (WTP).

It is known that the coefficient of determination R^2 obtained is 0.271802, or 27.18%. This shows that the variables of income, age, education, and number of family members can explain the Willingness to Pay (WTP) variable of 27.18%. While the remaining 72.82% is explained by other variables not included in the regression model. A regression line is good if R^2 is high, and vice versa if the value of R^2 is low, then the regression line is not good. Even though the R^2 value obtained from the analysis results is low, it does not mean that the research results are not good. However, we must understand that a low R^2 occurs for several reasons. In special cases, the independent variable (X) may not be a variable that well explains the dependent variable (Y). This is because there are large differences between the variables studied in the same time period (Widarjono, 2017).

The coastal area in Tarakan City is one of the beaches that is prone to abrasion. The abrasion was quite severe and hit residents' settlements around the coast and had an impact on the narrowing of coastal land, loss of residential land, changes in the socio-economic aspects of the population, and others (Utami, Wibowo, Hadi, & Permadi, 2021) . Various efforts to prevent damage to coastal areas due to abrasion have been carried out by the government and local environmental services. Such as planting mangrove forests or coastal plants that are able to withstand waves, or so-called vegetation; maintenance of mangrove forests; and also building structures or buildings to break waves (Takyi, El Mahrad, Nunoo, Adade, ElHadary, & Essandoh, 2022).

CONCLUSION

The results of the WTP analysis show that the average value of the community's maximum willingness to pay (average of maximum willingness to pay) in an effort to overcome the impact of beach abrasion in Tarakan City is IDR 61,075. This value represents the amount they are willing to spend in efforts to improve the quality of the coastal environment. Their preferences and the amount that they are willing to pay differ by income and the improved ecosystem service affected by the proposed intervention (Ureta, Motallebi, Vassalos, Seagle, & Baldwin, 107561). This shows that the public's awareness and willingness to pay for efforts to prevent the effects of coastal abrasion in Tarakan City is quite low. In addition, with a low average value of the maximum willingness to pay, this will involve the allocation of government funds to realize efforts to prevent coastal erosion (Cass, Shao, & Smiley, 2022).

Based on the results of multiple linear regression, the variables income, age, and education, with a significance level of 10%, partially have a significant effect on the willingness to pay (WTP) of coastal communities

in an effort to overcome the effects of beach abrasion. While the variable number of family members partially does not have a significant effect on the willingness to pay (WTP) of coastal communities in an effort to overcome the impact of beach abrasion in Tarakan City, In addition, it is known that the F_{hitung} value is 8.864739 > F_{tabel} 2.141 and the F_{hitung} probability value is 0.000004 0.1, so it can be concluded that the variables of income, age, education, and number of family members simultaneously influence the willingness to pay (WTP) of the community in an effort to overcome the impact of beach abrasion in Tarakan City.

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