Determining factors for the utilization of mangrove forest in Bontang, East Kalimantan

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Abstract. The area of mangrove forests in Bontang City may decrease over time. While mangrove forest and its ecosystem have great potential to prevent coastal abrasion, absorb and store carbon, which threatens climate change, and sources of income of the coastal communities. This research aims to analyzes determining factors to use mangrove forests and to know the behavior of the community towards preserving mangrove forests. Using primary data from 186 respondents, this study utilized logistic regression analysis method. The results show that majority of Bontang City residents are aware about the existence of protected mangrove forests. Determining factors that influence the Bontang city's people utilizing the mangrove forests are kind of job, knowledge and distance from mangrove forest areas.

Keywords: Mangrove, forest, Bontang, logistic model.

1 Introduction

Indonesia as an archipelago with vast seas is one of the countries with the largest mangrove forests in the world. Based on the National Mangrove Map officially released by the Ministry of Environment and Forestry in 2021, it is known that the total area of Indonesian mangroves is 3,364,076 Ha. One of the cities in Indonesia that has a mangrove ecosystem area is Bontang City. Bontang as one of the coastal areas has an area covered with mangrove forests scattered on its coastline. Some types of mangroves found in the marine waters of Bontang City are Rhizophora sp, Bruguiera sp, Avicennia sp, Sonneratia sp, and Ceriop sp [1].

Bontang City with its geographical location on the axis of the Trans Kalimantan road that connects Samarinda and East Kutai is quite profitable and makes it a considerable potential to support regional development. Bontang City also manages most of the potential natural resources in the form of oil and gas and non-oil and gas. This potential is very influential for the economic development of Bontang City in the long term and at the same time becomes the

strength of Bontang City itself to develop the regional economy. The potential that supports the economic activities of Bontang City includes the oil and gas raw material industry, such as the fertilizer and gas industry which is also the economic base and leading sector. Another potential of Bontang City lies in its vast marine waters of 349.77km2 (70.3%), with a coastline of 24.4km. This water area is not only rich in marine biota, but has a strategic position because it is directly facing the Makassar Strait which is the Indonesian Archipelago Sea Route II (ALKI II) and international shipping lanes [2].

Mangrove forests in the world reach an area of about 16,530,000 ha spread over Asia 7,441,000 ha, Africa 3,258,000 ha and America 5,831,000 ha, while in Indonesia it is reported to be 3,735,250 ha and is one of the countries that have the largest mangrove forests in the world. Indonesia's mangrove forests cover almost 50% of Asia's mangrove area and almost 25% of the world's mangrove forests [3]. Indonesia is a maritime country where ⅔ of its territory is ocean. This condition makes Indonesia have the largest mangrove forest in the world with an area of 3.36 million hectares. This area is 20 percent of the total area of all mangrove forests in the world.

Fig.1. Map of Bontang mangrove forest [4].

Global warming due to increased carbon dioxide (CO_2) in the atmosphere is one of the most common ecological problems faced by all countries. Forests play an important role in reducing atmospheric CO_2 through the process of photosynthesis. The amount of carbon in a tree can indicate its ability to absorb CO_2 from the atmosphere [5]. According to [6], some of the carbon will be converted into energy for photosynthesis, while the rest will enter the plant structure and be stored in stems, roots, twigs, and leaves. Mangrove forests can store three to four times more carbon per hectare than other tropical forests worldwide [7]. Indonesia has the largest mangrove forest in the world, which plays an important role in mitigating the effects of global warming [8]. Indonesia's climate mitigation potential from mangroves is 12.4 million t CO2 -e/yr (about 2.1% of annual emissions). Indonesia has the largest mangrove resource, which means it also has the largest potential for blue carbon conservation [9].

Mangroves play an important role in preventing coastal abrasion. They also produce fisheries and forestry commodities, filter waste naturally, serve as habitats and spawning grounds for several species of animals, and prevent seawater intrusion. Another important point is that mangrove ecosystems have great potential to absorb and store carbon, which threatens climate change. Thus, protecting mangrove ecosystems means preventing natural disasters that can be

caused by climate change. However, mangrove ecosystems are being depleted three to five times faster than typical forest loss. This can have serious ecological and socioeconomic impacts. Current estimates suggest that mangrove cover has halved in the last 40 years.

Geographically, East Kalimantan has five regencies/cities with 43 sub-districts that are in direct contact with the coast. It covers an area of 35,101.336 square kilometers. With a coastline of 3,592 kilometers, East Kalimantan is a strategic area because it is located in the waters of the Makassar Strait and Sulawesi Sea. It contains natural resources, one of which is mangrove forests [2]. The East Kalimantan Environmental Agency (DLH) noted that based on the analysis of Landsat 8 imagery in 2017-2018, Geospatial Information Agency (BIG) 2016, and field surveys in 2013-2018, East Kalimantan has 27 types of mangroves covering approximately 220,337 hectares or 6 percent of the total mangroves in Indonesia. Spread across seven districts/cities [1].

DLH Kaltim analyzed that the damage to mangrove forests in East Kalimantan particularly Bontang City, could occur due to excessive collection of wood for firewood, mud sedimentation, which shifted mangrove development towards the sea. So that the mangrove ecosystem that grows will be on top of unstable silt. This has led to the loss of mangrove rows as they are swept away by strong ocean currents and waves, which has contributed to the decline in the production of various marine fish species and ultimately resulted in a decline in the welfare of fishing communities.

The Bontang City area has the largest mangrove forest area along the coast and tidal areas. Bontang City is one of the cities in Indonesia that has a mangrove ecosystem area. Bontang as a coastal area has an area covered with mangrove forests spread across its coastline.

The area of mangrove forests in Bontang City may decrease over time. Whether it is converted into a residential area or for other commercial purposes. In fact, if the mangrove forest area is lost it will have an impact on reducing the potential of biological resources and economic resources for the people living around the mangrove forest.

Bontang Mangrove Park (BMP) is an effort to preserve mangrove forests in Bontang City. This area has enormous ecological and economic potential. The sprawling mangrove forest area prevents erosion that continues to threaten. Meanwhile, many people around BMP rely on tourism activities at this location as their livelihood. They are the ones who threaten the erosion of the bangrove forests in Bontang. For this reason, research is needed that analyzes what causes people to use mangrove forests. The behavior of the community towards preserving mangrove forests also needs to be studied.

2 Literatures

Benefits of mangrove forests

The word mangrove comes from the word mangal which means plant community. Mangrove forests are coastal forests where the water rises at high tide and falls at low tide. Mangroves are found in tropical and subtropical coastal areas around the world. So far, mangrove forests have been found in 102 countries, but only 10 countries have more than 5,000 square kilometers of mangroves [10].

Mangrove forests have many important functions for the environment and society. Here are some of the functions of mangrove forests [10]:

1. Protecting coastlines - Mangrove forests act as a natural barrier against storms and floods, protecting coastlines from erosion and helping to reduce the impact of natural disasters.

2. Habitat for plants and animals - Mangrove forests provide habitat for a wide variety of plants and animals, including fish, birds and crustaceans. Mangrove forests are also important sites for animal migration and reproduction.

3. Carbon storage - Mangrove forests absorb and store a lot of carbon dioxide from the atmosphere, so they play an important role in global carbon storage.

4. Food and fuel source - Mangrove forests are a source of food and fuel for local communities, including fish, shellfish and firewood.

5. Absorbs pollutants - Mangrove forests can also absorb pollutants from seawater, such as heavy metals and other chemicals, helping to maintain seawater quality.

6. Economic income - Mangrove forests can also generate economic income for local communities, such as through tourism, fishing and timber utilization.

Mangrove forests grow on brackish water swamps located on the shoreline and influenced by the tides, precisely in the coastal areas and around river mouths [11]. According to [12] the following are some of the benefits of mangrove forests in general, namely:

1. Prevents coastal erosion

Mangrove forests are one of the places that can maintain the border between land and sea areas. Coastal erosion will continue to erode the earth's surface, threatening the human environment. Mangroves are one of the most important means of saving the coastline from ocean waters.

2. Catalyzes soil and seawater

Soil can enter seawater continuously, because that part of the soil is in direct contact with seawater. To prevent this, the ecological benefits of mangroves are an obvious source of protecting the land around the sea.

3. Fishery Habitat

Several species such as shrimp, fish and crabs breed in mangrove forests. Meanwhile, humans need some of these living things as a source of nutrients and food ingredients that are important for health.

4. Provides broad economic impact

Mangrove trees that are widely planted in mangrove forests can be harvested like other types of plants. The benefits of mangrove debt for humans are useful to be processed into various decorative objects or crafts. This effort is very important to improve the community's economy and improve economic standards in the area.

5. Livestock Feed Sources

Mangrove trees can also be used as an alternative to animal feed. Mangrove trees that have been crushed and ground into animal feed powder containing nutrients are very good for the growth of livestock such as cows, goats or poultry.

6.   Prevent global warming

Mangrove plants are one of the supports for the warming of sea waters. In addition, mangroves also play a role in overcoming flooding problems in coastal areas.

7.   Income for coastal fishers

The benefits of mangrove forest areas are the most suitable place for breeding fish, shrimp and various other potential marine habitats that can be utilized by fishermen as a source of livelihood.

8.   Maintaining Water and Air Quality

Mangrove forest areas have a function to absorb all the dirt that comes from human waste and ships sailing in the sea. The benefits of mangrove forests for life are that they will absorb all kinds of harmful metals and make water quality cleaner. In addition, mangroves also help nature in getting better and cleaner air quality.

9.   Tourism Area Development

The mangrove forest area can be developed into a tourist attraction. In this way, the mangrove forest will become a tourist destination from various regions and foreign countries. Tourism will have a very good economic impact on the surrounding community and the country in particular.

10.   Providing a source of firewood

Mangrove forests are very useful for people who live in the area around mangrove forests. Mangrove trees and wood that have dried and rotted can be used as firewood.

11.   Science Development

Mangrove forests are one of the places to develop various types of science in the fields of marine, fisheries and chemistry. Many researchers need mangrove forests and are used as various sources of research. Mangrove forests will increase various types of discoveries that can be spread throughout the world.

12.   Maintaining Climate and Weather

Mangrove forests are a source for maintaining aquatic ecosystems between sea, coast and land and help humans in getting the most comfortable climate and weather to prevent natural disasters.

Economic motives in mangrove forest utilization

The social benefits of mangrove ecosystems are that they can be used as settlements and other human benefit designations. Ujung Kulon Conservation Society [13] mentions several economic functions of mangrove forests, including as a source of livelihood, production of various forest products (wood, charcoal, medicine and food), source of building materials and handicrafts, natural attractions, educational and research objects, aquaculture areas, salt making and plantation areas. The bark of the tree is used for preservatives and medicines. Various drugs

can be produced from mangrove plants, such as drugs for itching or inflammation of the skin, snake bite antidotes, rheumatism, digestive disorders and others.

Mangroves are not just a deterrent to abrasion, but can be utilized for a variety of foods. [14] explained that the existence of mangrove forests is also important for agriculture along the coast, especially as a protector from wind, tides, and storms. Honey bee cultivation can also be developed in mangrove forests.

In addition to agriculture, mangrove forests can also be used as nature tourism areas. In addition to providing direct income for the manager through the sale of entrance tickets and parking, this tourism activity is also able to grow the economy of the surrounding population by providing employment and business opportunities, such as opening food stalls, renting boats, and becoming tour guides.

In line with the increasing population that demands the availability of resources that support the economic activities of the community, the pressure on forests and mangrove forest areas is also increasing. Based on this fact, conservation and rehabilitation are crucial in maintaining the role of mangroves for natural sustainability [15].

Factors affecting forest resource utilization

Mangrove ecosystems have high economic and ecological value, but are very vulnerable to damage if they are not wise in maintaining, preserving and managing them. Human activities, natural resource utilization patterns and development patterns are blamed as important causal factors that cause damage to mangrove forest ecosystems. The main problems that often cause the degradation of mangrove areas are the construction of illegal ponds, the development of tourism areas that are not environmentally friendly, land use change into plantations, then the development of residential areas on the coastal green line (mangrove zone). All human activities in relation to the use of mangrove areas on a large scale are closely related to the high population and low economic levels of local communities [16].

According to data from the Ministry of Marine Affairs and Fisheries (KKP), the Bontang Mangrove Park (BMP) Ecosystem is part of the mangrove area of the Kutai National Park located in Bontang City covering an area of approximately 200 hectares. Giving the name BMP emphasizes the meaning that the mangrove forest area in question is in the Bontang City area, indicating that the development of this area is intended for the community and the Bontang City government and not just the property of BTNK, developed for the benefit of recreation, conservation, education and adventure. This is because excessive visitation will reduce the quality of the ecotourism area itself [17].

3 Method

This reserach uses primary data from interview. The population of the city of Bontang in 2022 is 185,928 people. With various limitations of time and funds, the total sample used was 186 respondents in Bontang City. This number represents the existing population using the Slovin formula. The Slovin formula is a formula used to find the minimum number of samples from a limited population or also called a finite population survey. This formula is included in a simple random sampling because each individual has the same opportunity to be sampled.

A socio-economic and environmental survey was carried out to find out the characteristics and behavior of the people around the Bontang mangrove forest area. The total number of respondents taken was 186 respondents taken from three sub-districts (see **Table 1** below).

Table 1. Number of Respondents per District in Bontang City

Subdistrict	Number of Respondents
Bontang Utara (north)	59
Bontang Selatan (south)	85
Bontang Barat (west)	40
Total	186

This research uses the logistic regression analysis method. Logistic regression is a type of non-linear regression model specifically for the classification of categorical variables [18]. Meanwhile, according to [19] logistic regression is a process in modeling the probability of discrete outcomes given the dependent variable. Logistic regression models are the most common of the binary models, something that can take two values true/false, yes/no, and so on. The results of the logistic regression analysis have a value between zero and one, with the following equation model [20]:

$$P_i = \frac{\exp(\beta_0 + \beta' x)}{1 + \exp(\beta_0 + \beta' x)} \tag{1}$$

According to [21] the logit method is very appropriate to use in classifying data. In obtaining the logit regression equation, it is necessary to derive the estimated categorical probability equation.

$$Ln = \frac{P}{1-P} = \beta_0 + \beta_1 X \tag{2}$$

The equation below is a simplification of the equation above.

$$Ln = \frac{P}{1-P} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n X_n \tag{3}$$

Then the mathematical model used for this research is as follows:

Utilization of mangrove forest $(p) = \beta_0 + \beta_1 Age + \beta_2 Job + \beta_3 Figure + \beta_4 Income + \beta_5 MangInc + \beta_6 Gender + \beta_7 Habit + \beta_8 Knowledge + \beta_9 Expenditure - \beta_{10} Distance$ (4)

Where:

Utilization	=	Utilization of mangrove forest: Have you ever used mangrove forest products in Bontang? (dummy: 1= Yes, 0= no)
Age	=	Age (years)
Job	=	Kind of jobs (1: civil servant; 2: private; 3: farmer; 4: fisherman)
Figure	=	Influential people (public figure) in Bontang City (dummy; 1=Yes, 0=No)
Income	=	Household income (1: Rp 0- 1million; 2: Rp 1– 2 million; 3: Rp 2– 3 million; 4: > Rp 3 million)
MangInc	=	Income obtained from selling mangrove wood (Rp)
Gender	=	Dummy (1=male; 2=female)
Habit	=	Habits of family or local people (dummy; 1=Yes, 0=No)

Knowledge = Knowledge of specific areas planted with mangroves (dummy; 1=Yes, 0=No)
Expenditure= Household expenditure per month
Distance   = Distance from people's homes to mangrove forests (meters)

There are several stages of analysis and tests required to obtain estimation results.

1. Multinominal test. The multicollinearity test is used to determine whether there is a relationship between each independent variable or not. The occurrence of multicollinearity causes the regression method to be less precise because there is instability in the p-value and the variables in the regression coefficient are very large [22]. To detect multicollinearity, it can be seen from the correlation between independent variables with a value of more than 0.8.

2. Goodness of Fit test. In carrying out the goodness of fit test using the Hosmer Lemeshow Test method. According to [23] states that the principles used in the Hosmer Lemeshow Test function to test the accuracy of a model against the data you want to study. A model that is said to be correct can be seen from the chi-square value which is greater than alpha.

3. Z-statistics test. The Z-statistic test is a test carried out on an econometric model. The Z-statistical test is used on large sample sizes, namely more than 30 [24]. This test functions to determine whether all the independent variables used have a significant effect on the dependent variable.

4 Result and Discussion

4.1 Respondent characteristics

Based on the results of a social, economic and environmental survey, 88 percent of respondents stated that they knew about the existence of protected mangrove forests. The public knows that mangrove forests are a tourist attraction in Bontang City and have been one of the objects whose existence has been protected in government regulations since 2012. Meanwhile, 12 percent of respondents stated that they did not know about the existence of protected mangrove forests. Those who stated that they did not know about the existence of mangrove forests were due to the relatively long access to mangrove forests.

Of the total respondents from Bontang City, 20 percent of people have used mangrove forest products. Utilization of forest products is obtained by people who are close to or earn their livelihood in mangrove forest areas. Meanwhile, the people of Bontang City who have never used mangrove forest products directly are 80 percent of the number of respondents.

Furthermore, the people of Bontang City who utilize mangrove forest products are dominated by fish. This can be seen based on the results of a survey conducted with a fish yield of 54 percent. The dominance of fish products used by the people of Bontang City is based on the mangrove forests that grow on the coast. The types of fish obtained include snapper, bawis, grouper, ketamba, and others. Apart from the fish obtained, crabs and shrimp are the products most widely used by the people of Bontang City.

The people of Bontang City are quite concerned about the diversity of protected mangrove forests. Based on the survey results obtained, 96 percent of respondents stated that they were

willing to help preserve mangrove forest areas. The people of Bontang City are of the view that if the mangrove forest area is preserved, the mangrove forest will also have a positive impact on the community, such as coastal erosion, storing or absorbing air pollution, improving economic welfare, and so on.

Meanwhile, 4 percent of the people who were respondents stated that they were not willing to help preserve mangrove forest areas. The people of Bontang City who are unwilling to help preserve the mangrove forest area are of the view that this is an obligation or duty of the local government because the people have already paid their obligations in the form of taxes.

In general, the people of Bontang City are quite obedient to the policies made by companies located in mangrove forest areas. Based on the survey results, around 68 percent of the total respondents followed or complied with regulations regarding prohibitions made by the company. The compliance of the people of Bontang City is based on the view that if the forest is managed by the company, the mangrove forest will be more sustainable and well maintained. Meanwhile, 32 percent of the total respondents stated that they did not follow company regulations because people still depend on or earn their livelihood in mangrove forest areas. If people are prohibited from utilizing mangrove forest products, then people will have no other alternative employment, so they have the potential to lose their jobs and not be able to support their families.

4.2 Determining factors to use mongrove forest

Before carrying out logistic regression analysis, several stages are required to prove that the variables used in the research are suitable for analysis. The initial test that needs to be carried out is the classical assumption test. In this research, the classical assumption test required is the multicollinearity test. The purpose of the multicollinearity test is to ensure there is no correlation between the independent variables. If there is multicollinearity, then the significance results from the regression carried out are not appropriate. If the correlation value is greater than 0.8, it means that the model is not free from multicollinearity. In this study, the correlation value was smaller than 0.8. This proves that this research escaped multicollinearity.

Next, the test carried out is the Statistical Z Test. The value of the Z test can be seen from the results of the logistic regression estimation. The Z test functions to determine the significance of the independent variable on the dependent variable. The independent variable can be declared significant if the Z test value is smaller than alpha. Based on Table 2, the variables of job, knowledge and distance have significant effects on the utilization of mangrove forest.

Variable of job has a positive influence and significant on the use of mangrove forests. Individuals who work as fishermen have an 89.10% higher probability of utilizing mangrove forest products, assuming cateris paribus. This is in line with research by [10] which states that mangrove forests can generate economic income for local communities, such as fishing.

The knowledge variable related to the location where the mangrove forest is located has a positive and significant influence on the use of mangrove forests. This means that individuals who know about areas planted with mangrove forests will have a 27.54% higher chance of utilizing mangrove forests than individuals who do not know where mangrove forests are located, assuming cateris paribus. These results are in line with research by [25] which states that the knowledge variable has a positive and significant effect on household choices in using

clean energy. People who understand what can be used from mangrove forest products will tend to use mangrove forests more.

Table 2. Logistic regression result

Utilization of mangrove forest	Coef.	St.Err.	t-value	p-value
Age	-0.004	0.022	-0.19	0.847
Job	0.891	0.321	2.78	0.005**
Figure	0.24	0.472	0.51	0.612
Income	0.09	0.206	0.44	0.661
MangInc	0.000	0.000	-0.03	0.979
Gender	-0.112	0.539	-0.21	0.835
Habit	-0.219	0.55	-0.40	0.691
Knowledge	0.691	0.519	1.33	0.183*
Expenditure	0.0001	0.000	-0.75	0.455
Distance	-0.0001	0.000	-2.23	0.025**
Constant	-2.431	1.435	-1.69	0.09**
Mean dependent var				0.199
Pseudo r-squared				0.127
Chi-square				13.166
Akaike crit. (AIC)				184.074
SD dependent var				0.400
Number of obs				186
Prob > chi2				0.215
Bayesian crit. (BIC)				219.557

*Significant at the 20% level; **Significant at the 10% level

The variable distance traveled from people's homes to the mangrove forest has a negative and significant effect on the use of mangrove forest products. Based on the estimation results, the probability of an individual using the mangrove forest increases by 10.01% with the cateris paribus assumption, when the distance from the house to the mangrove forest decreases by one meter.

4 Conclusion

Based on the results of a social, economic and environmental survey, majority of Bontang City residents are aware about the existence of protected mangrove forests. Although the people of Bontang City knew the existing of forest mangrove, most of them have never used mangrove forest products directly. About 20 percent of people who have used mangrove forest products are have the potential to destroy these forests.

Factors that influence the Bontang city's people utilizing the mangrove forests are kind of job, knowledge and distance. They have significant effects on the utilization of mangrove forest. Individuals who work as fishermen have a higher probability of utilizing mangrove forest products. The knowledge of the mangrove forest location has a positive and significant influence on the use of mangrove forests. The more they know the location of mangrove forest, the more they utilize the mangrove products. Moreover, the probability of an individual using the mangrove forest increases when the distance from the house to the mangrove forest decreases by one meter.

The impact of the results of this research for the government and society. For the government, the results of this study can be a reference for development and conservation of its region, especially on the coast. Meanwhile, for the community, the results of this study are to encourage them to continue conserving mangrove forests.

References

[1] Iqbal M. Bontang Mangrove Park: Peran penting keberadaannya bagi lingkungan dan masyarakat. Jakarta(ID): lindungihutan.com; 2022.

[2] Pemerintah Kota Bontang. Analisis strategis masterplan smart city rencana pembangunan Kota Bontang 2020-2029. Bontang(ID): Pemerintah Kota Bontang Books; 2019.

[3] Onrizal. Perubahan tutupan hutan mangrove di Pantai Timur Sumatera Utara periode 1977-2006. Jurnal Biologi Indonesia. 2010; 6(2).

[4] Fadillah K. Sela RS Tutupan Lahan (1709085005). Bontang; 2020.

[5] Utomo S D, Hidayat K F, Edy A, Sa'diyah N, Indrayani R, Halimatusrosidah E, Yustina H. Hibridisasi buatan kacang tanah dan fenotipe karakter tipe pertumbuhan, ukuran polong, dan jumlah biji per polong tanaman F1 hasil hibridisasi. Jurnal Agrotropika. 2021; 20(1): 49-57.

[6] Nuraini R A T, Pringgenies D, Suryono C A, Adhari V H. Stok karbon pada tegakan vegetasi mangrove di Pulau Karimunjawa. Buletin Oseanografi Marina. 2021; 10(2): 180-188.

[7] Donato C D, Kauffman J, Murdiyarso B, Kurnianto S, Stidham M, Kanninen M. Mangroves among the most carbon-rich forests in the tropics. Nature Geoscience. 2011; 4: 293 – 297.

[8] Murdiyarso D, Purbopuspito J, Kauffman J B, Warren M, Sasmito S, Donato D, Kurnianto S. The potential of Indonesian mangrove forests for global climate change mitigation. Nature Climate Change. 2015; 5.

[9] YKAN. Laporan tahunan YKAN fiskal 2021. Jakarta(ID): Annual Report; 2021.

[10] Sari A M. Hutan mangrove: Pengertian, fungsi, ciri-ciri dan manfaatnya. Medan(ID): Faperta Umsu; 2023.

[11] Wahyuningsih D. Menjaga kelestarian lingkungan dengan melestarikan hutan mangrove. Jakarta (ID): Kementrian Keuangan Republik Indonesia; 2021.

[12] Ana C. 12 Manfaat hutan mangrove bagi kehidupan manusia. Jakarta (ID): Kementerian Kelautan dan Perikanan; 2015.

[13] Ujung Kulon Conservation Society. Manfaat penanaman mangrove. ID: Ucsindonesia.Org; 2010.

[14] Anwar C, Gunawan H. Peranan ekologis dan sosial ekonomis hutan mangrove dalam mendukung pembangunan wilayah Pesisir Padang. In: Hendra. Prosiding hasil-hasil penelitian Hasil-hasil Penelitian: Konservasi dan Rehabilitasi Sumberdaya Hutan; 2007. numbers 25-28.

[15] Duryat R. Rehabilitasi mangrove untuk kesehatan lingkungan dan kesejahteraan masyarakat. Jurnal Pengabdian Fakultas Pertanian Universitas Lampung. 2023; 02(02): 133 – 145.

[16] Supriharyono. Konservasi ekosistem sumberdaya hayati di wilayah pesisir dan laut tropis. Jakarta(ID): PT. Gramedia Pustaka Utama Books; 2006.

[17] Haryanti S, Manurung A L, Rustam R, Boer C, Suba R B. Daya dukung ekowisata Bontang Mangrove Park di Taman Nasional Kutai, Kalimantan Timur. Ulin - J Hut Trop. 2023; Vol 7 (1):45-55 pISSN 2599 1205, eISSN 2599 1183.

[18] Gujarati D N, Porter D C. Basic Econometric. 5th Edition. New York: McGraw Hill; 2013.

[19] Edgar T W, Manz D O. Exploratory Study. In Research Methods for Cyber Security United State of America: Elsevier; 2017.

[20] Tinungki M G. Aplikasi model regresi logit dan probit pada data kategorik. Jurnal Matematika, Statistika, Dan Komputasi. 2010; Vol 6(2): 107–114.

[21] Gujarati D N. Basic Econometric. 4th Edition. New York: McGraw Hill; 2003.

[22] Azizah I N, Arum P R. Model terbaik uji multikolinearitas untuk analisis faktor-faktor yang mempengaruhi produksi padi di Kabupaten Blora Tahun 2020. Prosiding Seminar Nasional Unimus; 2021. p. 4, 61–69.

[23] Archer K J, Lemeshow S. (2006). Goodness-of-fit test for a logistic regression model fitted using survey sample data. The Stata Journal. 2006; Vol 6(1): 97–105.

[24] Abebe T H. The derivation and choice of appropriate test statistic (Z, t, F and Chi-Square Test) in research methodology. Mathematics Letters. 2020; Vol 5(3): 33.

[25] Adjakloe Y D, Osei S A, Boateng E N, Agyapong F. Household's awareness and willingness to use renewable energy: a study of Cape Coast Metropolis, Ghana. International Journal of Sustainable Energy. 2020; Vol 40 (Issue 5): Pages 430-447.