ECOLOGY ECONOMIC ANALYZE OF MANGROVE FOREST ECOSYSTEM IN NANIA, AMBON, MOLUCCAS, INDONESIA

Revalda Amanda Yacoba B. Salakory*, Salakory Melianus**
Department of Geography Education, Teaching and Learning Faculty, Pattimura University
Dr. Leimena Street, Ambon-Moluccas

DOI: 10.29322/IJSRP.8.6.2018.P7808
http://dx.doi.org/10.29322/IJSRP.8.6.2018.p7808

ABSTRACT **-** This study aims to (1) analyze about ecology condition of mangrove forest ecosystem and (2) estimate about total economic valuation of mangrove forest ecosystem in Nania. This research is a quantitative research. Data were collected through interviews, documentation and observation. Method analysis employed was Normalized Difference Vegetation Index (NDVI) and Total Economic Value (TEV). Mangrove forests in on 2015 are categorized 'lightly damaged' (2.40 Ha). *Overall, the economic value of mangrove forest ecosystem if undamaged is* Rp. 657.679.150 per year, with the following description: direct use value is Rp. 88.427.000 per year, indirect use value is Rp. 566.590.400 per year, option value is Rp. 468.000 per year.

Indeks Terms **-** Ecology, Economic, Mangrove Ecosystem Forest

I. INTRODUCTION

Mangrove is a forest ecosystem located in the intertidal zone between tropical and sub-tropical regions. Mangrove forests are considered as one of the most productive ecosystems in the world, as they provide environmental services for other living creatures in the surrounding area. Globally, about 150,000 km2 of mangrove forest is spread over 18 countries in the World including Indonesia, with description: 15.45% in Sumatera, 2.35% Sulawesi, 2.35% in Moluccas, 9.02% in Kalimantan, 1.03 in Java, 0.18% in Bali and Nusa Tenggara and 69.43% in Irian (Dahuri, 2013). However, in the last three decades, Indonesia has lost 40% of mangroves due to various development activities such as conversion of mangrove forest land to farming areas, settlements and other physical development scattered throughout Indonesia (Purnobasuki, 2011).

The mangrove area continues to decline annually In Nania Village. The decline in mangrove area occurred as a result of conversion in coastal areas. Madiama (2016) argued that mangrove area continued to decline to 5.56% (or 0,23 Ha) from the initial area of 4.29 Ha to 3.88 Ha within 9 years (from 2005 to 2014).

Recognizing the threatened existence of mangrove forest ecosystem, the Regional Government of Maluku Province and Ambon City conducted conservation regulates by determining mangrove area in Nania Village as a conservation area to protect the clearing of mangroves for other activities. Conservation's purpose to protect ecologi and economic aspect stability of mangrove forest ecosystem. But, one of the challenges in conserving mangrove ecosystems is the lack of knowledge about the ecology and economic value of the ecosystem. Which is one of the variables in measuring the mangrove forest ecosystem conservation strategy and regulates is ecology and economic analyze of mangrove forest ecosystem.

This study aims to: (1) analyze the ecology condition and (2) estimate the economic value of mangrove forest ecosystem in Nania Village.

II. RESEARCH METHODS

a. Study Area

This result conducted in Nania Village, by reason that mangrove area continued to decline every year until 2014 is 0,41 Ha.

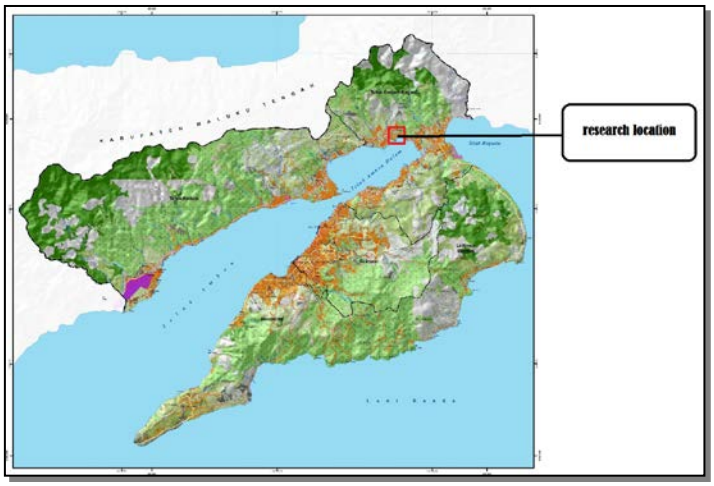

Figure 1. Land Cover Map of Ambon City
Source: MoluccasProvince Research and Development, 2008

b. Data Collection

Data were collected by employing the following methods:

1) Interviews with respondents based on questionnaires, to obtain data on respondent characteristics (including gender, age, education, number of family members and livelihoods), total economic value of mangrove forest ecosystems (including timber volume per Ha, timber sale price, tree diameter average, tree height average, operational costs of timber harvesting; fish, shrimp, crab, oyster catch, bird eggs, etc. in mangrove forest, selling price and cost, total fish catches in waters around mangrove forest and operational costs)

2) Documentation, to collect data on Landsat 8 ETM + Teluk Ambon Baguala 2015, downloaded from https://earthexplorer.usgs.gov, mangrove potential and

distribution as well as factors causing damage to mangrove forest ecosystem in Nania.

3) Observations made through field surveys of observed objects to test the accuracy of the vegetation index (NDVI).

c. Data Analysis

Collected data were then analyzed using the following methods:
1) Vegetation Index or NDVI (Normalized Difference Vegetation Index) [9], calculated by the following equation:

$$\textbf{NDVI} = \frac{NIR-red}{NIR+red}$$

criteria:

Index value	Density Category
0,01 - 0,25	Sparse (Heavily damaged)
0,25 - 0,50	Medium (Lightly damaged)
0,50 - 1,00	Solid (Undamaged)

After obtaining the NDVI value, a precision test is performed to adjust the image interpretation results to the conditions in the field through a ground survey at some sample points using the following equation:

$$\textbf{NDVI precision} = \frac{Correct\ total\ sample}{Total\ sample} x\ 100\%$$

2) Total economic value of ecosystem service [10] estimated based on following formula:

TEV = DUV + IUV + OV + EV

TEV = Total economic value
DUV = Direct use value
IUV = Indirect use value
OV = Option use value
EV = Existence value

III. RESULT AND DISCUSSION

a. Ecology Condition of Mangrove Forest Ecosystem

Mangrove forest in Nania dominated by 6 species, was *Sonneratia alba, Avicenia marina, Rhizophora stylosa, Rhizophora mucronata, Bruguiera gymnorhiza* dan *Lumnitzera littorea*, with ecology function as (a) *nursery and spawning ground, fishing ground* and (*feeding ground*) to sea creatures such as a fish, crabs, reptiles, etc., (b) feed for livestock, (c) raw materials for traditional medicines (d) shoreline protectors from coastal erosion and abrasion and (e) marine pollution controllers as well as (f) sediment catchers which came from construction activities on land (Uddin *et al*, 2013).

Damage to mangrove forest ecosystems was determined based on mangrove density values. It was analyzed using vegetation index or NDVI (normalized difference vegetation index). The NDVI value calculation is obtained from comparing infrared channel reflectance value close to visible light channel obtained from 458 Landsat imagery 8 ETM + acquisition imagery in June 2015, using ArcGIS 10.0 and ENVI 4.5 software.

Ecology condition of mangrove forest ecosystem analyzed based on mangrove density values, using vegetation index or NDVI (normalized difference vegetation index). The NDVI value calculation is obtained from comparing infrared channel reflectance value close to visible light channel obtained from 458 Landsat imagery 8 ETM + acquisition imagery in June 2015, using ArcGIS 10.0 and ENVI 4.5 software. NDVI scores were spread across ten plots in four research sites. The plot referred to in this study is the point of mangrove distribution based on NDVI analysis. NDVI values range from 0.26 to 0.57, therefore they can be categorized in medium density (NDVI value = 0.25-0.50) and solid (NDVI value = 0.50-1.00). NDVI values greater than 0.50 indicate that mangrove vegetation at some locations in Teluk Ambon Baguala is still relatively healthy and productive because it has a high level of greenery.

Based on the results of NDVI analysis, it is known that mangrove forest ecosystem in Nania village has medium vegetation density level and classified as lightly damaged (NDVI=0,26), respectively 2.40 Ha. The factors causing damage to mangrove forest ecosystem in Nania was:

1. mangrove forests are generally converted by the government, private and public for residential, recreation and tourism and other physical development areas (Suyadi, 2009; Pattipeilohy, 2014; Aisyawaty; 2015). This is in accordance with Salampessy et.al (2015) which states that the mangrove forest will be damaged by the conversion of mangrove forest area into a development area.

2. excessive sedimentation can result in death in some species of mangroves (*Avicennia sp*. And *Sonneratia sp*.) due to respiratory root depletetion/pneumothorax (Zamprogno *et al*, 2016). According to Pelasula (2008), sedimentation in the coastal area of Ambon City occurs as a result of land clearing by converting green land for settlement development without any damage mitigation to the land below it.

3. water pollution in Ambon Dalam Bay (TAD). This indicates a load of organic waste from the river to sea has exceeded the assimilation capacity of TAD (Selanno, 2009). Such conditions can lead to changes in environmental quality. Based on the results of Zhang et al (2014) study, the pollutant load entry into the waters can decrease dissolved oxygen levels that are highly needed by marine biota for respiration process. Dissolved oxygen content decrease in the waters directly affects the existence and survival of marine life (Zhang *et al*, 2014). In addition, another direct impact of mangrove vegetation contamination is the inhibition of respiration process due to the depletion of the respiratory root (pneumatophore) caused by waste resulting in mangrove trees death.

b. Economic Value of Mangrove Forest Ecosystem

The one approach used to valuation ecosystem service of mangrove forest is total economic value analyze. Total economic value is overall of mangrove forest ecosystem service value, based on direct use value, indirect use value, option value and existence value. The use value show that environment ability to conduce the directly product which used by communities, is direct use value, indirect use value and option value. The non use value based on environment service that haven't a market price, but useful to humanity, is existence value. (Suparmoko, 2014).

1. Direct Use Value (DUV)

Direct use value estimate based on price market of mangrove forest product, used by communities, is fish, crab, shell and reptile (*Hydrosaurus amboinensis*) to consume and sale. The direct use value of mangrove ecosystem forest is presented in table 1:

Table 1. Direct Use Value of Mangrove Forest Ecosystem

No	Direct Use Classification	Volume (Kg/Year)	Price (Rp/Kg)	Operational Cost (Rp/Tahun)	Direct Use Value (Rp/Year)
1	Fish	940	20.000	420.000	18.380.000
2	Shell	1.152	30.000	60.000	34.500.000
3	Crabs	144	250.000	708.000	35.292.000
4	Reptils	10	30.000	5.000	255.000
		Total			**88.427.000**

Source: Primary Data, 2017

Table 1 show that Crab is commodity with highest value compared to shell and reptile, is Rp. 35,292,000 per year. For information, dominant species of crab is Scylla sp. with weigh is 300 until 400 gram. Sometimes, the crab is not also to consume, but alson to sell to add a livelihood income. Catch process of crab conducted is 72th time per year. Then, use value of Crab estimated based on volume of catch (Rp/year), selling rpice and operational cost.. In Contras, reptile is commodity with low value, because *Hydrosaurus amboinensis* is one of conservate species in Ambon, with low population.

2. Indirect Use Value

In this research, indirect use value is (1) physic function, estimate based breakwater cost to beach line is 304 m, (2) biological function as spawning, nursery, feeding and fishing ground, estimate based on catch fishing production in Nania Village and (3) filtration of seawater instrusion estimated using cost to get pure water, based on mineral water use volume by communities per year. Indirect use value explained by table 2:

Table 2. Indirect Use Value of Mangrove Forest Ecosystem

No	Indirect Use Classification	Indirect Use Value (Rp/Year)
1	Physic function: breakwater	62.137.600
2	Biology function: *nursery*, *fishing* dan *feeding ground*	223.652.800
3	Filtration of seawater intrusion	280.800.000
	Total	**566.590.400**

Source: Primary Data, 2017

Table 2 exhibits value physic function is Rp. 62.137.600 per year, biological function is Rp. 223.652.800 per year and filtration of seawater intrusion is Rp. 280.800.000. Overall, the indirect use value of mangrove forest ecosystem in Nania is Rp. 566.590.400 per year.

3. Option Value (OP)

Option value of mangrove forest ecosystem in Nania village explained by table 3;

Table 3. Option Value of Mangrove Forest Ecosystem

No	Mangrove Area (Ha)	Biodiversity Value (Rp/Ha)	Option Value (Rp/Tahun)
1	2,40	195.000	468.000
	Total		**468.000**

Source: Primary Data, 2017

Table 3 shows that option value of mangrove forest ecosystem in Nania Village, which is Rp. Rp. 468.000 per year. Option value estimate based on biodiversity in mangrove forest, according to Ruitenbeek (1992) in Harahab (2010), is US$ 1.500/Km^2/year atau USd 15/Ha/year atau Rp. 195.000/Ha/year (US$ 1 = Rp 13.000 in 2015).

4. Existence Value (EV)

This value estimate using willingness to pay (WTP) by communities to repair the mangrove forest ecosystem damage. Overall, existence value of mangrove forest ecosystem in Nania Village is presented in table 4:

Table 4. Existence Value of Mangrove Forest Ecosystem

No	WTP Value (Rp/Year)	Family Total (KK)	Exsistence Value (Rp/Year)
1	4.500	1.170	2.193.750
	Total		**2.193.750**

Source: Primary Data, 2017

Table 4 show that exsistence value of mangrove forest ecosystem in Nania Village is Rp. 2.193.750 per year with WTP value Rp.4500 per year to 1.170. Based in this result, minimum value of WTP is Rp. 3.000 per family pear year. Average value of WTP is Rp. 4.500 per year. The lowest value of WTP indicated that low income of communites. This condition according with result result of Huu Tuan *et al* (2014) that income is one of indicator to estimate willingness to pay of communities.

Total Economic Value (TEV)

Total economic value of mangrove forest ecosystem service estimate based on accumulate of direct use value, indirect use value, option value and existence value. Then, the economic value of mangrove forest ecosystem in Nania Village in 2015 can be explained in table 5.

Table 5. Total Economic Value of Mangrove Forest Ecosystem

No	Mangrove Forest Ecosystem Services Classification	Total Economic Value of Mangrove Forest Ecosytem (Rp/Year)
1	Direct Use	88.427.000
2	Indirect Use	566.590.400
3	Option	468.000
4	Existence	2.193.750
	Total	**657.679.150**

Source: Primary Data, 2017

Table 5 exhibits total economic value of mangrove forest ecosystem in Nania Village is Rp. 657.679.150 per year to 2,40 Ha mangrove area, with description: direct use value is Rp. 88.427.000 per year, indirect use value is Rp. 566.590.400 per year, option value is Rp. 468.000 per year and existence value is Rp. 2.193.750 per year.

Table 5 also show that indirect use value is ecosystem service with highest value than another service. This condition means, mangrove forest ecosystem have a biggest environmental services. For that, it takes conservation efforts to minimize the mangrove forest ecosystem destruction so that its environmental function is maintained.

V. CONCLUSION

Overall, the economic value of mangrove forest ecosystem if undamaged is Rp. 657.679.150 per year, with the following description: direct use value is Rp. 88.427.000 per year, indirect use value is Rp. 566.590.400 per year, option value is Rp. 468.000 per year. and existence value is Rp. 2.193.750 per year.

Recognizing the mangrove forest condition in Nania Village almost lightly category with the biggest value of ecosystem service, the government must conducted collaborative conservation in this area, with integrate the actors on development (*tiga batu tungku*), is government, private and communities, to minimize mangrove forest ecosystem damage.

ACKNOWLEDGEMENT

In relation to the completion of this writing, the authors extend their appreciation and gratitude to the parties who have provided assistance, both substantially and financially. Without the opportunity, guidance, input and spirit support from CPC / mother, of course, this writing will not be realized as it is today. May Allah SWT always delegate His Grace and His Gift to us all in carrying out the devotion to the glory of our beloved country and nation. Amen.

REFERENCES

[1] Dahuri, Rokhmin dan Rais, Jacub dan Ginting, Sapta, P. dan Sitepu, M., J., 2008. *Pengelolaan Sumber Daya Wilayah Pesisir dan Lautan Secara Terpadu*. Jakarta: PT. Pradnya Paramita

[2] Dinas Kelautan dan Perikanan Kota Ambon. 2015. *Laporan Akhir: Penyusunan Rencana Detail Kawasan Strategis Perikanan di Kota* Ambon. Ambon

[3] Huu Tuan Tran dan Diem My, Nguyen Hoang dan Quynh Anh, Le This dan Van Toan, Nguyen, 2014. "Using Contingent Valuation Method to Estimate The WTP for Mangrove Restoration under The Context of Climate Change: A case Study of Thi Nai Lagoon, Quy Nhon City, Vietnam". *Ocean and Coastal Management* 95; 198-212

[4] Madiama, Saptono dan Muryani, Chatarina dan Santoso, Sigit, 2016. "Kajian Perubahan Luas dan Pemanfaatan serta Persepsi Masyarakat Terhadap Pelestarian Hutan Mangrove di Teluk Ambon Baguala". *Jurnal GeoEco* 2: 170-183

[5] Purnobasuki, Hery, 2011. "Ancaman Terhadap Hutan Mangrove di Indonesia dan Langkah Strategis Pencegahannya". *Buletin PSL Universitas Surabaya* 25: 3-6

[6] Rahman, Abdullah, F. dan Dragoni, Danilo dan Didan, Kamel dan barreto-muno, Armando dan hutabarat, Joseph, A., 2013. "Detecting Large Scale Conversion of Mangrove to Aquaculture with Change Point and Mixed Pixel Analyses of High-fidelity MODIS Data". *Remote Sensing of Environment* 130: 96-107

[7] Suparmoko, M. dan Sudirman, Dadang dan Setyanko dan Wibowo, Haryo. *Valuasi Ekonomi Sumber Daya Alam dan Lingkungan*. Yogyakarta: BPFE-Yogyakarta

[8] Uddin, Md., Shams dan van Steveninch E., de Ruyter dan Stuip, Mishka dan Shah, Mohammad, A., R., 2013. "Economic Valuation of Provisioning and Cultural Services of Protected Mangrove Ecosystem". *Ecosystem Services* 5: e88-e93

[9] Zamprogno, Gabriela, Carvalho dan Tognella, Monica, Maria, Pereira dan da Silva Quaresma, Valeria dan da Costa, Mercia, Barcellos dan Pascoalini, Savia, Soares dan do Couto, Ger Facco, 2016. "The Structural Heterogeneity of an Urbanized Mangrove Forest Area in Southeastern Brazil: Influence of Environmental Factore and Anthropogenic Stressors". *Brazilian Journal of Oceanography* 64: 1-7

[10] Zhang, Zai-Wang dan xu, Xiang-Rong dan Sun, Yu-Xin dan Yu, Shen dan Cheng, Yong-Shan dan Peng, Jia-Xi, 2014. "Heavy Metal and Organic Contaminants in Mangrove Ecosystems of China: a Review". *Environmental Science and Pollution Research* 23: 11.938-11.95

AUTHORS

Fist Authors - Revalda Amanda Yacoba B. Salakory, Economic Ecology of Environmental Resources, Department of Geography Education Pattimura University, salakory.revalda29@yahoo.com

Second Authors - Salakory Melianus, Professor of Medical Geography, Department of Geography Education Pattimura University, salakory_s3@yahoo.co.id