JOURNAL OF DEGRADED AND MINING LANDS MANAGEMENT
ISSN: 2339-076X (p); 2502-2458 (e), Volume 7, Number 4 (July 2020): 2241-2251
DOI:10.15243/jdmlm.2020.074.2241

Research Article

The spatial dynamics of land cover change along the Wallacea corridor in the key biodiversity area 'Buano Island', Maluku, Indonesia

Bokiraiya Latuamury*, Hendrik S.E.S Aponno, Husain Marasabessy, Miranda H. Hadijah, Wilma Imlabla

Department of Forestry, Faculty of Agriculture, University of Pattimura, Jl. Ir. M. Putuhena, Poka, Tlk. Ambon, Maluku 97233, Indonesia

*corresponding author: okky.environmentalscience@gmail.com

Received 3 March 2020, Accepted 8 April 2020

Abstract: Land cover change is an urgent global issue that needs to be addressed immediately. Its dynamics are of the greatest importance to Key Biodiversity Areas (KBAs) along the Wallacea Corridor, including Buano Island, whose land and sea are rich in biodiversity. KBA Buano Island is home to endemic and endangered birds, such as Moluccan scrubfowl (*Eulipoa wallacei*) and black-chinned monarch (*Monarcha boanensis*). Black-chinned monarch only lives on the island (*single-site species*). Buano waters have an interestingly diverse life, including dugong (*Dugong dugon*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), and many species belonging to the dolphin family (Delphinidae) and beaked whale family (Ziphiidae). This study was designed to analyze and map the spatial-temporal patterns of land cover changes on Buano Island. It employed a multi-temporal analysis on Landsat images from 1970, 1980, 1990, 2000, 2010, until now, and a t-test to analyze the results further. The t-test analysis produced t-count ≥ t-table at confidence level (α) of 0.05, indicating significant changes in land cover from 1970, 1980, 1990, 2000, 2010, until 2016. These multitemporal-spatial dynamics were attributable to fluctuation in population growth and open and straightforward access between the island and the capital of the regency. Furthermore, from the aspect of fishery and maritime affairs, Buano Island already had synergistic land area development.

Keywords: *Buano Island, land cover change, spatial dynamics, the Wallacea corridor*

To cite this article: Latuamury, B., Aponno, H.S.E.S., Marasabessy, H., Hadidjah, M.H. and Imlabla, W. 2020. The spatial dynamics of land cover change along the Wallacea corridor in the key biodiversity area 'Buano Island', Maluku, Indonesia. J. Degrade. Min. Land Manage. 7(4): 2241-2251, DOI: 10.15243/jdmlm. 2020.074.2241.

Introduction

Wallacea is a region dominated by small islands with an area of less than or equal to 2,000 km^2. These small islands have their distinctive ecological character. There, the number of species is relatively smaller than an area with the same size on the mainland. Nevertheless, the small islands within Wallacea have abundant endemic species. Various types of biodiversity on these islands, including birds, are not found on other islands or anywhere else in the world (single-island endemics). Small island ecosystems are vulnerable to natural disasters, such as volcanic eruptions and storms, and climate change impacts like sea-level rise and fires. For these reasons, endemic species on small islands are increasingly threatened by extinction. Other threats to the ecosystems are invasive or introduced species and the occupation of the human population that converts natural forests into settlements or agricultural land (Fan et al., 2008).

Great biological diversity is found in the tip of the Seram Bagian Barat Regency. Buano Island is home to endemic and endangered birds, such as Moluccan scrubfowl (*Eulipoa wallacei*) and black-chinned monarch (*Monarcha boanensis*). Black-chinned monarch only lives on this island *(*single-site species). Buano waters have an interestingly diverse life, including dugong (*Dugong dugon*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), and many species belonging to the dolphin family (Delphinidae) and beaked whale family (Ziphiidae). The local people's livelihood depends on the availability and accessibility of pelagic and demersal fish, eucalyptus (distillation), and woods of high economic value. However, in practice, the management of plant and animal biodiversity still not guarantees sustainability. People exploit woods excessively as firewoods for the eucalyptus refining process or sell them as building materials and catch fish using less environmentally friendly techniques (e.g., blast fishing).

Deforestation and forest degradation on Buano Island have caused problems for the conservation of biodiversity, namely habitat loss and species fragmentation-isolation within and between conservation/protected areas as the center of biodiversity. Consequently, interior species are isolated in small habitats and on the verge of extinction, especially for large-bodied species. Also, species with large home ranges encounter difficulty in moving from one conservation area to another owing to changes in land cover. Mostly, conflicts inevitably occur when isolated or marginalized animals enter the settled areas and cause human death. These animals have become the target of hunting because they have high economic value (Lima et al., 2002).

Land cover change in a landscape can accommodate diverse spatial information on a region, including physical, biological, social, and economic aspects. In the long term, this information provides the basis for the selection of management measures. Mapping the biodiversity potential of Buano Island, a Key Biodiversity Area (KBA), based on landscape and topographic variations is expected to be able to identify the aspects of biodiversity management on the island. Forest fragments play an ecological and economic role and synergize the bioecological home ranges of endemic species existing on the island on a management priority scale that is more effective and efficient (Silva et al., 2018).

Land cover change is dependent on population growth rate and socio-economic development. This causal link is feared to disrupt the sustainability of biodiversity and water resource conservation process in KBA Buano Island. The existing condition on the island shows the decline rate of forest function. As the habitat of wildlife forests continuously lose their functions and areas to fragmentation. Conservation area and protected forest as biodiversity centers are not interconnected. Habitat fragmentation has even occurred within a conservation area. The current situation in the field shows that most of the conservation areas and remnants on the small Buano Island have been fragmented because settlement, agricultural land, plantation, and other types of human activities that tend to transform land morphology have dominated today's landscape elements (Monteiro Junior et al., 2019). The land cover in KBA Buano Island, which is currently in the establishment process into an essential ecosystem area, has changed at a rate that threatens biodiversity conservation. A spatial analysis approach to mapping the pattern of land cover change in forest area is expected to provide recommendations for sustainable natural resource management. It requires a fundamental change in the conservation paradigm. This approach needs to be consistently mainstreamed in all sectors to achieve an equal perception of holistic and sustainable biodiversity conservation (Liu et al., 2017). The biodiversity conservation strategy on Buano Island (KBA Buano Island-IDN 199) should now be based on the ecological landscape, given that the currently practiced sectoral approach has not succeeded in bridging the problems of decreasing biodiversity number so far, including the endangerment and extinction of endemic species and severe deforestation. This issue accentuates the need to map land cover change in forest area based on the biogeophysical characteristics of Buano Island in Seram Bagian Barat Regency.

Materials and methods

Research Stage

The research was carried out in two stages. The first stage included two activities: (1) high-resolution image analysis and base maps production, and (2) spatial analysis of land cover change. The second stage was: (1) field survey to validate the map of land cover change, and (2) spatial analysis on land cover change based on the biogeophysical characteristics of small Buano Island.

Field survey and spatial mapping preparation

The equipment used in this research consisted of Indonesian topographic maps scale 1: 25,000, Global Positioning System, scanner, digitizer, plotter, printer, and ArcGIS 1065 software. The research also used several thematic maps, such as geologic, hydrogeologic, soil, and spatial plan maps; topographic maps scale 1: 50,000 or the Indonesian topographic maps scale 1: 25,000; National Survey figures in 2000-2010; and Village Potential figures 2000-2010. The land cover change was analyzed in Quantum GIS (SAGA GIS) and Geographic Information Systems (GIS) using the stages below.

Geometric and radiometric corrections of landsat images

Satellite imagery usually has a distortion or error due to the Earth's curvature and the movement of the platform carrying the image recording sensor. As an attempt to eliminate this error, satellite images need to be geometrically and radiometrically corrected before use. Geometric correction is the process of removing distortion from a satellite image so that it coincides with the actual position in the field. It is a ground check procedure using several control points in the field that already have a coordinate system. Aside from geometric correction, satellite images need radiometric correction for better visualization and proper interpretation. It corrects images from the atmospheric effects that disrupt the reception of light waves.

Landsat image interpretation

Satellite image interpretation is the process of identifying land cover type captured on the image. Landsat images were interpreted visually by referring to the land cover classification publicized by the General Directorate of Planning and Forestry, the Ministry of Forestry, which differentiates land cover into 23 classes. Geometric correction and image interpretation were carried out by this General Directorate as the 'guardian' of land cover map and data ('guardian' is a unit responsible for collecting, maintaining, updating, exchanging, distributing, and providing accessible data) in Indonesia. For a more focused analysis, the 23 classes of land cover above were reclassified into six classes. The definition of the thematic category using the classification system of six land covers is presented in Table 1. Land cover changes were analyzed by preparing a matrix of land cover change based on the GIS analysis results from 1972, 1981, 1990, 1997, 2002, 2009, until 2016.

Table 1. Land cover classes according to BPKH of Maluku Province.

No.	Groups	Land use types
1	Forest	1.1. Dryland Forest 1.2. Primary Mangrove Forest 1.3 Secondary Mangrove Forest
2	Agricultural Land	2.1. Dry Cropland 2.2 Multi-species Dry Cropland
3	Settlement	3.1. Rural Settlement
4	Bush/Shrub	4.1. Shrub 4.3. Shrub Swamp
5	Vacant Land	5.1. Bare Land 5.2. Open Land

These selected years coincide with the times of imaging between 1970 and 2010, as presented in Figure 1. From the matrix, each land cover change and the area it affects were identified. The GIS analysis of land cover change is depicted in the flow chart in Figure 2. It shows that the land cover classification system proposed by the General Directorate of Planning and Forestry was first reclassified into six classes for a more focused analysis. Time of imaging and Indonesian Topographic Maps (RBI) were used as a reference in mapping land use classes in 1972, 1981, 1990, 1997, 2002, 2009, and 2016. This study was emphasized on the spatial analysis of land cover change based on the biogeophysical characteristics and social-economic-cultural aspects of the local population.

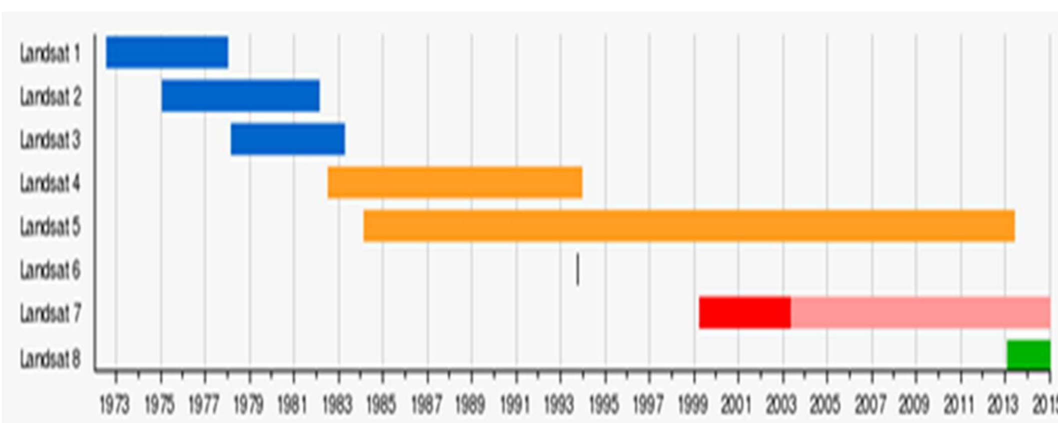

Figure 1. Periods of imaging by the landsat program.

The spatial analysis included:

a. Trendline analysis of land cover change pattern
b. Population analysis: population density and growth, agrarian population density, agricultural land pressure, built-up land ratio, dependency ratio, and poverty; and
c. Political and institutional analysis of watershed management and regional spatial planning.

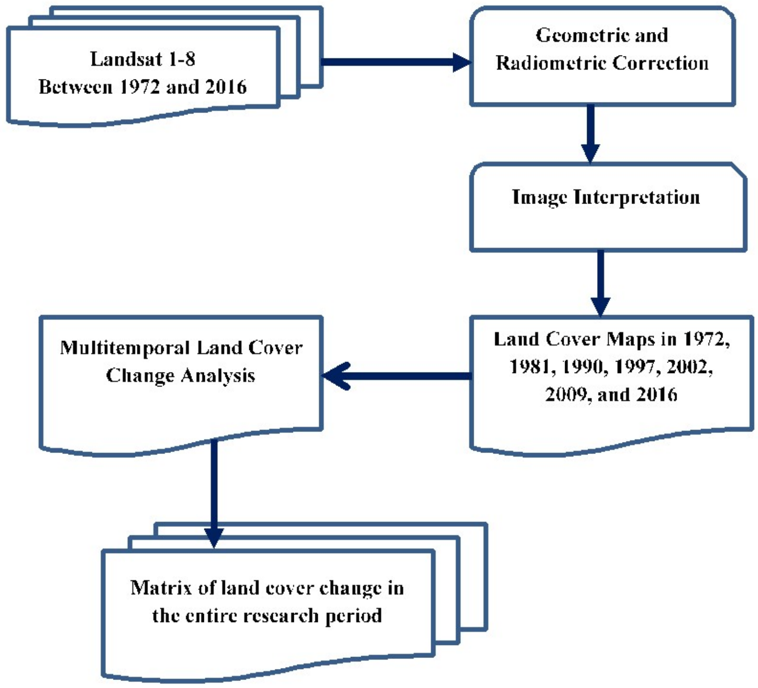

Figure 2. The flow chart of land cover change analysis.

Table 2. Satellite bands and spectral ranges (in nanometer) and their applications in mapping.

Bands	Spectral Ranges (nm)	Applications in Mapping
Band 1 – Aerosol Coastal	0.43-0.45	Coastal area and aerosol in the air
Band 2 - Blue	0.45-0.51	Bathymetric mapping (sea floor), distinguishing soil from vegetation
Band 3 – Green	0.53-0.59	Emphasizes growing vegetation
Band 4 – Red	0.64-0.67	Discriminates vegetation slopes
Band 5 – Near Infrared NIR	0.85-0.88	Emphasizes biomass content and shorelines
Band 6 – Short wave infrared SWIR 2	1.57-1.65	Discriminates moisture content of soil and vegetation, penetrates thin clouds
Band 7 – Short wave infrared SWIR 2	2.11-2.29	Accentuates the difference between moisture content of soil and vegetation, penetrates thin clouds
Band 8 – Panchromatic	0.50-0.68	15-meter resolution, sharper image definition
Band 9 – Cirrus	1.36-1.38	Improved detection of cirrus cloud contamination
Band 10 – Thermal Infrared TIRS 1	10.60-11.19	100-meter resolution, thermal mapping
Band 11 – Thermal Infrared TIRS 2	11.50-12.51	100-meter, thermal and soil moisture mapping

Source: USGS (https://www.usgs.gov/faqs/what-are-best-landsat-spectral-bands-use-my-research?qt-news_science_products=0#qt-news_science_products).

Rapidly occurring land cover change can be detected by applying remote sensing technology and geographic information systems to time-series satellite image analysis. Landsat imagery offers fast and accurate land cover delineation at regular times. In this study, Landsat images recorded in 1970, 1980, 1990, 2000, 2010, and 2016 were downloaded from https://glovis.usgs.gov/app. For each selected year, the cloud-free images were chosen and then analyzed to identify land cover change. In this study, Landsat 1 imagery was used to interpret the land cover change in 1973-1983,

Results and Discussion

The spatial analysis results of land cover change

The analyses of land cover change dynamics, both multi-temporal and spatial, covered the entire Buano Island. KBA Buano Island is a group of islands consisting of Buano (Nusa Puan), Nusa Tea, Nusa Mananut, Nusa Esuna, Puas, Kasuari, Kelapa, and Sarane Islands. It has two main villages, namely Negeri Buano Utara and Negeri Buano Selatan. Negeri Buano Utara has four sub-villages (Anauni, Kasuari Island, Huhua, and Naiselan), while Negeri Buano Selatan has two sub-villages (Huaroa and Pasir Panjang). The land tenure on this island is regulated by a customary system and collected in 9 Soa's that have the same customary system.

Buano Island covers a land area of 3,059,306.67 ha, consisting of 1,417,085.35 ha of Protected Forest, 1,471,413.27 ha of Convertible Production Forest, and Areas for Other Purposes covering 170,907.05 ha (Ministry of Environment and Forestry, 2015). Since the protected forest and convertible production forest have similar areas, stakeholders need to make Buano Island as their primary concern. This island has unique biogeophysical and socio-economic characteristics and a large number of endemic animals and plants, for which it is categorized as one of the Key Biodiversity Areas along the Wallacea Corridor.

The Landsat image interpretation produced five dominant classes of land cover, namely (1) forest (consisting of dryland forest, primary mangrove forest, and secondary mangrove forest), (2) agricultural land (dominated by dry cropland and multi-species dry cropland), (3) settlement (particularly rural settlement), (4) bush/shrub (shrub and shrub swamp), and (5) vacant land (bare land and vacant land). The calculated variations in the land cover area from 1972 until 2016 are described in Table 3.

From 1972 until 2016, the spatial pattern of land cover change showed a persistently decreasing area of the dominant land covers in Buano Island, namely dryland forest and primary and secondary mangrove forests. In the same period, the extents of agricultural land, settlement, shrub, and vacant land showed an increasing trend, as illustrated in Figure 3.

Land cover change in 1972 - 1981

This section discusses the spatial pattern of changes in forest cover during the first section of the research period. From 1972 until 1982, all types of land cover shrunk periodically. For instance, the forest area experienced a slight decrease from 251 million ha to 249 million ha. Meanwhile, agricultural land increased from 29.71 million ha to 30.54 million ha, settlement from 0.68 million ha to 0.711 million ha, and vacant land from 11.17 million ha to 11.75 million ha. In this period, the accessibility to and from Buano Island, or the inter-island transportation route, was limited. The administrative area of Seram Bagian Barat Regency was still under the control or authority of the Government of Maluku Tengah Regency. It is believed to be the cause of low accessibility on the island and, consequently, the slow decline rate of forest area. The decrease in the forest area was decelerated, as depicted in Figure 4.

Table 3. Land cover area (in million ha) from 1972 until 2016.

Years	Forest	Agricultural Land	Settlement	Vacant Land	Bush/Shrub
1972	251.51	29.71	0.68	11.17	12.86
1981	249.40	30.54	0.71	11.75	13.53
1990	229.13	49.37	3.45	13.52	10.45
1995	221.75	44.42	6.77	29.48	3.51
1997	239.13	32.65	5.29	14.43	14.43
2001	178.65	83.23	5.62	29.04	9.39
2002	198.72	57.35	5.81	33.16	10.90
2005	197.21	70.35	4.26	24.57	9.54
2009	155.14	99.05	3.83	40.02	7.89
2015	126.12	126.11	11.29	39.00	3.41
2016	122.22	81.70	10.90	85.84	5.27

Source: Analysis of Landsat Images in 1972-2016, 2019

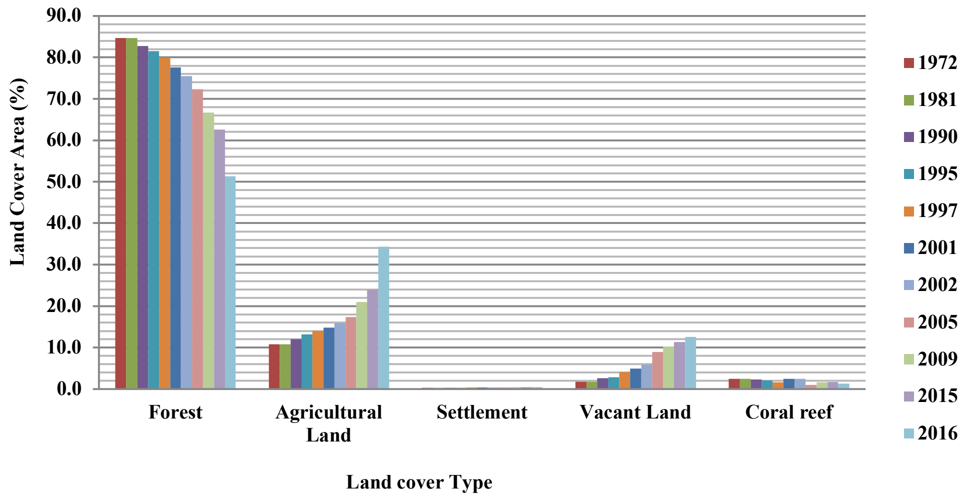

Figure 3. The Percentage of land cover on Buano Island from 1972 to 2016.

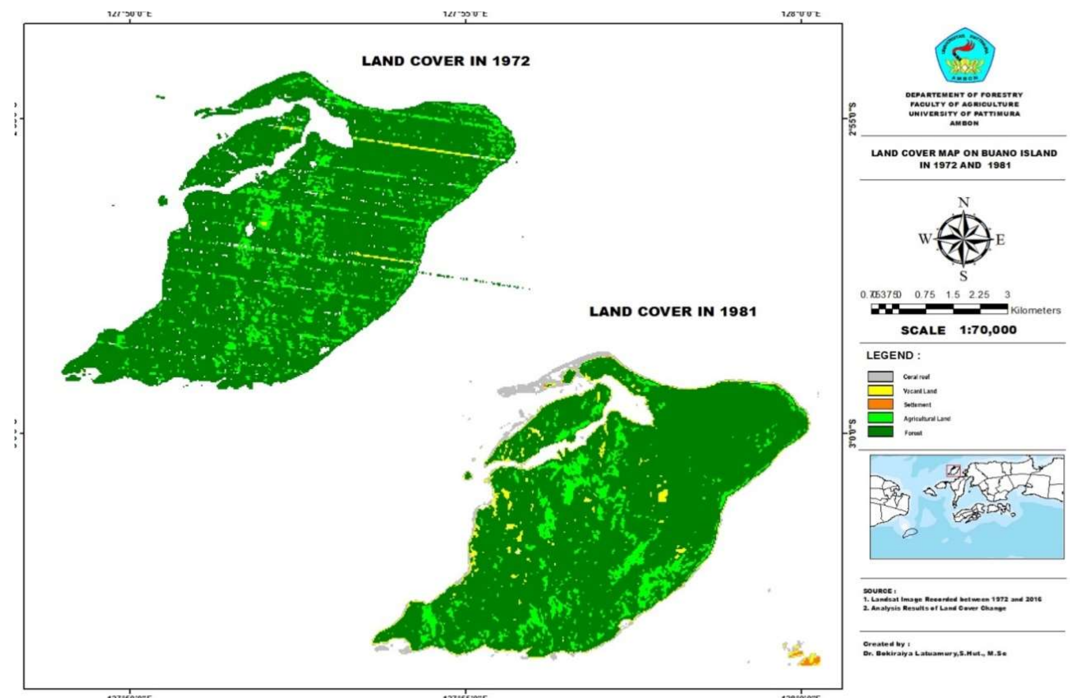

Figure 4. Land cover change on Buano Island from 1972 until 1981.

In 1972-1981, forest area was the dominant land cover in KBA Buano Island. Back then, Buano was a small island consisting mainly of a vast vegetation cover. Along with the simple living condition, the island experienced relatively slow development and population growth rate. The local people sparsely inhabited the coastal area of the island and were highly dependent on products from the vast forests.

Land cover change in 1972 - 1997

The time-series satellite image analysis of land cover change from 1972 until 1997 revealed that forest area, agricultural land, settlement, bush/shrub, and vacant land continued to change from the previous period significantly. For instance, forest area shrunk from 251 million ha to 229 million ha. Meanwhile, agricultural land increased from 29.71 million ha to 49.37 million ha, settlement from 0.68 million ha to 3.44 million ha, and vacant land from 11.17 million ha to 13.52 million ha. Land cover change persistently occurred at an increased magnitude and with considerable impact. The conversion of forest into agricultural land and vacant land mushroomed extensively. The multitemporal analysis indicated that land cover change in this period occurred both spatially and temporally. This finding was attributable to changes in population, and the socio-economic life continuously developed over space and time. Area expansion that turned Seram Bagian Barat into an autonomous regency affected the accessibility and regional development of KBA Buano Island. The spatial pattern of land cover change in this period is presented in Figure 5.

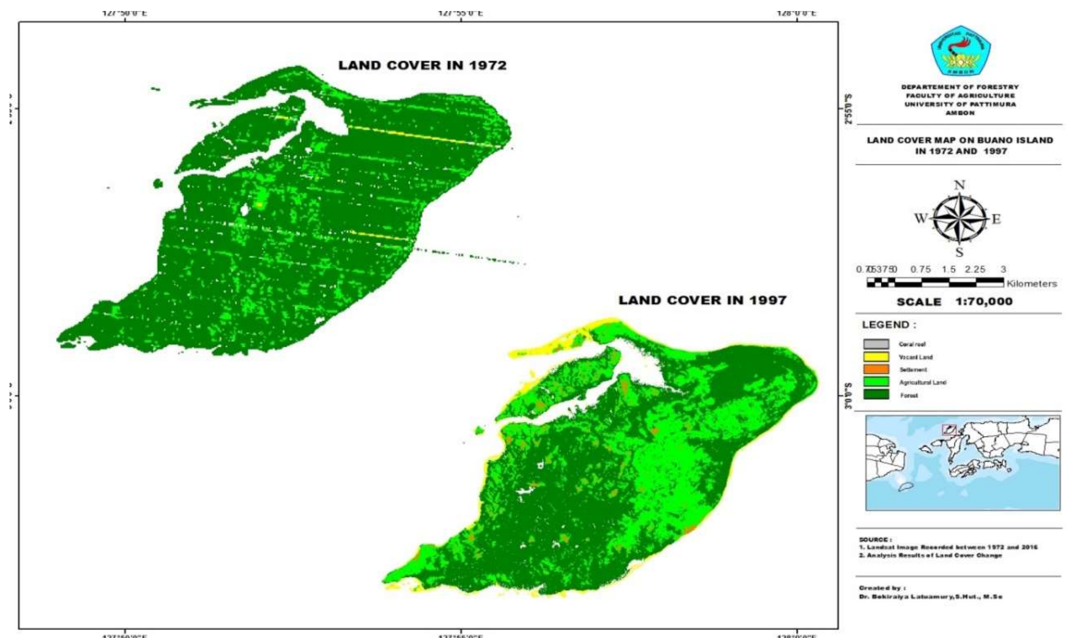

Figure 5. Land cover change on Buano Island from 1972 until 1997.

Land cover change in 1972 - 2002

The spatial pattern of land cover change in the third decade, from 1972 to 2002, showed that the forest area decreased periodically and was significantly converted into non-forest areas, whereas agricultural land, settlement, and vacant land expanded. The same expansion was also found in dry cropland and multi-species agricultural land. Forest area decreased from 251 million ha to 198.72 million ha. Meanwhile, agricultural land increased from 29.71 million ha to 57.35 million ha, settlement from 0.68 million ha to 5.81 million ha, and vacant land from 11.17 million ha to 33.16 million ha. Agricultural land and vacant land continued to increase, as presented in Figure 6.

The local population had a unique farming pattern compared to areas outside the island. A lack of soil fertility constrained agricultural practices on the island. Also, low accessibility contributed to less diverse agricultural activity. Consequently, the local people adapted to these agricultural limitations by cultivating annual crops or plants with high adaptability to nutrient-poor soils, such as cassava and other tubers, to meet their food needs.

The spatial pattern of land cover change between 1972 and 2009 was consistent with that of previous periods. Over time, the forest was converted into non-forest areas, such as agricultural land, settlement, and vacant land, as presented in Figure 7. Forest area continued to shrink significantly from 251 million ha to 155.14 million ha. Meanwhile, agricultural land increased from 29.71 million ha to 99.05 million ha, settlement from 0.68 million ha to 3.84 million ha, and vacant land from 11.17 million ha to 40.02 million ha.

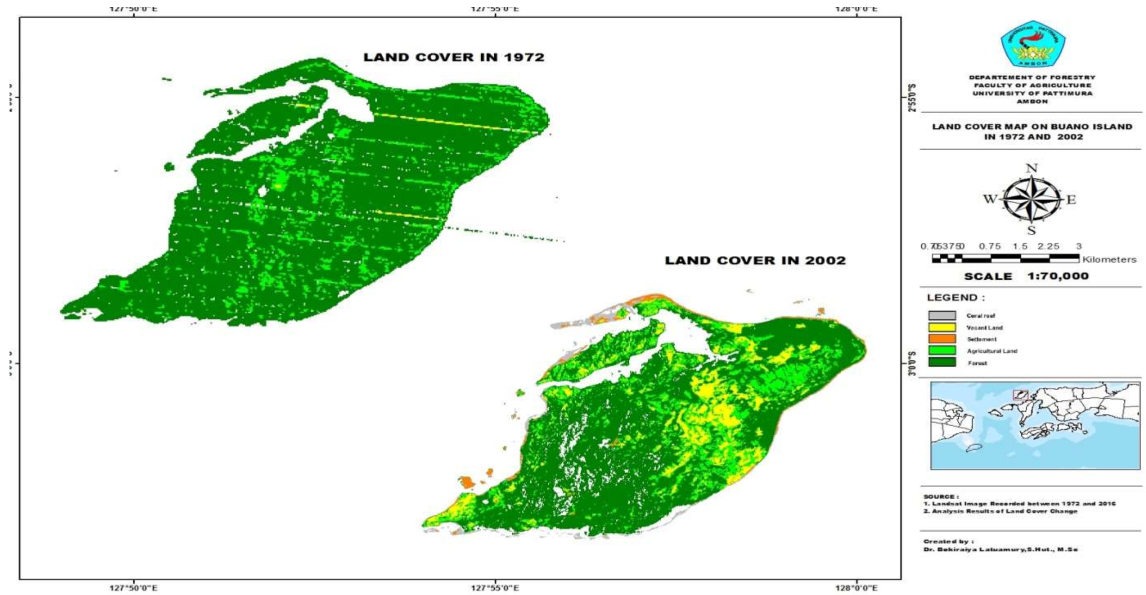

Figure 6. Land Cover Change on Buano Island from 1972 until 2002.

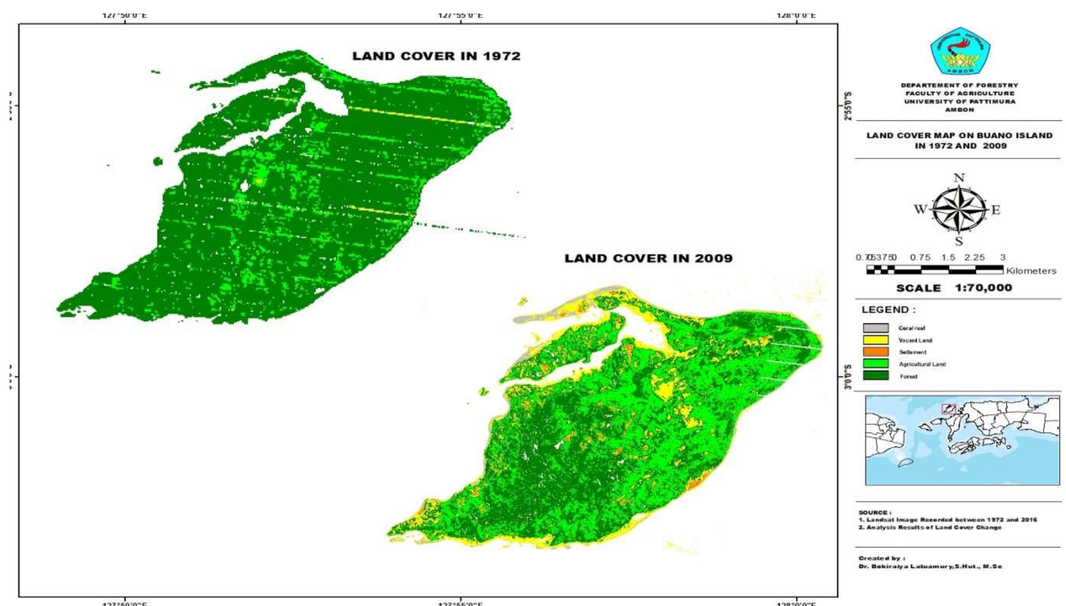

Figure 7. Land cover change on Buano Island from 1972 until 2009.

The agricultural land showed a significantly increasing trend, followed by vacant land. This condition was represented by forests that persistently decreased in size but not followed by improvement in people's welfare, resulting in negative impacts on the small island ecosystem. If the condition continues, it might severely threaten endemic animals and plants and, eventually, the rich biodiversity on the island and along the Wallacea Corridor.

Land cover change in 1972 - 2016

The spatial pattern of land cover change from 1972 until 2016 indicated a significant change in all types of land cover. Forest was exploited and converted extensively into agricultural land and vacant land. In this period, forest area shrunk from 251 million ha to 122.22 million ha. Meanwhile, agricultural land increased from 29.71 million ha to 81.71 million ha, settlement from 0.68 million ha to 10.91 million ha, and vacant land from 11.17 million ha to 85.84 million ha. These ongoing changes are feared to severely affect the environmental change on Buano Island (Figure 8). During the examination of the maps of land cover change together with the community, this study found that 1972 until the early 1980s marked the transition of logging practices from a traditional activity that used axes to the use of chain-saw on a small scale. However, in 1990-2000, when logging concessions were applied to Buano Island, large-scale tree felling started to occur. These logging practices were suspected as the cause of a considerable and rapid decrease in the forest area.

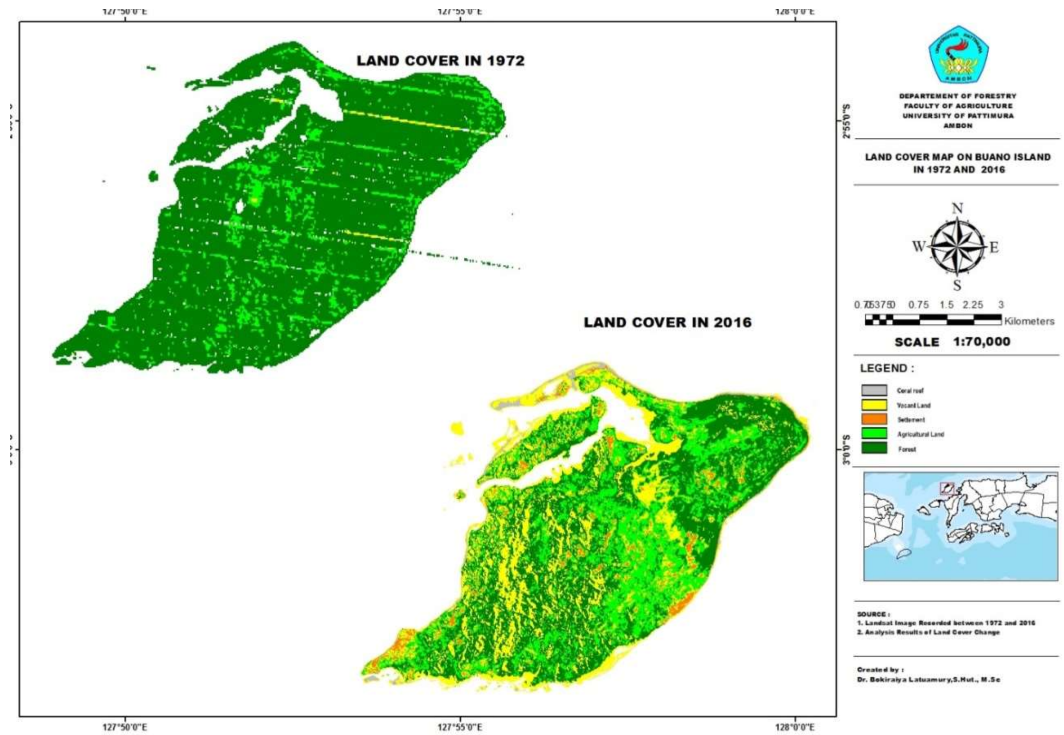

Figure 8. Land cover change on Buano Island from 1972 until 2016.

The dynamics of changes in forest area continued to occur in KBA Buano Island. Combined with uneven regional development (physical construction) and forest resource utilization throughout Indonesia, the limited accessibility of small islands from centers of economic growth creates driving factors for significant regional development. Every region has different characteristics depending on forest/natural resource potential and technological application.

The statistical analysis results of spatial patterns of land cover change on Buano Island

The analysis results in previous sections were further analyzed by a difference test (t-test) to achieve a conclusion about the variation in the spatial pattern of land cover change on Buano Island from one research period to another. The t-test analysis produced varying t-counts that all indicated significant changes in forest land (t = 13.99), agricultural land (6.81), settlement (5.12), vacant land (4.70), and bush/shrub (7.95) over these periods. These t-counts reflect significant statistical differences because they are higher than t-table = 2.228 at a confidence value of 0.000 ($\leq$ 0.05), as presented in Table 4. The t-test results approached the analysis results of spatial patterns of land cover change, meaning that all types of land cover on Buano Island experienced spatial and temporal variations during the research period. The spatial patterns show a significant decrease in forest area but a significant increase in agricultural land, settlement, vacant land, and bush/shrub. Hypothesis testing by t-test was intended to confirm the variations in land cover change on Buano Island during the research period.

Table 4. The results of one-sample test of land cover change.

Land Cover Types	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	α=0.05	
					Lower	Upper
Forest (1972-2016)	13.992	10	0.000	64.45227	54.1887	74.7158
Agricultural Land (1972-2016)	6.809	10	0.000	20.93373	14.0836	27.7839
Settlement (1972-2016)	5.122	10	0.000	1.74127	0.9838	2.4988
Vacant Land (1972-2016)	4.697	10	0.001	9.86500	5.1855	14.5445
Bush/Shrub (1972-2016)	7.953	10	0.000	3.00618	2.1640	3.8484

Source: Primary Data Analysis in SPSS, 2019

Factors influencing land cover change

Land cover change is a complex dynamic process that links the natural environment and humans and directly affects soil, water, the atmosphere, and other global environment interests (Koomen et al., 2007). Deforestation on Buano Island, which involves the conversion of forest into agricultural land, has a tremendous impact on biodiversity, soil, degradation, and community capacity (Lambin et al., 2003). Land use system is a combination of vegetation change cycles and management activities (i.e., planting and harvesting).

On the island, land cover change is the function of time and economic growth level (people's income). In other terms, forest transition is closely related to economic growth. One indicator that can be used in this case is GDP per capita. The process of forest conversion illustrates the relationship between forest cover and deforestation rate, provided that all social and economic factors have not changed (*ceteris paribus*). Therefore, the location with a low deforestation rate will have high forest cover. When forest cover decreases, there is a shift toward an elevated deforestation rate.

The correlation between deforestation and forest cover is illustrated as that of forest cover and deforestation rate, while the transition process or forest change is based on time. When forests cover an extensive area, it means that the deforestation rate is low. Then, the correlation line moves to the left where the deforestation rate increases and forest cover decreases. If the maximum peak is reached, it continues to move, and the deforestation rate decreases until the level is equal to zero. If it continues to decline, then negative deforestation or a turning point occurs and creates forest transition.

Deforestation rates are strongly dependent on several factors. In the theory of forest conversion to non-forest cover, deforestation is likely to increase if forest resources have high potential and if some of the forest covers are about to be restored. One way to study the transition process is by measuring the effects of forest cover on deforestation under the hypothesis that the wider the forest cover, the higher the deforestation rate.

Factors contributing to long-term agricultural land expansion are low GDP per capita and political failure in increasing the efficiency and management of natural resources sustainably (Barbierand Bugas, 2003). Jorgenson and Burns (2007) state that theoretically, there is an interaction between population growth and environmental degradation and between migration and encroachment in the rural area. Besides, the effects of economic growth on deforestation are controlled by the political aspect and other social welfare variables. The dynamics of the rural-urban population, combined with other aspects of national development, also affect natural environments, particularly the decline or increase in the correlation with the world's economic system.

Factors that drive forest deforestation on Buano Island are economy, institution, politic, agricultural development, logging, and infrastructure development. Population growth and changes in agricultural patterns are the two primary causes of deforestation. According to von Amsberg (1994), another parameter behind deforestation is the wood price. Log export ban imposed on several developing countries aims to increase the added value of domestically processed wood products, which appears to influence deforestation. The low price of domestic logs reduces the benefits received from forest commodities compared to when the land is used for other purposes, such as agriculture.

Conclusion

1. The spatial pattern of land cover change from 1972 until 2016 shows a decreasing trend in forest area (including secondary dryland

forest, primary and secondary mangrove forest) from one period to another, which is followed by a significant increase in agricultural land, settlement, bush, and vacant land.

2. The t-test results produced t-count > t-table (2.228) at a significance level of 0.000 (≤ 0,05). It means that all variations in land cover, namely forest (t-count = 13.99), agricultural land (6.81), settlement (5.12), vacant land (4.70), and bush/shrub (7.95) are significantly different from one period to another.
3. The correlation between deforestation and forest cover is illustrated as that of forest cover and deforestation rate, while the transition process or forest change is based on time. When forests cover an extensive area, it means that the deforestation rate is low. Then, the correlation line moves to the left where the deforestation rate increases and forest cover decreases. If the maximum peak is reached, it continues to move, and the deforestation rate decreases until the level is equal to zero.

Acknowledgement

The authors would like to thank the Dean of the Faculty of Agriculture and the Commitment-making Officer (PPK) of PNBP Fund in the Faculty of Agriculture, University of Pattimura for funding the research entitled The Spatial Dynamics of Land Cover Change along the Wallacea Corridor: in a Key Biodiversity Area (KBA) Buano Island, Seram Bagian Barat Regency, Maluku Province ("Dinamika Spasial Perubahan Penutupan Lahan Koridor Wallaceae Key Biodiversity Area (KBA) Pulau Buano Kabupaten Seram Bagian Barat Provinsi Maluku").

References

Barbier, E.B. and Bugas, J.S. 2003. Policies for Controlling Resource Conservation and Biodiversity Loss Accounting for the Effects of Corruption and Land Use Interactions. Paper prepared for the 4 BioEcon Workshop on the Economics of Biodiversity Conservation,"Economic Analysis of Policies for Biodiversity Conservation", Venice, Italy, 28-29 August

Fan, F., Wang, Y. and Wang, Z. 2008. Temporal and spatial change detecting (1998-2003) and predicting of land use and land cover in Core corridor of Pearl River Delta (China) by using TM and ETM$^+$ images. *Environmental Monitoring and Assessment* 137(2): 127-147, doi: 10.1007/s10661-007-9734-y.

Jorgenson, A.K. and Burns, T.J. 2007. Effects of Rural and Urban Population Dynamics and National Development on Deforestation in Less-Developed Countries, 1990–2000. Sociological Inquiry, doi: 10.1111/j.1475-682X.2007.00200.x.

Koomen, E. and Stillwell, J., 2007. Modelling Land-Use Change: theories and methods. In: Koomen, E., Stillwell, J., Bakema, A., Scholten, H.J. (eds.), Modelling Land-Use Change: Progress and Application, Springer, doi: 10.1007/978-1-4020-5648-2_1.

Lambin EF, Geist HJ, Lepers E., 2003. Dynamics of landuse and land-cover change in tropical regions. *Annual Report of Environment Resource* 28:205Repo.

Lima, A., Silva, T.S.F., de Aragao, L.E.O.C., de Feitas, R.M., Adami, M., Formaggio, A.R. and Shimabukuro, Y.E. 2012. Land use and land cover changes determine the spatial relationship between fire and deforestation in the Brazilian Amazon. *Applied Geography* 34: 239e246, doi: 10.1016/j.apgeog.2011.10.013.

Liu, G., Jin, Q., Li, J., Li, L., He, C., Huang, Y. and Yao, Y. 2017. Policy factors impact analysis based on remote sensing data and the CLUE-S model in the Lijiang River Basin, China. *Catena* 158: 286-297, doi: 10.1016/j.catena.2017.07.003.

Monteiro Junior, J.J., Silva, E.A., Reis, A.L.A. and Santos, J.P.M.S. 2019. Dynamical spatial modeling to simulate the forest scenario in Brazilian dry forest landscapes. *Geology, Ecology, and Landscapes* 3(1): 46-52, doi: 10.1080/24749508.2018.1481658.

Silva, R.M., Santos, C.A.G., Maranhao, K.U.A., Silva, A.M. and Lima, V.R.P. 2018. Geospatial assessment of eco-environmental changes in desertification area of the Brazilian semi-arid region. *Earth Science Research* Journal 22(3): 175-186, doi: 10.15446/esrj.v22n3.69904.

von Amsberg, J. 1994. *Economic parameters of deforestation (English)*. Policy, Research Working paper; no.WPS 1350. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/113261468740984341/Economic-parameters-of-deforestation.