Land Use Change as A Potensial Reduction of Biodiversity in Palu Bay Central Sulawesi

Lilik Prihadi Utomo

Abstract— **Increasing of development as increasing of population cause land use change that may have impact for   biodiversity. The aim is to determine the extent of land use change to the potential loss of biodiversity in the Palu bay and arrange the direction of space utilization in Palu Bay.   The method was survey with spatial approach. Land use change is determined by digitation of the remote sensing from 2010 to 2016 and overlay in order to determine impact of land use change towards reduction of biodiversity. The result showed that the land use change   into   settlement areas. So Settlement has increased from 662.43 Ha 2010 to 911.03 Ha in 2016. Land use change affect biodiversity causing losses to both ecosystems and humans. Therefore, The direction of city development through sustainable development should consider the green ecosystem space to   keep biodiversity. Some endemic plants should be planted in artificial green land and conducted   the programs of conservation coastal areas by   planting mangroves, ebony, coconut trees and others endemic plant along Palu Bay.**

Key words: biodiversity, Land use change, land cover change, remote sensing

———————————— ◆ ————————————

1 INTRODUCTION

City development, rapid population growth and human activities have been emergence of environmental issues. The most crucial problem is land use change because   the amount of land remains steady but the demand for land increases. Land use relate to human activities which utilization   land and resources will affect the land [1]. Conversion of open land into built-up land for various needs such as residential, industry, tourism and other infrastructures may result in an ecosystem change. The impacts of land use-land cover change are a major cause of declining ecological systems, soil degradation and biodiversity such as   reduced of food supply, climate changes, floods, landslide and carbon dioxide in the atmosphere   [2,3,4]. Damaging of habitat will reduce or loose the carrying capacity affect the fulfillment of human needs leading to endangered organisms. For example, rapid population density and urban developments have caused   35% of the extinction of rare spesies around urban areas in England [5]. In China, based on land cover data during 1990-2010, Ecosystem degradation significantly occurred by land cover change and rapid population growth [6]. The highly average of land use-land cover changes since 1970 was influenced by rapid population growth and intensification of land use [7]. Habitat loss is an important factor causing global biodiversity [4].

Biodiversity is a totalyof gen, spesies and ecosystem in a region [8,9]. Celebes island is an island where rich in biodiversity. Loss on biodiversity, push and direct pressure will contribute to degradation of global biodiversity and ecosystem services [9].

Population growth and urban development along Palu bay cause land use change. The coastal area of Palu Bay was exploited by fishermen group and salt farmers. However, Now,

The coastal is developed as a tourist area, residential and industrials, espercially C quarry mining. The Green areas decrease from year to year due to pressing of settlement needs. It was found that greenery open spaces have decreased from 80.4 % to 78.8% in Palu city for 13 years from 1997 up to 2010 . Based on spatial image analysis, in 1997, The distribution of closure open green spaces occurred throughout the sub-districts in Palu City, while in the following year until 2010, the city center was only dominated by built up land [10].

The research is focused on the administrative area of Donggala District and Palu City that located along Palu Bay. The cities of Palu and Donggala have been developing rapidly since the establishment of Palu City as a special economic zone. City rapidly development cause reduced in biodiversity. The analysis of relationship between land use – land cover change and its impact on biodiversity is required for spatial planning at the local level. Proper and correct spatial planning can minimize the impact of land use change that threatens biodiversity as one of the most important natural resources and ecosystem balance. This study aims to determine the extent of land use changes to the potential loss of biodiversity in the Palu Bay and arrange the direction of space utilization in Palu Bay.

2 STUDY AREA

Palu Bay has a coastline with 10,066 ha of water area and 77.1 km in length. Palu bay is located at $00^o38'$ 14,14"– $00^o54'$ 5,48"South Latitude   and $119^o44'21,59"$ – 119° 51' 5180"East Longitude. Administratively, it includes Donggala regency and Palu city. The area covers 7 district namely East Palu, Ulujadi, West Palu, Banawa, Central Banawa, Rio Pakava, and South Banawa (Figure 1).

———————————————————
- *Lilik Prihadi utomo is a Doctor in Geography graduated from Gadjah mada University Yogyakarta Indonesia. Hp. +6285757410230. Email : lilik56@ymail.com.*
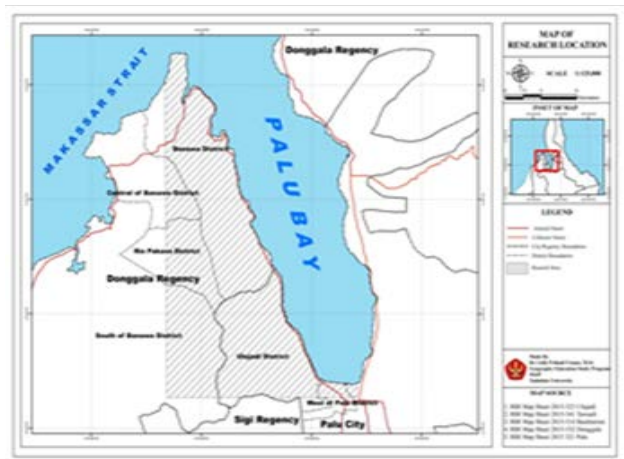.

Figure 1. Research Location

3. Procedure

This research used survey method with a spatial approach. The change areas were analyzed by overlay land use change during 2010 – 2016. Spatial data on land use changes are obtained at https://www.google.com/intl/en/earth/ site. The scale was 1: 175.000 at 2010, while during 2016, the scale was 1: 200.000. Scale was converted in order to uniform scale in the second data that is 1: 175.000, the consideration is the appearance of spatial data more clearly. The processing procedure performs digitization on each different image. The next step, overlay the results of digitizing to know the land use change. Uniform coordinate UTM (Universal Transfer Mercator) to get the area of observation in different years. Cleaning each polygon and ground check for data validation.

4   RESULT AND DISCUSSION

4.1 Land Use Change during 2010

During 2010, there have been 7 categories of land use namely settlement, field, shrub, garden, forest, swamp forest, and open space. The largest area was forest which covered 45,70% of total area, followed by shrubs 31,43% and fields 13,07%. The smallest area was open spaces covered 0,005% of total area. The largest forest area is in Banawa with an area of 2.802,62 Ha.

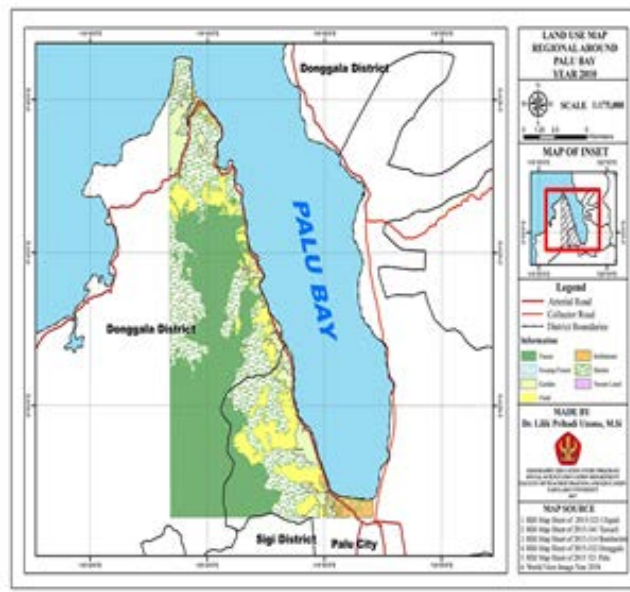| Types	Large (Ha)	Percent (%)
Settlement	630.25	2.98
Field	2.763.26	1.,07
Shrub	6645.96	31.43
Garden	1439.52	6.81
Forest	9665.30	45.70
Open space	1.16	0.01
Swamp Forest	2.26	0.005
Total	21.147.71	100

Figure 2. Land Use Change in Palu Bay during 2010

4.2 Land Use Change during 2016

In 2016, There were 6 categories of land use namely settlement, field, shrub, forest, garden, and open space. Some areas have been changed into settlement area to fulfill demand for housing as population growth.

Types	Large (Ha)	Percent (%)
Settlement	894.36	4.35
Field	3153.77	14.89
Shrubs	6743.61	31.89
Garden	1134.18	5.36
Forest	9060.05	42.84
Open spaces	161.74	0.77
Total	21147.71	100
Total	21.147.71	100

TABLE 2. Land Use Change in Palu Bay during 2016

Based on Table 2, The largest areas was forest which covered 42.84 % of total areas. Open spaces was the smallest area with covered 0.77% of total areas. During the 2016, there were not found Swamp forest. There were land use changes to settlement areas. The largest conversion area for settlement was found in Ulujadi as much 207.98 Ha.
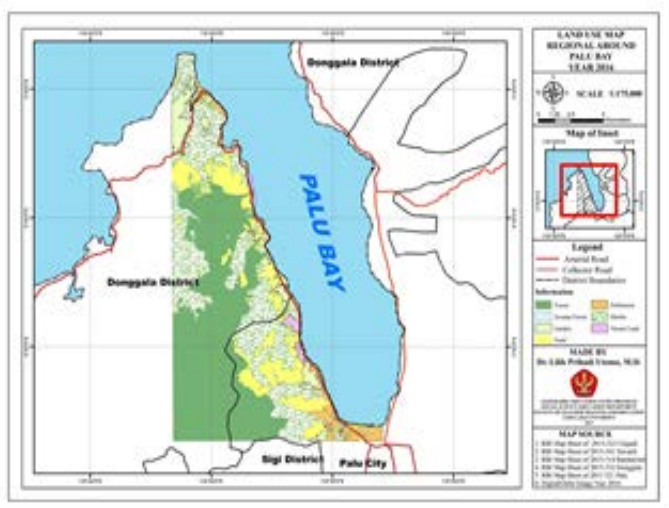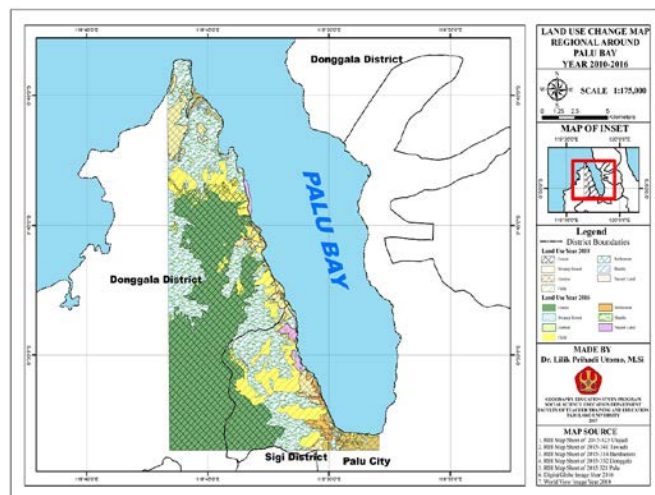
Figure 2. Land Use Change in Palu Bay during 2010

4.3 Land Use Change during 2010-1016

During 2010-2016, there is some land use changes (Table 3) as the city develops and population growth.

Landuse	Change
Settlement	264.11
Field	390.51
Shurb	97.65
Garden	-305.34
Forest	-605.25
Open Space	160.58
Swamp Forest	-2.26
Total	0.00

Note : - = reduced area

Table 3. Landuse Change during 2010-2016

There are 3 areas have reduced a namely garden, forest and Swamp forest. Settlement area increase as population growth and city develops. While open spaces indrease because there is a regulation that as city develop they have to provide an open space. The overlay is shown in Figure 4.

Figure 4. Overlay land use during 2010- 2016 along Palu Bay.

The survey showed rapidly settlement growth in some areas relate to city development. The establishment of Palu as a special economic zone have influence economy and population growth lead to land use change. There is some area that has changed. Conversion of shrubs become C quarry mining, mall, offices, and hotels was found in West Palu dan Donggala. While Conversion shrubs into settlement found in Silae villages. Shrubs are converted into tourist area is found in Banawa (Anjungan of Donggala).

4.4 Groundtruth

Based on the survey, in the district of Banawa, Central Banawa and South Banawa, there are mangrove conservation areas. There are 4 species of mangrove namely Rhizophoramucronata Lam, Rhizophoraapiculata Blume, Sonneratia alba Sm, and Avicennia alba Blume. The other plants such as Java wood Lanneacoromandelica, coconut Cocosnucifera, erminalia mantaly, Areca catechu, Leucaena sp, Muntingi acalabura, Jarrophacurcas, Casiasiamea, Musa sp, Samaneasaman (Jacq.) Merr, Swieteania mahagoni, Nypa fruticans Wurmb, Xanthosomasagittifolium L., Polyalthialongifolia, Mimusopselengi, Pterocarpusindicus, Cyrtostachyssp, Terminaliacatappa, Tamarindusindica, Bambusa Sp, Manihotesculenta, Carica papaya, Mangifera indica, Morinda citrifoliaL., Annona muricataL. Averrhoa bilimbi, Syzygium oleana, Moringa oleifera.

4.5 Discussion

The growing numbers and needs of populations will increase the need for housing, socia-economic and cultural life

activities. Increasing demand for land is not accompanied by quality and quantity of land. The limited land is causing mismatches of land use with the biophysical conditions and destingation of land [11]. Ulujadi sub-district, located in Palu, city is the biggest sub district experiencing land conversion. The conversion of forest into settlement areas lead to significant reduction in quantity and quality of tree species. The reduced vegetation will affect the runoff characteristics. Rainwater is not restrained by plant roots due to decline of vegetation. As a result, the rainfall becomes runoff that may lead to get flood. At the end of 2016, There were 3 sub-district in Ulujadi got flood causing many houses were submerged in mud. Flood damaged road, bridge, and waterways. The conversion of open land into built-up land causes reduced of infiltration. Thereby they increase runoff. Flood also causes the surface land becomes marginal because organic material is dissolved to the bottom of slope [12].

The expansion of environmental development to accomodate population growth will cause use of inefficient land resources [13]. Land use change is a complex process influenced by nature and human activities. Increasing of construction areas in urban will reduce vegetation, create high runoff, erosion, and sedimentation leading to land degradation [14]. Several causes of land degradation is caused by human activities [15]. The process of land clearing damages vegetation that cover the surface of soil causing erosion and flood. The implications are the loss of nutrients and organic materials lead to retreat of soil quality and effect on biodiversity [16].

3.6 Conformity Analysis with Palu Spatial Planning

Cities development without formal planning will affect biodiversity. Development housing and its associated services and infrastructure effect on ecosystems through land-use change. Based on map analysis and the 2010 Spatial planning of Palu City, the location of C quarry mining is a disaster-prone area which is not suitable for continuous exploration. It will negatively impact on distribution of plant in surrounding area of mining. There is a need for supervision from the government and related institutions so not to damage the biodiversity and environment around the mine.

The direction of development both Palu City and Donggala District is more to the coastal area which is built many settlements and public facilities. This will influence the plants in the coastal areas. If biodiversity gradually extinct so human beings will be threatened. It is urgent to conserve biodiversity and the environment that requires collaborative efforts across the landscape.

Land use planning is the most important physical plan in the process of spatial planning [17]. Control and allocation of optimally space use will direct land use in accordance with function and ability to support sustainable development. Land use directives to be aligned with land use patterns. Land use changes and regional policies must be based on thorough understanding of the ecological and social characteristics

City Development should concern to the concept of green city ecosystem. Preservation of biodiversity is essential through the implementation of sustainable development. Preservation of environmental carrying capacity of urban eco-

systems can produce a wide variety of environmental products and services to support the livelihoods. Management biodiversity occupies the green space elements in an urban spatial plan, either in the form of natural green open space built on public land and non-public land in protected area and or cultivation area [18]. Green space should be planted by endemic plant of Central Sulawesi such as ebony, moringa trees, mangrove, coconut trees or others endemic species.

4 CONCLUSION

City development and population growth causes land use change. During 2010-2016, Settlement, Field and Open spaces have increased by 264.11 Ha, 390.1 Ha and 160.58 Ha, respectively. In the contrary, forest and gardens have reduced as much 605.25 and 305.34 Ha, respectively. Some forest and shrub areas hve reduced and been converted to settlement and open spaces areas. Landuse change into settlement area will reduce biodiversity and may lead to disaster such as flood. Therefore, the direction of city development through sustainable developmeny should consider green ecosystem space to keep biodiversity. Some endemic plants should be planted in artificial green land such as mangroves, ebony, coconut tress, moringa and others and conducted the programs of conservation coastal areas.

REFERENCES

[1] S. Baja, *Land Use Planning in Regional Development Planning*, Andi, Yogyakarta, 2012.

[2] A.E. Obayelu, "Assesment of Land Use Dynamics and the Status of Biodiversity Exploitation and Preservation in Negeria", *J. for the Advancement of Developing Economics*, 3(1), 37-55, 2014

[3] A.M. Sanchez-Cuervo, A.M. Aide, M.L. Clack, and A. Etter, "Land Cover Change in Colombia : Surprising Forest Recovery Trends Between 2001 and 2010". *J. PloS One*, 7(8), 2001.

[4] E.O. Sala, F.S. Chaplin III, J.J. Armesto, E. Berlow, J. Blowfields, R. Dirzo, E.H. Sanwalds, L.F. Huenneker, R.B. Jackson, A. Kinzig, R. Leemans, D.M. Lodge, H.A. Mooney, M.Oestrheld, N.L. Poff, M.T. Sykes, B.H. Walker, M. Walker, and D.H. Wall, "Global Biodiversity Scenarios for the Year 2010", *J. Science*, 287, 1770-1774, April 2000. Available at http ://www.researchgate.net/publication/12606072

[5] B. Czech, P.R. Krausman, and P.K. Devers, "Economic Associations among Endangerment Species in the United States", *BioScience*, 50, 593-601, 2000.

[6] G. Zhao, L. Jiyuan, W. Kuang, Z. Ouyang and Z. Xie, "Disturbance Impacts of Land Use Change to Biodiversity PriorityAreas across Cina", *J. of Geographical Sciences*, 25(5), 515-529, 2015

[7] F.Alessandra, L. Maiorano, and L. Boitani, "Change in Land Use/Land Cover Patterns in Italy and Their Implications for Biodiversity Conservation", *J. landscape Ecol.*, 22, 617-631, 2007.

[8] A.J. Meduna, A.A. Ogunjinmi and S.A. Onadeko, "Biodiversity Conservation

Problem and Their Implication on Ecotourism in Kainji Lake National Park Nigeria", *J. of Sustainable Development in Africa*, 10(4), 59-73, 2009

[9]   A. Sutarno and D. Setyawan, "Indonesia's Biodiversity: Loss and Management Effort to Ensure the Sovereignty of the Nation". *Proc. National Seminary on Indonesia Biodiversity Community*, 1(1), March 2015.

[10] F. Ahmad, "Modelling of Urban Forest for the Amelioration of Microclimate in Palu City", PhD Dissertation, Bogor Agricultural Institute, Bogor, 2012, available at http://repository.ipb.ac.id/handle/ 123456789/58340.

[11] Ritohardoyo, S. "*Land Usage and Land Use*", Obor, Yogyakarta, 2013

[12] Aln. De la Cretaz and P.K. Barten, "*Land Use Effect on Streamflow and Water Quality in the Northeastern United States*", CRC Press, Florida, 2017

[13] L. Xu, Z. Li, H. Song, H. Yin, "Land use Planning for Urban Sprawl basel on the CLUE-S Model: A Case Study of Guang Zhou China, *Entropy*, 15(9), 3490-3506.

[14] Sun Yu, S.T.Y. Tong, M. Fang, and Y.J. Yang, "Exploring the Effects of Population Growth on Future Land Use Change in the Las Vegas Wash Watershed : An Integrated Approach of Geospatial Modelling and Analytics, Environ Dev. Sustain Dordrecht (NL): Springer Science Bussiness Media., 2013..

[15] K.T. Osman, "*Soil Degradation, Conservation, and Remediation*", Springer Science Business Media, Dordrecht, DOI: 10.1007/978-94-007-7590-9, 2014

[16] Surni, S. Baja and A. Usman, The Dynamics of Land Use Change, Land Cover to Biodiversity Loss in Tallo River Basin, South Sulawesi", *Proc. National Seminary on Indonesia Biodiversity Community*, 1(5), August 2015.

[17] E. Rustiadi, S. Saefulhakim and D. R. Panuju, "*Planning and Development Areas*, Pustaka Obor Foundation, Jakarta, 2011.

[18] C. Kusmana, "Biological Diversity (Biodiversity) as a Key Elements of Green Urban Ecosystem", *Proc. National Seminary on Indonesia Biodiversity Community*, 1(8), December 2015.