Evaluation of Zoning System in Gunung Palung National Park Using Satellite Images

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1. INTRODUCTION

National parks in Indonesia are managed by the zoning system to prevent conflict among protection, preservation, and utilization interests as well as to maintain the parks' benefits and functions. This zoning system is determined using a spatial analysis carried out by regarding the physics, biophysical, and socio-cultural communities. Lee et al. (2014) divided the zoning system for conservation purposes into three grades: 1) a conservation zone with restrictions on the use of artificial approaches; 2) a transition zone for visitor use, landscape formation, and management facilities; and 3) others—namely, a buffer zone to protect the conservation zone. Implementing a zoning system is expected to reduce unwanted forest coverage changes. Lung (2010) explained that land coverage has been defined as the earth's surface and immediate subsurface, including natural vegetation, crops, and human built-up structures; hence, land coverage change refers to the replacement of one coverage type with another. Thus, the trend of national park land coverage changes can be used as an indicator to measure the success of the zoning system implementation. This research analyzes forest coverage change patterns between the pre-implementation (2005–2010) and post-implementation (2010–2015) zoning system period.

2. STUDY AREA

The Gunung Palung National Park (GPNP) is located in West Kalimantan, Indonesia, and its zoning—designed in 2009—was effectively implemented in 2010. The zoning model was determined based on the Regulation of the Minister of Forestry No. 56/Menhut-II/2006 about National Park's Zoning Guidelines. Zones in the GPNP area consist of 1) Core Zone, 2) Wilderness Zone, and 3) other zones (Special Zone, Settlement Zone, Rehabilitation Zone, Utilization Zone, Religion Zone, and Traditional Zone). **Fig. 1** shows zones and their percentages in GPNP. The Wilderness Zone and Core Zone occupy the greatest area (47.49% and 32.78%, respectively), while the smallest zoning areas are covered by Settlement Zone and Special Zone (0.08% and 0.12%, respectively).

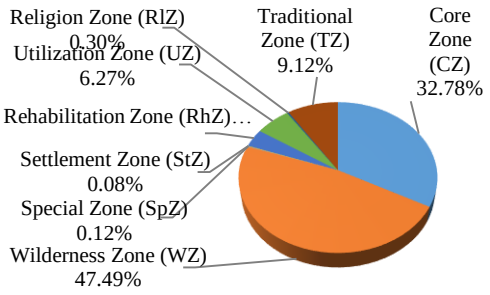


Fig. 1 Zone designations and their proportion in GPNP

3. LAND COVERAGE DERIVED FROM SATELLITE IMAGES

The dataset imagery interpreted in this research is from Landsat Thematic Mapper (TM) in 2005, 2010, and 2015 obtained from USGS and the vector data of the GPNP map (including the zoning map) from the GPNP office. Landsat imagery was analyzed using Erdas Imagine Software and Arc GIS 9.3.

GPNP land coverage was classified into 8 categories by considering the land coverage classifications released by the National Standard of Indonesia Agencies No. 7645 (2010). The supervised classification method was used to analyze time series imagery datasets of the GPNP area. **Fig. 2** shows the land coverage map derived from TM imagery.

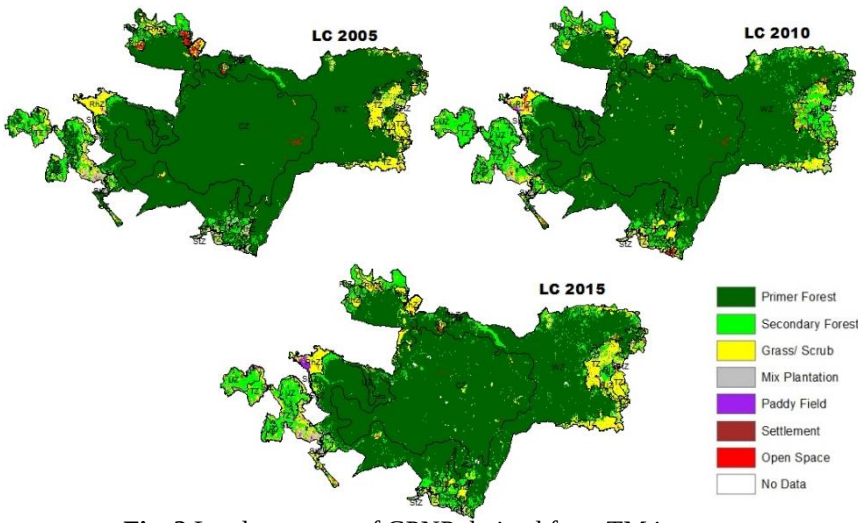


Fig. 2 Land coverage of GPNP derived from TM imagery

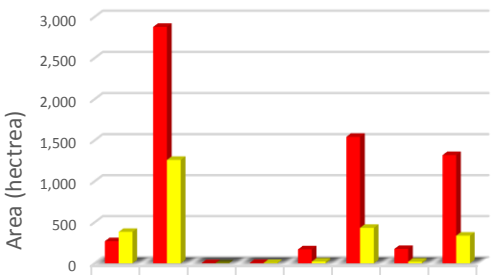
Zamzani (2008) stated that GPNP lost 3,686 hectares of forests at a rate of 0.6% annually from 1992 to 1999. The rate increased dramatically between 1999 and 2004, and the national park lost 9,148 hectares of forest land—or approximately 2.0% annually. These results indicate that GPNP is very vulnerable to changes in land coverage that cause the degradation of the national park area function as a conservation area. These land coverage changes in GPNP continued until 2015.

Table 1 shows the land coverage categories and their areas based on land coverage classifications from 2005, 2010, and 2015. Most GPNP areas are covered by primary forest: 83,008 hectares in 2005, although this significantly decreased to 74,689 hectares in 2015. Meanwhile, the size of secondary forest rose from 6,755 hectares in 2005 to 12,933 hectares in 2015. The area of paddy fields and settlement increased while other land coverage remained stable.

Table 1. Area (in hectares) of land coverage in GPNP

Land Coverage Category	Area (Ha)		
	2005	2010	2015
Primary Forest	83,008	77,040	74,689
Secondary Forest	6,755	14,429	12,933
Grass/Scrub	8,060	7,029	9,868
Mix Planting	1,831	1,126	1,537
Paddy Field	95	178	599
Settlement	15	66	119
Open Space	836	834	727
No Data	135	32	264
Total	100,735	100,735	100,735

4. CHANGES OF PRIMARY FORESTS IN EACH ZONE



	CZ	WZ	SpZ	StZ	RhZ	UZ	RlZ	TZ
2005-2010	270	2,879	2	5	171	1,543	176	1,321
2010-2015	384	1,262	0	3	22	434	20	338

Fig. 3 Land coverage degradation (in hectares) of Primary Forest in each zone

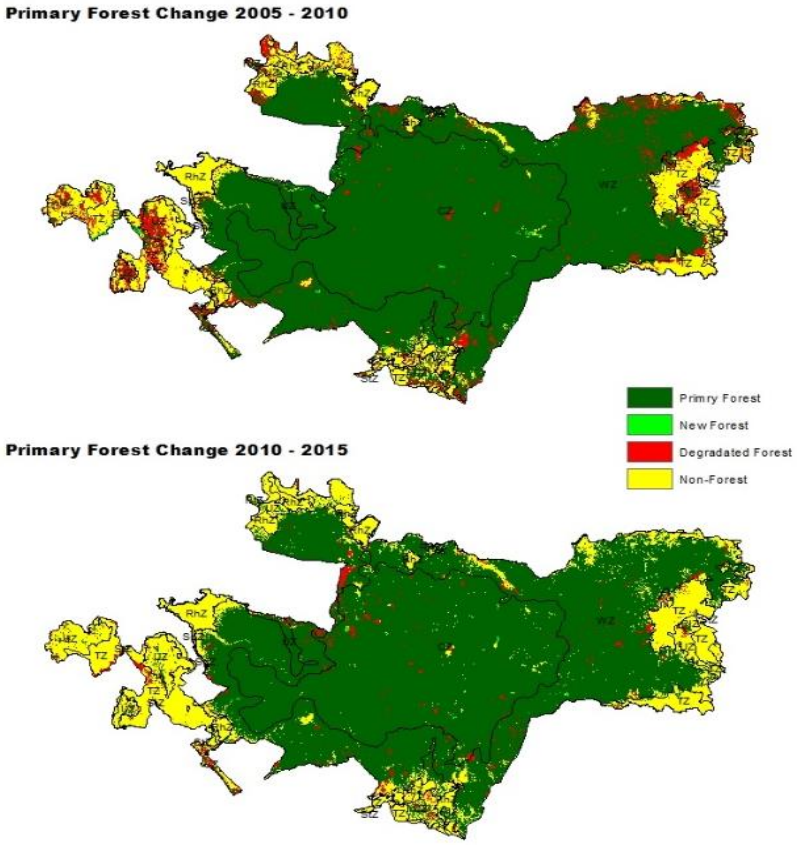


Fig. 4 Primary Forest changes of GPNP in 2005–2010 and 2010–2015

The changes of primary forest land coverage were examined to evaluate the effectiveness of the zoning system. For this evaluation, a land coverage map derived from TM imagery was overlaid on an existing zoning map. **Fig. 3** shows the land coverage degradation of Primary Forests during the two periods. Significant changes occurred in every zone between 2005 and 2010 except the Core Zone (CZ). Primary Forest degradation is the highest in the Wild Zone (WZ), reaching 2,879 hectares; between 2010 and 2015, it decreased to 1,262 hectares. Such trends are also evident in the Utilization zone (UZ) and Traditional Zone (TZ). Results of these analysis reveal that the zoning system is effective for reducing forest degradation in GPNP.

To find the location and distribution of Primary Forest change, four land coverage changes—Primary Forest (no change), new forest (other land coverage converted to forest), degraded forest (Primary Forest becomes non-forest), and non-forest—were derived by overlaying the land coverage map on the zone map. **Fig. 4** shows land coverage changes related to the Primary Forest.

In the period before the zoning system implementation, the most degraded forest (shown in red) between 2005 and 2010 were spread around the national park boundary (red color) whereas from 2010 to 2015, they had no characteristics. This happens because the GPNP area boundaries directly intersect near residential areas and plantations. Based on administrative data, GPNP is directly adjacent to six districts: Matan Hilir Utara in the south, District Sukadana in the west, Simpang Hilir in the north, Sungai Laur in the east, and the District of Sandai and Nanga Tayap in the southeast. However, this condition increases the risk of forest degradation as many people are engaged in the resources obtain within GPNP. Unfortunately, the existing zoning system restricts people's activity in each zone that could possibly increase the forest coverage change rate.

5. SUMMARY

The crosstab analysis of forest coverage patterns from two different periods in GPNP management showed that the rate of forest changes after implementation of the zoning system was lower than in the previous period. Therefore, based on the land coverage analysis (without considering the driving force behind the forest degradation), the national park zoning system is effective for reducing forest coverage changes in GPNP.

REFERENCES

Gunung Palung National Park. 2009. Zonasi Taman Nasional Gunung Palung.

Gwan Gyu Lee, Min Sun Kim, Jung Hwan Lee & Jae Jun Kim. 2014. Zoning Management by Quantitative Landscape Assessment for Forest Pathway – The Case of Forest Paths of The Mt. Jiri National Park, South Korea, Forest Science and Technology, 10:4, 179-189, doi:10.1080/21580103.2014.891538

Indonesia Ministry of Forestry. 2006. Regulation of the Indonesian Minister of Forestry No. 56/Menhut-II/2006. National Park's Zoning Guidelines. Indonesia – Jakarta.

Lung, Tobias. 2010. Assessing Processes of Long-Term Land Cover Change and Modelling Their Effects on Tropical Forest Biodiversity Patterns – A Remote Sensing and Gis-Based Approach for Three Landscapes in East Africa (Doctoral Dissertation). Dresden University of Technology. Retrieved from http://www.qucosa.de/recherche/frontdoor/?tx_slubopus4frontend [id]=6217.

Zamzani, Franky. 2008. Process of Deforestation and Agricultural Expansion in Gunung Palung National Park, West Kalimantan, Indonesia (Master Thesis).