

Land Use-Land Cover Changed Analysis in Ogan Watershed, South Sumatra During 2014-2019 Period

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Abstract

Land use-land cover (LULC) is one of the indicators commonly used in monitoring the quality of natural resources. Most of the Ogan watershed is a peat ecosystem that plays an important role in maintaining the balance of the ecosystem and water supply. During the 2014-2019 period the Ogan watershed experienced several wildfires and infrastructure development, particularly freeways. This study aims to analyze changes in the LULC in the Ogan watershed during the 2014-2019 period. LULC analysis uses remote sensing technology by utilizing Sentinel and Landsat satellite imagery data. LULC identification used the visual image interpretation method, while LULC changes were analyzed using the GIS technique with the spatial overlay method. The results showed that changes in LULC led to the LULC managed class, where the increase in area occurred in the rubber and oil palm plantation classes. Meanwhile, the highest reduction in area occurred in the dry land forest class. Changes in LULC that occurred during the observation period had a negative impact on the watershed in the form of land degradation, decreased levels of biodiversity and increased fire vulnerability. Based on these results, land use in the Ogan watershed needs to be controlled and land management practices must pay attention to environmental sustainability aspects.

Keywords

land use, land cover, land use-land cover changed, remote sensing, GIS

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1. INTRODUCTION

A Watershed is an area around a river body that has a conservation function for ecosystem balance (Beucher, 1982 ; Shao et al., 2019). Land use in the watershed area will change the hydrological system and have a negative impact on the ecosystem if it is not managed properly. Watershed areas that are used for built-up areas and infrastructure lead to a reduction in the catchment area and an increase in the volume of rainwater runoff to rivers. Meanwhile, the land conversion of watersheds to agriculture and plantations will cause changes in the hydrological system with the development of canals. An increase in the volume of water run into the river bodies and changes in the hydrological system in the watershed will increase the potential for flooding, especially in downstream areas.

South Sumatra Province is one of the developing and advanced regions in Indonesia, especially Sumatra Island. The South Sumatra region is crossed by several large rivers

and has a large peatland ecosystem. Several watersheds in the South Sumatra region are peatland ecosystems that have characteristics of hydrological inundation over years. In recent decades, peat fires in South Sumatra indicate that peat ecosystem management practices still need improvement (Elz et al., 2015 ; Miettinen et al., 2014 ; Miettinen et al., 2011) . The Ogan River Basin is one of the watersheds in the South Sumatra region where most of its area is a peat ecosystem (Wahyunto et al., 2004). The Ogan watershed has an important role for South Sumatra, especially the city of Palembang, which is the downstream area of the Ogan watershed.

The utilization of land in the Ogan watershed area will have an impact on the watershed's hydrological system and increase the potential for flooding in Palembang City, which is the capital of South Sumatra Province. Land use can be identified by LULC analysis using remote sensing technology utilizing satellite image data. Meanwhile, changes in

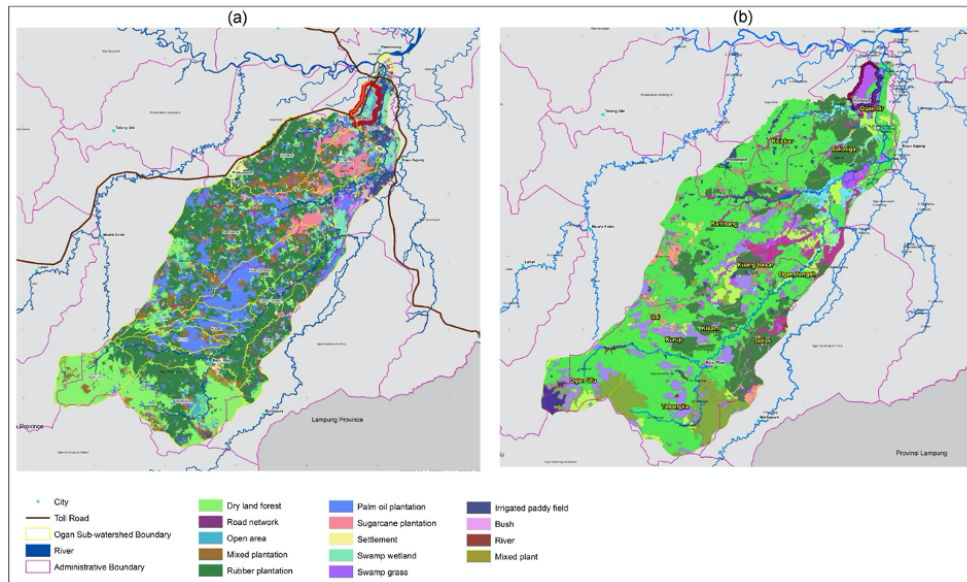


Figure 2. LULC in Ogan Watershed area (a) LULC 2019; (b) LULC 2014

The highest increase in area in the LULC class occurred in the rubber plantation and oil palm plantation classes. The increase in the area of the plantation type indicates the existence of land use efforts in the research location which are included in the South Sumatra peat ecosystem. The increase in the area of rubber plantations reached 35%, while oil palm plantations were around 83% of the area in 2014. The trend of increasing plantation area after the fire period, especially on peatlands, is in accordance with the results of previous studies (Miettinen and Liew, 2011 ; Miettinen et al., 2012), where the fire is used as a tool to prepare land for managed LULC (plantation) class. During the observation period, the study location which was dominated by peatlands experienced several fires with severe fires in 2015 (Putra et al., 2019a ; Putra et al., 2019b). Based on the function of the Ogan watershed, an increase in the area of plantation has a negative impact on watershed management practices because the changes that occur will affect the natural hydrological conditions of the Ogan watershed.

On the other hand, the change in LULC in the dry land forest class became the highest reduction in area at the study location. At least 36% of dryland forest area decreased during the 2014-2019 period. Spatially, the decrease in dry land forest area was caused by an increase in the area of the plantation, in other words, most of the dry land forest classes were converted to rubber and oil palm plantations. Land conversion from natural type (forest cover) to managed land requires land engineering, especially in the hydrological planning and vegetation planting sections. Changes in hydrological systems and vegetation that tend to be homogeneous have resulted in decreased biodiversity at the conversion area. The decrease in the level of diversity certainly has a negative impact on the sustainability of the

ecosystem in the research area.

The development of road infrastructure (road network class) is identified in the Ogan watershed, where the area of the road network in 2019 increased compared to 2014. An increase in the area of the road network was identified in the construction of the Palembang-Indralaya (Palindra) freeway on the north side of the Ogan Watershed area. The LULC type before the freeway was built was bush, swamp, and water body (river) class. The existence of the Palindra toll road causes the peatland ecosystem in the area to become drier in the dry season, so that the level of fire prone is higher (Pratiwi et al., 2021; Putra et al., 2019b). A recapitulation of changes in LULC at the study location is presented in Table 1.

4. CONCLUSIONS

Changes in the LULC that took place in the Ogan Watershed area during the 2014-2019 period mostly led to the type of managed LULC (plantation). The results of spatial analysis related to changes in LULC which are associated with a literature review show that the changes are negative. Changes in LULC have resulted in land degradation, decreased levels of biodiversity and increased potential for fires. In addition, changes in LULC are indicated to use fire as a tool of land preparation. This certainly contributes to climate change, where fires will emit carbon into the atmosphere (Latif et al., 2018 ; Page et al., 2002). Based on the research results, changes in the LULC in the Ogan watershed need to be controlled. On the other hand, land management practices in plantations and agriculture need to pay attention to environmental sustainability aspects to avoid negative impacts.

Table 1. Recapitulation of LULC changed in Ogan Watershed area

Land Use/ Land Cover	Area (Ha)		Changed	
	2014	2019	Ha	%
Dry Land Forest	217,000	139,689	-77,311	-35.63
Road Network	521,000	1,151	630,000	120.92
Open area	53,996	18,973	-35,023	-64.86
Mixed Plantation	62,593	75,442	12,849	20.53
Rubber Plantation	241,438	327,492	86,054	35.64
Palm Oil Plantation	66,588	121,872	55,284	83.02
Sugarcane Plantation	41,482	31,831	-9,651	-23.27
Settlement	16,167	28,312	12,145	75.12
Swamp Wetland	2,732	4,443	1,711	62.63
Swamp Grass	2,668	13,184	10,516	394.15
Irrigated Paddy Field	8,345	2,803	-5,542	-66.41
Bush	48,521	8,098	-40,423	-83.31
River	5,711	4,433	-1,278	-22.38
Mixed Plant	26,493	4,687	-21,806	-82.31

REFERENCES

- Beucher, S. (1982). Watersheds of functions and picture segmentation. *ICASSP '82. IEEE International Conference on Acoustics, Speech, and Signal Processing*, **7**; 1928–1931
- Elz, I., K. Tansey, S. E. Page, and M. Trivedi (2015). Modelling deforestation and land cover transitions of tropical peatlands in Sumatra, Indonesia using remote sensed land cover data sets. *Land*, **4**(3); 670–687
- Hooijer, A., M. Silvius, H. Wösten, S. Page, A. Hooijer, M. Silvius, H. Wösten, and S. Page (2006). PEAT-CO2. *Assessment of CO2 emissions from drained peatlands in SE Asia, Delft Hydraulics report Q*, **3943**
- Huijnen, V., M. J. Wooster, J. W. Kaiser, D. L. Gaveau, J. Flemming, M. Parrington, A. Inness, D. Murdiyarso, B. Main, and M. van Weele (2016). Fire carbon emissions over maritime southeast Asia in 2015 largest since 1997. *Scientific reports*, **6**(1); 1–8
- Latif, M. T., M. Othman, N. Idris, L. Juneng, A. M. Abdullah, W. P. Hamzah, M. F. Khan, N. M. N. Sulaiman, J. Jewaratnam, N. Aghamohammadi, et al. (2018). Impact of regional haze towards air quality in Malaysia: a review. *Atmospheric Environment*, **177**; 28–44
- Miettinen, J., A. Hooijer, J. Wang, C. Shi, and S. C. Liew (2012). Peatland degradation and conversion sequences and interrelations in Sumatra. *Regional Environmental Change*, **12**(4); 729–737
- Miettinen, J. and L. K. Liew, S. C ;and Kwoh (2011). Peatland deforestation in Sumatra and Kalimantan over the 1990s and 2000s. **119076**(April); 2000–2003
- Miettinen, J., C. Shi, and S. C. Liew (2011). Deforestation rates in insular Southeast Asia between 2000 and 2010. *Global Change Biology*, **17**(7); 2261–2270
- Miettinen, J., H. Stibig, and F. Achard (2014). Remote sensing of forest degradation in Southeast Asia—Aiming for a regional view through 5–30 m satellite data. *Global Ecology and Conservation*, **2**; 24–36
- Page, S. E. and A. Hooijer (2016). In the line of fire: the peatlands of Southeast Asia. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **371**(1696); 20150176
- Page, S. E., F. Siegert, J. O. Rieley, H.-D. V. Boehm, A. Jaya, and S. Limin (2002). The amount of carbon released from peat and forest fires in Indonesia during 1997. *Nature*, **420**(6911); 61–65
- Pratiwi, U. H., I. Eddy, S. Edward, and Ngudiantoro (2021). Hydrological characteristics analysis of Ogan Watershed, South Sumatra, Indonesia. *Ecology, Environment and Conservation Paper*, **27**(1); 427–435
- Putra, R., E. Sutriyono, S. Kadir, and I. Iskandar (2019a). Understanding Fire Distribution in The South Sumatra Peat Area during the Last Two Decades. *International Journal of GEOMATE*, **16**(54); 146–151
- Putra, R., E. Sutriyono, S. Kadir, I. Iskandar, and D. O. Lestari (2019b). Dynamical Link of Peat Fires in South Sumatra and the Climate Modes in the Indo-Pacific Region. *The Indonesian Journal of Geography*, **51**(1); 18–22
- Shao, Z., H. Fu, D. Li, O. Altan, and T. Cheng (2019). Remote sensing monitoring of multi-scale watersheds impermeability for urban hydrological evaluation. *Remote Sensing of Environment*, **232**(2018); 111338
- Turetsky, M. R., B. Benscoter, S. Page, G. Rein, G. R. van der Werf, and A. Watts (2015). Global vulnerability of peatlands to fire and carbon loss. *Nature Geosci*, **8**(1); 11–14
- Wahyunto, S. Ritung, Suparto, and S. H (2004). *Map of Peatland Distribution Area and Carbon Content in Kalimantan*. Wetlands International-Indonesia Programme, 1

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