Analysis of land cover changes within the working area of nagari forest: a case of Nagari Sungai Buluah Timur, Padang Pariaman District, West Sumatra

E Rosita¹, Yonariza², and F Asmin³

¹ Environmental Science Study Program, Andalas University Postgraduate Program, Padang, Indonesia
² Faculty of Agriculture, Andalas University, Padang, West Sumatra, Indonesia
³ Provincial Forestry Service of West Sumatra Province, Padang, West Sumatra, Indonesia

Email: evirosita.salmi@gmail.com

Abstract. Nagari forest is a social forestry scheme adopted in West Sumatra province to ensure the rights of the community to manage and ensure sustainable management of state forests. Analysis of changes in land cover can be an interesting study to identify the pattern of land use by the community after given the right to manage (permit). This study aims to analyze the change of land cover on the working area of nagari forest in Nagari Sungai Buluah Timur, Padang Pariaman district. The method used was spatial land cover analysis based on land cover data of the Ministry of Environment and Forestry in 2013 and 2017 validated with land cover data from Google Earth in 2014 and 2018. Field observations and interviews were also conducted to strengthen the analysis of the causes of the change. Based on the results of the analysis, land cover changes occur due to increased community agricultural cultivation activities after obtaining the right to manage. Changes occur from primary dryland forest and dryland farming to shrubs. Based on Google Earth interpretation, shrub cover also turns into dryland farming.

Keywords: spatial analysis, nagari forest management rights, establishment of work area

1. Introduction

The West Sumatra Provincial Government is one of the Indonesian provinces that is focusing on the expansion of the social forestry scheme, mainstreaming community-based forest management (CBFM or PHBM in Indonesian abbreviation). In accordance with the PHBM Development Roadmap in West Sumatra 2012-17, the provincial government agreed on a commitment to expand forest management practices by local communities covering an area of 500,000 ha by 2017 [1].

The initiation of expanding the social forestry scheme is based on the fact that the West Sumatran people have a high dependence on forests and forest products. According to data published by National Bureau of statistics [2], more than 54 percent of the West Sumatra population lives in the countryside or village called nagari and, according to data from the Ministry of Forestry [3], as many as 518 villages / nagari in West Sumatra are in and around the state forest areas. That are, rural communities, most of them are farmers, are also depending their lives on forests and forest products, both tangible and intangible benefits. However, approximately 69% of the poor in West Sumatra are in the countryside [2].

Village forest scheme, Nagari forest is a social forestry scheme adopted in West Sumatra province. One of the schemes is implemented in Nagari Sungai Buluah Timur. Central Government license of
Nagari Sungai Buluh Timur Forest based on Decree issued by the Minister of Forestry Decree Number. 856 / Menhut-II / 2013 dated on December 2, 2013 regarding Working Area of village forest covering an area of 1,336 ha and followed up by issuance of Nagari Forest Management Rights by the Governor of West Sumatra Number 522.4-789-2014 dated on October 16, 2014 with an area of 780 ha. The management of Nagari Sungai Buluh Timur Forest is carried out by the village government by setting up a unit called the Nagari Forest Management Task Force (LPHN) of the Sungai Buluh village established through the Decree of the Nagari Executive decision Number 02 / SK / WN-SB / 1/2014 dated on January 28, 2014.

Various studies related to implementation of Sungai Buluh Timur Nagari forest have been carried out. There was a research in 2017 which examined ecotourism development by measuring contributions of the nagari forest into the livelihood structure and its effect on nagari economy [4]. Meanwhile, another research concluded that community participation in Nagari Sungai Buluh Timur is sufficient in the management of the nagari forest [5]. These studies are in line with the goals of the Nagari forest development. However, land use and changing land cover after implementation of Nagari forest has not been examined; whole forest cover is an important indicator of a forest management. This study took this opportunity and aimed at identifying land use patterns in the nagari forest area as indicator of sustainable management of Nagari forests. This study analyzes changes in land cover and the causes of changes in the working area of the Nagari Sungai Buluh Timur Forest.

2. Method
This research was conducted from April to May 2018 at Nagari Sungai Buluh Timur Forest, Batang Anai District, Padang Pariaman, West Sumatera Province. The location of the research is shown in Figure 1. The site was selected based on consideration that this village is among the pioneer of village forest program implementation. Actually Nagari Sungai Buluh Timur was a sub-division of Nagari Sungai Buluh. Village forest in this Nagari is a state forest area belonging to protection forest category to which the management right for this forest area was granted to the community in 2014.

Data on forest biophysical characteristics collected were land cover in 2013 and 2017. Main data sources for forest cover were based on the Ministry of Environment and Forestry. To validate land cover data, this study also used land cover data from Google Earth in 2014 and 2018. Google Earth is a useful tool to validate and study land cover changes [6,7]. The accuracy of Google Earth can be relied on for land use analysis and land cover [7,8].

Data collection was also carried out through field observations and interviews. Field observations were intended to do ground check on land cover data, while interviews were intended to explore information about community land use. Interviews were conducted with key figure dealing with forest management within the management unit of village forest and leaders as well as people who are familiar with the condition of Nagari Sungai Buluh Timur Forest. In addition, documentary data collection was also carried out through the nagari profile and the Nagari Sungai Buluh Timur Forest document and the information, including other supporting data from the relevant agencies.
Figure 1. Location of the Nagari Sungai Buluah Timur Forest
Data analysis was conducted by using ArcGIS 10.3 which compares land cover changes in 2014 and 2018. Changes are discussed in the context of land use observed from field observations and interviews.

3. Results and Discussion

3.1. Overview of the Study Area
Nagari Sungai Buluh Timur is the easternmost nagari in Batang Anai sub-district, Padang Pariaman District, West Sumatra Province, which is located in forest boundary. The nagari area is 54.02 km² [9]. This Nagari consists of 7 Jorong (sub-villages), namely Kuliek, Salisikan, Kuliek Bukit Pagang, Kuliek Kapalo Banda, Salisikan Sironjong, Salisikan Lasuang Batu, and Salisikan Simpang Masjid. Nagari Sungai Buluh Timur is located in the expanse of the Bukit Barisan hills in the eastern part and the lowlands to the west, north and south. As of 2018, the population of Nagari Sungai Buluh Timur is 2,226 people belong 532 household.

Based on the functions of the forest area, Nagari Sungai Buluh Timur includes conservation forests, protected forests, and other land use area. Nagari Sungai Buluh Timur Forest is located in the Bukit Barisan Protected Forest area. Based on the analysis of land slope, the Nagari forest area has a flat slope (0-8 percent) covering an area of 133.60 ha, surging (8-15%) covering an area of 267.20 ha, rather steep (15% -25%) covering an area of 400.80 ha, and steep (25% -40%) covering 534.40 ha. Meanwhile, based on rainfall analysis from the Padang Pariaman Climatology Station (BMKG) in
February 2018, this nagari belongs to a high rainfall category, where the precipitation ranges from 200-300 mm/month.

Some land in the Nagari Sungai Buluah Timur Forest has become community farming areas. Based on field observations and interviews, many people cultivate rubber, *jengkol*, *durian*, and *petai*. Some land, especially in the upstream part, is maintained as a protected area to maintain water supply for agriculture and settlements. There are also some tourism attraction waterfalls inside the nagari forest area due to steep slope as mention earlier.

3.2. Land Cover
Changes in land cover were analyzed from land cover data released by the Ministry of Environment and Forestry for 2013 and 2017, as shown visually in Figure 2. In the 2013 data, the types of delineated land cover are primary dryland forests and dryland agriculture. In 2017, the types of land cover were delineated into five types of land cover, namely primary dryland forest, dryland agriculture, shrubs, settlements, and open land. Table 1 shows changes in the area of each land cover. The areas were compared according to the permitted working area (PAK) and according to the Nagari forest management rights (HPHN) given by the government.

| Types of Land Cover       | Area according to PAK (ha) | Area according to HPHN (ha) |
|---------------------------|-----------------------------|----------------------------|
|                           | Year 2013 | Year 2017 | Year 2013 | Year 2017 |
| Primary dryland forest    | 368.12    | 365.75    | 304.16    | 301.79    |
| Shrubs                    | -         | 52.55     | -         | 46.95     |
| Dryland agriculture       | 967.88    | 910.78    | 475.84    | 428.89    |
| Settlements               | -         | 4.55      | -         | -         |
| Open land                 | -         | 2.37      | -         | 2.37      |
Figure 2. Nagari Sungai Buluah Timur Forest Land Cover
Based on Figure 2, it can be seen that the community began to clear land in work area that had been given permission to cultivate dryland agriculture after the issuance of CBFM right. The shrub delineated in the figure indicates the activity of land clearing for agricultural cultivation.

The land cover was validated as seen in Figure 2 by using Google Earth. From the interpretation of land cover in 2014 and 2018 on Google Earth, the land cover is delineated as presented in Table 2 and Figure 3.

**Table 2. Changes in land cover area using Google Earth**

| Land Cover                  | Area according to PAK (ha) | Area according to HPHN (ha) |
|-----------------------------|----------------------------|-----------------------------|
|                             | Year 2014 | Year 2018 | Year 2014 | Year 2018 |
| Primary dryland forest      | 364.98    | 355.75    | 296.72    | 287.49    |
| Shrubs                      | 20.55     | 18.14     | 18.99     | 16.13     |
| Dry land agriculture        | 939.21    | 948.21    | 463.47    | 470.94    |
| Settlements                 | 2.77      | 3.04      | -         | -         |
| Open land                   | 4.56      | 7.21      | 0.82      | 5.44      |
| Rice Field                  | 3.93      | 3.65      | -         | -         |
Based on Figure 1 and Figure 2 above, there are differences in interpretation of land cover between the Ministry of Environment and Forestry land cover data and Google Earth. A ground check was conducted on various land cover observed by Google Earth. The results presented in Figure 2 indicate that various agricultural cultivation activities were carried out by the community in the working area of the nagari forest that had been granted permission.

3.3. Causes of Changes in Land Cover

Based on the results of spatial analysis, field observations, and interviews, changes in land cover occur due to changes in land use patterns at the community level as presented in Table 3. In general, changes occur due to the increase in community farming activities after obtaining permission to manage protected forest areas.
### Table 3. Changing Patterns of Nagari Sungai Buluah Timur Forest Land Cover

| No | Pattern Changes                      | Indications for Causes of Change                                                                                                                                                                                                 |
|----|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Primary dryland forest to dry land agriculture | There is land clearing activity for agricultural cultivation, for example, planted with chilies and turmeric, where the plant is planted under old stands or bigger plants namely *durian* and *jengkol*, tree crops. |
| 2  | Primary dryland forest to open land    | In addition to land clearing for agricultural cultivation, changes also occur due to landslides.                                                                                                                                 |
| 3  | Dry land farming to settlements       | There are several new houses caused by children or nephews who are new to the house and build houses.                                                                                                                            |
| 4  | Farming of dry land to shrubs         | There is an activity to change the type of cultivated plants developed by the community planting vegetables and spices among old plants (land with some durian trees and planted with annual crops) |
| 5  | Paddy fields to dry land farming     | There are several plots of rice fields that are turned into second food crops (*palawija*) fields which are planted with eggplant and vegetables.                                                                                       |
| 6  | Rice fields to settlements            | There are several rice fields that turn into houses.                                                                                                                                                                         |
| 7  | Shrubs to dry land farming           | There are agricultural cultivation activities after the land has been cleared before (for example there are already planted with cloves and *petai*) (planting seeds ex avocado, longan, mangosteen given by the Forestry Office) |
| 8  | Farming of dry land to open land      | - there are people who open new fields with some durian stems and according to the plan will be planted with mangosteen and *petai*  
  - some just cleared their fields which included *durian*, *petai* and *jengkol* plants where the owner of the farm cleared other crops besides the three plants and planned to plant agroforestry crops in the interlude of *durian*, *petai* and *jengkol* plants |
  - Location of the tree house  
  - Forest Fire  
  - The rock cliffs that have just been cleared  
  - Landslide |

Agricultural cultivation activities conducted by the Nagari Sungai Buluah Timur community have indeed led to land clearing in the working area of the Nagari forest. However, people usually plant land directly with various types of commercial tree crop such as rubber, *petai*, *jengkol*, and *durian*. Farmers in West Sumatra generally plant directly after land clearing [10,11]. Land clearing is usually carried out on forest lands that have been determined by considering the slope of the land. Steep land is usually maintained by its forest cover as a protected area. Recent research on nagari forest
management emphasized that the people of Nagari Sungai Buluah Timur manage the nagari forest by considering economic and ecological sustainability [12].

The planting also follows the pattern of agroforestry with a mixture of woody plants, fruit-producing plants and seasonal crops. In West Sumatra, the pattern of agroforestry is known as parak which has proven to provide social, economic and ecological benefits to the community [13-15]. Planting activities are also supported by the allocation of government activities through the West Sumatra Provincial Forestry Office and BPDAS Agam Kuantan. Activities carried out were in the form of nursery and planting in the working area of the nagari forest.

The granting of management rights in the form of nagari forests increases the activities of agricultural cultivation of the community, both in areas previously cultivated and in newly opened areas. Nagari forests provide certainty of state forest management rights to the community. This is part of increasing community participation in forest management. Community empowerment in forest management is important to ensure the protection and conservation of forest resources [16,17]. The community of Nagari forest managers needs to carry out forest management activities in accordance with the developing local wisdom and work plans communicated with the government.

4. Conclusion
Nagari Sungai Buluah Timur forest is managed by the local community after obtaining Nagari forest management rights (HPHN) from the Governor of West Sumatra since 2014. Based on an analysis of land cover changes in 2013 and 2017 according to Ministry of Environment and Forestry data, land cover changes occur due to extensive depreciation primary dryland forest and dry land farming into shrub. This change is caused by an increase in agricultural cultivation activities. However, based on the interpretation of Google Earth in 2014 to 2018, the extent of primary dryland forest cover has indeed decreased, but the extent of dry land agricultural cover has increased due to changes in bush cover to dryland agriculture. The causes of changes in land cover also occur due to the development of settlements and natural disasters (landslides and fires).

This study verifies that agricultural cultivation activities have increased after the granting the management rights (HPHN). This indicates the expansion of economic access for local communities who depended on forests. However further research needs to be done, especially to find out the socio-economic life of the local community after granting the HPHN and ensure the principles of sustainable forest management.

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