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Mapping of Tree Health Categories in Community Forests in Lampung Province

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Abstract. The sustainability of community forests in supporting various aspects of community life can be supported by maintaining their potential. One of them is through an assessment of the health of the trees. They know the condition of the damage and the actions that must be taken. The utilization of Geographic Information Systems (GIS) in assessing the health condition of the forest is very much needed to facilitate management through the health condition of a forest that is described spatially. The data analysis results showed 17 clusters of observation plots used in total. The cluster plots are spread over 5 clusters in good condition, and 1 cluster in lousy condition in East Lampung Regency. 6 clusters are in good condition, and 1 cluster is in moderate condition in Pesawaran Regency. And 2 clusters in good condition and 2 clusters in terrible condition in Tulang Bawang Regency. Overall, the average health condition of trees in community forests in Lampung Province is still in good condition. However, good management is needed to prevent the spread of damage from becoming more expansive. Preventive measures can be taken with good maintenance, pest eradication, and more organized harvesting. dilakukan dengan pemeliharaan yang baik salah satunya dengan pemberantasan hama penyakit serta pemanenan yang lebih terorganisir

Keywords: Community Forests, Geographic Information System (GIS), tree damage

1. Introduction

Lampung Province has a variety of community forests used as a source of livelihood and income by the community. Many products can be produced through various cropping patterns, both in timber forest and non-timber forest products [1]. Apart from the economic aspect, community forests also provide ecological and social benefits. Community forests can maintain the surrounding ecological conditions like forests in general [2]. Community forests are managed with various cropping patterns; each planting pattern has different management techniques and problems. It depends on the type and cropping pattern used [3].

The many benefits of community forests make various actions in management urgently needed. This action helps maintain forest sustainability so that the utilization and condition of community forests can be balanced [4]. Forest conditions can be assessed from the health of trees through observations of damage which are then mapped into several health categories [5]. Mapping the health condition of the tree is one of the developments of science related to forest management. Through



information data regarding damage, it is possible to overcome the damage that might be prevented as early as possible so that the damage that occurs does not worsen and spreads [6].

Data on tree health assessments can be combined using Geographic Information System (GIS) technology. GIS in forest health can make it easier for managers to see community forest health conditions [7]. However, community forests that are not healthy need to be handled, considering their function as supporters of people's lives. Thus, this study aimed to assess and map the health condition of trees through tree damage in community forests in Lampung Province.

2. Method

This study analyzes research data on community forests in 3 districts in Lampung Province, namely Tulang Bawang Regency, East Lampung Regency, and Pesawaran Regency. The research location can be seen in **FIGURE 1**. The tools used in this research are GPS (Global Positioning System) and handheld GNSS (Global Navigation Satellite System), which are used to obtain the coordinates of each cluster plot. In addition, a laptop equipped with ArcGIS 10.6.1 software was used to map tree health conditions in each district in Lampung Province. The material used is data on tree health conditions through the value of damage to each cluster plot in the People's Forest of Lampung Province.

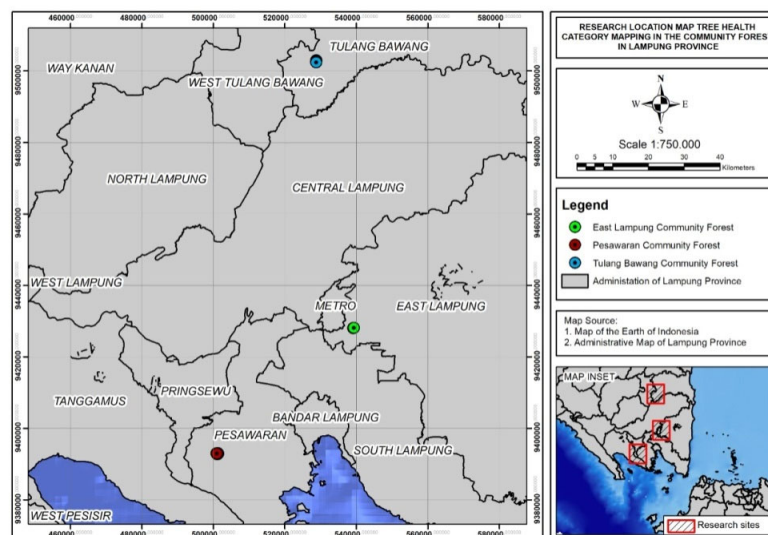


Figure 1. Mapping research location

The value of tree damage is obtained through the Cluster Plot Level Index (CLI) value. Previous studies have carried out calculations regarding CLI, namely in East Lampung Regency [7], Pesawaran Regency [8], and Tulang Bawang Regency. The CLI value is obtained by first looking for the TLI (Tree Level Index) value. The TLI value is obtained from the total index value of damage experienced by a tree. After obtaining the TLI value, the PLI (Plot Level Index) value is searched using the following formula [9].

$$TLI = [IK1] + [IK2] + [IK3] \quad (1)$$

$$PLI = \frac{\sum TLI}{\sum \text{Tree in plot}} \quad (2)$$

$$CLI = \frac{\sum PLI}{\sum Plot} \quad (3)$$

The CLI value is then used to find the range value in the Tree Health Value Category (KNKP) through the highest and lowest values of CLI in each plot cluster using the following formula [10]:

$$KNKP = \frac{NT - NR}{JK} \quad (4)$$

Where: NT = highest value of tree health in each plot cluster, NR = lowest value of tree health in each cluster plot, JK = number of tree health category classes (good, moderate, and bad).

3. Result and Discussion

East Lampung Regency used six observation clusters to represent the state of community forests there. The 6 clusters consist of 5 clusters with good conditions and 1 cluster with the lousy condition. Clusters with poor conditions were found in cluster 6, with the most dominant damage in open wound damage, broken branches, to cancer. The damage contributed significantly to the CLI value as presented in **TABLE 1**.

Table 1. . CLI value on cluster plots in the community forest, East Lampung Regency

Cluster plot	CLI	Category
1	2.0	Good
2	2.5	Good
3	2.5	Good
4	3.3	Good
5	2.5	Good
6	7.7	Bad

The cluster of observation plots used is spread out between 6 points. The distribution of the cluster plots is based on the type of cropping pattern as shown in **FIGURE 2**, which includes 2 clusters on a polyculture cropping pattern, 2 clusters on a monoculture cropping pattern, and 2 clusters on an agroforestry cropping pattern. Clusters of monitoring plots with poor conditions were found in community forests with agroforestry cropping patterns. The tree species observed included kapok tree (*Ceiba pentandra*), teak (*Tectona grandis*), and petai (*Parkia speciosa*). The lack of tree diversity causes the spread of pests and diseases more quickly, so the damage caused is varied [11]. Damage to open wounds and broken branches are some of the most common types of damage found in community forests [12]. While the type of cancer damage is damage with a high weighting value [13]. This damage can be caused by various factors, both biotic and abiotic [14]. Based on this, the damage value is relatively high, which impacts the high value of the damage index at the cluster level in the observation plot cluster.

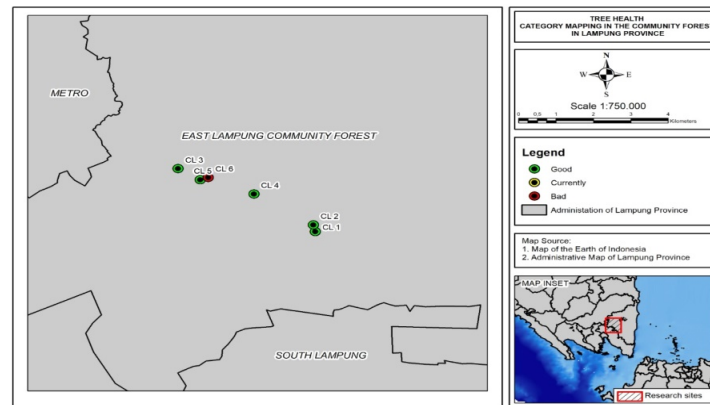


Figure 2. Distribution map of tree health categories in cluster plots in the community forest, East Lampung Regency

Seven cluster plots were used in community forests in Pesawaran District. The number of cluster plots used is based on a sampling intensity of 2.5% of the total observation area. The seven cluster plots are spread over several points, as shown in **FIGURE 3**, with 6 clusters in good condition and 1 cluster in moderate condition. Clusters in moderate conditions were found in the ninth observation plot cluster. Like East Lampung Regency, community forests in Pesawaran Regency are also planted with an agroforestry pattern. However, the tree species found were less diverse, including Wareng (*Gmelina arborea*), Waru (*Hibiscus tiliaceus*), Medang (*Phoebe bournei*), Bayur (*Pterospermum javanicum*), Tangkil (*Gnetum gnemon*), and Acacia (*Acacia* sp.).

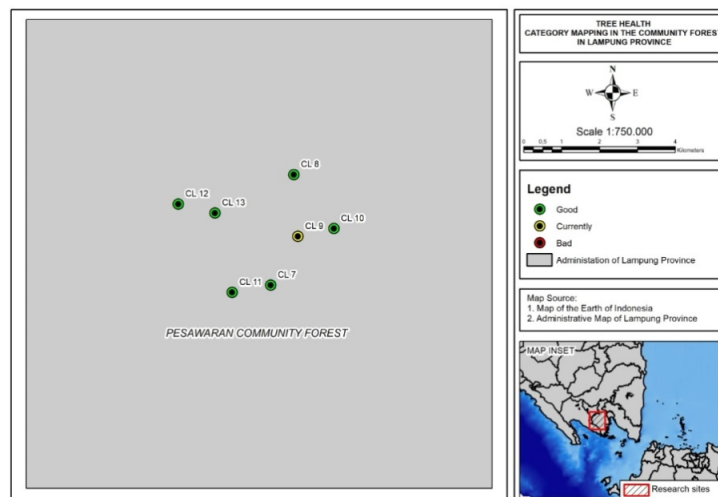


Figure 3. Distribution map of tree health categories in cluster plots in the community forest of Pesawaran Regency

The types of damage found included open wounds, lianas, damaged shoots, dead shoots, and broken/dead branches. Based on the damage, it is known that the cause of the damage was caused by pests and diseases [8]. This damage impacts the CLI value as presented in **TABLE 2**, which shows the health condition of a tree [5]. The damage experienced in cluster 9 is still classified in the moderate category. Control is needed to handle this damage by providing fungicides or cleaning up lianas that

spread and cause damage to trees [15]. This precaution is needed to ensure that the trees in the observation plot cluster do not suffer more severe damage to minimize losses if not handled as early as possible.

Table 2. CLI value on cluster plots in Pesawaran District community forest

Cluster-plot	CLI	Category
7	2.8	Good
8	3.3	Good
9	3.6	Moderate
10	2.2	Good
11	2.9	Good
12	2.7	Good
13	2.6	Good

In Tulang Bawang District, four plot clusters represent tree health conditions in community forests. The observed community forests have a monoculture cropping pattern based on rubber (*Hevea brasiliensis*). The four clusters observed were located on two different lands. Based on observations, it was found that 2 clusters were in good condition and 2 clusters were in bad condition as shown in **FIGURE 4**. Both clusters in poor condition were influenced by the type of damage found, namely leaf damage and cancer in rubber plants. Cancer damage is caused by fungal attacks on rubber tree tapping grooves [16]. Tapping grooves that are not given special treatment are susceptible to attack by pests and diseases.

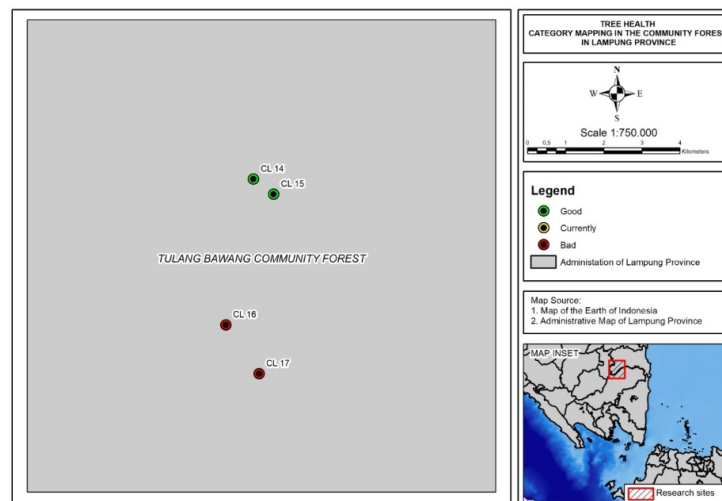


Figure 4. Distribution map of tree health categories in cluster plots in the community forest of Tulang Bawang Regency

Unlike before, the type of cancer damage was only found in a few trees in the cluster plot with health conditions, so that the CLI value obtained was relatively low, as presented in **TABLE 3**. Cancer damage to rubber plants could be prevented by applying fungicides to the tapping grooves after tapping [17]. In addition, tapping not too often and making tapping grooves that are not too deep to hit

the stem can also be used as an effort to prevent cancer damage [18]. Routine maintenance of community forests is very much needed. The aim is to prevent the spread of pest and disease attacks on plants. Monoculture planting patterns also have a high enough role against pests and diseases. Pests and diseases are generally easier to spread in community forests with monoculture cropping patterns [19].

Table 3. CLI values on cluster plots in the community forest of Tulang Bawang District

Cluster-plot	CLI	Category
14	1.4	Good
15	1.7	Good
16	6.0	Bad
17	6.2	Bad

Overall, the observation plot clusters used were 17 clusters spread over three regencies, namely 7 clusters in East Lampung Regency, 6 clusters in Pesawaran Regency, and 4 in Tulang Bawang Regency. The health condition of trees in each district is presented based on the condition of each observation cluster in the form of a map in **FIGURE 5**. Cluster plots with a good health condition are marked in green, moderate conditions in yellow and poor conditions in red. Based on this, it is known that there are 13 clusters of plots in good condition, 1 cluster in moderate condition, and 3 in lousy condition.

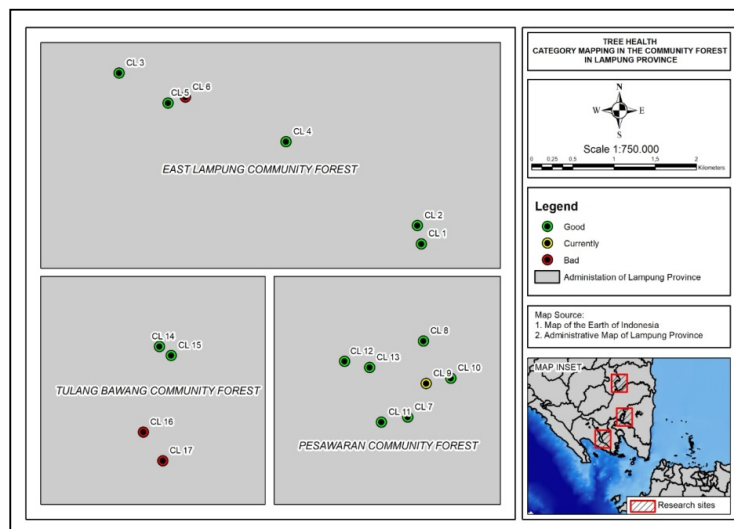


Figure 5. Mapping of tree health categories in community forests in Lampung Province

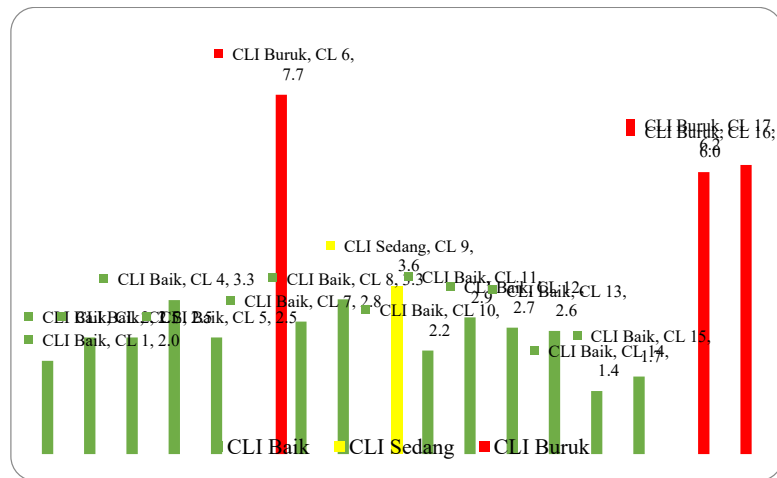


Figure 6. Comparison of CLI values in each cluster plot in the community forest of Lampung Province

Various factors can cause damage to trees. Some of them include the cropping pattern used, the type of tree planted, the area of land used, soil conditions, climatic conditions, pests and diseases, and so on [20]. Several factors can be taken to prevent the damage [21]. Climatic conditions significantly influence the damage [22]. Several cases show that pest attacks continue to increase due to climatic conditions that support the growth of these pests [18]. A humid climate is usually a condition that is vulnerable to pests and diseases [23]. Some of the damage supported by climatic conditions was in the form of fungal attacks that like humid climate conditions [24]. Trees with poor health were only found in a few clusters, and fungal attacks caused the most damage. These fungal attacks cause various damages that affect the CLI value, as presented in **FIGURE 6**. Fungi usually spread through the wind or puddles of water which then sticks to the surrounding trees [25]. This distribution makes the fungus usually found in clusters of trees [26].

4. Conclusion

Tree damage in community forests in Lampung Province was mapped based on the color of each cluster of observation plots. Plot clusters in good condition are marked in green, cluster plots in moderate condition are marked in yellow and cluster plots in poor condition are marked in red. Based on 17 clusters used in 3 regencies in Lampung Province, it is known that 5 clusters are in good condition and 1 cluster is in bad condition in East Lampung Regency. 6 clusters are in good condition, and 1 cluster is in moderate condition in Pesawaran Regency, and 2 clusters are in good condition, and 2 clusters are in bad condition in Tulang Bawang Regency. Overall the average health condition of trees in community forests in Lampung Province is in good condition. However, good management is needed to prevent the spread of damage from becoming more expansive. Preventive measures can be taken with good maintenance, one of which is the eradication of pests and diseases and more organized harvesting.

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