Analysis of the vitality of the *Agathis dammara* tree at Situ Gunung Resort, Gunung Gede Pangrango National Park

I R Maulana, Rahmat Safe’i* and Siti Fauzia Rochmah

Department of Forestry, Faculty of Agriculture, University of Lampung, Jln. Prof. Dr. Ir. Soemantri Brojonegoro No. 1, Bandar Lampung 35145, Indonesia

*Email: rahmat.safei@fp.unila.ac.id

Abstract. Vitality is the vigor value of the trees in responding to environmental conditions. Determined vitality value was by calculating tree damage and crown condition. The *Agathis dammara* tree is a native Indonesian plant in the Situ Gunung Resort, Gunung Gede Pangrango National Park (TNGGP). This study aims to determine the vitality and value of the health status of *Agathis dammara* trees at Situ Gunung Resort, TNGGP. The research location is in the utilization zone at the Situ Gunung Resort, TNGGP, covering an area of 700 ha. Built observation plots based on the Forest Health Monitoring (FHM) cluster plot design as many as nine cluster plots. They have calculated tree damage based on the location where found the damage was in the FHM method. Calculated condition canopy based on five parameters visual crown. Assessment of tree health status uses a forest health assessment information system. The results showed that the location where found the most damage was at the root and lower stem (code 2) as many as 67 trees, dominated by liana damage (code 20) as many as 43 trees, with an average damage level of 35%. The live crown ratio 20-35%, crown density 25-50%, foliage transparency 50-70%, crown diameter 2.5-10 m, and dieback 0-5%. The value of the health status of the *Agathis dammara* tree has a value of 1.69-2.44. Thus, these conditions illustrate that the vitality and value of the health status of *Agathis dammara* trees at Situ Gunung Resort, TNGGP are in the medium criteria and category.

1. Introduction

Gunung Gede Pangrango National Park (TNGGP) has a zoning form of management. The zoning system includes utilization zones, conservation zones, core zones, jungle zones, traditional zones, rehabilitation zones, and special zones. The zoning is spread over several resorts in TNGGP. One of the best management resorts is Situ Gunung Resort, located in Region II of TNGGP Management, precisely in Sukabumi Regency. Situ Gunung Resort has a utilization zone of 700 ha, which is dominated by a similar plant, namely Damar (*Agathis dammara*). This resin forest is an overflow of land belonging to Perum Perhutani, but it has turned into a TNGGP area over time. This zone is utilized in the form of environmental services, tourism, education, and conservation centers. In order to stay awake and well managed, the resin plant must have the right form of management.

Sustainable forest management can be achieved through forest health assessments [1]. Forest health is an indicator of sustainable forest management [2]. Forest health is a method used to monitor, assess, and report on the status, changes, and current trends in the long term of forest health using measurable ecological indicators [3]. Ecological indicators are used and adapted to local ecosystem conditions, which are dynamic, adaptive, and ensure the sustainability of forest resources [4].
One of the indicators to determine the health of the forest is the vitality indicator. Vitality is the value of tree strength in response to environmental conditions [5]. The vitality value is determined by calculating the location of the damage, the cause of the damage, and the severity of the damage. The condition of tree damage can indicate where trees are said to be healthy or sick [6]. Vitality is described by measuring the extent of tree and crown damage. This value was obtained from tree assessment using the Forest Health Monitoring (FHM) method.

Forest Health Monitoring (FHM) is a condition monitoring method introduced by the USDA for monitoring designed for forest health [7]. Forest health monitoring is needed to obtain reliable data to achieve sustainable forest management [8]. This is because the purpose of forest health assessment and monitoring is to achieve sustainable forest sustainability. Therefore, this study was conducted to determine the vitality and value of the health status of *Agathis dammara* trees at Situ Gunung TNGGP Resort. This study was conducted to determine the value of forest health status in Situ Gunung, Gunung Gede Pangrango.

2. Research methods

2.1. Research Time and Location

This research was conducted in July 2021. The research location was in forest *Agathis dammara* of Situ Gunung Resort, Gunung Gede Pangrango National Park.

![Location of the research plot cluster](image)

**Figure 1.** Location of the research plot cluster

2.2. Research Tools and Objects

This study uses the following tools: tally sheets, plastic labels, tacks, magic cards, binoculars, nails, compass, permanent marker, meter, tape meter (150 cm), Global Positioning System (GPS), and digital cameras. The objects in this study were nine cluster plots for Forest Health Monitoring (FHM) which contained teak stands at the seedling, sapling, pole, and tree phases.

2.3. Research methods

Forest health assessment was carried out using the FHM method [9]. FHM monitors forest health conditions introduced by the USDA for monitoring designed for forest health [1]. In addition, this method is used to determine the health assessment of community forests [10].
Determination of the number of Agathis dammara forest FHM clusters in Situ Gunung, GNP in this study was determined based on the research area multiplied by the sampling intensity. The result of this multiplication is that the area to be sampled is then divided by the area of the observation plot [11]. The area of the utilization zone is 700 Ha. The sampling intensity used is 0.5%. Therefore, while the area of the cluster plot is 0.4 Ha, the number of clusters created is 9 clusters of observation plots.

Vitality is known by observing the condition of tree damage and crown condition. Measurement of tree damage and crown condition was carried out on the trees in the subplot. Tree damage is identified from each damage that occurs in observations from the roots to the top of the tree. Observation of damage to trees can be done by looking at the location of damage, type of damage, and severity. The type of tree damage is a form of plant growth disturbance whose symptoms can be seen from the shape, size, color, and texture [12]. The type of tree damage in each part of the tree was assessed based on the severity threshold. The type of damage will be assessed if it meets the predetermined severity threshold. If the damage does not meet the severity threshold. The condition of tree level damage (Tree Level Index - TLI) is obtained based on the IK value for each tree using the formula:

\[ TLI = IK1 + IK2 + IK3 \]

The weighting values used in each location code, type, and level of damage to trees that make up the forest are different. The weighting values used in the data analysis are listed in Table 1.

### Table 1. Weighting values for each location code, type, and severity of trees making up the TNGGP Agathis dammara forest

| Tree damage location code | Weighted value (x) | Tree damage type code | Weighted value (y) | Severity code/tree damage | Weighted value (z) |
|---------------------------|--------------------|-----------------------|--------------------|----------------------------|--------------------|
| 0                         | 0                  | 01; 26                | 1.9                | 0                          | 1.5                |
| 1                         | 2.0                | 02                    | 1.7                | 1                          | 1.1                |
| 2                         | 2.0                | 03; 04                | 1.5                | 2                          | 1.2                |
| 3                         | 1.8                | 05                    | 2.0                | 3                          | 1.3                |
| 4                         | 1.8                | 06                    | 1.5                | 4                          | 1.4                |
| 5                         | 1.6                | 11                    | 2.0                | 5                          | 1.5                |
| 6                         | 1.2                | 12                    | 1.6                | 6                          | 1.6                |
| 7                         | 1.0                | 13; 20                | 1.5                | 7                          | 1.7                |
| 8                         | 1.0                | 21                    | 1.3                | 8                          | 1.8                |
| 9                         | 1.0                | 22; 23; 24; 25; 31    | 1.0                | 9                          | 1.9                |

Source: [13]

The condition of the tree crown in the FHM method was measured based on the following parameters: live crown ratio (LCR), crown density (Cden), foliage transparency (FT), crown diameter (CDWd), and dieback (CDB).

The value obtained from the measurement of the tree crowns that make up the Agathis dammara forest is coded according value class [14]. This code is used to determine the visual crown rating (VCR). Codes and value classes are presented in Table 2.
2.4. Data analysis
The final value of forest health condition is a condition that describes the health of the damar forest. The final value of forest health can be found using the following formula [9]:

\[ \text{NKH} = \sum (NS \times NT) \]  (1)

Information:
- \( \text{NKH} \) = final value of the health condition of the Agathis dammara forest
- \( \text{NS} \) = the value of the parameter score of the vitality indicator
- \( \text{NT} \) = total weighted value of the parameters of the indicator vitality

The score value (NS) was obtained from the transformation of the parameter values of each cluster plot with a score range of 1-10. While the weighted value (NT) is obtained by using the Analytic Networking Process. In this case, the weighted value for the vitality indicator parameter of crown condition is 0.22, and tree damage is 0.27.

3. Results and Discussion
Forest health assessment is primarily determined by indicators related to the main functions of the forest. In the assessment of forest health, each indicator plays a vital role in carrying out forest functions. For example, the vitality indicators have different priority values according to the conditions in Agathis dammara forest, TNGGP. The location of the damage to the resin tree can be seen in Figure 2.

![Figure 2. Distribution of tree damage locations in the damar forest](image-url)
The distribution of forest tree damage locations can be seen in Figure 2. The most damage in the resin forest was at the root and lower stem damage locations, as many as 67 trees. Other locations where damage was found the most were the location of the bottom and top, and the location of the top of the stem. The location of tree damage helps identify the type of tree damage that occurs because each location of damage has different characteristics or types of damage symptoms. The distribution of the types of damage to the resin tree can be seen in Figure 3.

![Figure 3. Distribution of tree damage types in Agathis dammara forest](image)

The type of damage that occurred at the forest stand location was dominated by liana damage found in 43 trees inhomogeneous forest stands around the observation plot cluster. In addition, the type of damage that occurred in other Agathis dammara forest stands was the type of damage to rust/tumor. The sensitivity level of trees susceptible to damage varies so that the severity of the intensity and type of damage experienced by trees varies. This damage can also be caused by pests and diseases [15]. Another indication of the cause is competition between trees in the forest area.

To determine whether a forest is healthy or not, it is necessary to calculate using the PLI and VCR formulas. In table 3, there are the results of the PLI and VCR calculations for the damar forest.

| Cluster Plot | VCR | PLI |
|--------------|-----|-----|
| 1            | 2.31| 4.63|
| 2            | 2.26| 3.47|
| 3            | 2.13| 4.73|
| 4            | 2.17| 3.90|
| 5            | 2.25| 1.94|
| 6            | 2.00| 3.27|
| 7            | 2.16| 3.69|
| 8            | 2.43| 4.27|
| 9            | 2.00| 0.33|

Table 3. Plot Level Index (PLI) and Visual Crown Ratio (VCR) for each cluster plot in Agathis dammara forest
The results of the tree health assessment that have been carried out on the three parameters of the location of damage, the type of damage, and the severity of the damage are then collected and calculated in the tree damage index. The lowest PLI value for tree damage is in cluster 9 with a value of 0.33, while cluster 3 has the most significant level with a value of 4.73. The higher the PLI value, the more severe the damage to the trees, whereas a low PLI value indicates that the level of tree damage that occurred was minor or not severe.

Observation of the crown condition was carried out by measuring the parameters of the survival crown ratio, crown density, crown transparency, crown diameter, and dieback. The condition of the crown can be known by looking at the value of the VCR. The smallest VCR value for tree damage was found in cluster plots 6 and 9 with a value of 2.00, while cluster 8 with a value of 2.43. The highest VCR value indicated that the crown had a good crown density. A good crown condition can be influenced by the availability of nutrients, sunlight, water, and sufficient growing space for the growth of the tree crown. The occurrence of damage to the low tree crown (CLI) affects the condition of the crown density. According to [13], dense tree conditions limit the space between trees to develop, especially in branch development. Competition between tree branches with each other opens up opportunities for many tree branches to be damaged. The high density can be interpreted that the tree has a crown cover with lush foliage so that the need for photosynthesis to support tree growth can be met [16].

The assessment of PLI and VCR results was used to calculate the final value of forest health conditions. The final value and condition of the *Agathis dammara* forest health category can be seen in table 4.

| Cluster Plot | Forest health final score | *Agathis dammara* forest health condition category |
|--------------|---------------------------|--------------------------------------------------|
| 1            | 18                        | Good                                             |
| 2            | 15                        | Good                                             |
| 3            | 14                        | Good                                             |
| 4            | 14                        | Good                                             |
| 5            | 10                        | Medium                                           |
| 6            | 8                         | Medium                                           |
| 7            | 11                        | Medium                                           |
| 8            | 19                        | Good                                             |
| 9            | 2                         | Bad                                              |

The value of the health status of the *Agathis dammara* tree has a value of 1.69-2.44. Thus, this condition illustrates that the vitality and health status of *Agathis dammara* trees at Situ Gunung Resort, TNGGP is in the medium criteria and category. The highest value in plot cluster 8 (eight) with a value of 19, and the lowest is in plot cluster 9 (nine) with a value of 2. This is influenced by the intensity of damage experienced by the number of trees in a stand. In general, forest management in TNGGP, especially the Situ Gunung Resort, is going good.

The level of forest health in TNGGP is influenced by several factors, including forest management, plant species, and human activities. However, national park forest management is the most critical factor. Therefore, urban forest management needs to be considered so that the health of the stands can be maintained. According to [17], maintenance actions are needed to overcome or prevent the development of the causes of damage so that trees can carry out their physiological functions usually.

Human activities also affect the health of the stands because there is some damage to the trees caused by human activities. Although open wounds are the most severe damage due to human activities such as improper pruning of branches and other activities either intentionally or unintentionally, animal activities also cause open wounds to appear. These open wounds can cause
cancer and wood rot fungus attacks. In addition, other activities such as trading activities (establishing a place to sell) can cause tree damage [12]

4. Conclusion
From an assessment of the *Agathis dammara* forest at the Situ Gunung Resort, TNGGP, there was damage with the highest number of trees located on the roots, and lower stems and many lianas were found. The final value of forest health obtained is 1.69-2.44, which means that the condition of the *Agathis dammara* forest at Situ Gunung Resort, TNGGP has medium criteria. The level of forest health in TNGGP is influenced by several factors, including forest management, plant species, and human activities. National park forest management is the most critical factor.

References
[1] Pratiwi L S and Safe'i R 2018 *Ecogreen* 4 9
[2] Safe'i R, Latumahina F S, Dewi B S and Ardiansyah F 2021 *BIODIVERSITY* 22 2072
[3] Safe'i R, Sari R N, Iswandaru D, Latumahina F S, Taskirawati I and Kaskoyo H 2021 *Annals of RSCB* 25 4400
[4] Safe'i R, Darmawan A, Kaskoyo H and Rezinda C F G 2021 *ICOSETH, J of Physics: Conference Series* 1842.
[5] Safe'i R, Hardjanto, Supriyanto and Sundawati L 2014 *JISBAR* 8 340
[6] Abimanyu B, Safe'i R and Hidayat W 2018 *JHPPK* 3 12
[7] Rochmah S F, Safe'i R, Bintoro A, Kaskoyo H and Rahmat A 2021 *ULICoSTE, IOP Conf. Series: Earth and Environmental Science* 739
[8] Ardiansyah F and Safe'i R 2020 *ACHOST: IOP Conf. Series: Earth and Environmental Science* 755
[9] Safe'i R, Hardjanto, Supriyanto and Sundawati L 2015 *J. Researcher. Plantation Forest* 12 175
[10] Ansori D P, Safe'i R and Kaskoyo H 2020 *Perennial Journal* 6 1
[11] Kustanti A 2011 *Mangrove Forest Management* (Bogor: Bogor Agricultural University Press) 248
[12] Safe'i R, Latumahina F S, Suroso E and Warsono 2020 *Plant Cell Biotechnology and Molecular Biology* 21 103
[13] Tsani M K and Safe'i R 2017 *Journal of Tropical Forests* 5 215
[14] Mangold R 1997 *Forest health monitoring: field methods guide* (USA: USDA Forest Service) 301
[15] Utari, V, Ekyastuti, W and Oramahi A 2017 *Journal of Sustainable Forests* 5 999
[16] Asriyanti W and Inmasari 2015 *Journal of Warta Rimba* 3 103
[17] Mamun 2016 *Forest Health Status in the PT Indominco Mandiri Coal Mine Reclamation Area, East Kalimantan* (Bogor: Bogor Agricultural Institute) 49