# Impact of lighting on damage of living and waste at community forest in Rajang village, Lembang district, Pinrang regency

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**Submission date:** 10-Mar-2023 11:16AM (UTC+0100)
**Submission ID:** 2033802929
**File name:** Mujetahid_7.pdf (1.27M)
**Word count:** 4242
**Character count:** 18751

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To cite this article: A Mujetahid *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **343** 012056

View the article online for updates and enhancements.

# Impact of lighting on damage of living and waste at community forest in Rajang village, Lembang district, Pinrang regency

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**Abstract**. This study aims to determine the form of damage from residual stand of trees and waste that occurs in logging activities in Community Forest in Rajang Village, Lembang district, Pinrang. The results of this study are expected to be useful as an information for the public and other stakeholders and could be considered in the decision-making in the forestry sector in carrying out the logging. This research was conducted in May and June 2015 at the Community Forest Rajang Village, Lembang, District Pinrang. Primary data were collected by interviewing the harvester and observation also measurement of residual vegetation waste that occurs, while secondary data obtained from research reports, institutions or agencies. The research showed that every 1 tree felling causes damage to remaining 2 trees with the extent of damage varies from heavy, medium and light but dominated with heavy damaged with logging waste that occurred is large enough up to 23%.

## 1. Introduction

Timber harvesting or forest exploitation consists of a series of elements of activity whose overall goal is to convert trees into other forms so that they can be moved directly at the point of sale so that in this way the economy and culture of the community will be more beneficial. One of timber harvesting activities series is logging which aims to make the size of the tree in the form of smaller dimensions. In the implementation of this activity, it will certainly clash directly with the existence of vegetation in the forest concerned.

As an impact of the harvesting of forest products, several problems will arise, including the presence of wood waste and damage of the remained residual stand due to the exploitation of the forest. The logging linkage that is part of forest harvesting against wood waste and damage to living stands, according to [1] damage caused by timber harvesting is not only in residual stands and soil but also under-storey and litter and waste produced.

The damage to the residual stand and the height of the waste due to logging is caused by improper felling direction, too close distance between stands, slope of the land, inadequate logging tools, high variation in tree age classes and due to low human skills. Based on this matter and noticing the facts in the field, it is necessary to conduct a study on the impact of harvesting activities on waste and residual stand damage that occur when logging was not carried out in a planned manner.

The research was conducted to find out (1) the form of damage to standing trees and (2) waste that occurs in logging activities. This research is expected to be useful as an information material for the

IOP Conf. Series: Earth and Environmental Science **343** (2019) 012056 doi:10.1088/1755-1315/343/1/012056

community and related parties and is taken into consideration in making decisions in the field of forestry, especially logging.

## 2. Research methods

*2.1. Place and time.* This research was conducted from May to June 2015 in the Rajang Village Forest in Lembang District, Pinrang Regency, South Sulawesi.

2.2. *Research tools and materials.* Tools and Materials used were meter tape, meter roll, compass, label paper, stake, raffia rope, *Tally Sheet*, writing stationery and camera.

2.3. *Data collection method.* Data collection methods used in this study were location observation and direct interviews in the field. The types of data obtained are:

*2.3.1. Primary data collection.* Primary data in the form of diameter, length/height of the tree to determine the volume of the stem, bearing size to determine the amount of waste produced and the number of trees to find out standing residences, besides secondary data obtained from books, results of previous research and related institutions or agencies become an important reference.

2.3.2. *Secondary Data Collection.* Secondary data taken, namely data such as stand potential before logging activities were carried out in the form of forest concession maps, topographic maps, and a list of names of trees in the forest area.

The level of damage to residual stand tree can be analyzed by calculating the number of trees cut and trees damaged by logging. Information on the extent of damage to residual stands due to logging activities, the formula used [2]

$$\mathbf{K = \frac{R}{P - Q} \times 10}$$

Where: K = Damage level of residual stands (%)
P = Number of trees 10 cm in diameter before logging (tree / plot)
Q = Trees cut number (trees/ha).
R = Trees damaged number due to logging

To find out the percentage of wood harvesting waste, a comparison between the volume of wood harvesting waste and the total volume of timber harvesting (stem volume plus the volume of wood harvesting waste) is used. The percentage of wood harvesting waste can be calculated using the formula [3]:

$$\textbf{\% Waste} = \mathbf{V1 / V2 \times 100\%}$$

Where: V1 = Wood harvesting waste volume that is not utilized.
V2 = The timber harvesting total volume that is expected to be utilized (Harvested waste volume + Logs transported volume).

Calculation of log volume which is expected to be utilized at the logging location is carried out using the Brereton formula [4] :

$$\mathbf{V = \tfrac{1}{4}\,\pi[\{(du + dp)/2\}/100]^2 \times t}$$

Where: V = volume ($m^3$)
π = 3.14
dp = base diameter (cm)

du = end diameter (cm)
t = length (m)

## 3. Resulth and discussion

### 3.1. Residual stands

*3.1.1 Pre-logging standing potential.* Based on the results of the study in the field, the number of trees above 10 cm in diameter with a logging area of 0.8 ha before logging was 546 trees. Grouping of trees based on diameter can be seen in Table 1.

**Table 1.** Number of trees before logging based on diameter class

| Plot | Diameter Class (cm) | | | | | Number (Tree) |
|---|---|---|---|---|---|---|
| | 10-19 | 20-29 | 30-39 | 40-49 | ≥50 | |
| 1 | 38 | 14 | 20 | 18 | 8 | 98 |
| 2 | 39 | 18 | 22 | 12 | 6 | 97 |
| 3 | 29 | 15 | 37 | 35 | 27 | 143 |
| 4 | 34 | 19 | 22 | 21 | 14 | 111 |
| 5 | 29 | 17 | 24 | 19 | 6 | 97 |
| ∑ | 169 | 83 | 128 | 105 | 61 | 546 |

Table 1 shows that the most dominant tree diameter class was the tree diameter class 10 cm - 19 cm which was 169 trees and the co-dominant tree diameter class was the class diameter of 30 cm - 39 cm which was 128 trees, while the lowest number of trees was in the class tree diameter ≥50 cm which was 61 trees. This is because planting and felling trees are not carried out simultaneously so that the size of the trees varies greatly. Tree logging carried out on a class of ≥20 cm in diameter, this is because the diameter class was considered to meet the logging requirements and in accordance with the purpose of timber utilization in the area to be sold to the wood processing industry or to local residents.

3.2. *Residual stand damage due to longging.* Damaged trees are trees that experience one of the following conditions: 1. Damaged headers >30% or broken branches; 2. Stem wounds >¼ circumference with a length of 1.5 m; and 3. Cut Rooting or broken [5]. One of the forms of damage to the residual stand that occurred was caused by a lack of skills of the loggers, who put aside the surrounding trees affected by felling trees so that the trees experienced physical defects.

**Table 2.** Number of trees by form of damage

| Damage Form | Plot (Tree) | | | | | Σ Tree | (%) |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | |
| Broken Header | 7 | 11 | 25 | 9 | 8 | 60 | 27 |
| Cracked Trunk | 2 | 0 | 3 | 1 | 2 | 8 | 4 |
| Broken trunk | 3 | 8 | 31 | 17 | 10 | 69 | 31 |
| Skin damage | 8 | 5 | 7 | 8 | 5 | 33 | 15 |
| Tilted | 1 | 2 | 9 | 0 | 3 | 15 | 7 |
| Collapsed | 3 | 1 | 11 | 6 | 13 | 34 | 16 |
| Broken Banir | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Σ Tree Damage | 24 | 27 | 86 | 41 | 41 | 219 | 100 |
| % Tree Damage | 28 | 31 | 81 | 49 | 57 | 50 | 50 |
| Average$^2$ | 3 | 4 | 12 | 6 | 6 | 31 | 14 |
| Σ Residual Stand | 63 | 59 | 20 | 43 | 31 | 216 | |
| Σ Tree | 87 | 86 | 106 | 84 | 72 | 435 | |

Table 2 shows the most common forms of damage to standing trees, namely trunk damage was 31% (69 trees) and 27% (60 trees) of canopy damage and 16% (34 trees) collapsed. The results of this research are not much different from the Matangaran's research (2003) which showed the greatest damage occurred in the form of broken rod damage of 42% and collapsing 28%. The difference in shape and percentage of damage to residual stands was caused by differences in stand density before logging. This is due to the large number of standing trees which are smaller in diameter than felled trees and have wide canopy crushed by logging trees.

The highest damage to the residual stand was found in the cutting plot 3, which was 86 of 106 damaged trees, and cutting plots 4 and 5, respectively 41 and 41 of 84 trees damaged and 72 trees and the most common form of stand damage was canopy damage and broken stems, this is because the felling plot has the highest logging intensity and has a tight spacing.

**Table 3.** Number of trees in cutting based on diameter class

| Plot | Diameter Class (cm) | | | | | Number (Tree) |
|---|---|---|---|---|---|---|
| | 10-19 | 20-29 | 30-39 | 40-49 | >50 | |
| 1 | 0 | 2 | 9 | 0 | 0 | 11 |
| 2 | 0 | 2 | 9 | 0 | 0 | 11 |
| 3 | 0 | 11 | 26 | 0 | 0 | 37 |
| 4 | 0 | 15 | 12 | 0 | 0 | 27 |
| 5 | 0 | 7 | 18 | 0 | 0 | 25 |
| Σ | 0 | 37 | 74 | 0 | 0 | 111 |

Table 3 shows that the diameter class of the logged trees was only from diameter of 20 cm - 29 cm to 30 cm - 39 cm class because the diameter class is considered to meet the logging requirements to fulfill the raw materials of the wood processing industry and local residents. Most logging was found in plot 3, 37 trees were cut down. This is because the logging plot is based on the diameter class of many trees that meet the logging requirements.

Based on the made measurements results, that obtained data from the logging activities of 111 trees which caused damage to residual stands only 219 trees, this means that every 1 logging tree resulted 2 damage residual stands of the trees. In contrast to the results of the research by [6] which stated that every 1 tree/ha logging causes 1 tree/ha residual damage, the difference in the results of this research is due to the different intensity of logging, density, and tree diameter. This research took the example of damaged tree diameter ≥10 cm, while the research of [6] took the example of damaged tree diameter ≥20 cm. in the activity of logging, damage can be grouped into several categories.

The category of residual stand damage due to logging that occurred in the research location can be seen in Table 4.

**Table 4.** Damage residual Stand Due to Logging Category

| Damage Form | Residual Stand Damage Category (Tree) | | | ∑ Tress | Average (Tree) | (%) |
|---|---|---|---|---|---|---|
| | Soft | Middle | Heavy | | | |
| Broken Header | 9 | 16 | 35 | 60 | 20 | 27 |
| Cracked Trunk | 3 | 2 | 3 | 8 | 3 | 4 |
| Broken trunk | 11 | 6 | 53 | 70 | 23 | 32 |
| Skin damage | 14 | 9 | 11 | 34 | 11 | 16 |
| Tilted | 1 | 4 | 10 | 15 | 5 | 7 |
| Collapsed | 3 | 7 | 22 | 32 | 11 | 15 |
| Broken Banir | 0 | 0 | 0 | 0 | 0 | 0 |
| Average | 6 | 6 | 19 | 31 | | |
| (%) | 19 | 20 | 61 | 100 | | |
| Total | 41 | 44 | 134 | 219 | | |

Table 4 above shows that damage to residual stands categorized as severe damage is 61% or 134 trees, then middle damage is 20% or 44 trees, and minor damage is 19% or 41 trees. The percentage of the category of severe damage in this research is 61%, whereas in Rohidayanti's research (2012) it was 49%. This percentage difference is caused by differences in tree density, logging intensity, and diameter limit of the damaged trees measured. This research took the diameter of the damaged tree ≥10 cm, while in the research of [7] took the diameter of the damaged tree ≥20 cm.

**Table 5.** Residual Stands Damage due to logging

| Plot | Potential Before Harvesting (Tree) | Number of trees cut (trees) | Number of trees damaged due to logging (trees) | Logging Damage (%) |
|---|---|---|---|---|
| 1 | 98 | 11 | 24 | 28 |
| 2 | 97 | 11 | 27 | 31 |
| 3 | 143 | 37 | 86 | 81 |
| 4 | 111 | 27 | 41 | 50 |
| 5 | 97 | 25 | 41 | 58 |
| ∑ | 546 | 111 | 219 | 50 |
| Average | 109 | 22 | 43 | 49 |

Table 5 shows that the residual stands damage is 50% (219 trees damaged), the average value of tree damage due to tree logging is 43 trees damaged, the biggest damage to trees is in plot 3,81% (86 trees damaged) and plot 4 and 5 each 50% (41 trees damaged) and 58% (41 trees damaged). 50% of residual damage is included in the category of middle damage. This is in accordance with [8] stating that damage <25% includes the minor category. 25% - 50% included as moderate damage category and > 50% included as the severe damage category.

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3.3. Utilization of logged timber from community forests

*3.3.1. Wood Processing Industry*. Timber products from community forests in Rajang Village, Pinrang Regency are processed by industries which are then sent out of the area to be used as furniture products such as Jepara. In the table below you can see the bearing diameter class produced from the logging plot.

**Table 6.** Bearing Diameter Classes

| Diameter Class (cm) | Bearing size | | | Volume ($m^3$) | Selling point/$m^3$ (Rp) |
|---|---|---|---|---|---|
| | Average length (m) | Average width (m) | Average Height (m) | | |
| 10-14 | 4 | 0.134 | 0.128 | 2.826 | 2.122.000 |
| 15-19 | 4 | 0.171 | 0.158 | 26.296 | 60.490.000 |
| ≥20 | 3.9 | 0.207 | 0.192 | 6.520 | 19.560.000 |
| ∑ | | | | 35.642 | 82.172.000 |
| Average | | | | 11.90 | 27.390.000 |

Table 6 shows that the bearing volume purchased by the wood processing industry was 35,642 $m^3$ at a price of Rp 82,172,000, the bearing price ± Rp 250,000 according to the bearing size. At 15 cm - 19 cm diameter class sizes produced the largest bearing volume, 26,296 $m^3$. While the class diameters of 10 cm -14 cm and ≥20 cm are only 2,826 $m^3$ with a selling price of Rp.2,122,000 and 6.52 $m^3$ with a selling price of Rp.19,560,000. This is due to the large number of small tree parts that make it possible to be the bearing size.

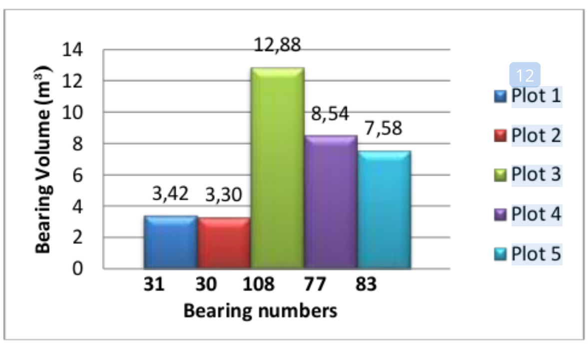


**Figure 1.** Industrial Bearing Volume

The picture above shows that the most logged bearing plots is logging plots number 3 which is 108 bearings or 12.88 $m^3$, while the logging plots which produce the least bearing is logging plots number 2 which is 30 bearings with 3.30 $m^3$ volume. This is because in the logging plot number 3, the number of logged trees is more than the other logging plots.

*3.3.2. Local people.* Parts of trees that has not met the requirements for bearing will be used as logs, these logs are purchased by local people to become economically valuable furniture products. Table 7 shows the amount of logs produced from the logging plot.

**Table 7. Amount of logs purchased by Local Residents**

| Logs size (m) | | Volume (m³) | Logged tree numbers (Tree) | Logs Numbers (log) | Selling point (Rp) |
|---|---|---|---|---|---|
| Average Length | Average Diameter | | | | |
| 1.939 | 0.242 | 28.605 | 111 | 79 | 3.160.000 |

Table 7 shows that 111 logged trees, the part of the tree that is logged is 79 parts or equal to 28,605 m³ with a selling point (value) Rp. 3,160,000, with a estimated price Rp. 40,000/log. This is due to the large number of small-diameter tree parts that do not meet the requirements to be bearings so they are used as logs to have economic value.

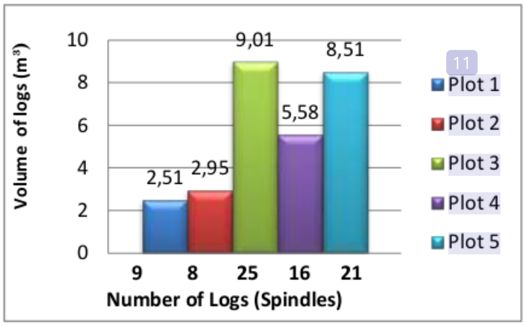


**Figure 2.** Spindles Used by Local People

The picture above shows that the logging plot that produces the largest volume of logs is plot 3, which is 9.01 m³ and plot 5 which is 8.51 m³, while the smallest log volume is logging plot 2 which is 2.51 m³. This is because the number of trees logged in the logging plot 3 and 5 is more than the logging plot 2.

### *3.3.3. Waste*

*3.3.3.1. Logged Wood Volume.* Research on the logged wood volume is an activity whose purpose is to interpret the amount of waste that occurs or lags at the logging location. The Number of logged wood volume that occurs in the logging plot can be seen in Table 8.

**Table 8.** Logged wood volume

| Plot | Real Log Volume (m³) | Logging waste Volume (m³) | Part Tree becomes waste | | |
|---|---|---|---|---|---|
| | | | T(m³) | B (m³) | BU(m³) |
| 1 | 6.6 | 2.44 | 0.07 | 0.87 | 1.5 |
| 2 | 6.41 | 2.48 | 0.06 | 1.12 | 1.3 |
| 3 | 21.51 | 8.44 | 0.26 | 3.48 | 4.71 |
| 4 | 14.65 | 5.59 | 0.18 | 2.21 | 3.2 |
| 5 | 16.47 | 6.66 | 0.14 | 2.97 | 3.55 |
| Σ | 65.64 | 25.61 | 0.72 | 10.65 | 14.25 |
| Average | 13.13 | 5.12 | 0.14 | 2.13 | 2.85 |

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Table 8 shows that the highest actual log volume measurements for the logging plots 3 are 21.51 m³ and the logging plot which produces the lowest actual log volume is logging plot 2, which is 6.41 m, this is because in plot 3 the number of logged trees is greater than the another logged plot another.

In the shown table above, it can be seen that there is a volume of logging waste of 25.61 m³ obtained from the overall logging waste. The largest logging wastes are found in plot 3 and smallest logging plots found in plot 1 which are 8.44 m³ and 2.44 m³ respectively. This is because in the logging plot 3 the number of logged trees is more so that it produces more waste compared to other logging plots. The largest part of the tree that produces waste is at the end of the stem from the total height of the tree which is equal to 14.25 m³. This is because the wood at the end of the tree trunk is wasted and is considered not to be eligible to be used as a bearing so that it has the potential to become a cutting waste.

*3.3.3.2. Definition of community forest logging waste in rajang village.* Based on the research results in Community Forest logging in Rajang Village, the waste obtained from logging in the community forest, which was deliberately abandoned/left because it was considered to be of no economic value and had not fulfilled the requirements to be used as bearings or logs. The volume of logging waste obtained from the results of measurements in the field can be seen in Table 9.

**Table 9.** Logging Waste Volume

| **Plot** | **Logging Waste Volume** | | | **% Volume** |
|---|---|---|---|---|
| | Average Diameter (m) | Length average (m) | Volume (m³) | |
| 1 | 0.45 | 3.82 | 2.44 | 9 |
| 2 | 0.44 | 3.26 | 2.48 | 10 |
| 3 | 0.45 | 3.63 | 8.44 | 33 |
| 4 | 0.44 | 3.62 | 5.59 | 22 |
| 5 | 0.5 | 4.01 | 6.66 | 26 |
| Number | | | 25.61 | 100 |
| Average | | | 5.12 | 20 |

Table 9 shows that the waste that occurred in each logging plot 20% averaged or 5.12 m³/plot of 25.61 m³ total volume. The logging plot that produces the largest waste is logging plot 3 which is equal to 33% (8.44 m³) while the plot that produces the smallest waste is logging 1, which is 9% (2.44 m³).

*3.3.3.3. Wood Potential Wast.*

Waste is a part of the tree that should be utilized, but because of various reasons, it is to be left in the forest [5]. Potential waste is wood waste which is considered to be able to be utilized (potential) but because it has to be abandoned in the logging location. The percentage of waste at the felling location can be seen in Table 10.

**Table 10.** Wood Waste Actual Percentage in the Logging Location

| Plot | Log Potential Volume (m³) | Real Waste Volume (m³) | Waste Percentage % |
|---|---|---|---|
| 1 | 7.595 | 0.992 | 13 |
| 2 | 7.573 | 1.159 | 15 |
| 3 | 25.324 | 3.818 | 15 |
| 4 | 16.688 | 2.037 | 12 |

| | | | |
|---|---|---|---|
| 5 | 19.438 | 2.968 | 15 |
| Total | 76.618 | 10.973 | 14 |
| Average | 15.324 | 2.195 | 14 |

Table 10 shows that from 76,618 m³ potential log total volume, 10,973 m³ produced waste. The area that produces the most waste is a logging plot 3 of 15% or 3,818 m³ and a logging plot 5 is around 15% or 2,968 m³. This is because in the logging plot 3 the number of trees logged is more copared to other logging plots.

## 4. Conclusions

Based on observations obtained from logging activities carried out by the community in the Rajang Community Forest in Lembang Sub-District, Pinrang Regency, conclusions can be made: Of the 111 trees logged, each 1 logged tree caused damage to residual stands of only 2 trees with varying degrees of severity, medium and light which is dominated by the level of heavy damage. The percentage of wood waste due to logging in the Community Forest of Rajang Village, Lembang Subdistrict, Pinrang Regency of the potential volume was 111.88 m³ of waste which was 23%.

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