# THE EFFECTS OF CONTROLLED SKIDDING TECHNIQUE ON RESIDUAL STAND DAMAGE AND GROUND EXPOSURE IN SWAMP FOREST LOGGING

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## ABSTRACT

The case study was carried out at a swamp forest company in Riau in 2001. The aim of the study was to determine the effect of controlled skidding technique to residual stand damage and ground exposure. Data collected includes: felled trees, poles, trees with the diameter 20 cm up, damaged poles, damaged trees and ground exposure. The data was analyzed with t-test. The study showed the following results:

1. The average of residual stand damage caused by controlled skidding technique was 29.05% for poles and 19.8% for trees. The average of residual stand damage caused by conventional skidding technique was 34.2% for poles and 24.9% for trees. The difference of 5.1% (poles) and 5.1% (trees) were significant at 95%.
2. The average of ground exposure caused by controlled skidding technique and conventional skidding technique was respectively 16.06% and 18.4%. The difference of 2.34% was significant at 95%.

Key words: controlled skidding technique, residual stand damage, ground exposure

## I. INTRODUCTION

Log extraction on swamp forest is different with that on dryland forest. In the case of swamp forest tractors or logging trucks can not be used for log extraction. Instead log extraction is usually carried using "ongkak"[2] (for log skidding) which is also known as "kuda-kuda" system and log is transported using lorries.

Log skidding with "kuda-kuda" system is operated after the skidtrail have been prepared. The activity is usually carried out by a team consisting of 6-10 people. Productivity of this system is relatively low. Suhartana (2000) showed that average of work productivity of conventional skidding with "kuda-kuda" system is 14.35 $m^3$ hm/hour. The system also causes a relatively high residual stand damage and a wider ground exposure. Suhartana *et al.* (2000) also noted that residual damages of trees, poles and ground exposure caused by conventional skidding are: 28.54%; 38.66% and 19.84% respectively.

To ensure the sustainability of swamp forest and the log production, a controlled log extraction technique including controlled skidding technique is necessary. Skidding activity should confirm with the TPTI [3] system. It is determined in TPTI that skidding operation must be preceded by skidtrail preparation. With a good planning, residual stand damage and ground exposure can be minimized.

The aim of this study is to determine the effect of controlled skidding technique to residual stand damage and ground exposure. The target of the study is to obtain more information about performance of the techniques related to residual stand damage and ground exposure aspects.

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2 Ongkak is a wood tool for log skidding through a wood construction road at swamp forest.

3 TPTI is a system where commercial trees with diameter of 50 cm and up in permanent production forest and diameter of 60 cm and up in limited production forest are removed, leaving a minimum of 25 young commercial and healthy trees with diameter of 20 cm and up per hectare and distributed evenly in the area. The cutting cycle of the TPTI system is 35 years.

## II. MATERIALS AND METHOD

### A. Time, Location and Tools

The study was carried out at a swamp forest belonging to PT Diamond Raya Timber in Riau in 2001. This concession is located in Rokan Hilir Sub Forest District, Riau. The slope of the area is generally between 0-10% at the altitude of 0-25 meter above sea level. Swamp Meranti and Ramin trees dominate the area. Stand density is 105-140 trees/ha (for diameter of 10 cm and up), and the trees are mostly buttressed. The brushwood density is relatively high. Logging is done by chainsaw for felling and bucking, "kuda-kuda/ongkak" for skidding and lorries for transportation .

The object of the study was located at site No. 701, felling block of the year 2001. The tools used for study were ruler, helling meter, compass, plastic rope, stop watch, paint, paint-brush and "ongkak".

### B. Procedure

Data were collected by direct field measurement and interview with labours . The steps were as follows:

1. Define a felling site that would be respectively felled and skidded.
2. From the chosen felling site, four plots of 100 m x 100 m each for controlled skidding technique and four plots for conventional technique were made.
3. Felling and skidding were done according to the following method:

**At the controlled plot**

1. Skidtrail was planned based on the topography and trees distribution. Skidtrail was made as short as possible and as much as possible avoiding another residual stand.
2. Brushwood around trees that will be felled was cleaned.
3. Felling direction was defined to avoid damage of nucleus trees, mother trees, ravine and residual stand around the felled trees.
4. Cutting buttress of trees with buttress .
5. Under cut and back cut were set with maximum height of 54 cm.

**At the conventional plot**

The technique of felling and skidding operations was done according to the local logging practices.

The parameter were:

1. Residual stand damage caused by skidding.
2. Number of stands with diameter of 10 cm and up before and after skidding.
3. Ground exposure caused by skidding.

Tree damage was valuated based on criteria of Directorate General of Forest Utilization (1994), i.e. :

(1) Canopy damage was more than 30% or main branch was broken.

(2) The injury trunk was more than 1/4 arround trunk with the length of 1.5 meter.

(3) The root was cut or 1/3 from its buttress was damaged.

A tree was considered damaged if one or more of the criteria was shown.

### C. Data Analysis

**1. Poles damage (Pd)**

Residual stand damage for poles, called poles damage, was calculated using the following formula:

$$Pd = \frac{Sdp}{Sp} \times 100\%$$

where: Pd = Poles damage (%); Sdp = Sum of damaged poles (poles/ha) and Sp = Sum of poles before felling (poles/ha).

**2. Tree damage (Td)**

Residual stand damage for trees, called tree damage, was calculated based on percentage of sum of tree damage to sum of healthy trees. Tree damage caused by skidding was calculated with the following formula:

$$Td = \frac{Std}{T\text{-}Sft} \times 100\%$$

where: Td = Tree damage (%); Std = Sum of trees damage (trees/ha); T = Sum of all trees before felling (trees/ha) and Sft = Sum of felled trees (trees/ha).

**3. Ground exposure**

Canopy exposure was projected on the forest floor and measured with millimeter block or plannimeter to calculate its percentage to logged area.

Data of controlled skidding technique were compared to the conventional technique using t-test (Steel and Torrie, 1976).

## III. RESULT AND DISCUSSION

### A. Residual Stand Damage

Number of residual stand damage for poles caused by controlled skidding and conventional skidding techniques was presented respectively in Table 1 and Table 2 , and for trees in Table 3 and 4.

Table 1. Pole damage caused by controlled skidding technique

| Plot | Poles density (Poles/ha) | Felled trees (Trees/ha) | Slope (%) | Damage (Trees /ha) | Damage (%) |
|---|---|---|---|---|---|
| 1. | 35 | 6 | 2 | 9 | 25.7 |
| 2. | 47 | 7 | 4 | 17 | 27.7 |
| 3. | 58 | 12 | 8 | 19 | 32.8 |
| 4. | 50 | 10 | 5 | 15 | 30.0 |
| Σ | 190 | 35 | 17 | 60 | 116.2 |
| M | 47.5 | 8.75 | 4.25 | 154 | 29.05 |
| SD | 9.5 | 2.75 | 3.3 | 3 | 3.06 |
| CV(%) | | | | | 10.5 |

Remarks: Σ = Sum; M = Mean; SD = Standard deviation; CV = Coefficient of variation.

Table 1 shows that controlled skidding activity causes poles damage between 25.7-32.8% with an average of 29.05%. On the other hand Table 2 shows that conventional skidding technique caused poles damage between 33.3-35.7% with an average of 34.2%.

Table 2. Pole damage caused by conventional skidding technique

| Plot | Poles density (Poles/ha) | Felled trees (Trees/ha) | Slope (%) | Damage (Trees /ha) | (%) |
|---|---|---|---|---|---|
| 1. | 55 | 9 | 8 | 19 | 34.5 |
| 2. | 30 | 5 | 2 | 10 | 33.3 |
| 3. | 45 | 8 | 4 | 15 | 33.3 |
| 4. | 56 | 10 | 5 | 20 | 35.7 |
| Σ | 186 | 32 | 19 | 64 | 136.8 |
| M | 46.5 | 8 | 4.75 | 16 | 34.2 |
| SD | 12.06 | 2.16 | 2.5 | 4.55 | 1.14 |
| CV(%) | | | | | 3.3 |

Remarks: Σ = Sum; M = Mean; SD = Standard deviation; CV = Coefficient of variation.

Based on the pole damage, controlled skidding was better than conventional skidding technique (t-cal = 3.124*, t-table 95% = 2.447). Hence if the controlled skidding technique is implemented, it can minimize pole damage about 5.1%. CV's value of poles damage of controlled skidding technique was higher than that of conventional skidding technique (Table 1 and Table 2). It means that poles damage variation on controlled skidding technique was higher than that on conventional skidding technique. However, skidding technique using excavator is better than the controlled skidding method (Suhartana *et al.*, 2000). This is probably caused by a high floatation of the machine for operating on wet area.

Table 3. Tree damage caused by controlled skidding technique

| Plot | Poles density (Poles/ha) | Felled trees (Trees/ha) | Slope (%) | Damage (Trees /ha) | (%) |
|---|---|---|---|---|---|
| 1. | 70 | 6 | 2 | 10 | 15.6 |
| 2. | 75 | 7 | 4 | 13 | 19.1 |
| 3. | 82 | 12 | 8 | 17 | 24.3 |
| 4. | 79 | 10 | 5 | 14 | 20.3 |
| Σ | 306 | 35 | 17 | 54 | 79.3 |
| M | 76.5 | 8.75 | 4.25 | 13.5 | 19.8 |
| SD | 5.2 | 2.75 | 3.3 | 2.88 | 3.58 |
| CV(%) | | | | | 18.1 |

Remarks: Σ = Sum; M = Mean; SD = Standard deviation; CV = Coefficient of variation.

Table 3 shows that tree damage caused by controlled skidding technique, with an average of felled trees of 8.75 trees/ha at trees density of 76.5 trees/ha, was 14.1-24.3% with an average of 19.8%. Thus felling with the average of 8.75 trees/ha caused average of trees damage of 19.8% x (76.5-8.75) trees/ha = 13.4%. Number of commercially healthy trees with diameter of 20 cm and up after skidding was in average of (100-19.8)% x (76.5-8.75) trees/ha = 54.3 trees/ha

Table 4. Tree damage caused by conventional skidding technique

| Plot | Tree density (Trees/ha) | Felled trees (Trees/ha) | Slope (%) | Damage (Trees /ha) | (%) |
|---|---|---|---|---|---|
| 1. | 70 | 6 | 2 | 10 | 15.6 |
| 2. | 75 | 7 | 4 | 13 | 19.1 |
| 3. | 82 | 12 | 8 | 17 | 24.3 |
| 4. | 79 | 10 | 5 | 14 | 20.3 |
| Σ | 306 | 35 | 17 | 54 | 79.3 |
| M | 76.5 | 8.75 | 4.25 | 13.5 | 19.8 |
| SD | 5.2 | 2.75 | 3.3 | 2.88 | 3.58 |
| CV(%) | | | | | 18.1 |

Remarks: Σ = Sum; M = Mean; SD = Standard deviation; CV = Coefficient of variation.

Table 4 shows that tree damage caused by conventional skidding technique, with an average of felled trees of 8 trees/ha at trees density of 50.5 trees/ha, was 24.3-26.0% with an average of 24.9%. It means that felling with the average of 8 trees/ha caused average of trees damage of 24.9% x (50.5-8)trees/ha = 10.6%. Number of commercially healthy trees with diameter of 20 cm and up after skidding was in average of (100-24.9)% x (50.5-8) trees/ha = 31.9 trees/ha.

As pole damage aspect, controlled skidding technique was better than conventional skidding technique (t-cal = 2.781*, t-table 95% = 2.447) in tree damage aspect. Hence if the technique is implemented, it can minimize tree damage about 5.1%. CV's value of tree damage of controlled skidding technique was higher than that of conventional skidding technique (respectively 18.1% and 3.2%). It showed that tree damage variation on controlled skidding technique was higher than that of conventional technique. However, using excavator (valuing 15.8%) is better than that of the controlled skidding method (Suhartana *et al.*, 2000). Again, this is probably caused by a high floatation of the machine for operating on wet area.

### B. Ground Exposure

Calculations of ground exposure caused by controlled skidding technique and conventional technique are presented in Table 5 and Table 6.

Table 5. Ground exposure caused by controlled skidding technique

| Plot | Felled trees (Trees/ha) | Felled trees (Trees/ha) | Slope (%) | Damage (Trees /ha) | (%) |
|---|---|---|---|---|---|
| 1. | 6 | 70 | 2 | 1,475 | 14.75 |
| 2. | 7 | 75 | 4 | 1,575 | 15.75 |
| 3. | 12 | 82 | 8 | 1,750 | 17.50 |
| 4. | 10 | 79 | 5 | 1,625 | 16.25 |
| Σ | 35 | 306 | 17 | 6,425 | 64.25 |
| M | 8.75 | 76.5 | 4.25 | 1,606 | 16.06 |
| SD | 2.75 | 5.2 | 3.3 | 114.3 | 1.14 |
| CV(%) | | | | | 7.1 |

Remarks: Σ = Sum; M = Mean; SD = Standard deviation; CV = Coefficient of variation.

Table 6. Ground exposure caused by conventional skidding technique

| Plot | Felled trees (Trees/ha) | Felled trees (Trees/ha) | Slope (%) | Damage (Trees /ha) | (%) |
|---|---|---|---|---|---|
| 1. | 9 | 55 | 5 | 1,875 | 18.75 |
| 2. | 5 | 42 | 2 | 1,750 | 17.5 |
| 3. | 8 | 45 | 4 | 1,775 | 17.75 |
| 4. | 10 | 60 | 8 | 1,950 | 19.5 |
| Σ | 32 | 202 | 19 | 7,350 | 73.5 |
| M | 8 | 50.5 | 4.75 | 1,837.5 | 18.4 |
| SD | 2.2 | 8.4 | 2.5 | 92.4 | 0.92 |
| CV(%) | | | | | 5.0 |

Remarks: Σ = Sum; M = Mean; SD = Standard deviation; CV = Coefficient of variation.

Table 5 shows that controlled skidding activity caused by ground exposure is between 14.75-17.5% with an average of 16.06%. Table 6 shows that conventional skidding technique caused ground exposure between 17.5-19.5% with an average of 18.4%. It means that controlled skidding technique was better than conventional technique (t-cal = 3.195*, t-table 95% = 2.447). Implementing controlled skidding technique may minimize ground exposure about 2.34%. CV's value of ground exposure of the controlled technique was higher than that of conventional technique, even though using excavator will be much better (Suhartana *et al.*, 2000).

Ground exposure is caused by felling, skidtrail building and skidding activity. Ground exposure on conventional skidding technique was wider than that on either controlled or excavator, because the technique needs "ongkak" trail and "beko" (loading point/TPn) facilities. Wood for "ongkak" and "beko" is taken from poles and trees around the logging site. It appears that implementing the controlled technique is necessary to reduce forest damage. It will also contribute significantly to the effort of attaining ecolabelling.

## IV. CONCLUSION

1. The average of residual stand damage caused by controlled skidding technique was 29.05% for poles and 19.8% for trees. While that caused by conventional skidding technique was 34.2% for poles and 24.9% for trees. The difference of 5.1% (poles) and 5.1% (trees) is statistically significant.
2. The average of ground exposure caused by controlled skidding technique and conventional skidding technique are respectively 16.06% and 18.4%. This difference of 2.34% is statistically significant.

## REFERENCES

Directorate General of Forest Concession. 1994. Indicator technics of the Indonesian selective cutting and planting at natural land forest. Forestry Department, Jakarta.

Steel, R. G. D. and J.H. Torrie. 1976. Principles and Procedure of Statistics. Mc.Graw-Hill Book Co., New York.

Suhartana, S. 2000. Comparising between manual and excavator skidding system at swamp forest Part I : Work productivity. Forest Products Info 6(1): 31-37. Forest Products Research and Development Center, Bogor.

Suhartana, S., Dulsalam and M.M. Idris. 2000. Comparising between manual and excavator skidding system at swamp forest part II : The effect of the system to residual stand damages and ground exposure. Bulletin of Forest Products Research 17(4):231-241. Forest Products Research and Development Center, Bogor