Multicriteria Decision Analysis for Selecting the sustainable Logging System in Teak Plantation

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Introduction

**Teak** (*Tectona grandis L.f.*) of Labiatae family is a deciduous tree with straight, smooth stem with small buttress root.

The trunk is very tall, with minimum height of 20 m.

construction, furniture, planking and laminating.
Introduction

Forest certification is a market mechanism that compels the farmer, producer and other relevant parties to improve forest and plantation management, along with production and trading process to the international standard without legal enforcement.
Sustainable development is development and growth with balance between economical, social and environment factors and optimized use of limited national resources.
Introduction

Total of Forest area in Thailand: 16,398,128.3 ha.

Certified Forest Plantation area in Thailand: 73,724.9 ha.

0.45%

Source: https://info.fsc.org (2019)

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Logging in Thailand still emphasizes productivity and profit rather than other factors such as the social and environment impact. There is also lack of correct logging planning and use of existing equipment which might not be well-suited to the logging area.
This study therefore aims to analyze logging systems to find an effective method that can lead to forest certification and sustainable forest management.
Khao Kra Yang Forest Plantation is under Phitsanulok Area Forest Industry Organization.

- The geography is Hanginal plain with elevation between 200 and 700 meters above mean sea level.
- Silvicultural system is selection thinning.
- Rotation period are 30 years.
- Total of area 2,420 hectares.
Materials and methods

Phase 1
- Investigation area
  - Stand data
  - Terrain data
    - Harvesting Systems
      - Technological Evaluation
        - Technological suitable systems
          - Ecological evaluation criteria
          - Economical evaluation criteria
          - Social evaluation criteria
          - Utility Analysis
          - Aggregation of area

Phase 2

Multicriteria Decision Analysis for Selecting the sustainable Logging System in Teak Plantation
Materials and methods

Slope is a limitation for both tracked and wheeled vehicles, and skid trail is a limitation for machines such as toweryarders and skidders. Another factor is the limiting DBH for feller bunchers, harvesters and processors depends on the type of harvesting head.
## Materials and methods

### Table 1 Definitions of logging systems and technological specifications to stand and terrain data

<table>
<thead>
<tr>
<th>Systems</th>
<th>Logging Systems</th>
<th>Technological Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Slope</td>
</tr>
<tr>
<td>A</td>
<td>Chainsaw &amp; Elephant</td>
<td>&lt; 20%</td>
</tr>
<tr>
<td>B</td>
<td>Chainsaw &amp; Skidder</td>
<td>&lt; 35%</td>
</tr>
<tr>
<td>C</td>
<td>Chainsaw &amp; Tractor</td>
<td>&lt; 30%</td>
</tr>
<tr>
<td>D</td>
<td>Chainsaw &amp; Toweryarder &amp; Processor</td>
<td>&lt; 100%</td>
</tr>
<tr>
<td>E</td>
<td>Harvester &amp; Toweryarder</td>
<td>&lt; 60%</td>
</tr>
<tr>
<td>F</td>
<td>Harvester &amp; Forwarder</td>
<td>&lt; 30%</td>
</tr>
<tr>
<td>G</td>
<td>Feller buncher &amp; Skidder &amp; Processor</td>
<td>&lt; 35%</td>
</tr>
<tr>
<td>H</td>
<td>Feller buncher &amp; Tractor &amp; Processor</td>
<td>&lt; 35%</td>
</tr>
</tbody>
</table>
# Materials and methods

## Table 2 classify of slope

<table>
<thead>
<tr>
<th>levels</th>
<th>Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-20</td>
</tr>
<tr>
<td>2</td>
<td>20-30</td>
</tr>
<tr>
<td>3</td>
<td>30-35</td>
</tr>
<tr>
<td>4</td>
<td>35-40</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 40</td>
</tr>
</tbody>
</table>

## Table 3 classify of skidding trail

<table>
<thead>
<tr>
<th>levels</th>
<th>Skidding trail (m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-200</td>
</tr>
<tr>
<td>2</td>
<td>200-400</td>
</tr>
<tr>
<td>3</td>
<td>400-600</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 600</td>
</tr>
</tbody>
</table>
Materials and methods

**Terrain (DEM)**
- <20%
- >20%
  - <30%
  - >30%
    - <35%
    - >35%
      - <40%
      - >40%

**Skid Trail**
- <200 m.
- >200 m.
  - <400 m.
  - >400 m.
    - <400 m.
    - >400 m.
      - <600 m.
      - >600 m.
        - <800 m.
        - >800 m.

**Logging Systems**
- Chainsaw & Elephant
- Chainsaw & Tractor
- Harvester & Forwarder
- Feller buncher & Tractor & Processor
- Chainsaw & Skidder
- Feller buncher & Skidder & Processor
- Harvester & Toweryarder
- Chainsaw & Toweryarder & Processor
Materials and methods

Classify soil condition, 66 random sample plots in experimental area are analyzed by using a Skokagro static penetrometer examine soil compaction. Soil samples are collected from each sample plot to examine their soil type.
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Results

Legend

C  Chainsaw-Tracktor
A  Chainsaw-Elephant
B&G  Chainsaw-Skidder,Feller Buncher-Skidder-Processor
D  Chainsaw-Tower Yarzer-Processor
E  Harvester-Tower Yarzer
H  Fellerbuncher-Tractor-Processor
F  Harvester-Forwarder

Multicriteria Decision Analysis for Selecting the sustainable Logging System in Teak Plantation
Results

% of the total logging area

A: 28%
B&G: 13%
C: 26%
D: 8%
E: 7%
F: 12%
H: 6%

A: Chainsaw & Elephant
B: Chainsaw & Skidder
C: Chainsaw & Tractor
D: Chainsaw & Toweryarder & Processor
E: Harvester & Toweryarder
F: Harvester & Forwarder
G: Feller buncher & Skidder & Processor
H: Feller buncher & Tractor & Processor

Multicriteria Decision Analysis for Selecting the sustainable Logging System in Teak Plantation
Results

Analysis of plot no.1971 sample plot also shows that the most soil is *sandy clay loam* and soil compaction is mostly low to moderate compaction, soil erosion and water flow are very likely to occur. Also, shear resistance and bearing capacity are low, which means the plot is *inaccessible for heavy machinery*. 
Conclusions

Experience and sense of the plantation owner are the main decision-making factors with relatively less concern about potential impact.

This study is preliminary result on multicriteria decision analysis for selecting the sustainable logging system in Teak plantation.

Technologically suitable system is the output of this study. Soil compaction is also analyzed to assess load-bearing capabilities.

It is in a process of preparing relevant factors information. Further study is necessary to investigate the best logging system based on sustainability and awareness of social, economic and environmental factors.

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This research was supported by Kasetsart University Research Development Institute (KURDI) in research program: Applying precision forestry to teak plantation in Northern Thailand.
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