Assessing sustainability of timber production of teak plantations under the risk of destruction


Extended Abstract:

1. Introduction

Recently, there has been increasing public concerns on the sustainability of timber production of teak plantations in Java, Indonesia, mainly because most of the plantations are dominated by young stands and they always face with the high risk of destruction. A number of criteria and indicators for sustainable forest management also require forest managers to demonstrate that their forests could produce a perpetual sustained yield of timber. However, the existing method to determine annual allowable cut (AAC) of teak plantations in Java, which is based on a neoclassical method of area and volume controls, is less suitable for assessing the sustainability of plantations under the risk of destruction. In this study, we proposed an alternative method to assess the effect of forest destruction to the sustainability of timber productions and to determine optimal harvest levels of teak plantations under the risk of destruction.

2. Methods

This study was conducted in Kebonharjo forest management unit (FMU), located in Central Java, Indonesia. Teak plantations in the FMU are dominated by young stands (<30 years). We used a dynamic linear programming (LP) method proposed by Reed and Errico (1986) to project a 5-year age class distributions from one (a 5-year) period to another and then optimize their harvest levels through a 140-year planning horizon. The projection of age class distributions was conducted using probability transition matrices consisting of destruction and survival probabilities, which were derived from a survival analysis (Tiryana et al., 2009). To estimate timber yields, we used the existing yield table of middle site class (for clear-cutting and thinning yields) and the lowest site class (for salvage-cutting yield). Optimal
harvest levels under four destruction rates, i.e. zero, low (4.4–6.3% per period), medium (9.4–15.9% per period), and high (18.5–49.6% per period) were determined by developing 12 LP models with the objective of maximizing total harvest volume (of clear-cutting, salvage-cutting, and thinning) subject to the constraints of sequential harvest flows (±10%) and minimum cutting-ages (of 71, 61, and 51 years). The optimal solutions were compared to each other to analyze the trend of timber volume and age class distribution at the end of planning horizon.

3. Results and Discussion

The optimal harvest levels of teak plantations were greatly affected by the rate of destructions. Depending on the limit of cutting-age used in the LP models, the harvest levels generally decreased with increasing the destruction rates. Compared to the no destruction scenarios, total harvest volumes decreased to about 0.6–2.6%, 3.6–10.3%, and 14.1–25.8% when the destruction rates were assumed to be low, medium, and high, respectively. While the harvest levels under the high destruction rates decreased over planning periods, the harvest levels under the scenario of low and medium destruction rates tended to gradually increase until the rotation periods and then gradually decrease towards the end of planning horizon. This behavior is reasonable because from one period to another the plantations grow continuously and the use of minimum cutting-age constraints allows the increase of mature stands. The increase of allowable harvest levels on a forest with less mature stands was also reported by Armstrong (2004). In addition, reducing the limit of cutting-ages from 71 to 61 or 51 years increased the total harvest volume up to 15.2% (low destruction), 9.4% (medium destruction), and 1.5% (high destruction). However, reducing the length of rotations tended to produce ending age class distributions with less mature stands (≥30 years old). Although the present teak plantations are dominated by young stands, our results confirmed that the FMU can maintain the sustainability of timber production if they can control and minimize forest destructions. More importantly, forest managers should set up AAC within the range of harvest levels estimated under the high and low destruction rates. In this context, the proposed method can help forest managers to determine an appropriate harvest level under a certain assumption of destruction rate. The proposed method can also be extended to include other management objectives (e.g. maximize net present value) and non timber benefits (e.g. carbon sequestration). These issues will be investigated in our further studies.