Introduction

Timber harvest in tropical forests is a widely discussed topic for its impacts on deforestation and land conversion. As logging techniques and cycles vary, damages to the residual forest undergo dramatic changes. Besides its function as global sink for carbon dioxide a logged-over forest following practices of reduced-impact logging is also expected to increase economic profit compared to a conventional logged forest. Other studies show convincingly that only economic profit will lead to conservation and sustainable practices. In this context, criteria for sustainability and ecological certification of timber wood are subject of much current debate. Computerised simulation models aiming to estimate growth and yield of tropical rain forest should become a useful tool to broader this discussion.

In this study we use the rain forest growth model FORMIND2.0 for analysing the effects of various recruitment scenarios and different logging strategies on forest dynamics. Is there an optimal combination of the logging parameters (strategy, cycle length, recruitment assumptions) which maximise yields and minimise changes in the forest structure?

The model FORMIND

FORMIND2.0 is a individual-oriented process-based forest growth model to simulate the spatio-temporal dynamics of uneven-aged mixed forest stands. For complete model description of current version please refer to literature (Köhler and Huth, 1998, Kammesheidt et al., 2000). The model describes forest dynamics as a mosaic of interacting forest gaps of 20 m²×20 m² in size. Within these plots trees are not spatially-explicit distributed, and thus all compete for light and space following the gap model approach. The carbon balance of each individual tree incl. photosynthesis and respiration is modelled explicitly. Thus, we can match measured diameter increment for different PFT, size and light conditions accurately. Allometric relationships connect above-ground biomass, stem diameter, tree height and crown dimensions. Details of growth processes are taken from related model FORMIX3-Q (Ditter et al., 2000). Beside increasing mortality through self-trimming in dense plots one of the main processes of mortality is gap creation by falling of large trees.

Species grouping

We simulate forest dynamics for a dipterocarp lowland rain forest in Sabah, Malaysia.

Results

Surprisingly, recruitment assumptions do not influence quantity of harvest yields, but with regard to species composition is biased towards mid successional species in seed tree scenarios. Yields were maximised in long logging cycles and reduced impact logging strategy. Some examples of forest dynamics is shown in following figures.

It is not clear if and how seed dispersal will alter in response to high fractions of early successional species as seen in most conventional scenarios. Habitats of most animals acting as seed dispersers or predators are altered and their futures are uncertain. Thus, we understand our results as very optimistic. Simple relationships of logging impacts as function of logging intensity emerge from analysis. They are easily comparable with field data and validate our analysis as reasonable. Furthermore, they are a practical tool for estimating impacts of human disturbances on residual forests.

Conclusions

FORMIND2.0 is able to analyse various logging strategies with respect to their impacts on residual rain forest. Reduced impact logging scenarios with cycles length of 80 years gained highest timber yields. However, in highly fragmented landscapes long term recruitment of most tree species is questionable. As recruitment is important for species composition large disturbances of any kind threaten late successional tree species with extinction.

References


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