

Aggregated modelling of disturbed and undisturbed rainforest dynamics

Aims

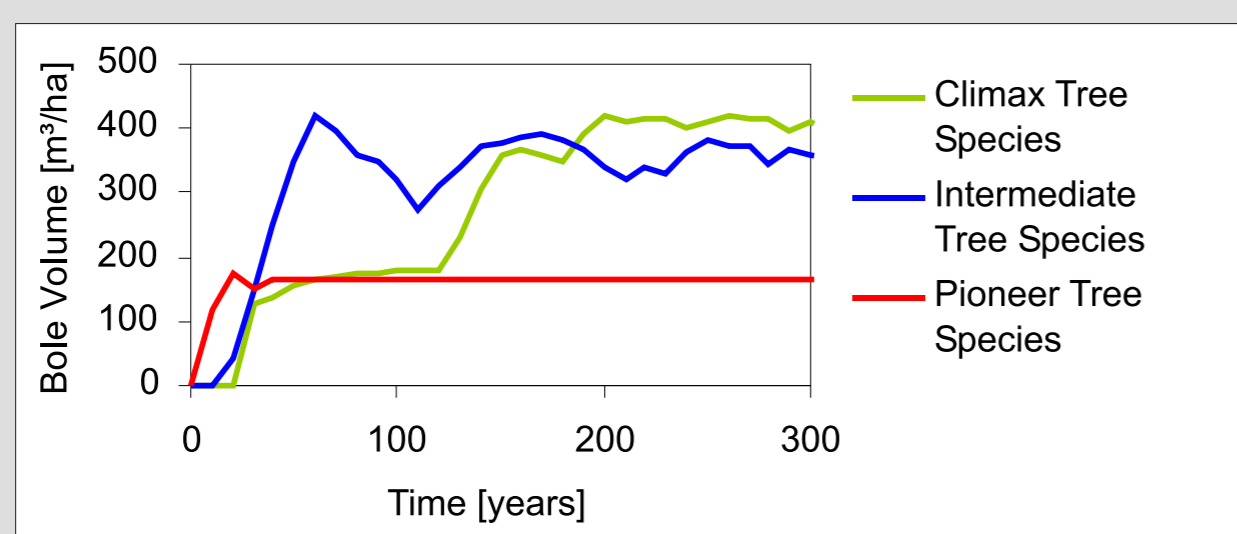
- Development of an easily applicable rainforest simulation model (FORREG) to calculate bole volume dynamics with
 - few, easily acquirable parameters
 - a short simulation time
- Assessment of the impact of different logging strategies on yield and on the ability of the forest to re-grow

Approach of the FORREG model

FORREG distinguishes three tree species groups

Species group	Light demand	Growth speed	Potential height
pioneer tree species	high	fast	15-25 m
intermediate tree species	low	medium	25-36 m
climax tree species	low	slow	>36 m

FORREG reproduces the results of a more complex model (FORMIX3-Q) with coupled differential equations



Forest growth simulated with FORMIX3-Q without inter-species competition

$$\frac{dV_P}{dt} = \frac{1}{K_M} V_P \left(\frac{V_P}{V_{mat,P}} - 2 \right) - \frac{V_{mat,P}}{K_M} c_P$$

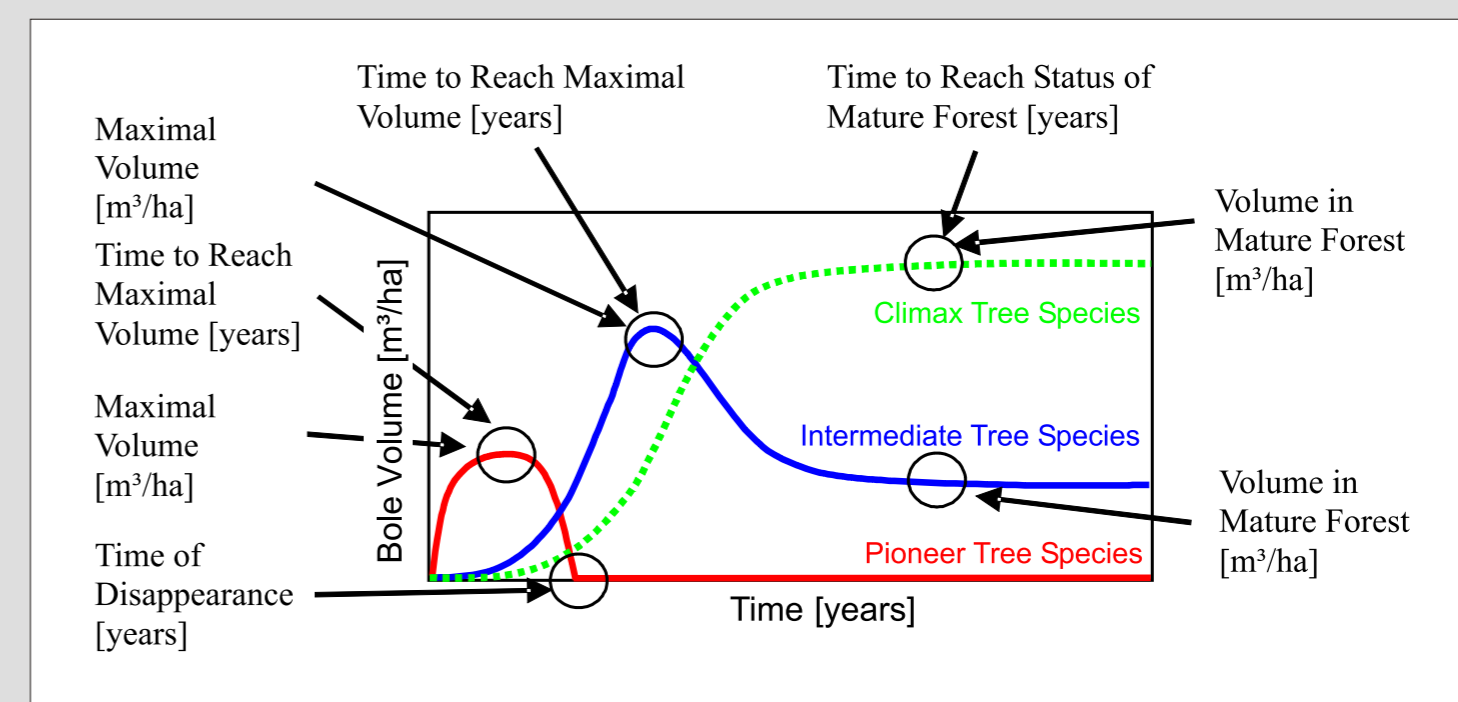
with $c_P = 1 - \frac{w_{IP}}{w_{CP}} \frac{V_I}{V_{mat,I}} - \frac{w_{CP}}{w_{IP}} \frac{V_C}{V_{mat,C}}$

$$\frac{dV_I}{dt} = (a_{input} - g_I - V_I) \left(1 - \frac{w_{II}}{w_{CI}} \frac{V_I}{V_{mat,I}} - \frac{w_{CI}}{w_{II}} \frac{V_C}{V_{mat,C}} \right)$$

$$\frac{dV_C}{dt} = (a_{input} - g_C - V_C) \left(1 - \frac{w_{IC}}{w_{CC}} \frac{V_I}{V_{mat,I}} - \frac{w_{CC}}{w_{IC}} \frac{V_C}{V_{mat,C}} \right)$$

How to acquire the parameters?

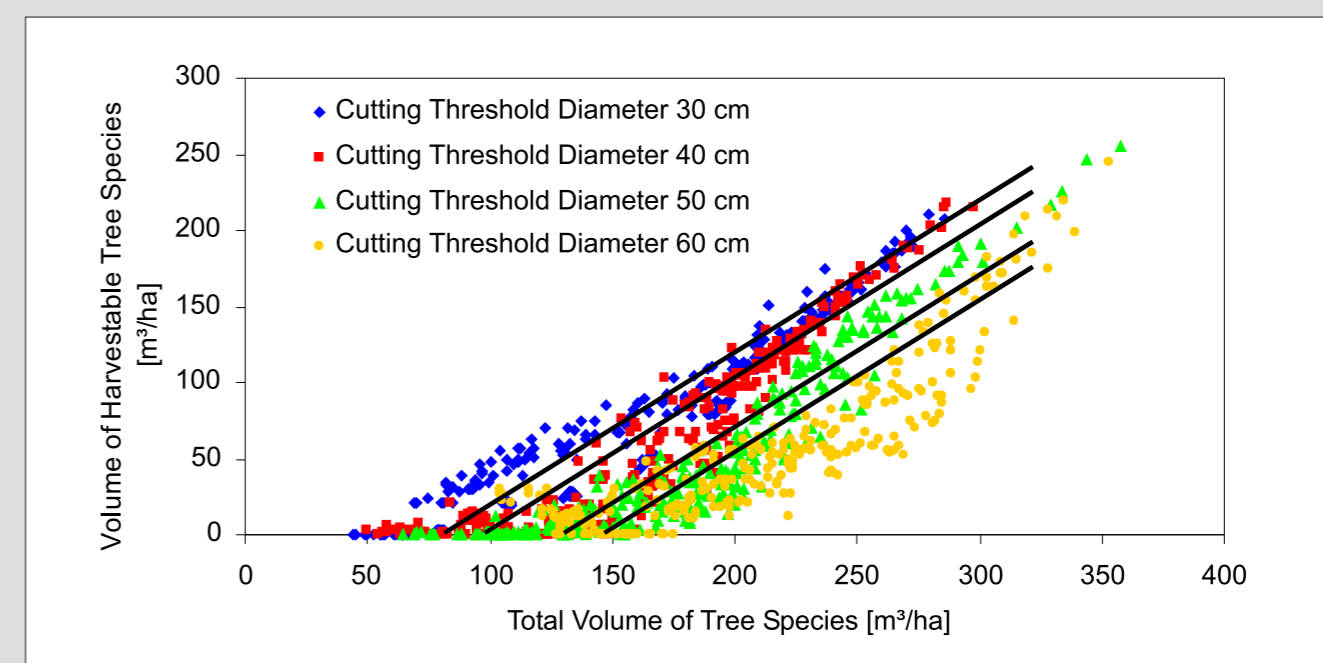
Implementation of a **genetic algorithm** as an optimization process: fit the model parameters to “characteristic values” of the forest



Characteristic values of a forest

Logging operation

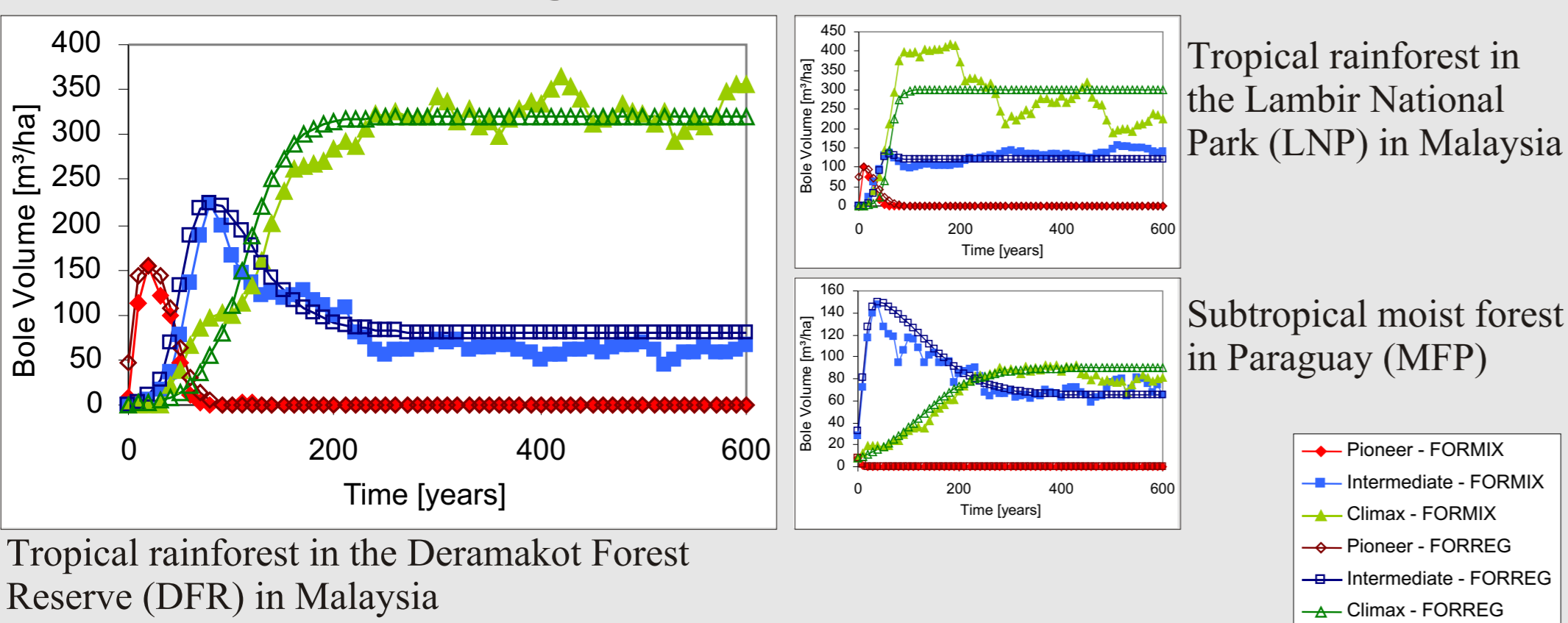
Estimation of the current harvestable bole volume with an estimate function



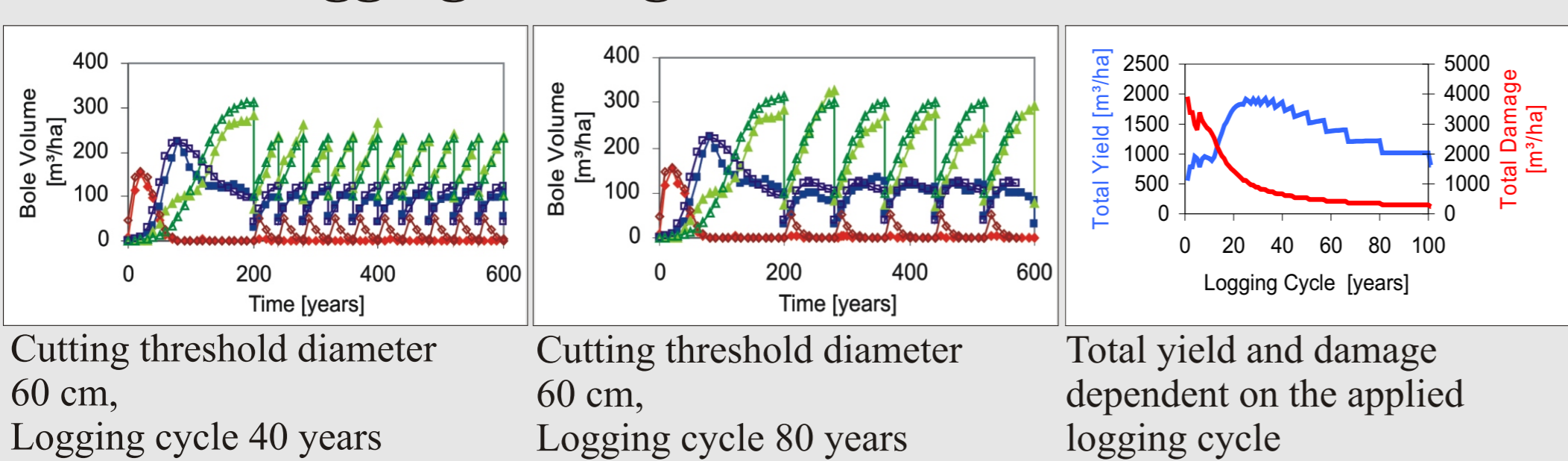
Linear estimate of the harvestable volume dependent on the cutting threshold diameter (data calculated by FORMIX3-Q)

Results - Comparison of the Models

Undisturbed forest growth of three sites



Different logging strategies in the DFR



Discussion

- With the help of a genetic algorithm a rainforest model was developed, which is relatively **easy to parameterise**
- The **simulation time is short**, since only aggregated processes are modelled
- The resulting bole volumes of the complex FORMIX3-Q model and the new FORREG model agree altogether well, this applies to undisturbed as well as disturbed sites
- Differences in results for the Lambir National Park can be explained by the fact that no size classes are modelled in the FORREG model. However, these differences do not significantly change results for different logging strategies (not shown)
- The logging cycle has an important influence on the obtained yield and the caused damage, an optimal logging cycle can be found in terms of yield.

References

- Glauner, R., T. Ditzer, and A. Huth. 2003. Growth and yield of tropical moist forest for forest planning: an inquiry through modeling. *Can. J. Forest Res.*, 33: 521-535.
 Huth, A. and T. Ditzer. 2001. Long-term impacts of logging in a tropical rain forest - a simulation study. *For. Ecol. Manage.*, 142: 33-51.
 Pearce, D., F.E. Putz, and J.K. Vanclay. 2003. Sustainable forestry in the tropics: panacea or folly? *Forest Ecol. Manag.*, 172: 229-247.
 Putz, F.E. and V. Viana. 1996. Biological challenges for certification of tropical timber. *Biotropica*, 28: 323-330.