A Spatially Explicit Individual-based forest simulator

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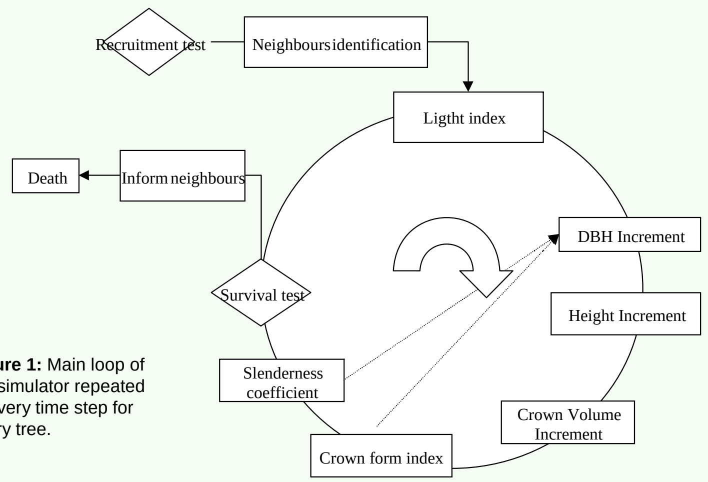

Figure 1: Main loop of the simulator repeated at every time step for every tree.

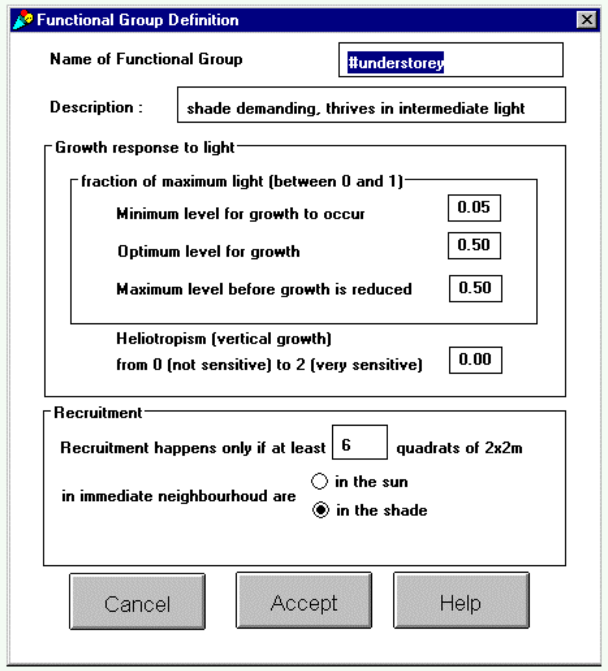

Figure 2: Species are grouped according to their light requirements. light level influences both growth and regeneration.

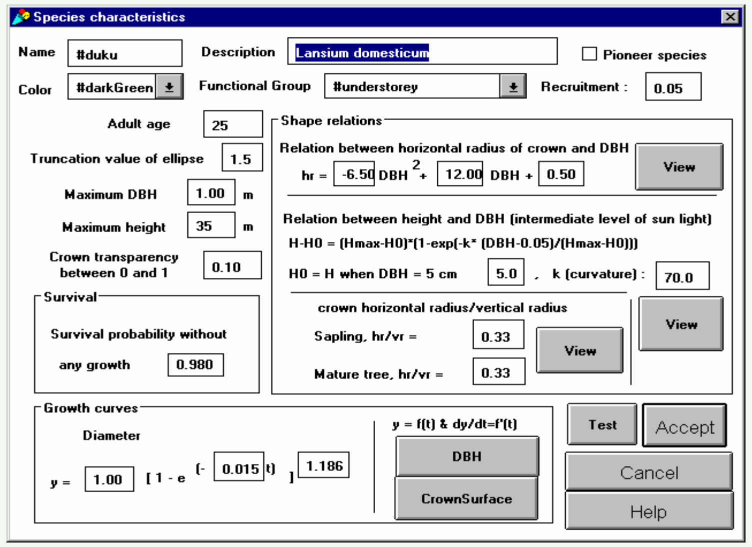

Figure 3: Species features include: DBH growth function, and geometric characteristics defining evolution of crown shape with size.

Overview

Individual trees of different species compete for light and space on a one-hectare toric space. Computations are carried out on a yearly time step. Capture and use of both resources (light and space) are species dependent and mediated through a number of parameters related to distinct geometrical and physiological characteristics for each species. A light interception module uses crown optical and geometrical characteristics to compute how much light is available to each tree. Competition for space is monitored by computing at each time step how much surface of each crown envelop is free from overlapping by neighboring crowns and stored as the crown form index. Recruitment and mortality are also governed by species dependent parameters. Mortality is a function of the growth rate. Secondary mortality can occur due to tree fall possibly creating canopy gaps. Recruitment depends on the specific biological cycle of the species. The potential number of offspring of the late successional species (e.g. *Lansium domesticum, Shorea javanica or Durio zibethinus*) depends on the number of sexually mature adult trees. On the contrary pioneer species have a constant recruitment pressure independent of the actual number of adult trees as they have wind spread or dormant seeds. Actual recruitment is ultimately governed by actual light conditions.

The way ahead...

Future enhancements include developing a 3D visualisation of the forest and a more interactive interface allowing user to manage a plot of forest by selecting, transplanting, planting, felling individual trees. This would be combined with a possibility to define scenarios at plot level and let the computer implement these. Another add-in will deal with resin and fruit production paving the way to economic analysis.

We foresee a number of **possible uses** for our model.

The model can be used to **explore a range of different management scenarios**. An example of question we plan to use the model for is : under what circumstances (individual growth rate, resin production rate, tree population structure, prices, etc) would felling a particular tree become economically more attractive than collecting its resin ?

Applying statistical analyses to fully characterised virtual agroforests is an opportunity **to revisit and assess the validity (powerfulness and robustess) of statistical analyses** used in the field. For example, how much variance in tree growth is left unexplained by applying a General Linear Model using standard predictors based on the same hypotheses as the model to an artificial agroforest? This not only gives us a way of estimating the importance of the non linearities neglected in GLM but also, by comparison with data obtained fron the real world this gives a chance to evaluate the importance of factors not taken into account in the model such as spatial variability in fertility, genetic variability etc...

We also plan to use the computer model as **a medium to sollicit farmers ecological knowledge** about their system. This would serve as a partial validation of the ecological model, and would help in defining realistic management scenarios.

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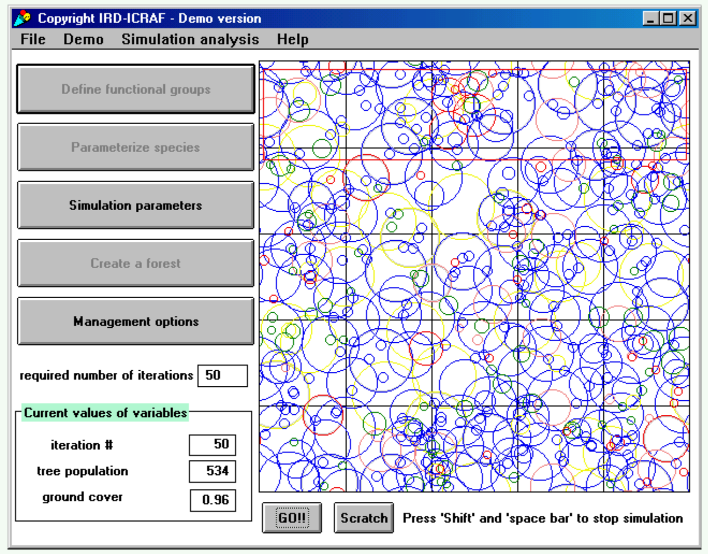

Figure 4: Main interface shows vertical projection of crowns.

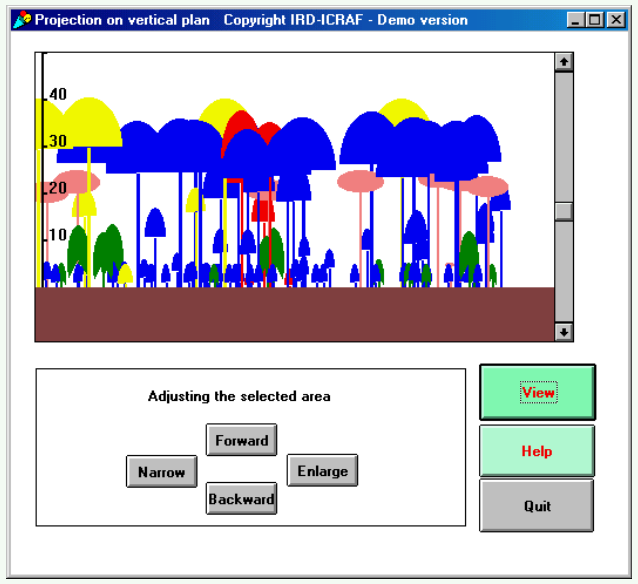

Figure 5: Side view of the selected profile.

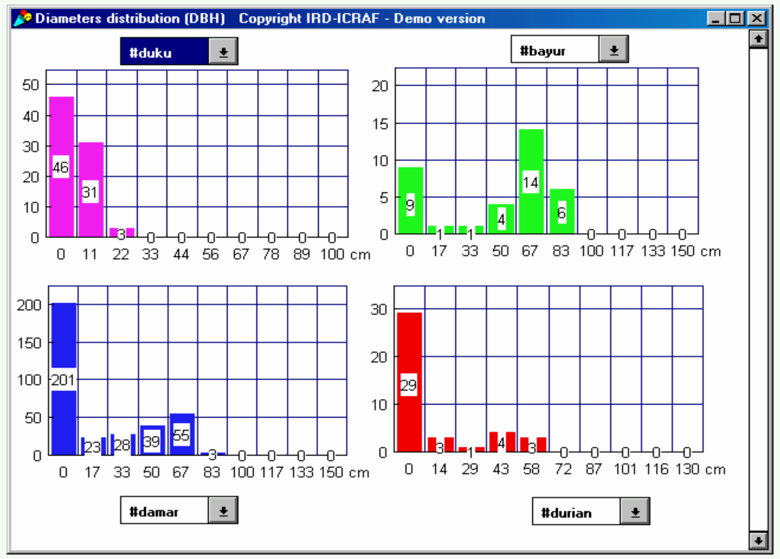

Figure 6: Built-in data analysis tools allow user to explore both structural and dynamic characteristics of the simulated agroforest. DBH distribution for a sample of species is shown here.