

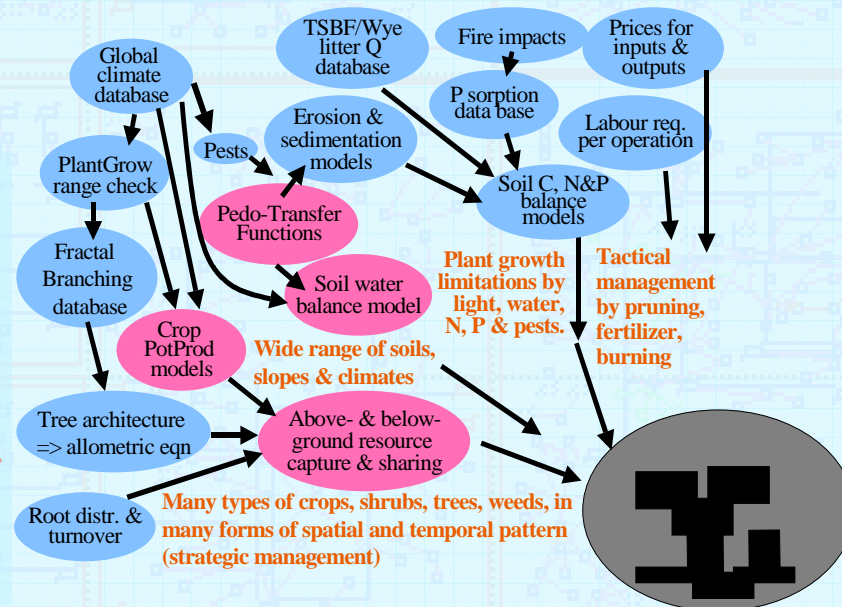
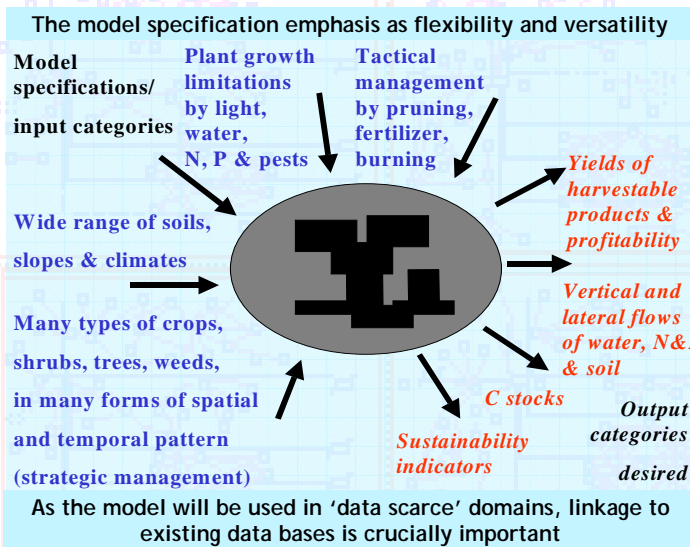


WaNuLCAS: a model of Water, Nutrient and Light Capture in Agroforestry Systems to evaluate Alternatives to Slash and Burn



M VAN NOORDWIJK, B LUSIANA and Q M KETTERINGS

WaNuLCAS was developed (using Stella) to represent tree-soil-crop interactions in a wide range of agroforestry systems where trees and crops overlap in space and/or time (simultaneous and sequential agroforestry). The model is based on above and below ground architecture of tree and crop, elementary tree and crop physiology and soil science (daily water, N, P and SOM balance for 4 soil layers and 4 horizontal zones). The model can provide a coherent way of evaluating sustainability indicators, C stocks and profitability for a range of land use systems, considered as 'alternatives to slash and burn'. A new module describes the effects of slash-and-burn land clearing on soil C, N and P transformations.

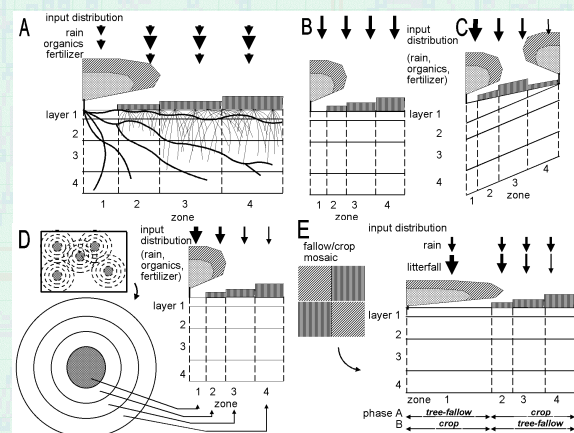
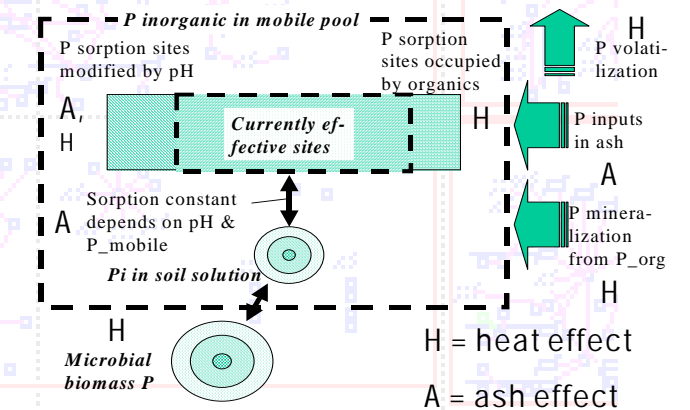
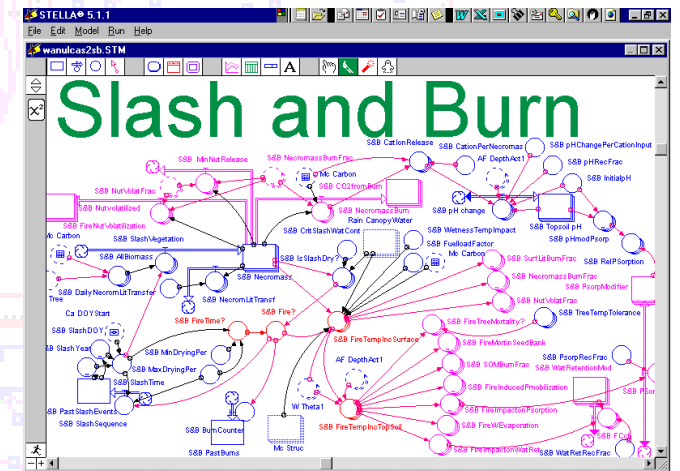


Representation of slash-and-burn events in WaNuLCAS

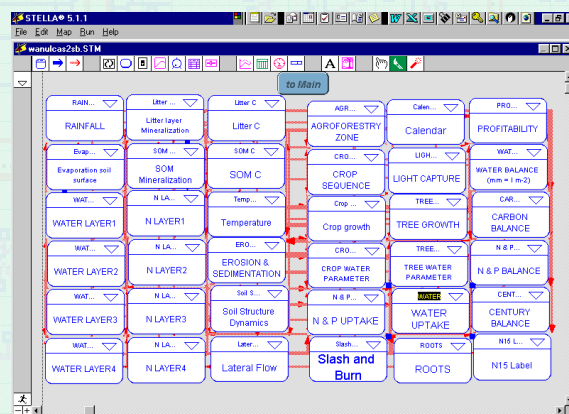
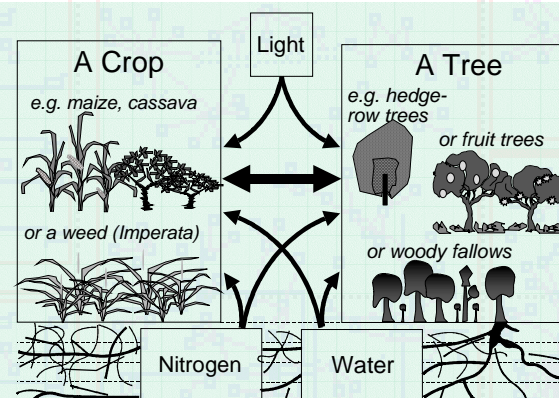
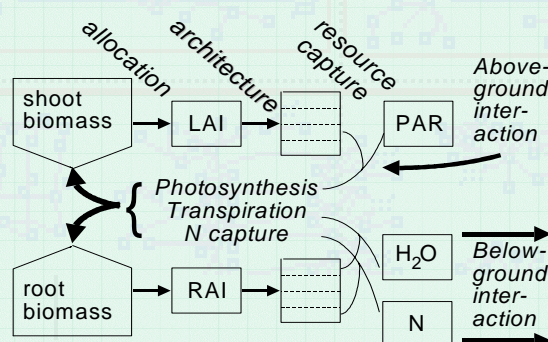
A number of 'Slash' events can be defined in the event calendar. Slash events transfer all current aboveground biomass in tree, weed or crop pools to the S&B_Necromass pool. From the S&B_Necromass a fraction can be transferred daily to the surface litter pool, where it will follow century-model based transformations of C, N and P pools. When the necromass has no intercepted water from rainfall the switch 'S&B_IsSlashDry?' will be turned on, allowing burn events to take place.

Burn events are defined by specifying a minimum number of days after the most recent 'slash' event. A fire event will be implemented on the first day in this period that the signal 'S&B_IsSlashDry?' is on. During a burn event, the temperature increase at the soil surface is calculated from the necromass + structural part of surface litter, with corrections for their respective moisture contents. The temperature increase in the topsoil is derived from the temperature increase at the soil surface, modified by soil water content of the topsoil. Burn events can have impacts on a number of pools in the model, either via the temperature at the soil surface or that in the top soil:

- reduction of surface necromass, surface litter and SOM pools,
- allocating all C of the burnt necromass to CO₂, and 1 - S&B_NutVolatFrac of its N and P content to mineral nutrients at the soil surface,
- induce a (one-off) transfer from the immobile P fraction in the topsoil
- induce a semi-permanent relative change of the effective P sorption with a gradual return to the original P sorption value,
- release cations into the topsoil from burnt necromass, leading to an
- increase of topsoil pH; this change of pH will modify the P sorption properties as well, with the overall effect obtained by multiplying the two factors,
- evaporate all soil water from the topsoil if the temperature exceeds 100°C
- modify soil water retention properties with a gradual return to the original values
- induce tree mortality if the temperature exceeds the temperature tolerance.



WaNuLCAS concepts of zones and layers



Sector map

Concern	Global	Watershed functions	Sustainability	Profitability
Indicators	C stocks, GHG flux	Filter effects on H ₂ O and soil flows	SOM, nutrient balance, weediness	Net present value, returns to labour
Land use system:				

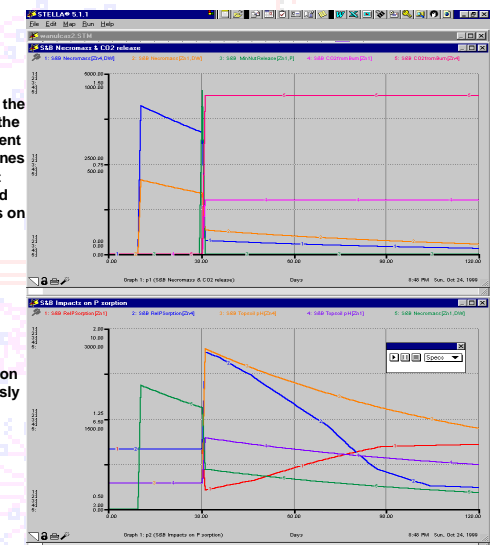
tree crops in agroforestry arrangements

contour hedge-row systems

crop-fallow rotations (incl. S&B events)

Can be simulated

Results for test runs of the Slash&Burn sector of the model show that different fuel load in different zones can lead to different effects on soil pH and contrasting net impacts on P sorption



Further parameterization of the model is obviously needed

References :
Van Noordwijk, M. and Lusiana, B., 1999 WaNuLCAS, a model of water, nutrient and light capture in agroforestry systems. Agroforestry Systems 43: 217-242

For info on the WaNuLCAS model of water, nutrient and light capture in agroforestry system, please check: <http://www.icsear.org/id/wanulcas/>

For the 'crop down, fallow up' or CDFU model of fallow rotations at landscape scale: <http://www.icsear.org/id/models/cdfu.htm>

Meine van Noordwijk, +62-251-625415, M.van-noordwijk@cgiar.org