Simulation Study to Assess the Impact of Biomass Allocation Characteristic of Plant on the Carbon Sequestration in Forest Ecosystem

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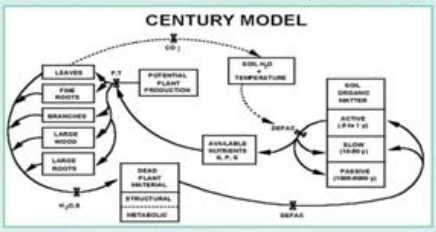
Introduction

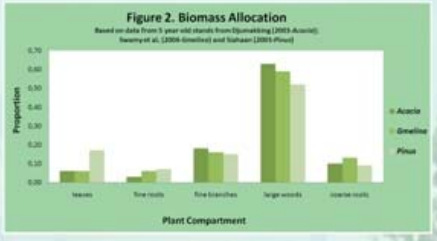
In reforestation project for climate change mitigation, it is important to select species having characteristic that can maximize carbon sequestered in the ecosystem.

The amount of carbon sequestered in ecosystem is determined not only by the level of biomass production but also the transfer of biomass into litter & dead materials and decomposition which release the carbon back into the atmosphere.

CENTURY model (Parton *et al*., 2001; Metherell *et al*., 1993) provides a tool for examining the effect of plant characteristic and environmental condition on the carbon sequestration by taking into account key processes of nutrient cycling of an ecosystem (Figure 1).

Figure 1. Framework of CENTURY model (Parton *et al*., 2001)





Objective

To investigate how plant characteristic in terms of biomass allocation to different parts of plant, i.e. leaves, stem, fine branch, coarse root and fine root, affects the rate of carbon sequestration in a reforestation setting.

Methodology

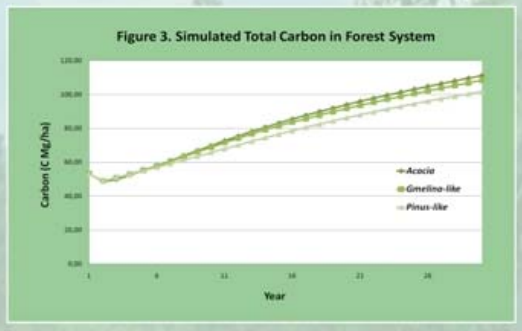
Model Parameterization

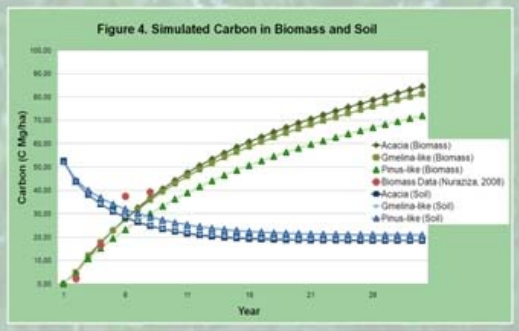
The model was parameterized to represent a reforestation setting planted with *Acacia mangium* at Parung Panjang Site in West Java, Indonesia (approx. 75 m asl., 3000 mm/yr rainfall & 21 – 33 °C).

Simulation scenario

Simulation was conducted for *Acacia mangium* and two other "hypothetical species" in which all characteristics are the same with A. *mangium* except biomass allocation, i.e. representing that of *Pinus merkusii* and *Gmelina arborea*. They are called *Pinus*-like and *Gmelina*-like thereafter (Figure 2).

Results & Discussions



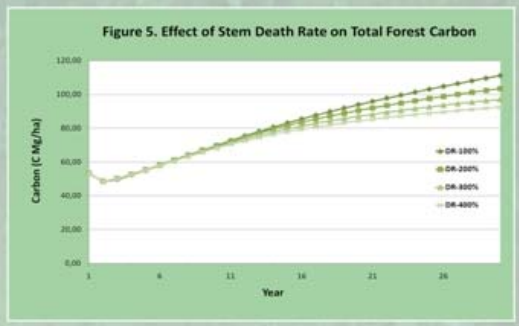


Higher allocation to stem leads to higher carbon sequestration at forest system level (Figure 3). The difference lies mainly on the biomass carbon (leaves, branches, stem, fine and coarse roots) rather than soil carbon (Figure 4).

Examination on the dynamics generated by the model indicates that the high carbon level of the stands with higher allocation to stem is associated with the large amount of biomass, which are put in compartment having low biomass turn-over rate, e.g. death rate of stem << leaf.

Importance of the rate biomass turn-over to the amount of carbon sequestered can be examined through a sensitivity analysis that varies the value of death rate of the stem.

The sensitivity analysis demonstrates that increasing stem death rate up to 4 times from the default values (wooddr (4) = 0.002) can decrease the total forest carbon up to 18 ton/ha (Figure 5).



Conclusions

1. Plant with higher carbon allocation to stem potentially sequesters more carbon in forest system.
2. This characteristic is associated with the large amount of biomass, which are put in compartment having low biomass turn-over rate.

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