Tropentag, September 19-21, 2012, Göttingen - Kassel/Witzenhausen

"Resilience of agricultural systems against crises"

Microclimate Controls of Shade Trees in Agroforestry

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Abstract

In agroforestry and park systems the crops are growing under the canopy of so called "shade trees". The growth rates and yield of crops depend strongly on energy and water fluxes between agroforestry system and atmosphere. The microclimate in agroforestry systems is strongly influenced by number (canopy density) and structural parameters of shade trees. Therefore, the shade trees can be used to reduce or mitigate the negative effect of climate variability (including climate change) on crop growth and yield. To quantify the influence of shading trees during different seasons, different meteorlogical conditions (cloudy, clear sky), as well as cumulative annual effects, the radiation and turbulent transports in agroforestry canopies were modelled on example of cacao (*Theobroma cacao*) agroforestry system in Indonesia. Three typical shade tree species - *Aleurites moluccana*, *Cocos nucifera* and *Gliricidia sepium* - were chosen for the experiment. Because of high heterogeneity of vegetation structure typical for agroforestry system a three-dimensional modelling approach has to be applied to describe the canopy transport adequately. In the present study the high resolution small scale 3D model of radiative transfer (SPM3D) (Bioclimatology Group, Göttingen University) was implemented. The wind regime was modelled by means of 3D Boundary layer Model SCAlar DIStribution (SCADIS) (Wind Energy, TU Copenhagen). The structure of different shade trees and its variations were measured directly and retrieved from hemispherical photos. The inaccessible structural parameters were estimated using allometric functions obtained from direct measurements. The results show the non-linear influence of the number, size and spatial distribution of shade trees on radiative and wind regimes in cacao agroforestry systems.

Keywords: Agroforestry, climate change, microclimate, shade trees, cacao modelling

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