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Sensitivity analysis of the water balance in the WaNuLCAS model: a case study using cocoa-based agroforests in Cameroon

Fayolle S.[1] (stolian.fayolle@cirad.fr), Justes E.[1], Metay A.[2], Saj S.[3]

[1] *UMR SYSTEM - CIRAD, Montpellier, France*; [2] *UMR SYSTEM - Montpellier SupAgro, Montpellier, France*; [3] *UMR SYSTEM - CIRAD, Kourou, French Guiana*

In various regions of the world, climate change is predicted to induce modifications of the rainfall regime which, in turn, are to probably prompt changes in agricultural land-uses. In Central Cameroon, where cocoa cultivation is already carried out in sub-optimal rainfall areas, rainfall changes could threaten this currently crucial source of revenue. Yet, local cocoa growing systems include many complex agroforestry systems (AFS) that may not respond similarly to rainfall variability and drought than less diversified or monospecific cocoa plantations (Jagoret *et al*., 2017). The impact of climate change on such AFS and their resilience is debated in the recent literature (Abdulai *et al*., 2018) and needs to be investigated.

Modelling could significantly contribute to the understanding of the main processes governing AFS functioning and be of great use to check for climate change effects on these processes. However, the relevance of simulated results greatly depends on model performance and modelling AFS remains today a scientific challenge. Therefore, few models are currently available. Yet, the WaNuLCAS model has proven to be efficient at modelling AFS particular crop-tree systems (Van Noordwijk and Lusiana, 1999) albeit it has not been extensively used for tree-tree systems. Furthermore, cocoa AFS often exhibit diverse structural parameters (functional type, height and age of cocoa or associated trees) which may greatly alter WaNuLCAS' outputs (Coulibaly *et al*., 2014). We thus carried out a sensitivity analysis for evaluating the WaNuLCAS functioning and its ability to represent the change in water fluxes in cocoa AFS. WaNuLCAS was parameterised with soil and plant data collected in a previous study in Cameroon from 144 AFS distributed among three sites (Saj *et al*., 2017). The dataset contained information on the: i) density of cocoa and associated trees, ii) their DBH and basal area, iii) date of cocoa stand establishment, and iv) soil features. Weather data were retrieved from Nasa's "TRMM" survey. We performed a sensitivity analysis of WaNuLCAS v4.01 to analyse the effects of structural parameters on water balance. The tested parameters were: i) density of trees, ii) soil characteristics, and iii) farmers' management practices. Values of the parameters were changed up to 50% of the measured range. We analysed the water fluxes simulated, such as cocoa and associated trees transpiration, soil evaporation, drainage, and run-off.

The work is on-going and final results shall be available for the WAF congress. Preliminary results indicate that WaLNuCAS is sensitive to rainfall variability and could be further used for analysing water fluxes of cocoa AFS under climate change scenarios. These results will allow determining the parameters and variables to be measured in priority in a future field experiment.

Keywords: WaNuLCAS, Water budget, Cocoa, complex systems, Sensitivity analysis.

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