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The Importance of Soil Fertility Constraints in Modeling Crop Suitability under Progressive Climate Change in Tanzania

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Abstract

Spatial crop suitability models are important planning tools for agricultural development, especially regarding climate change adaptation. The original version of the EcoCrop model predicts crop suitability based on monthly temperature and precipitation, without taking into account soil constraints. Recently, continuous soil property maps of Tanzania were produced (Vagen et al, submitted) based on data from systematic surveys across sub-Saharan Africa. The aim of the present study was to assess the effects of incorporating information on soil fertility constraints, such as low soil organic carbon content (SOC) into the EcoCrop model. Crop suitability maps derived with and without consideration of low SOC were compared. SOC values were extracted for 1036 locations of common bean (Phaseolus vulgaris L.) presence and the 2-percentile (0.9% SOC) was taken as a lower limit for suitability. The EcoCrop model was then run with current climate data, with and without SOC as a limiting factor, to create suitability maps. An independent spatial point dataset of registered bean presence/absence (n=1113), and regional production statistics were used for validation. The agreement between bean presence and bean suitability was higher (Cohen's unweighted kappa=0.06) when low SOC was included in the model compared to when only climate was considered (kappa=0.02). The regional statistics showed that the proportion of the area where low SOC restricted the suitability was negatively correlated with the proportion of the area planted with beans (r =-0.42, p=0.07). In summary, we identified a lower limit of SOC for the soil to be suitable for common beans production and investigated the importance of taking this soil fertility constraint into account for accurate suitability modelling. It was concluded that for more accurate suitability modelling, e.g. for decision support for adaptation to climate change, low SOC should be considered as a constraining factor.

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