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Does fire frequency/intensity influence tropical vegetation structure. Or *vice versa* ?

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Several theories exist as to the basis for the large variations in the degree of tree cover observed across the savanna biome - much of which does not seem readily accountable for in terms of variations in precipitation. These come into basically two classes: those which invoke differential environmental and/or edaphic effects on tree as oppossed to grass growth and/or mortality (for example, adverse affects of heavy soil texture and/or waterlogging) and those which suppose that feedbacks associated mostly with fire can give rise to a "steady-state" tree-grass mixtures of varying degrees of woodiness at any given level of precipitation (at least above a certain threshold). Of related interest is an understanding of which climatic and/or soil factors determine the geographical location of "zones of tension" (*ZOT*) where both forest and savanna are found growing as discrete mosaics within the same area. And which specific factors within a *ZOT* which determine whether forest or savanna is found.

In order to help clarify the above issues, we analyse data from over 60 forest and savanna sites sampled on three continents, examining the extent which variations in savanna and/or forest structure could be accounted for by a wide range of measured variables. Vegetation structure was analysed using a uniform protocol (see Torello-Raventos *et al*.; this session) with soil measurements including texture, exchangeable cation, total nitrogen and total phosphorus concentrations; not only in surface layers as is usually the case, but also to 4m where possible; also noting rooting abundances and possible/absence of physical constraints to plant growth such as hardpans or compact layers and incorporating this information into an index of soils physical constraints (Quesada et al., 2010). We also took into account additional environmental factors, such as mean annual precipitation (P), a precipitation seasonality index (ϕ) and total soil moisture holding capacity (W), then using mixture discriminant analysis to develop of model capable of predicting the occurrence of the 12 vegetation formations of Torello-Raventos *et al* on the basis of the measured environmental/edaphic variables.

The final model was a close to perfect predictor of vegetation class with both climatic and edaphic factors assuming importance. For example, at the intercontinental scale, the occurrence of *ZOT* at considerable lower P in Africa as compared to South America is explained to a large degree by a lower ϕ (due to a generally occurring bimodal seasonal pattern in Africa), but with higher soil surface cations concentrations in Africa soils also important. Some previously enigmatic observations are also accountable for by the model. For example, large variations in woodiness of Brazilian savannas under the same climatic regime are readily accountable for by grassier savannas (*Campo sujo*) having extremely low subsoil [Ca] and an associated lack of root development or water uptake when compared to proximal woodland vegetation types. In other cases, soil physical conditions are clearly important. For example, hardpan development controls vegetation structure at P of around 1 m a^{-1} in West Africa.

We conclude that the edaphic controls of tropical vegetation structure may be many, deep and complex and that cursory surface soil observations provide an inadequate means to assess the existence or magnitude of such effects. Moreover, though elegant and mathematically impressive it is not necessary to invoke fire/vegetation feedback models to explain global variations in savanna structure. Indeed, we suggest that fire characteristics are more a function of vegetation form (in turn controlled by soils and climate) than *vice versa*. The more complex feedback models currently flooding the literature would seem to be more the construct of some clever human minds, as opposed to mechanistic explanations for what seems to be (in the absence of digging a few holes) an enigmatic but false degree of unexplainable variation in savanna/forest structure.

Reference

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