Submission from the Inter-American Institute for Global Change Research (IAI)

The Inter-American Institute for Global Change Research (IAI) provided in documents FCCC/SBSTA/2009/MISC.5 and FCCC/SBSTA/2010/MISC.6, updates related to its research in the La Plata Basin. In this submission, the IAI presents a summary of research advances which suggest that land use changes may affect the regional climate of the La Plata Basin.

The La Plata Basin is one of the world's main food exporters, and it is therefore a key region for global food security. During the last three decades, increased demand for food, biofuel and cellulose have been driving large-scale changes in land use that affected more than 30 million hectares. The IAI is investing important research efforts in the La Plata Basin integrating scientific groups that are studying the impacts and feedbacks of the main land use changes on biophysical variables (e.g., soil carbon stocks, climate, water resources) as well as on socioeconomic characteristics (e.g., employment, rural migration, food production, rural livelihoods).

Climate determines ecosystem structure and functioning through the timing and amount of water and solar energy (Stephenson, 1990). Conversely, ecosystems also influence climate through multiple pathways, primarily by determining the energy, water, and chemical balances between the land-surface and the atmosphere (Chapin *et al.*, 2008). These balances are determined by biophysical properties at the land surface, such as albedo, surface roughness, stomatal resistance, leaf area index and others. Changes in land cover will thus have an impact on those interactions, the overlying boundary layer, and eventually the processes that modulate precipitation (e.g., Pielke and Avissar 1990; Stohlgren et al. 1998; Pielke et al. 2007)**.** The size, the geographic location and the patchiness of an area where land cover changes take place may determine the extent to which they affect local, regional and global climate (Marland et al. 2003).

Changes in land cover imply changes in the land's biophysical properties. In order to understand the complex nature of their coupled interactions, it is necessary to resort to regional mesoscale models that simulate land surface-atmosphere feedbacks and their impacts on regional climate. IAI research results indicate that land use change in the La Plata basin is significantly affecting the albedo (surface reflectance) of large areas. Reduced reflectance as a consequence of, for instance, tree plantations which have 30% lower albedo than natural grasslands causes warming, which could reduce the benefits of carbon sequestration in these afforestations. In contrast, the enhanced albedo after deforestation of the semiarid Chaco - which reduces warming - could counterbalance the greenhouse effects of carbon released upon conversion to agriculture.

The regional climate of the La Plata basin is sensitive to extensive changes in land cover, and those changes are highly non-linear. In regions where forests and savanna are replaced by crops, an overall increase in albedo leads to a reduction of sensible heat flux and near surface temperature. A decreased stomatal resistance favors more evapotranspiration, but the more noticeable effect corresponds to a reduction of surface roughness that leads to stronger low-level winds that, in turn, favor a larger amount of moisture being advected out of the northern part of the basin. Changes from grasslands to crops reduce the albedo and thus increase the near surface temperature. As the reduction in surface roughness is not as large as in the northern sector, there is a deceleration of the northerly moisture fluxes, and a net increase of moisture flux convergence and precipitation. However, since changes in land use are heterogeneous, lateral gradients of the land biophysical properties will lead to differential forcings on the atmosphere, and advective processes not accounted in a point energy balance will develop. Given the large regions under land cover change, it should be expected that effects will affect regions outside the basin, due to, e.g., advective processes in downstream circulations and precipitation.

The regional effects of deforestation imply changes in the surface water and energy budgets, as well as in the low level circulation (e.g., through changes in the surface roughness). In the case of the Amazon, deforestation may lead to a reduction of evapotranspiration and moisture flux convergence (MFC), and consequently of precipitation (Nobre et al. 1991). The deforestation affects not only the intensity of precipitation, but may shift patterns due to, e.g., advective processes (Hahmann and Dickinson 1997). Remote effects can also be expected (Werth and Avissar 2002).

A consistent set of time-varying biophysical properties has been identified by taking advantage of the Ecosystem Functional Types (EFTs) homogeneous functioning and the parameters of land surface models. Some land-surface properties showed greater interannual variability than others across the entire study area. Considerable interannual variability was found for surface roughness, stomatal resistance, and minimum leaf area index. Low interannual variability was observed for emissivity, and radiation stress. Rooting depth, background albedo, Green vegetation fraction, and maximum leaf area index showed intermediate variability.

Numerical experiments with a regional climate model show that a representation of the land surface that takes into account realistic conditions during anomalous periods reduces the model biases in precipitation and improves the representation of extremes like floods and droughts. It is further suggested that inclusion of interannual variability of land surface conditions in regional models adds information that can lead to improvements in climate predictability.

The impacts and associated feedbacks of land use changes on biophysical and socioeconomic variables are complex and non-linear, and include a multitude of dimensions. The coupled human and natural dimensions of land use change processes require effective inter-disciplinary research to identify and propose feasible options to mitigate the resulting impacts.

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