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A conceptual framework for regional feedbacks in a changing climate

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Terrestrial ecosystems and climate influence each other through biogeochemical (e.g. carbon cycle) and biogeophysical (e.g. albedo, water fluxes) processes. These interactions might be disturbed when a climate human-induced forcing takes place (e.g. deforestation); and the ecosystem responses to the climate system might amplify (positive feedback) or dampen (negative feedback) the initial forcing. Research on feedbacks has been mainly based on the carbon cycle at the global scale. However, biogeophysical feedbacks might have a great impact at the local or regional scale, which is the main focus of this article. A conceptual framework, with the major interactions and processes between terrestrial ecosystems and climate, is presented to further explore feedbacks at the regional level. Four hot spots with potential changes in land use/management and climate are selected: sub-Saharan Africa (SSA), Europe, the Amazon Basin and South and Southeast Asia. For each region, diverse climate human-induced forcings and feedbacks were identified based on relevant published literature. For Europe, the positive soil moisture-evapotranspiration (ET) is important for natural vegetation during a heat wave event, while the positive soil moisture-precipitation feedback plays a more important role for droughts in the Amazon region. Agricultural expansion in SSA will depend on the impacts of the changing climate on crop yields and the adopted agrotechnologies. The adoption of irrigation in the commonly rainfed systems might turn the positive soil moisture- ET feedback into a negative one. In contrast, South and Southeast Asia might face water shortage in the future, and thus turning the soil moisture-ET feedback into a positive one. Further research is needed for the major processes that affect the ultimate sign of the feedbacks, as well as for the interactions, which effect remains uncertain, such as ET-precipitation interaction. In addition, socio-economic feedbacks need to be added in the ecosystems-climate system since they play an essential role in human decisions on land use and land cover change (LULCC).