Feedbacks between the dynamics of forest cover, precipitations and land use changes; their consequences on tipping-points in the Bolivian Amazon, a modelling approach

Rafaela M Molina Vargas*[1,2,3,4], Isabelle Gounand[5], Anne-Sophie Lafuite[6], and Elisa Thebault[7]

[1]Institut d'écologie et des sciences de l'environnement de Paris – APHP, Pitié-Salpêtrière university hospital, Sorbonne Université UPMC Paris VI – France

[2]Institut de Recherche pour le Développement (IRD en Occitanie) – iEES - Paris – France

[3]Sorbonne Universite – Institute of Ecology and Environmental Sciences - iEES – France

[4]Instituto de Ecologia, Universidad Mayor de San Andrés, La Paz, Bolivia. – Bolivia

[5]Institut d'écologie et des sciences de l'environnement de Paris (iEES Paris) – Institut de Recherche pour le Développement, Sorbonne Universite, Université Paris-Est Créteil Val-de-Marne - Paris 12, Centre National de la Recherche Scientifique, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement – France

[6]Station d'Ecologie Théorique et Expérimentale (SETE) – CNRS : UMR5321 – Moulis 09200 SAINT GIRONS, France

[7]Sorbonne Universite – Institute of Ecology and Environmental Sciences - iEES – Sorbonne Université - Faculté de Sciences - Bât. 44-45 4, place Jussieu 75252 PARIS cedex 5, France

Abstract

Land cover change is one of the main factors affecting tropical forests, their functioning and their connectivity. The Amazon basin hosts the world's most extensive tropical rainforest, is one of the most biodiverse ecosystems, and drives the region's climate stability. Recent studies have modelled the positive feedbacks between forest and hydro-climatic dynamics in the Amazon and highlighted the risk of a tipping point leading to the collapse of the forest in response to deforestation and climate change.
Direct socio-economic factors (e.g. human decisions linked to agricultural exploitation or conservation) and global indirect (e.g. global trade), which are related to deforestation dynamics, have been little considered in this context. We developed a simplified mechanistic model integrating forest/climate feedbacks and socio-economic drivers of de- and re-forestation to investigate how ecological, climatic and socio-economic dynamics interact, and affect the risk of tipping point of the forest and the coexistence between agriculture and natural areas.

Our results show, as expected, that the coexistence between natural areas and agriculture, and the risk of collapse of the forest in natural areas, strongly depend on the values associated to forest conservation and forest ecosystem services as well as on the price of agricultural

*Speaker

products and the dependence of agriculture on precipitation. However, while rarity-based or precipitation-based incentives for forest conservation, as well as protection of a significant proportion of natural areas, promote coexistence between agriculture and natural areas, policies based on forest ecosystem services tend to decrease such coexistence. We discuss the results of this model in relation with strategies for effective conservation of the Bolivian Amazon forest.

Keywords: Bolivian Amazon forest, tipping, point, socio, ecological modelling, ecological, climate feedback