Socioecological effects of global land-use competition: A biophysical modelling approach based on the human appropriation of net primary production framework

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Growth of population and GDP are forecast to result in a massive rise of agricultural output, perhaps by 70-100% until 2050. In addition, efforts to substitute biomass for fossil fuels on a grand scale could at least double humanity's present biomass demand. Some scenarios expect that bioenergy use will rise by factors between 2 and 5 over its present volume of ~50 EJ/yr in the next decades. However, approximately three quarters of the entire global land area (except Antarctica and Greenland) are currently used for human purposes, and the remaining areas are unlikely to contribute much as they are either ecologically highly valuable (pristine forests) or very unproductive (alpine or arctic tundras and deserts). Raising biomass production will hence require an intensification of land use and/or involve land-use competition. Intensification may raise biomass production per unit area and year and thereby reduce land demand, but it often has considerable ecological costs (e.g. emissions, water demand). Competition for land occurs when several agents demand the same good or service produced from a limited area. It implies that when one agent acquires scarce resources from land, less resources are available for competing agents. Possible negative effects of increased competition for land include pressures on biodiversity, rising food prices, land conflicts and GHG emissions. In this presentation I will discuss how the socioecological metabolism approach can help analyzing land-related limits and functions in particular with respect to production and consumption of biomass and carbon sequestration. The metabolism approach has yielded databases (such as global HANPP and biomass flow data) and a biomass balance model (BioBaM) that can be used to analyze land-use competition. In my presentation I will report on recent studies of land-use competition in 2050 based on the BioBaM model that help to better understand biophysical option spaces as well as trade-offs and synergies between changes in demand (e.g. diets), agricultural technology (e.g., yields and livestock feeding efficiencies) and bioenergy (energy crops, residues). I will also outline ongoing work to better understand the full GHG consequences and other ecological pressures resulting from different future land-use and biomass demand scenarios.