Land Use / Land-Use Change in an Emissions Constrained World:
The Need of a New Approach

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Preface: The poster reflects the authors' perspective of systems analytical issues of relevance to the topic. These issues had been discussed in a wider setting at the **Land Use, Land-Use Change (LUC) Vision Workshop**, held 12–14 September, in Rio de Janeiro, Brazil. The Workshop had been organized by Brazil's Center for Strategic Studies and Management (CGEE), together with Brazil's National Institute for Space Research (INPE) and the Austrian-based International Institute for Applied Systems Analysis (IIASA) with the objective to prepare for a multi-institutional research agenda under the leadership of CGEE.[a] The poster elaborates these systems analytical issues in greater detail than what had been possible at the Workshop.

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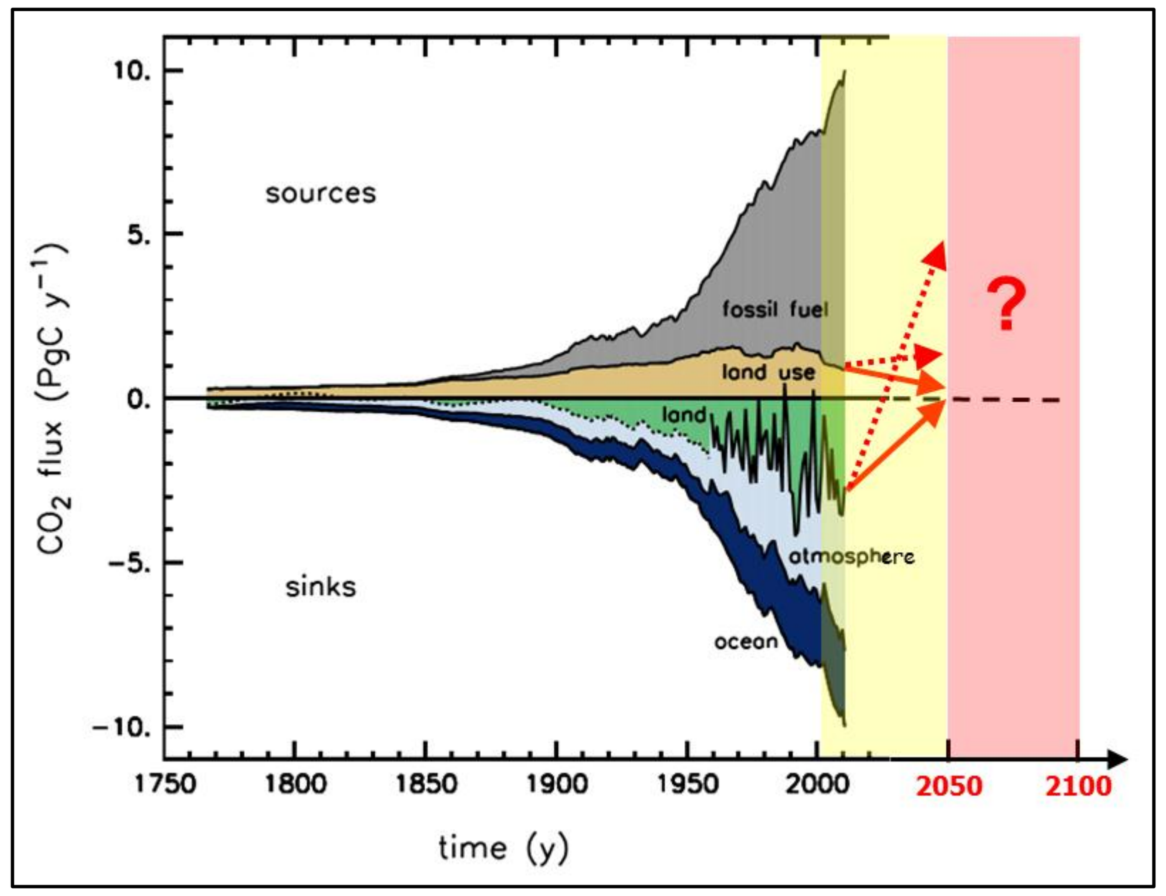
The concept of constraining cumulative greenhouse gas (GHG) emissions globally until, e.g., 2050 influences climate policy-making since the 2009 UN Climate Change Conference in Copenhagen. Cumulative emissions allow specifying the risk of exceeding a global warming target (e.g., 2ºC) by 2050 and beyond better than any other concept. Cumulative emission constraints must be expected to receive increasing attention in the future both scientifically and politically. However, the treatment of emissions from land use / land-use change (LUC) under this concept falls short.

Challenge



To hold the increase in global temperature to 2ºC as of 2050, emissions from land use need to be constrained cumulatively, while the multi-functional uses of land need to be adjusted to meet the needs of a population of 9 billion without putting sustainability of nature at stake.

Figure from Global Carbon Project (2011); modified.

Major Problems

1. The LUC system needs to meet more than one constraint

Above and beyond limiting cumulative emissions the LUC system needs to meet the 'sustainability' constraint – while warranting the growing demand of ecosystem services. However, sustainability is best understood locally and at the global scale, but less so at scales in between. A guide of how to translate, and track, sustainability across spatial scales is missing.

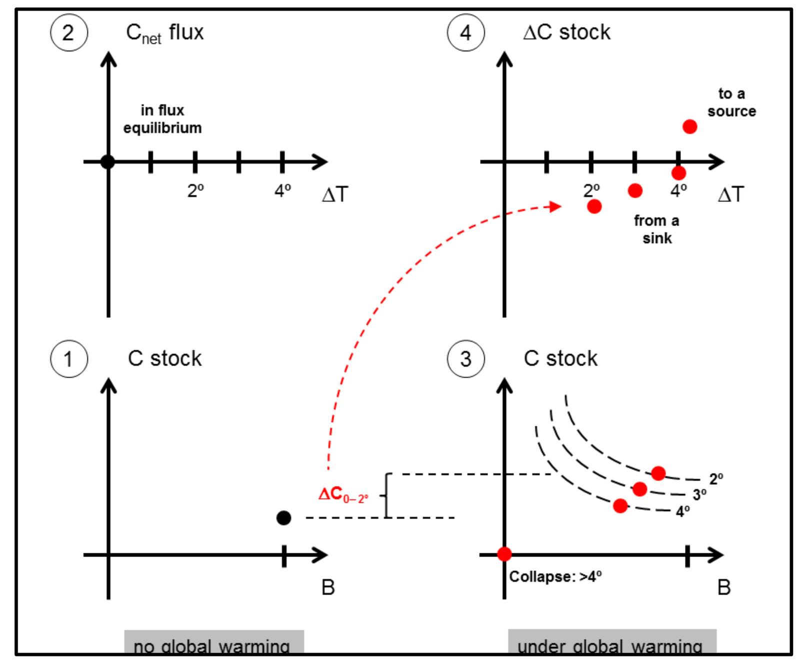
2. The LUC system comprises emissions and removals

The net LUC emissions flux is the sum over sources and sinks. Currently, it enters the cumulative emissions concept like fossil-fuel emissions, i.e., a source flux. However, the problem is that a sink reduces a source but their uncertainties still add up. The consequence is that the risk of exceeding a specified global warming target – this risk is derived based on a multitude of model-based, forward-looking emission-climate change scenarios – is (substantially?) underestimated.

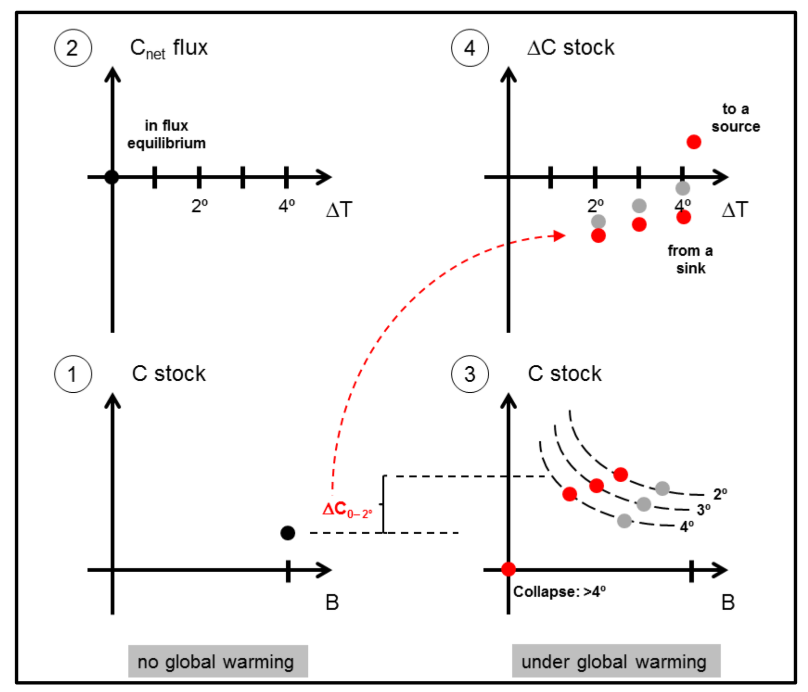
3. The not directly human-impacted terrestrial biosphere cannot be neglected

The crucial assumptions underlying the concept of constraining cumulative emissions globally are: (a) that the not directly human-impacted part of the terrestrial biosphere stays in or returns to an emissions balance; (b) that this return, which refers to CO_2-C, implies in turn that the emissions and removals of CH_4, N_2O, etc. also return to an emissions balance; and (c) that these returns happen without feedbacks and surprises.

Tackling Problem #1



Top: Simplified LUC system: global planetary boundary perspective under land-cover change only as a result of global warming. The LUC system is described by two parameters: carbon (C) and biodiversity (B); while changing environmental conditions under global warming are quantified by changes in global temperature (T). The functional relation of C and B is hypothetical and serves illustrative purposes only. The left side (1 and 2) reflects the undisturbed LUC system in equilibrium which has accumulated a moderate amount of carbon; while the right side (3 and 4) shows how the system might turn into a (preliminary) sink in a warmer world, though poorer in terms of biodiversity. However, the carbon sink is assumed to decrease with increasing environmental stress (T↑). The LUC system is assumed to collapse for a temperature increase greater than 4ºC.



Bottom: Simplified LUC system: global socio-ecological boundary perspective under land use. The LUC system can be described by C and B still. It would be these two parameters that matter and that need to be considered across spatial scales.

Research Needed

Our understanding of the LUC system in an emissions constrained world with both in perspective global planetary boundaries **and** global social-ecological needs is inadequate. This calls for a 'simplified', generic type of systems analysis for the support of highly detailed, bottom-up driver-policy response models with the focus on LUC from sub-global to global scales. This new type of systems analysis would allow understanding, more fundamentally than before, the multitude of constraints that we might face in a warmer world in the future, their interdependencies and uncertainties; and it would also be used to anticipate thresholds and 'surprises'.