Fourth International Conference on Earth System Modelling
4ICESM-44, 2017

The limits to global-warming mitigation by terrestrial carbon removal with biomas

L. Boysen
Germany (lena.boysen@mpimet.mpg.de)

Biomass plantations (BPs) are used to guarantee net negative emissions in most of the current mitigation scenarios that stay around or below 2°C global warming by 2100. However, their feasibility in terms of carbon sequestration, subsequent utilization and environmental and social consequences has so far been very uncertain.
We here give an overview of terrestrial carbon dioxide removal (tCDR) potentials and trade-offs with other actors on land by analyzing a set of possible BP scenarios in combination with different levels of emission pathways simulated by a biogeochemical process model. These scenarios range from systematic and rather far-fetched assumptions of large-scale conversion of agricultural and/or natural land over strict constraints on land availability to a sophisticated transient socio-economic mitigation scenario. This analysis framework enables us on the one hand to explore the upper ceilings to tCDR in dependence of BP's extent, point of implementation in time and background climate. On the other hand, we can estimate the preconditions for a successful mitigation pathway from a biosphere perspective aiming at the minimization of side-effects.
We show that the option space for tCDR is likely limited. tCDR is not a viable option to delay, stop or even reverse climate change if mitigation efforts in the near-term future are insufficient or fail completely. Although carbon extraction potentials could be sufficiently large on a partially mitigated pathway (e.g. >300GtC on a RCP4.5 pathway), trade-offs for food production and natural ecosystems would be severe if more than 1.5 Gha of land would be converted to BPs by 2035 or 2050. Contrarily, the needs for increasing food production on crop and pasture areas for a growing world population and the conservation of ecosystems would likely limit the land availability for BPs and thus, substantially reduce the potential for tCDR to 10-100GtC. Strictly following the land-use patterns of the mitigation scenario RCP2.6 to avoid such conflicts would still need at least two requirements to guarantee the success of staying within the climate guardrails (i.e. extracting ∼160-180GtC): first, a strong increase in irrigation water supply and second, highly efficient carbon processing and storage (i.e. reducing carbon losses). Emissions and biogeophysical effects from land conversion for and from management of BPs (e.g. increased fertilizer application and residue removal) are the main drivers for reducing the ineffectiveness of tCDR and should therefore be accounted for in the land selection process for BPs.
However, we argue that tCDR could also have beneficial side-effects in selected places (e.g. marginal land) and that forest conservation and restoration (e.g. following the Bonn challenge) as well as smart and sustainable land management (e.g. low-tillage and biochar application) could still lead to substantial carbon removal on land.