ICYESS2013-73
Interdisciplinary Conference of Young Earth System Scientists
Hamburg, Germany, 22 – 25 September 2013

Implications of uncertainties on the feasibility of the climate change mitigation mechanism "Reducing Emissions from Deforestation and forest Degradation" (REDD+)

D. Plugge (1), T. Baldauf (2), and M. Köhl (1)

(1) Institute for World Forestry, University of Hamburg, Germany (daniel.plugge@uni-hamburg.de), (2) Thünen Institute for World Forestry, Federal Research Institute for Rural Areas, Forestry and Fisheries, Hamburg, Germany (thomas.baldauf@ti.bund.de)

According to the United Nations Food and Agricultural Organization's Forest Resources Assessment 2010 (FAO FRA 2010), the world's forests store 289 gigatonnes (Gt) of carbon in their biomass. However, the destruction of forests released 0.5 Gt of carbon per year between 1990 and 2010. Following estimates of the Intergovernmental Panel on Climate Change (IPCC) the emissions from deforestation represent between 12 % and 20 % of global anthropogenic CO_2 emissions, which calls for urgent activities to maintain the remaining areas of natural forests. The Stern-Review, an effort to describe the economic implications of climate change to policy makers, identified that "emissions from deforestation are very significant" and that "curbing deforestation is a highly cost-effective way of reducing greenhouse gas (GHG) emissions". As part of a global climate change mitigation strategy REDD+ (Reducing Emissions from Deforestation and forest Degradation) should support developing countries to take additional actions that reduce emissions from deforestation and forest degradation by mobilization and distribution of financial resources.
Our research focuses on the development of a transparent, robust and operational measuring, reporting and verification system (MRV) to monitor the development of forest areas and their carbon stocks and the aligned uncertainties of such a system. The United Nations Framework Convention on Climate Change (UNFCCC) demanded to tackle methodological issues concerning "means to deal with uncertainties in estimates aiming to ensure that reductions in emissions [] are not overestimated" and the development of a MRV system to provide reliable estimates on these reductions. Only on the basis of reliable estimates on reduced emissions from deforestation and forest degradation financial benefits form REDD+ can be generated in form of carbon credits. The MRV system therefore forms a milestone for the feasibility of REDD+. However, any MRV system is subject to high uncertainties.

The uncertainties of a MRV system are mainly linked to the assessment of deforestation and forest degradation areas (activity data, AD) and the carbon stock changes in those areas (emission factor, EF). The estimation of AD and EF is subject to two major error types: sampling errors and non-sampling errors. Sampling errors arise from inferring from a subset of the population to the whole population. Non-sampling errors encompass all other sources of errors involved in a survey, which can be the faulty application of definitions, classification errors, and errors arising from the application of functions and models or frame errors.
The quantification of AD requires estimates of forest area changes over time. Where remote sensing techniques are used, the uncertainty embedded in estimating changes between two points in time is influenced by the map accuracies at both occasions and the magnitude of changes. The detectability of degradation by remote sensing data is another critical issue. Especially in natural forests stands in the (sub-) tropics, which are characterized by heterogenic vertical stand structures and contiguous canopy covers, degradation can only be detected, when the formerly closed canopy cover is dissolved.
EFs are quantified by in-situ assessments in forest stands, which follow the rules of probabilistic sampling theory. Carbon stock of trees is quantified via volume or biomass figures. As those cannot be assessed directly they are estimated through volume or biomass functions based on measured tree parameters. Volume estimates are converted into biomass estimates and subsequently transferred into carbon stock estimates by applying biomass-carbon conversion factors. EF-estimates are subject to various error sources, including measurement errors and function errors. Frame errors arise through the assessments of a limited set of field plots which may not be representative for all forest types and disturbance levels within a country.

For a reliable MRV methodology it is suggested to apply the 95%-confidence interval to quantify the un-

certainty of estimates. However, from a statistical point of view the confidence interval is related to sampling errors only. The total survey error quantifies all error sources associated with an estimate and can be realized via an error budget. Furthermore, the principle of conservativeness is proposed to address the high uncertainties of REDD+ estimates. It is reflected by utilizing the "reliable minimum estimate" (RME) that serves as a surrogate of the lower bound of the confidence interval. The RME can be expanded from a mere sampling error perspective to the concept of total survey errors.
While the overall potential of REDD+ has been widely discussed, minor attention has been drawn to the implications of uncertainties associated with the estimation of carbon stock changes. To raise awareness of this issue, we conducted several simulation studies with different sets of countries that show high to low deforestation and forest degradation rates. These studies, showing the high dependency of the feasibility of REDD+ on the aligned uncertainties, as well as further studies on how to tackle these uncertainties form the basis for the presentation proposed to the ICYESS conference.