Greenhouse gas (GHG) leakage and net mitigation of typical carbon sequestration practices in China's terrestrial ecosystem

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Many management practices in cropland, forest and grassland ecosystems can extend forest area, increase carbon input or prevent C loss from vegetation and soil, and subsequently enhance C sinks and stocks. These management practices are considered as promising carbon sequestration measures. However, during implementation of these measures, the production, transportation and consumption of corresponding materials (such as synthetic fertilizers) and fossil fuel, the additional trace GHG emissions, and the processes taking place elsewhere as a result of the implementation activities may lead to GHG budget change other than the carbon stock, and form GHG leakage. Consequently, in order to reveal the true contribution of these practices to global warming mitigation and GHG reduction, full GHG budget need to be considered rather than the impact on soil and vegetation carbon alone. We built the frame of “Carbon Accounting and Net Mitigation (CANM)” and serious of CANM methods to investigate the GHG leakage and net mitigation of typical carbon sequestration practices in China's terrestrial ecosystem, including China’s national ecological restoration projects, and forest, cropland and grassland managements. The results showed large variations in carbon contributions, GHG leakages and their counteraction effects among different practices and ecosystems. The counteraction effects of GHG leakage from forest management and some forest-related ecological restoration projects were relatively small and could hardly exceed 25%. Meanwhile, the GHG leakage of some cropland management practice (e.g., straw return in rice paddies) could fully offset the carbon sequestration in soil. But reduction of synthetic fertilizer application in accordance with the national fertilization recommendations might own considerable net GHG mitigation potential. Grazing prohibition could sequester carbon in grassland ecosystem, but the transfer of grazing activity could offset about half of the carbon sequestration effect. Therefore, policies and technical approaches to minimize GHG leakage are necessary to enhance the GHG mitigation effect of the ecosystem carbon sequestration practices.