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Quantifying changes in ecosystem services provision in coffee and cocoa agroforestry systems

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Historically, coffee and cocoa production has been an important cause of tropical forest loss and degradation. Yet, cocoa and coffee agroforestry also contribute to the livelihoods of millions of smallholder farmers. They support important ecosystem services both locally and in the wider landscape, such as water and climate regulation, soil related services, pollination services, carbon sequestration, habitat services, etc. These services are often not recognised and taken into account in farm and national level decision-making. As a result, traditional low-input multi-functional agroforestry systems with high tree shade are being transformed to high input low shade monoculture agroforestry or replaced by non-tree based seasonal cash crops. Yet, tree cover in coffee and cocoa agroforestry can contribute not only to sustainable production at the local level, but also to national level targets regarding deforestation and reforestation, as set out under national REDD+ strategies, the SDGs, Aichi targets and land restoration commitments. In this study, we modelled the potential gains and losses in ecosystem services from coffee and cocoa systems under different future landuse change scenarios - expressed as tree cover change - in focus production districts in Ethiopia and Ghana respectively. Scenarios included: conversion of existing agroforestry to monoculture maize, decreasing or increasing tree-shade and expansion of agroforestry to areas with lower tree cover. We used a hydrological model to assess change in freshwater provision, water quality and soil erosion, and adapted equations relating crown cover to above ground biomass to estimate change in carbon stocks within the main hydrological basins affected by the production areas. Carbon and soil erosion were most affected: increasing tree cover increased carbon stocks and decreased erosion risk. Water quality overall improved with increased tree cover, whilst water provision varied with the water use of different vegetation types. Importantly, this study highlights gaps in knowledge and data for quantifying ecosystem services provision from agroforestry systems at the national or sub-national scale. The results from the modelled scenarios and the further assessment of their implications for the values of ecosystem services flowing from these systems can help clarify potential consequences for local livelihoods, national economies and REDD+