



Uncertainties of climate and CO₂ impacts on carbon stocks and biome distribution in Africa

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Climate change is expected to cause vegetation change in Africa, with profound impacts on ecosystems and biodiversity. Projections of future ecosystem states are constrained by uncertainties regarding relative impacts of climate change and CO₂ fertilisation effects. Rising atmospheric CO₂ drives climate change, but also directly affects plant physiological functions via carbon uptake, carbon allocation, water use efficiency, and growth. We use the adaptive Dynamic Global Vegetation Model (aDGVM) to quantify uncertainties in projected African vegetation until 2099. High-resolution climate forcing for the aDGVM, was generated by regional climate modelling. An ensemble of 24 aDGVM simulations based on six downscaled General Circulation Models (GCMs) under two Representative Concentration Pathways (RCPs 4.5 and 8.5) with plant-physiological CO₂ effects enabled and disabled was implemented.

Under strong climatic change with high CO₂ increases (RCP 8.5), almost a third of terrestrial Africa is projected to experience biome changes with woody encroachment into grassy biomes dominating biome changes. Projections under medium-impact scenarios (RCP 4.5) still predict biome changes for around a quarter of Africa. With climate change only and elevated-CO₂ effects disabled, woody encroachment is weak and reduction of forest cover in favour of savannas prevails. Change in aboveground vegetation carbon until 2099 varied from a strong increase under elevated CO₂ (61.5%, RCP 8.5; 33.9%, RCP 4.5) to a small increase of 5.4% (RCP 4.5) and a decrease of -13.6% (RCP 8.5) without CO₂ effects.

CO₂ effects in combination with RCP scenarios caused the greatest uncertainty in projected ecosystem changes. Downscaled GCM projections caused weaker uncertainties in the simulations. Future biome changes due to climate and CO₂ change are therefore likely in large parts of Africa. Their magnitude and location often remain uncertain. Climate mitigation and adaptation response measures that rely upon vegetation-derived ecosystem services will need to account for

alternative climate futures.