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The supply-demand balance of Sahelian net primary production under future climatic and socio-economic scenarios

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Global warming and increasing atmospheric carbon dioxide concentrations in combination with rapidly growing human population increases pressure on Sahelian ecosystems to provide food, feed and fuel resources. The region has been subjected to severe droughts that have contributed to fluctuating levels of food insecurity over the past four decades. Climate change has the potential to further destabilize the region's food security through increases in temperature accompanied with decreased precipitation amounts in the western areas (Niang et al., 2014; Roehrig et al., 2013). The Sahel's mostly agro-pastoral population strongly depends on the products of photosynthesis (net primary production, NPP) for their food resources, biofuel, and animal feed. The aim of the research is to quantify the supply and demand of NPP in the Sahel from 2000 to 2100 under future climate and socio-economic scenarios. We define the term "supply" as the annual amount of available NPP in the ecosystem, and the term "demand" as the annual amount of NPP required by the inhabitants of the Sahel (Abdi et al., 2014). Thus, it is important to investigate under which future climate scenarios NPP demand outstrips available supply in the Sahel.

The relationship between supply and demand of NPP measures socio-ecological vulnerability and our analysis allows for a spatially explicit estimation of human impact on ecosystems. We will estimate the supply of NPP per climate grid cell (0.5 x 0.5 degrees) with a rapid global NPP meta-model based on the state of the art dynamic vegetation model LPJ-GUESS (Smith et al., 2014). The meta-model will be forced with climate data from four representative concentration pathways (RCPs). The demand of NPP will be quantified with the parsimonious agricultural land-use model (PLUM), which is designed to replicate global land-use change and consumption patterns (Engström et al., 2016). The model will be driven by socio-economic data and settings derived from five shared socio-economic pathways (SSPs). PLUM outputs (i.e. NPP demand) are provided country-wise to downscale NPP demand to the same spatial resolution as the supply of NPP following the disaggregation approach suggested by Abdi et al. (2014).

In this study, we expect to find combinations of climate, carbon and socio-economic scenarios where the local NPP demand exceeds the NPP supply provided by the vegetation. These potential local "hot spots" of food shortage and their respective climatic and socio-economic narratives will be highlighted and discussed.

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