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Continuous observations of CO2 and CH4 exchange from East-African rangelands

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Semi-arid rangelands in Sub-Saharan Africa (SSA) are an important source of food security and nutrition but are under increased anthropogenic pressure by a growing population. These rangelands are characterized by nutrient poor soils and distinct wet and dry season(s). Due to the soil and climate combination, conventional crop agriculture is rarely feasible without irrigation and mineral fertilizer amendments, which in turn are limited by prohibitively high fertilizer prices and lack of water. Instead, pastoral livestock keeping is a valuable option to use these marginal lands and – under the right management – can be a sustainable form of food production and biodiversity protection given that most of these landscapes have co-evolved with megafauna over millennia. Despite the global role of livestock systems on climate change, there is still limited understanding on the role of SSA rangelands. At the same time, livestock systems emit greenhouse gases (GHG) and can promote global warming. But despite the impact of livestock systems on climate change, our understanding of the role of SSA rangelands is limited. To date, a thorough assessment that includes continuous GHG exchange measurement in combined wildlife-livestock systems on the African continent has not been undertaken. Here we provide the first eddy covariance (EC) measurements of CO_2/CH_4/H_2O fluxes from the ILRI Kapiti Wildlife Conservancy - a benchmark rangeland site in East Africa that is grazed by livestock and wildlife. Our results show continuous ecosystem CO_2 uptake from the wet to dry seasons with considerable CO_2 emission pulses following precipitation events after long dry periods that turn the landscape into short-term net CO_2 emitters. In contrast to CO_2, CH_4 fluxes are highly variable and depend particularly on wildlife and/or livestock being present in the fetch of the EC tower. In addition to EC measurements and given the need for scaling of our results, we relate CO_2 and CH_4 fluxes to simple remote sensing measurements of vegetation greenness derived from phenological cameras. Our results show good agreement between the two approaches. Yet, more

observations across a climatic gradient and along varying management intensities are needed to reduce existing uncertainties in the effect of SSA rangelands on climate change. To build a complete GHG budget, hot spots of greenhouse gas emissions such as from livestock enclosures or water bodies as well as soil carbon sequestration have yet to be accounted for.