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Incorporating vegetation trends to the MEDALUS-ESA approach for assessing environmental sensitivity at the national scale: the case of Kenya

Elias Symeonakis¹, Eva Arnau-Rosalén¹, Antony Wandera², Thomas Higginbottom³, and Bradley Cain¹

¹Department of Natural Sciences, Manchester Metropolitan University, Manchester, UK

²Northern Rangelands Trust, Private Ba-60300, Isiolo, Kenya

³Department of Mechanical, Aerospace and Civil Engineering, University of Manchester, Manchester, UK

Land degradation is one of the main causes of loss of productivity and ecosystem services worldwide. According to the United Nations Convention to Combat Desertification (UNCCD), sub-Saharan Africa is on a path to experiencing some of the strongest increases in pressures on land and land-based resources than any other continent. Assessing the sensitivity of sub-Saharan African countries to land degradation is, therefore, important for identifying areas of concern, setting a baseline for national land degradation neutrality targets, and for the prioritisation of mitigation measures. The widely used MEDALUS-ESA framework is employed here to assess the sensitivity of Kenya to land degradation using the year 2010 as a baseline. We modify the MEDALUS-ESA approach by adding two important variables that are closely linked with observed land degradation in Kenya: soil erosion and livestock density. Altogether, 16 indicators are estimated from existing global-to-national-scale land cover, vegetation (MCD12Q1, MOD44B), soil (ISRIC African SoilGrids), elevation (SRTM), population and livestock density data, divided into 4 main environmental quality indices (vegetation, soil, climate and management). In order to address the dynamic nature of the land degradation process, we incorporate two additional vegetation indicators: the statistically significant ($p \leq 0.05$) trend over the last three decades in the Normalised Difference Vegetation Index (NDVI) and the Rain Use Efficiency (RUE; estimated using the GIMMS3g dense NDVI dense time-series and precipitation from CHIRPS). Our results show that ~40% of the country is in critical and ~48% in fragile condition, with respect to environmental sensitivity. Our approach is successful in identifying areas of known long-term degradation, for example the rangelands South and East of Nairobi (e.g. Machacos and Kitengela) and the parts of the northern rangelands (e.g. Yamicha and eastern parts of Isiolo District). It is also successful in mapping the areas of least concern, including some of the major protected areas (e.g. Tsavo National Parks, Meru National Park and the Masai Mara National Reserve) and forested areas (Mt Kenya and the Aberdares). Our modification of the MEDALUS-ESA is an important tool that can be employed at the national scale using free and open-access data to assess environmental sensitivity and assist in the UNCCD efforts to successfully define land degradation neutrality targets.

