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The spatial-temporal dynamics of charcoal production in Zomba, Malawi

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The drivers of deforestation and forest degradation are complex, interrelated and often associated with limited data and understanding (Geist and Lambin 2002). In sub-Saharan Africa, high rates of urbanisation and the subsequent increase in energy demand mean that trees located near urban demand centres are at increasing risk of overexploitation and degradation due to unregulated charcoal production (e.g. Ahrends et al. 2010).

The literature on common property and open access resource management in developing countries rarely addresses temporal or spatial characteristics of the resource, and the econometric literature on forest resource extraction seldom explores the interactions between spatial decisions and temporal patterns of extraction (Robinson et al. 2008). However, deforestation policy responses are compromised if spatial and temporal dimensions become disconnected (Vance and Geoghegan 2002) and livelihoods often suffer when resources are overexploited (Hardin 1968).

Whilst there is some evidence to predict the location of charcoal extraction activities (e.g. Green et al. 2013), there is little detailed understanding of communities' decisions to engage in the charcoal trade. Therefore, understanding why communities engage in charcoal production, and how these decisions vary spatially and temporally, is critical for more targeted and effective policy interventions, for both forest management and sustainable rural development. We explore how perceived socio-economic factors influence communities' decisions to engage in charcoal production, and how this affects the spatial-temporal production dynamics across the production landscape.

We examine the production landscape of Zomba, a small city in southern Malawi. Drawing on a survey from 28 villages (representing 23% of producing communities) and rapid rural appraisals from three case-study villages, our study finds seven interconnected and multi-scaled socio-economic factors that influenced communities' participation in charcoal production: resource access; market demand; lack of alternative income generating opportunities; political change; rural poverty; population pressures and food security. These factors led to considerable fine-scale variability within Zomba's production landscape in terms of the locations, duration and intensity of production periods; the location of charcoal resources that villages accessed and the occurrence and heterogeneity of different socio-economic factors.

Malawi's National Forestry Policy is currently under review. Identifying the relative importance of the factors that determine local charcoal production in production landscapes can support the design of more effective policy interventions for improving rural livelihoods and sustainably managing forests in this region. Twin-focus on better governance of forested areas (including encouraging more efficient charcoal production) and the development of alternative income generating activities such as agriculture, may be cumulatively successful for forest protection and improved rural livelihoods.

Urban charcoal demand across many developing nations is predicted to increase in the future and the trade, although largely informal (thus unregulated), it is predicted to provide a livelihood for 12 million people across sub-Saharan Africa by 2030 (Mwampamba et al. 2013). Lessons learnt from this study indicate that locally specific and national analyses of events are useful to assess the outcomes of possible

changes in policy or plan interventions to manage charcoal production, to protect both livelihoods and forests alike.