Fuel at crossroads

Kiruki, H.M.

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SUMMARY

Humans have for long relied on charcoal production for their energy needs, as evidence of production sites and kilns are found dating from the middle ages onwards. Urbanisation in sub-Saharan Africa at the beginning of the 20th century heralded a new era where charcoal production was highly commercialised due to high energy demand in urban areas. However, this new found importance of charcoal lacked policy and institutional support in many sub-Saharan countries. This led some scholars to believe that due to rapid population growth and inefficient wood fuel consumption techniques, sub-Saharan Africa was headed for a wood fuel crises by the end of the century. While the wood fuel crises never materialized and was dispelled as simplistic and alarmist, the damage on charcoal as a potential sustainable source of energy was done. The negative image of the charcoal industry is because it has been mainly associated with environmental degradation and pollution, unstainable use of wood, and a toxic work environment. However, views on a more positive role of charcoal production on livelihoods of rural communities have been emerging. It is now widely accepted that production and use of charcoal will increase and continue into the future in sub-Saharan Africa. This therefore calls for better understanding of the role of charcoal in land cover change, its impact on species composition and rural livelihoods. It is from this understanding that sustainable management strategies of this resource can be explored. This study was designed to give a 360^0 view of charcoal production at a very local scale in order to get an intensive understanding of the effects of charcoal production on the environment and the local community. In order to gain such understanding, we have used an array of methods and disciplinary perspectives: integrating remote sensing, ecological studies, economics and modelling in one study.

Chapter 1 gives a brief overview of woodlands in sub-Saharan Africa and the goods and services which they provide to the local population. We further discuss what drives land cover change in the woodlands, including natural and anthropogenic factors. Among the anthropogenic factors, population growth and the demand for goods and services drive woodland cover change. Charcoal is one of the goods from woodland areas and it has been linked to woodland degradation as people seek to meet their daily livelihood objectives.

Chapter 2 presents the trends of land cover change for a case study in Kitui, Kenya, based on the analysis of Landsat satellite images from 1986 to 2014 and based on interviews of households who have lived in the area for at least 20 years. Remote sensing images after 1999 suggest that charcoal production is among the major factors of degradation and land cover change, as patches of woodland degradation after 1999 are smaller as compared with the ones between 1986 and 1999. There is a close similarity between the remote sensing data and interview data on land cover change, showing that the community is aware of the land cover changes taking place around them. This chapter further shows how the community is linking their dwindling agricultural production and climate change events to land cover changes associated with charcoal production. Despite charcoal providing a livelihood for around 66% of the households (see Kiruki et al., 2016 for more details), the community felt that their environment, wealth and social relations have been affected by land cover changes caused by charcoal production. This provides an opportunity and point of entry to engage the community and charcoal makers on ways to reduce woodland cover change and degradation.

Chapter 3 looked closer at the representative land cover types to examine how species diversity, size class distributions and regenerative capacity of the woodlands were affected by the three land cover types as identified in Chapter 2. Ordination plots show that different land cover types support different species with species diversity, tree density and biomass decreasing with increasing intensity of land use. Small trees (< 20 cm) form a high percentage the population in farmlands (97%) and high intensity charcoal areas (66%) and hold a much lower percentage of the woody biomass (60% and 15% respectively) indicating that charcoal making can result to almost bare ground. This was also picked up by 30m resolution satellite images used in the land cover classification (Chapter 2). The achieved understanding of species composition can help in managing the environmental sustainability of the woodland system, as degradation of the environment will feedback directly on the livelihood options of the inhabitants.

In Chapter 4, we analysed the importance of charcoal income on the livelihoods of the community in the study area. We also developed a typology of the charcoal makers based on the contribution of charcoal to the total household income. Charcoal income, even though it does not lift households

out of poverty, mitigates the impact of poverty by reducing poverty severity and depth. The achieved understanding of the role of charcoal in livelihoods opens possibilities for planning its sustained management and informed decision making when drafting local policies. An example of a policy that currently misses a perspective of the local livelihood situation, is the current charcoal ban in Kitui county. Thousands of charcoal makers are now facing uncertain future as the Kitui county government abruptly banned charcoal production and trade.

In Chapter 5, we used an agent-based model to simulate how charcoal makers decisions determined the quantities of charcoal to produce and how this affected the final number of charcoal producers and the extent of woodland cover change into the future. Human decision making in this context is guided by factors inherent to the charcoal maker (e.g. gender) and external factors, such as drought and policies in force. By representing variation in behaviour and decision making of different charcoal makers, we can present spatial changes that might occur given various responses to different policies and environmental conditions. This representation of future woodland and charcoal producer dynamics helps us to understand the totality of the interactions between humans and the woodland system and can be used to discuss possibilities of sustained woodland management. However, none of the scenarios simulated lead to a sustained woodland cover as improvements in technology and price would trigger a larger inflow of charcoal makers leading to continued degradation of the woodland system.

In the final chapter, the main findings are discussed and compared with most current literature in order to ascertain their contributions to our understanding of various aspects of charcoal production. We highlight the societal relevance of this work in our quest for more understanding of the charcoal sector and suggest areas for further research. The man findings of this research are:

- We have demonstrated the potential of medium resolution satellite imagery together with physical field observations and community interviews in identifying drivers of land cover change, charcoal included.
- The community in our study area is aware that charcoal production is negatively affecting their environment but have to continue making

charcoal due to low agricultural productivity occasioned by frequent droughts.

- Charcoal production in our study area may be a poverty trap as all the proceeds from charcoal production are used for subsistence purposes: there is no asset accumulation to help households engage in other more productive activities.
- Our agent-based modelling results show that in the next twenty years charcoal makers will have their livelihoods seriously disrupted as there will be no woodlands of sufficient quality left to make charcoal. The woodlands will be degraded and it is expected that charcoal makers will therefore sink deeper into poverty.
- Women risk losing charcoal-based livelihoods earlier than men making them more vulnerable to poverty as they cannot venture deeper into woodlands to make charcoal.
- Operationalization of charcoal policies and legislations would help to formalize the charcoal industry in Kenya and promote sustainable charcoal production.