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## Effects of charcoal ban on value chains and livelihoods in Kenyan coast – Stakeholders' perceptions

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### ABSTRACT

Charcoal production in Africa has been seen by experts and authorities as a driver of forest degradation and deforestation; hence, governments are implementing measures to address this problem, including banning of charcoal production and trade. The effectiveness of these policies is uncertain, and stakeholders' reactions to, and perceptions of, the regulations are unknown. This study analyzed impacts, perceptions, and feedback reactions among stakeholders after the charcoal ban was introduced in Kenya in February 2018. The conceptual framework refers to the theories on sustainability transitions, and data was collected through key informant interviews, focus group discussions (FGDs), individual interviews, workshops, and surveys among value chain actors, organizations, and government agencies in Kwale, Taita Taveta and Mombasa counties in Kenya. Several economic, behavioral, attitudinal, and institutional consequences of the ban were identified. The policy showed characteristics of a negative feedback loop, meaning the policy may not succeed in reaching its purpose because of adverse side effects. Possible "policy mix" approaches and advancement of alternative charcoal sources such as briquettes could in the long-term, promote sustainable development of the Kenyan charcoal sector hence supporting the policy implementation.

### 1. Introduction

The forest and energy sectors in Africa are connected. About 47% of the continent's annual forest harvest is used for household energy and biomass that accounts for 45% of the primary energy demand in the continent (IEA, 2019, p 28). Forest and energy use impact on the atmospheric carbon quantities and, consequently, climate change (Nunes et al., 2020). Charcoal is the fastest growing wood energy type and this increased by 66% between 2000 and 2018 (FAO, 2020a). Due to population growth and current urbanization trends, the consumption of charcoal is projected to increase further until 2030 (Chiteculo et al., 2018; IEA, 2019). Charcoal production, transport and retail provide jobs and income to millions of people in the informal sector in Africa (Mwampamba et al., 2013; FAO, 2014, p 23; Jones et al., 2016; Smith et al., 2017). However, if based on unsustainable practices, the sector could drive

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forest degradation and hence for this reason, charcoal production and use is a concern for many African governments (FAO, 2017).

Governments in African have enacted charcoal-related policies to protect forests and halt declining forest cover (Zulu, 2009; Smith et al., 2015; Doggart and Meshack, 2017; FAO, 2017). The policies, which usually contain restrictions, and in some cases charcoal bans, have shown mixed results (FAO, 2017) attributed to poverty that compel actors to continue with charcoal production to earn a basic income, widespread dependency on charcoal for cooking, and restricted administrative resources to monitor the enforcement of the legislations (Zulu, 2009; Smith et al., 2017). However, few studies have documented how the enactment of a charcoal ban impacts on the stakeholders and the market – and how these impacts in turn influence the policy making process.

Kenya features several of these challenges for natural resources management and household energy policies (FAO, 2017; IEA, 2019; FAO 2020b). To address these challenges in the bioenergy sector, the Kenya government, through the Ministry of Forestry and Wildlife and Ministry of Energy formulated and gazetted The Forest Charcoal Rules in 2009 to regulate production, transportation and marketing of charcoal (Republic of Kenya, 2013). The charcoal rules required charcoal producers to organize themselves and form Charcoal Producers Associations (CPAs). The roles of CPAs included; promoting sustainable charcoal production, ensuring implementation of reforestation and conservation plans for sustainable charcoal production, developing and implementing a code of practice for the purposes of self-regulation and assisting the Kenya Forest Service (KFS) in enforcing sustainable charcoal production, transportation and marketing (Republic of Kenya, 2013). The charcoal rules led to setting up CPAs in the country. Prior to the ban, the CPAs managed tree resources for charcoal production, obtained production licence, supervised and carried out surveillance to ensure that right species and technologies are used for charcoal production, facilitated the issuance of certificate of origin to transporters to confirm the source of charcoal, established of charcoal collection centres where all producers could take their charcoal for sale to transporters, bargained for better prices and undertook tree planting in harvested areas according to the reforestation and conservation plans (PISCES, 2012; Republic of Kenya, 2013). The charcoal rules restored order and ensured coordinated production, transportation and trade of charcoal making the industry nearly sustainable. Despite the successes achieved through the charcoal rules, the Kenya government felt that more actions were needed to halt deforestation and forest degradation in line with international policies, agreements and global agenda 2030 for sustainable development.

As charcoal production in Kenya doubled between 2000 and 2019, there were calls for enactment of policies that halt forest cover loss in the country (Republic of Kenya, 2016) in line with the Sustainable Development Goals (SDGs) (UN, 2015), the New York Declaration of Forests (NYDF, 2014), and the Paris Agreements (UN, 2015). Consequently, a national ban on charcoal trade was introduced in Kenya in February 2018 to halt the forest destruction. It was also meant to fast track the government efforts towards meeting the UN recommended minimum forest cover of 10% by 2022 and restore essential ecosystem services such as carbon storage and the provision of clean water (Republic of Kenya, 2016). The policy can therefore be labeled as a measure to promote a *sustainability transition* of the forestry and bioenergy sectors (Republic of Kenya, 2018a, 2018b, 2018c). *Sustainability transitions* are multi-dimensional processes, involving several sub-goals, sectors, actors and policies through which established socio-technical systems shift to more sustainable means of production and consumption. (Geels, 2004; Markard et al., 2012; Edmondson et al., 2019; Köhler et al., 2019). The charcoal ban affected both the forest use and energy sector, and the different actors in the forestry and bioenergy sectors, and contained several goals such as increased forest cover, socio-economic growth, climate resilience and water management (Republic of Kenya 2016). The charcoal ban therefore presented several traits of a policy envisioning a sustainability transition.

Challenges to creating a sustainable charcoal value chains have been examined by the FAO (2017). Cerutti et al. (2015) and Sola et al. (2017) developed analytical frameworks for creating sustainable charcoal value chains. Operational and economic aspects of charcoal production in Kenya have also been reported by Njenga et al. (2013) who highlighted the sector's growing importance for the people and the economy. Kiruki et al. (2019) demonstrated that balancing of conservation and livelihood needs on charcoal production is a very demanding task. Obstacles to promote sustainable charcoal production in other regions in Africa, are also described in Zulu and Richardson (2013), Zorrilla-Miras et al. (2018) and Smith et al. (2019). However, fewer studies have focused on the interaction between charcoal policies and the sectors' key actors. Little is also known on how policies are received by stakeholders and how they lead to changes in the market and use of charcoal. Such insights would be needed to promote the charcoal sector's sustainability and avoid negative impacts on millions of households throughout Africa (FAO, 2014).

The objective of this study was to determine and describe the effects and successive reactions among value chain actors following a charcoal ban in Kenya that aimed at reducing charcoal production and use. Effects of the policy were analyzed using the following research questions:

1. How did key value chain actors react to, and perceive, the effects of the charcoal ban policy?
2. How were policymakers in turn affected by actual changes in the sector and what were their reactions and sentiments?
3. Does the overall assessment of the effects and feedbacks indicate a long-term success of the charcoal ban policy?

The research findings were also used to outline potential ways to improve the long-term effectiveness of a charcoal regulations.

The study applied a participatory and actor-focused approach to understand the perceived impacts, reactions and views among the key stakeholders namely charcoal producers, transporters, vendors/wholesalers, consumers (households and small enterprises), environmental non-governmental organizations (NGOs), Kenya Forest Service (KFS) and county governments. It analyzed the charcoal ban after it was implemented in Kenya in February 2018, in three counties—Kwale, Mombasa, and Taita Taveta. The study focused on the early impacts and reactions one and half years after a ban when people could still recall the pre-ban situation, and how conditions and behavior had changed after the ban.

### 1.1. Conceptual framework: sustainability transitions

Sustainability transitions are defined as changes that will meet human needs and reduce hunger and poverty while maintaining the life support systems of the planet (Leiserowitz et al., 2006). This study used an adapted model by Edmondson et al. (2019) in presenting sustainability change within a socio-technical system of actors' resources, policies, and socio-economic features of the system that create societal functions (Geels, 2004; Edmondson et al., 2019). It also draws on elements of the sustainable livelihoods framework (Scoones, 1998; DFID, 1999) and stakeholder theory (Freeman, 1994). Stakeholders can constitute different entities, groups, individuals and associations (Mitchell et al., 1997).

The adapted framework (Fig. 1) includes the key drivers for co-evolution of policy and socio-technical systems: policy change, policy effect, and feedback mechanisms. It describes a development where policies are formulated, implemented, interpreted, and later expanded, or downscaled, through feedback loops. In the framework, policy changes impact the society, the economy, and the environment through *resource*, *interpretative* and *institutional effects* (Table 1, Fig. 1). *Resource effects* refer to perceived impacts on physical resources, economic outcomes for different groups, and livelihood consequences, including different adaptations by actors. *Interpretative effects* encompass how the changes have been understood and interpreted by actors, while *institutional effects* refer to the adaptations of administrative functions to the policy. Feedback mechanisms indicate how actors, the environment, and the economy in turn influence policy making. These feedback mechanisms are divided into: *socio-political feedback* that includes viewpoints or expressed opposition to the policy from target groups; *fiscal feedback* that stands for results on public (county or national) finances, and *administrative feedback* that indicates internal continued sense of meaning and commitment among administrating units to implement the policies' intentions. Hence the chain of impacts and feedback mechanisms may create virtuous feedback loops that generate support and resources for a certain policy, or negative feedback loops that generate few visible benefits which in the long run may erode the policy.

This study follows the framework in Edmondson et al. (2019) adapted to emphasize livelihood consequences and changed market behavior after the charcoal ban in Kenya. These effects underpin feedback mechanisms affecting the policymaking.

## 2. Materials and methods

### 2.1. The study area

The study was conducted in Kwale, Taita Taveta and Mombasa counties in the coast region of Kenya (Fig. 2). Kwale and Taita Taveta counties were selected because they are key charcoal producing areas in the country (MEWNR, 2019). Moreover, Kwale and Taita Taveta counties exhibit socio-economic and political characteristics that mirror the situation for the national level; rapid population increase, expansion of farmland, policy goals to increase the forest cover, and high poverty levels hence increasing use of charcoal. Production of charcoal in Kwale and Taita Taveta counties has had adverse impacts on the forests and woodlands (Republic of Kenya, 2018d; Republic of Kenya, 2018e; Republic of Kenya, 2018f). Lastly, the charcoal rules of 2009 were piloted in Kwale and Taita Taveta counties where the first charcoal producer associations (CPAs) were formed to ensure sustainable charcoal production, transportation and marketing, and the two counties accounted for almost 30% of the charcoal produced in the country (Republic of Kenya, 2013). Additionally, the two counties were among those counties with the highest number of registered CPAs that were actively

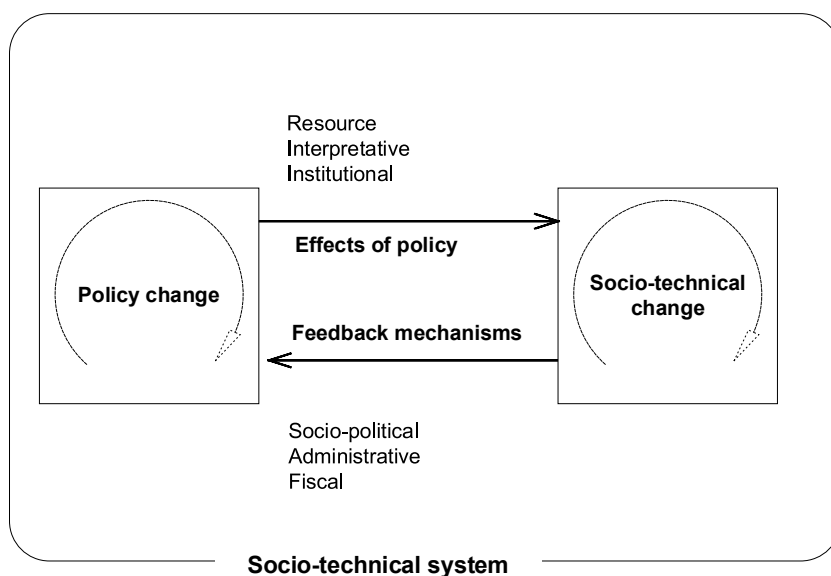
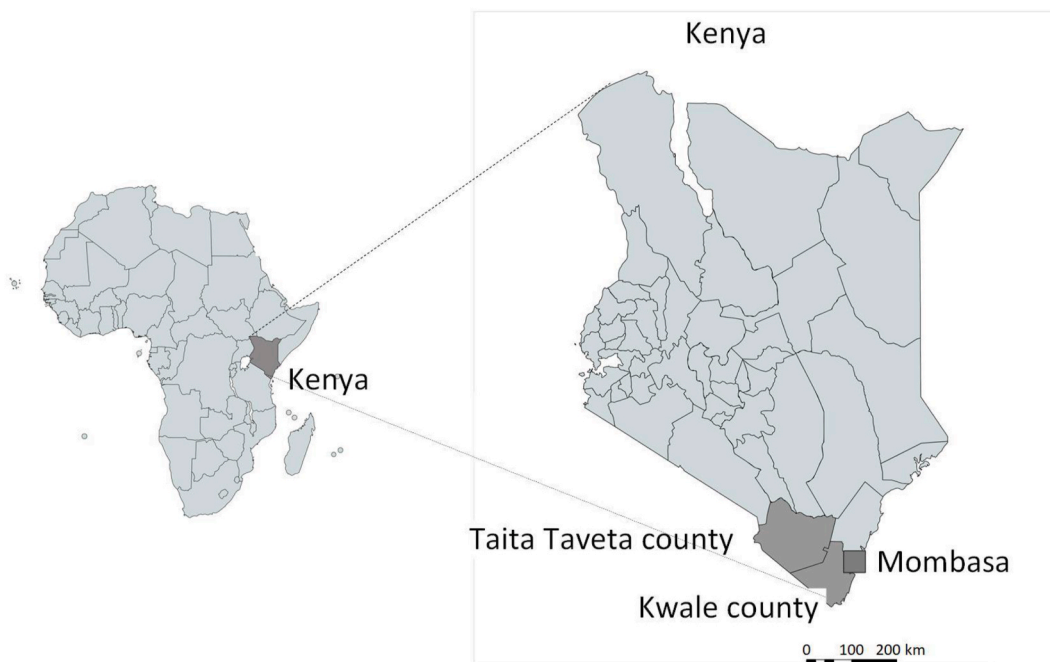


Fig. 1. Framework for this study (Adapted from Edmondson et al., 2019).

**Table 1**  
Effects of policy and feedback mechanisms.

Component	Definition
Resource effects	Resources that the policy bestows upon the environment, economy, or society. Adaptation/substitution and livelihood effects.
Interpretive effects	Target groups' cognition, understanding and expectations of the policy.
Institutional effects	Direct impacts of policy on institutional structure (organizations, agencies, and associations).
Socio-political feedback	Actors' opinions about the specific policy reflected in views of whether it should be maintained, eliminated, or changed. Support or opposition of the policy. Ways to articulate stakeholders' feedback.
Fiscal feedback	Public budgetary consequences of the policy.
Administrative feedback	Internal sentiments and dedication among public employees who are responsible for implementing the policy. Reputation effects for administrative agencies.



**Fig. 2.** Map showing the study region.

engaged in charcoal production and trade in Kenya. Therefore, it was anticipated that the effects of the ban would be clearly manifested in the two counties. Mombasa county, typically a city county is a major market for the greater proportion of the charcoal produced in Kwale and Taita Taveta counties, hence its selection in this particular study.

Taita Taveta produces charcoal for local towns and distant markets such as Nairobi and Mombasa. A large area (62%) of the county is within Tsavo East and Tsavo West National Parks. A larger quantity of charcoal is produced in Kwale, both for smaller towns and for Mombasa, which is the main consumer market for charcoal (Table 2).

Charcoal is used by 11.5% of the households in Kwale and by 30% in Mombasa (Republic of Kenya, 2018e; Republic of Kenya, 2018f). The annual charcoal production in Taita Taveta and Kwale accounts for 1.7–3.4% of the total annual production in Kenya (Roos et al., 2021). The county integrated development plans for Kwale and Taita Taveta, call for an increased community involvement in the management of forest resources and better protection of forests on both public and private land (Republic of Kenya, 2018d, 2018f).

**Table 2**  
Overview of the study counties in Kenya.

County	Area, km <sup>2</sup>	Population	Forest area, km <sup>2</sup>	Production/consumption
Taita Taveta	17 084	347 909	280	Production and consumption
Kwale	8270	713 488	1250	Production and consumption
Mombasa	230	1 266 358	4	Consumption

Source: Republic of Kenya, 2018d, Republic of Kenya, 2018e, Republic of Kenya, 2018f

## 2.2. Data collection and analysis

A qualitative case study methodology was applied to reflect views, processes, and relationships requiring a contextual perspective (Dillon and Reid, 2004; Flyvbjerg, 2006; Eisenhardt and Graebner, 2007; Yin, 2013). The illegality of the sector made it impossible to access a well-defined sampling frame of respondents or record the exact quantities of charcoal produced and traded. Hence, our approach considered guidelines for qualitative research involving trustworthiness, triangulation, and transferability of the approach (Bell et al., 2019).

The research focused on the policy change (charcoal ban) and the associated consequential effects and feedback mechanisms. Mixed methods approach was applied that combined different data collection methods, comprising of individual and key informants' interviews, focus group discussions (FGDs) and stakeholders' workshops. Mixed methods are becoming more established in social sciences allowing for triangulation and flexible data collection (Johnson et al., 2007; Yin, 2013; Bell et al., 2019).

The study focused on the perceived and experienced impacts of the charcoal ban among stakeholders when it had been in force for 18 months, a period long enough to allow the impacts of the ban to manifest and be analyzed. The data collection instruments were structured according to the conceptual framework (Edmondson et al., 2019). The data collected covered perceived impacts of the charcoal ban and respondents' views, perceptions, and reactions to it (Table 3). Data collection instruments are provided in Appendix A.

The research involved an initial study in June 2018 of the supply chain structure, and processes. The main data collection was undertaken between June and September 2019 and included: (1) FGDs with charcoal value chain actors; (2) interviews with representatives of county governments of Kwale, Mombasa and Taita Taveta, Kenya Forest Service; and (3) interviews with retailers, small restaurant managers/owners and customers in Mombasa. The interviews and FGDs were conducted in charcoal producing sub counties in the two counties – Kinango and Lunga Lunga sub counties in Kwale county, and Mwatate and Voi sub counties Taita Taveta county. The selected sub counties were previously active charcoal production hubs due presence of expansive woodlands and few alternative income sources. In Mombasa County, Changamwe, Likoni and Kisauni sub counties were selected for the interviews because the majority of the inhabitants are low-income earners who entirely depend on charcoal as the main source of energy for cooking. Nineteen key informants were selected based on direct involvement, specific perspectives and long-standing experience of the charcoal sector. They included officials of CPAs (11), Kenya Forest Service officers (4), county government officials from departments of environment and forestry (2), Environmental Non-governmental organizations (1) and National Government Affirmative Action Fund (1). In addition, 62 consumers in Mombasa who were randomly selected from households that exclusively depend on charcoal for cooking were also interviewed. Moreover, 20 charcoal retailers and 31 cafés/restaurant managers/owners were interviewed to provide their perspective on the impacts of charcoal ban. The retailers were approached at various hours of the days outside charcoal selling points. Given the sensitivity of the study attributed to the illegal nature of charcoal movement and trade at the time, village elders ('nyumba kumi' elders) were valuable in mobilizing the respondents to participate in the interviews who would otherwise be apprehensive. The village elders accompanied the enumerators to conduct the interviews and the survey in Mombasa; this gave the respondents confidence to share the information without fear of being reprimanded by authorities, hence ensuring the validity of the data collected.

The information generated from key informants, consumers, retailers and café/restaurant owners interviews was subjected to three validation workshops (Kwale, Taita Taveta and Mombasa) bringing together key informants (producers, transporters, vendors, government agencies and NGOs) for confirmation and corroboration of facts gathered during the field interviews to ensure quality and authenticity of the findings being reported.

The interviews were conducted in Swahili language by local native speaking enumerators with minimum qualification of college diploma in either social sciences or community development. The enumerators were gender balanced as provided by the constitution of Kenya whereby a third were women. They received a two-day course on the data collection tools prior to the data collection was started. Moreover, the questionnaires were developed, tested and adjusted before use in data collection. Confidentiality of the respondents was assured in accordance with the International Society of Ethnobotany Code of Ethics (International Society of

**Table 3**  
Data collection and sample size in the study areas.

Data collection method	Respondents	Counties		
		Kwale	Taita Taveta	Mombasa
FGDs (3 h)	Sessions with representatives of CPAs (producers, transporters)	7	4	
Key informant interviews (2 h)	Environmental Non-governmental organizations (WWF)	1		
	Ecosystem Conservator, KFS		1	
	County Executive Committee		1	
	National Government Affirmative Action Fund (NGAAF) which falls under the Ministry of Public Service, Youth and Gender Affairs		1	
Stakeholder workshops	KFS officers (Mombasa, Kwale, Taita Taveta)	1	1	1
	County Director of Natural Resources			1
Vendor and customer survey	Two meetings with stakeholders. Number of participants: 37 (Taita Taveta) and 22 (Kwale). Participants included producers, transporters, vendors, agencies, NGOs	1	1	1
	20 charcoal vendors, 31 hotel/restaurant owners, 62 consumers			113

Ethnobiology, 2006).

Data was recorded in written form and analyzed thematically through coding, thematic techniques, and pattern matching (Miles and Huberman, 1994; Tong et al., 2007; Silverman, 2013). In the analysis, only aspects that were recorded and emerged several times in different data collection methods (e.g. both FGD and key informant) were considered.

### 3. Results

#### 3.1. The socio-technical system and policy change

The socio-technical system refers to the initial resources, policies, and socio-economic features of the system under study. In this case, the socio-technical system encompassed forests and charcoal value chains from production to the end users/customers.

The national ban on logging and charcoal production in public forests was imposed on February 24, 2018 for an initial period of three months (90 days), and a taskforce was convened to review forestry management in the country (Republic of Kenya, 2018a) (Fig. 3). The ban effectively barred the production and movement of charcoal, but not the use. It was implemented by KFS personnel, and trade in the three counties was stopped and the charcoal found in the collection centres and on transit is seized and culprits arrested. The ban has been repeatedly extended and is still in force as of September 2021. The main gap in the implementation of the ban was the fact that logging is typically done in public forests but most of the charcoal comes from private and community forests, and therefore, the ban which targeted public forests, ended up banning production, transportation and trade of charcoal from private lands hence impacting negatively on rural livelihoods. Therefore, in practice, it is difficult for the controlling authorities i.e. Kenya Forest Service to distinguish and verify different origins of charcoal, which means that charcoal production has also been suppressed on private lands and community forests.

This policy changes generated effects on the socio-technical system, and subsequently feedback mechanisms (Fig. 1), which are outlined in the subsequent sub-sections.

#### 3.2. Resource effects

The policy change that rendered most transported charcoal illegal leading to reduced volumes throughout the value chain—from producers to transporters and retailers (Fig. 4). The scale of these reductions differed, but respondents reported a decrease of 30–50% in the traded volumes of charcoal compared to the quantities that were channeled through the CPAs before the ban was imposed. The main cause for the reduction in volumes was the risks associated with fines and confiscations at the production stage and, to a higher degree, for transporters. Even in areas where charcoal could be produced legally, (e.g., wood from private land), production decreased. The reduced product streams resulted into reduced charcoal consumption. Vendors reported reduced sales, from 20 bags per day before the ban to three bags after the ban. Buyers purchases charcoal more frequently, and to some extent even daily in smaller quantities (0.5–2.0 kg bags).

Supply also became irregular after the ban was instituted, especially during the rainy season, with occasional empty inventories at the sales points. These interruptions inconvenienced low-income customers who usually buy in small quantities several times a week and therefore were directly affected by stockouts. Furthermore, producers, middlemen and customers complained of declining charcoal quality, such as overburnt charcoal and powdered or adulterated charcoal with unburnt pieces of wood.

The increase in illegal production and trade of charcoal was also noted. Some members of CPAs continued to produce charcoal on their own without selling it via the CPAs established collection centres. This illicit charcoal was transported at odd hours on back roads to avoid detection and arrests by authorities. Transportation using lorries was replaced by motorbikes that carried four bags per trip, which is the permitted load for subsistence uses but not for sale. Besides motorbikes, small common station wagons (locally known as Proboxes) were also used to transport charcoal to the market at night. Therefore, the ban encouraged corruption due to black market nature of the charcoal business hence resulting into law enforcement agencies making gain of the situation. These complex production and supply patterns that emerged after the ban coupled with corruption practices among law enforcement agencies exacerbated the already existing irregular availability of charcoal to customers.

According to the respondents, external charcoaling entrepreneurs, unassociated with the local communities or the CPAs, increased their operations in the region following the ban. These producers used their own labor and transport since they have the capacity to carry out production and trade of charcoal individually.

After the ban was imposed, imported quantities started to flow into Mombasa albeit illegally without an import permit issued by KFS. These quantities originated from Uganda and Tanzania because of a stronger Kenyan currency and the fact that charcoal

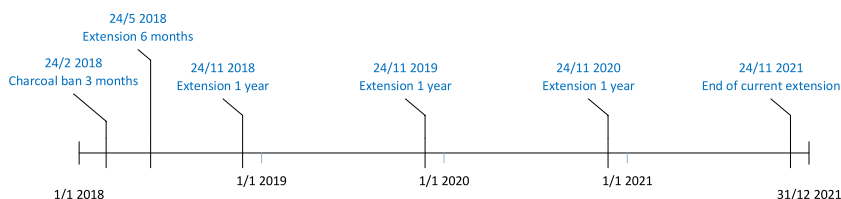


Fig. 3. Timeline of charcoal for the charcoal ban in Kenya.

*"The levels have decreased because many community locals are afraid of cutting down trees." (Producer focus group, Kwale)*

*"The only difference is that tree harvesting is done illegally at odd hours, e.g., at night." (Producer focus group, Taita Taveta)*

*"The forest has not recovered due to increased illegal activities and CPAs' lack of mandate to regulate harvesting." (Producer focus Group, Taita Taveta)*

*"Producers, vendors, transporters are all afraid of being arrested anytime. Quality of charcoal has decreased." (Producer focus group, Kwale)*

*"Charcoal transport is done at night to evade many unexpected costs." (Transporter focus group)*

*"Income is greatly reduced because there is no business. Some of us have families, and it's becoming even harder to take care of our families adequately." (Vendor, Kwale)*

*"Charcoal prices have risen because the demand for charcoal increased with less supply." (Vendor, Mombasa)*

*"I have not adapted because I am really suffering most of my profits go to buying charcoal." (Hotel owner, Mombasa)*

*"I cannot even save. I am forced to buy charcoal so that I can cook for my customers." (Restaurant owner, Mombasa)*

*"Transportation of the charcoal has added an extra cost; initially, we used to buy it right from our doorsteps from lorries, but now they are not easily available." (Customer, Mombasa)*

*"I cook in evenings only after the ban." (Customer, Mombasa)*

*"Prices have increased. We face hostility from the retailers as we bargain while buying." (Customer, Mombasa)*

*"I had my kerosene stove. So, I have no problem and buy kerosene when there is no charcoal. I use paraffin stove at times so as to save charcoal to use it later." (Customer, Mombasa)*

**Fig. 4.** Quotes from participants on the resource effects of the charcoal ban.

production in Uganda and Tanzania was still (reportedly) legal.

The other outstanding change was the increase in charcoal prices along the value chain. On average, the prices at the producer stage increased from about 5.8 to 9.7 USD per bag (35–40 kg; 100 Kshs = USD 0.973, June 1, 2019) after the ban, representing an average price increase of 67%. The average prices for consumers more than doubled from 7.8 USD per bag before the charcoal ban, to 16.5 USD per bag after the ban. A corresponding average consumer price increase has also been witnessed for small quantities, from 0.5 to 1 USD per 1 kg bags. Since prices of paraffin and Liquid Petroleum Gas (LPG) simultaneously increased during the same period, for end consumers in Mombasa it meant that their purchasing power was adversely affected.

Consequently, the ban strained household budgets for value chain producers, middlemen and customers/consumers. The reduced volumes produced within the CPAs diminished income-generating opportunities in woodland-producing areas. However, it was also indicated that the above-mentioned illegal charcoal producers took advantage of the increased charcoal prices to produce more charcoal albeit illegally. In Mombasa, increased charcoal prices affected, primarily, low-income households. The overwhelming conclusion is that the ban made life "harder" throughout the value chain, particularly when the prices of other commodities had also

increased. For Mombasa households, energy need accounted for 14–35% of household budgets after the ban, and the charcoal share was 10–25% of the energy need for households.

- “The levels have decreased because many community locals are afraid of cutting down trees.” (Producer focus group, Kwale)
- “The only difference is that tree harvesting is done illegally at odd hours, e.g., at night.” (Producer focus group, Taita Taveta)
- “The forest has not recovered due to increased illegal activities and CPAs’ lack of mandate to regulate harvesting.” (Producer focus Group, Taita Taveta)
- “Producers, vendors, transporters are all afraid of being arrested anytime. Quality of charcoal has decreased.” (Producer focus group, Kwale)
- “Charcoal transport is done at night to evade many unexpected costs.” (Transporter focus group)
- “Income is greatly reduced because there is no business. Some of us have families, and it’s becoming even harder to take care of our families adequately.” (Vendor, Kwale)
- “Charcoal prices have risen because the demand for charcoal increased with less supply.” (Vendor, Mombasa)
- “I have not adapted because I am really suffering most of my profits go to buying charcoal.” (Hotel owner, Mombasa)
- “I cannot even save. I am forced to buy charcoal so that I can cook for my customers.” (Restaurant owner, Mombasa)
- “Transportation of the charcoal has added an extra cost; initially, we used to buy it right from our doorsteps from lorries, but now they are not easily available.” (Customer, Mombasa)
- “I cook in evenings only after the ban.” (Customer, Mombasa)
- “Prices have increased. We face hostility from the retailers as we bargain while buying.” (Customer, Mombasa)
- “I had my kerosene stove. So, I have no problem and buy kerosene when there is no charcoal. I use paraffin stove at times so as to save charcoal to use it later.” (Customer, Mombasa)

Profit margins for transporters and traders became slimmer because of reduced turnover, and the actors along the value chain reported that they were no longer able to save, whereas others were forced to sell assets used in charcoal production to meet their needs and started to look for alternative income sources.

Livelihood effects of the ban were also felt throughout the value chain. The main uses of charcoal income by actors (producers, vendors, and transporters) were school fees, food, clothes and housing. Hence, for charcoal value chain actors who depended on the charcoal trade for their income, expenditures on these items were affected. Indirect consequences involved adverse impacts on quality of life, harmony, and social consequences whereby children had to drop out of school because of an inability of parents to pay school fees. Breaking up of marriages/families was also mentioned because of reduced income that is needed to meet basic needs, and which could be generated through charcoal business.

Supply chain adaptations were reported in all stages along the value chain. The main fallback income sources for charcoal producers and transporters were found in the informal sector – subsistence farming, casual labor, small-scale businesses, transport and masonry. It should be noted that few respondents among charcoal producers, transporters, and vendors were contemplating migrating to cities or urban centres to seek employment as a consequence of the reduced charcoal income.

Consumer behavior changes included reduced consumption, acquisition of more efficient energy-saving cooking stoves, and

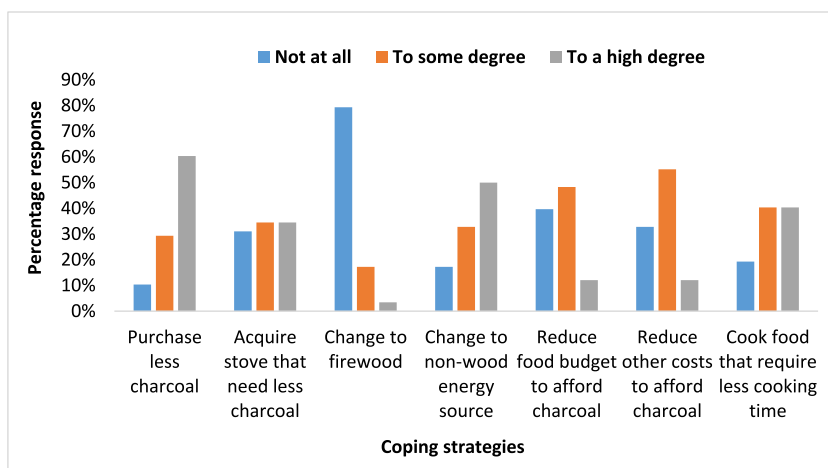


Fig. 5. Households’ coping strategies to the increased price for charcoal (N = 58).



switching to alternative fuels (mainly liquefied petroleum gas [LPG] or Kerosene). However, these improved cooking technologies were costly and came with new cooking practices. Other respondents reported only cooking once per day or avoiding foods that required long cooking time, like beans to reduce the quantity of charcoal needed. The ban also affected a large number of small restaurants and cafes in Mombasa which were forced to cut down on the quantity of food prepared for customers. The coping strategies of households and restaurants and cafes are shown in Figs. 5 and 6.

A comparison of Figs. 5 and 6 suggests that both households and restaurant owners reduced their charcoal consumption, although the latter category was more restricted in this aspect. Households changed to other fuels, reduced other costs, and cooked foods that need less cooking time. Owners of small restaurants/cafes had a greater tendency to use fuelwood and to reduce other operation costs. In both cases, the charcoal ban affected the total operations budget.

### 3.3. Interpretative effects

Interpretative effects describe how the policy change was perceived by stakeholders, i.e. whether they noticed a change that was better or worse. With regard to the policy’s primary motive, to protect the forests from further degradation and loss, respondents gave disparate observations (Fig. 7). Some actors, believed that the charcoal ban would reduce forest loss. However, others argued that even if deforestation and forest degradation decreased, households would suffer. Other respondents believed that the ban would have no impact on forest conditions or that it was too early to determine how the forests would be affected. Yet others claimed that the reduced activity among CPAs was offset by increased illegal activities and by the fact that tree planting that was periodically organized by CPAs, had stopped. In summary, stakeholders expressed contrasting effects of the ban on the conditions of the forests.

“Poor implementation of policy by relevant enforcers. The actors were not involved in policy making thus they are not even aware that they are breaking the laws.” (Producer focus group, Taita Taveta)

“It will not achieve its purpose since an alternative could have been given. It is a bad policy” (Women producer focus group, Kwale)

“The charcoal ban is not effective, charcoal production still goes on.” (Vendor, Mombasa)

“It helps the government conserve the environment but as average citizens we are suffering.” (Vendor, Mombasa)

“It’s all negative. Nothing has changed, life has become more expensive right now.” (Customer, Mombasa)

“It’s both positive and negative. Positively, the environment has changed slightly with rains being a blessing, but negatively the cost of living is becoming unbearable.” (Customer, Mombasa)

“Yes, I have witnessed a woman being arrested when she was receiving her charcoal from the transporter. All her charcoal was also taken away.” (Customer, Mombasa)

“The members of the producer associations have been the most disadvantaged because the ban has opened up for non-members who produce charcoal indiscriminately and the associations have no power to police them as before.” (Key informant, Taita Taveta)

The winners of the ban, according to some respondents, were wildlife and conservation interests and representatives of the tourism industry. The ban’s effects on livelihoods had created discontent among most categories of those interviewed, due to both the ban’s negative livelihood effects as well as its hurried and inadequate implementation with short notice and limited consultative process

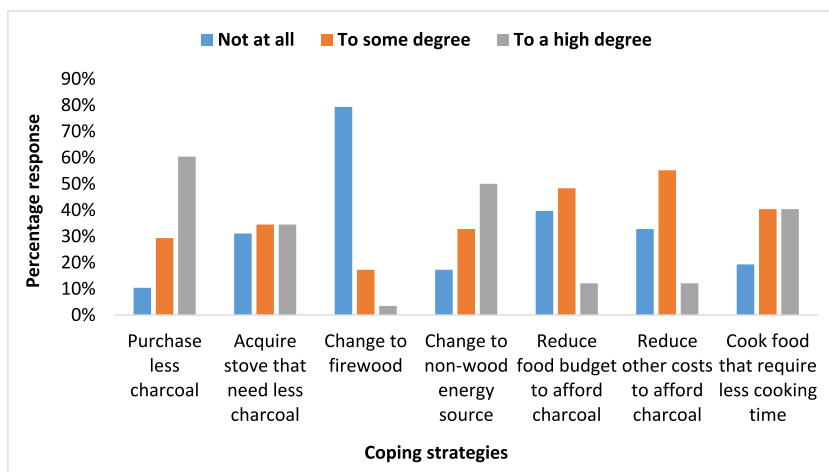


Fig. 6. Small restaurants and cafes’ coping strategies to the increased price for charcoal (N = 30).

*“Poor implementation of policy by relevant enforcers. The actors were not involved in policy making thus they are not even aware that they are breaking the laws.” (Producer focus group, Taita Taveta)*

*“It will not achieve its purpose since an alternative could have been given. It is a bad policy” (Women producer focus group, Kwale)*

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**Fig. 7.** Quotes from participants on the interpretative effects of the charcoal ban.

with key stakeholders. There were complaints regarding the lack of community participation in the whole process that led to the imposition of the ban. Furthermore, negative reactions on the implementation stemmed from arrests of transporters and confiscation and destruction of charcoal by law enforcement agencies.

Respondents frequently reported that informal fees was being charged for illegal movement and trade of charcoal by officials of law enforcement agencies. The situation created a poor relationship with the authorities based on fear and distrust.

### 3.4. Institutional effects

Institutional effects involve the repercussions of the charcoal ban on organizations and administrative authorities (Fig. 8). The key institutional effect of the 2018 policy to ban charcoal production and trade was the weakening of the CPAs. In the 2009 charcoal regulations, CPAs were responsible for facilitating sustainable charcoal production, overseeing and organizing reforestation, and assisting KFS in ensuring sustainable charcoal production practises as provided by the law and regulations. After the ban, CPAs could no longer perform these functions, designated charcoal collection centres which had been established by CPAs closed down, and the issuance of certificates of origin for the charcoal to allow valid movement to the market stopped. As a result, the CPAs could not charge membership fees and hence have become financially constrained. The CPAs also stopped developing conservation and reforestation plans for the areas they had been harvesting wood from, and the existing plans which had been developed prior to the ban are no longer being implemented. Given that the CPAs are not generating revenue as it was the case before the ban, conservation funds and conservation and reforestation plans in their areas of operation have ceased to exist.

*“Due to the charcoal ban, charcoal producer groups (CPGs) are no longer recognized e.g. Bura CPG, Landi CPG have been weakened.” (Producer focus group, Kwale)*

*“Enforcement of the ban is being fully implemented. Many members have stopped engaging in the business.” (Transporter focus group, Kwale)*

*“The number of police officers have been increased in every road block to enforce the ban and arrest those doing charcoal business this has enabled rise in corruption.” (Vendor, Kwale)*

"Due to the charcoal ban, charcoal producer groups (CPGs) are no longer recognized e.g. Bura CPG, Landi CPG have been weakened." (Producer focus group, Kwale)

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"The number of police officers have been increased in every road block to enforce the ban and arrest those doing charcoal business this has enabled rise in corruption." (Vendor, Kwale)

"The police visit our shops often but mostly they request for some fee and they leave afterwards." (Vendor, Mombasa)

"Police officers confront those selling charcoal on the streets but they are given some small fee and they go away." (Customer, Mombasa)

"There is increased policing- monitoring. Officers have been deployed for this purpose." (Authority)

Fig. 8. Quotes from participants on the institutional effects of the charcoal ban.

"The police visit our shops often but mostly they request for some fee and they leave afterwards." (Vendor, Mombasa)

"Police officers confront those selling charcoal on the streets but they are given some small fee and they go away." (Customer, Mombasa)

"There is increased policing- monitoring. Officers have been deployed for this purpose." (Authority)

The recruitment of KFS rangers and police was increased to effectively enforce the law. The protection department of the KFS was allocated more funds to conduct more frequent surveillance and arrests. The number of roadblock patrols also increased. Hence, resources used for implementing the charcoal ban increased after it was enacted placing a heavy financial burden to the government.

### 3.5. Socio-political feedback

Social-political feedback, entails *cognitive feedback*, indicating tacit views on whether a policy should be continued, lifted or changed; and *constituency/agenda feedback* when these views were voiced (Edmondson et al., 2019). Most value chain actors believed that the charcoal ban should be lifted or amended through a consultative process involving all key stakeholders in the charcoal industry. However, these perceptions mainly stayed among the actors, as there appeared to be a barrier to present these views to the Ministry of Environment and Forestry through KFS which is the Ministry's lead agency responsible for the development and sustainable management, including conservation and rational utilization of forest resources for the socioeconomic development in the country (Fig. 9).

Instead of a strict ban, actors along the charcoal value chain preferred a regulated charcoal sector involving licenses and obligations to replant trees in harvested areas and granting more control and power to local CPAs. Hence, licenses and movement permits should be given to charcoal producers and transporters, and traders to regulate the sector. Producers also indicated that the government should have restricted activities of external charcoaling entrepreneurs who continued to operate undisturbed despite the ban.

Other desired actions by producers included capacity-building efforts involving technical skills and knowledge in silviculture, harvesting, tree-seedlings growing, and improved methods of charcoal production to enhance production efficiency.

The opposition to the charcoal ban or requests for modifications were less common. This is because CPAs and their national umbrella organization lost authority when charcoaling activities became illegal after the ban. Lack of income to the CPAs that used to be generated when the charcoal rules and regulations were being implemented also crippled their operations, hence weakening their voice and authority to seek redress with the relevant government authorities. However, producers, transporters, vendors, and women organizations had reportedly petitioned to the national government through the Ministry of Environment and Forestry that the ban should be lifted. Several petitions and requests for special arrangements have been noted from various parts of Kenya (The Nation, 2018; The Standard, 2018).

*“Some women groups demanded that the charcoal ban would be lifted but no action has been taken yet.” (Women producer focus group, Kwale)*

*“Ban should be lifted because many jobs associated with charcoal production are lost. Promote tree planting in public land e.g. schools, dispensaries etc. Each group to establish tree nursery for seedlings production.” (transporter focus group, Kwale)*

*“Transporters who are main players have not petitioned government because they don’t have an association.” (Vendor, Mombasa)*

*“The authorities should find a way in which the lower and middle class people could be helped because charcoal is too expensive and at the same time our forests are not safe and saved.” (Customer, Mombasa)*

*“We are afraid of approaching the authorities and ask for the ban to be modified.” (Customer, Mombasa)*

*“Yes, in our women group we have people who discuss these issues but I haven’t seen anyone forwarding such requests to the authorities.” (Customer, Mombasa)*

*“The associations have requested for the lifting of the ban but to include measures to restore the forest as a requirement. They have also requested for a level playing ground so that there are incentives for being a member of an association.” (Key informant, Taita Taveta)*

*“Yes, there have been some discussions with some actors at the county level in convenings where group discussions generated recommendations that have been communicated to higher authorities including the office of the Governor.” (Government officer, Mombasa)*

**Fig. 9.** Quotes from participants on the socio-political feedback of the charcoal ban.

*“Some women groups demanded that the charcoal ban would be lifted but no action has been taken yet.” (Women producer focus group, Kwale)*

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*“Yes, there have been some discussions with some actors at the county level in convenings where group discussions generated recommendations that have been communicated to higher authorities including the office of the Governor.” (Government officer, Mombasa)*

### 3.6. Administrative feedback

The administrative feedback mechanism refers to the internal morale, sense of mission and external reputation among the administrative bodies in charge of the implementation of the policy and personal commitment of the administrative bodies in charge of the policy's implementation (Fig. 10). The officers from law enforcement agencies were obliged to implement and monitor and enforce the charcoal ban; thus, it is difficult to determine whether they really support the policy. However, the authorities were not able to seize all the illegal charcoal displayed by traders along the Mombasa-Nairobi Highway and other market centres. This could be attributed to the limited human resources and the fact that strict enforcement of the ban would lead to a negative reputation of the law enforcement authorities and its personnel in the local community.

"The authorities should establish a good relationship with the charcoal business actors if they want the policies to be successfully implemented." (Producer, Taita Taveta)

"Some producers are relatives of staff and see how hard life is now experienced." (Producer focus group, Kwale)

"Law enforcers are not keen to ensure the implementation of the ban." (Customer, Mombasa)

"Immediately the ban was issued the police did not want to see any charcoal vehicle even the suppliers couldn't supply in the open. They had to sell in private areas but nowadays we see people selling in the open." (Customer, Mombasa)

### 3.7. Fiscal feedback

Before the ban, according to The Forest Conservation and Management Act 2016 and Charcoal Rules of 2009, the transporting of charcoal required movement permit issued by KFS at the cost of 0.3 USD per bag. Transporters used to pay 0.1 USD per bag of to the county governments as cess fees. The collection centres (vendors) used to pay for 2 USD per year for business permit to the county governments. However, these taxes were no longer charged and public finances were reduced. In fact, this burden is even larger because forest authorities have also stepped up their monitoring and enforcement efforts of the charcoal ban since CPAs have been stripped off their power to monitor illegal charcoaling activities (Fig. 11).

"The need to increase monitoring and arresting the offenders has increased cost of transport and personnel expenses. Revenue has been lost." (Government officer)

"Tax return from charcoal has greatly been reduced because of lack of permits to do business." (Key informant, ENGO)

"Ensured the protection branch of KFS has been allocated more funds to conduct more frequent surveillance." (Government officer)

### 3.8. Stakeholder's differences in perceptions on the charcoal ban

Perceptions and views on the charcoal ban were similar across stakeholder groups who emphasized on the reduced volumes and livelihood impacts. Retailers claimed that charcoal use would continue because of the high price of alternative energy sources. Middlemen described a reduced supply and lower turnover that impacted negatively on their incomes. Small restaurant owners complained of an increasing cost share being used for charcoal (20% with a large variation). Urban consumers said an increasing share

*"The authorities should establish a good relationship with the charcoal business actors if they want the policies to be successfully implemented." (Producer, Taita Taveta)*

*"Some producers are relatives of staff and see how hard life is now experienced." (Producer focus group, Kwale)*

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*"Immediately the ban was issued the police did not want to see any charcoal vehicle even the suppliers couldn't supply in the open. They had to sell in private areas but nowadays we see people selling in the open." (Customer, Mombasa)*

Fig. 10. Quotes from participants on the administrative feedback arising from the charcoal ban.

“The need to increase monitoring and arresting the offenders has increased cost of transport and personnel expenses. Revenue has been lost.” (Government officer)

“Tax return from charcoal has greatly been reduced because of lack of permits to do business.” (Key informant, ENGO)

“Ensured the protection branch of KFS has been allocated more funds to conduct more frequent surveillance.” (Government officer)

Fig. 11. Quotes from participants on the fiscal feedback of the charcoal ban.

of their household income was being used on energy for cooking. Representatives of authorities particularly KFS officers, emphasized the need to protect forests from increasing charcoal production. However, they also reported the increased use of public resources for monitoring and enforcing the ban, together with reduced tax revenues to the government. The authorities also wished to achieve better dialogue with community organizations. Charcoal producers described reduced revenues and indirect social effects (reduced resources for basic needs and school fees). In this aspect, similar observations were made by both men and women producers. Transporters predominantly complained about roadblocks and informal fees charged to allow illegal movement and trade of charcoal, which still continues despite the ban. The main concern among ENGO representatives was the doubt in the policy’s effectiveness and that it would not succeed to control charcoal production.

4. Discussion

4.1. Policy change effects and feedback

The findings demonstrate how the sustainable transition framework (Edmondson et al., 2019) can be used to elaborate how feedback loops with time determines policy effectiveness. Adapted to the case of charcoal value chains in Kenya, these aspects of the framework are elucidated in Fig. 12.

Resource effects of the charcoal ban encompasses volumes, prices, household budgets, and various adaptation mechanisms among key actors in the charcoal value chain. Generally, the ban has resulted into reduced resources for the poor rural households (i.e both producers and customers). However, the charcoal ban and associated increase in charcoal prices seems to have benefited some producers and the new entrants into the illegal production and trade of the product. The ban seems also to have benefited retailers selling alternative energy options like Kerosene and gas. Respondents believe that even if the harvesting of trees in forests is reduced, the price

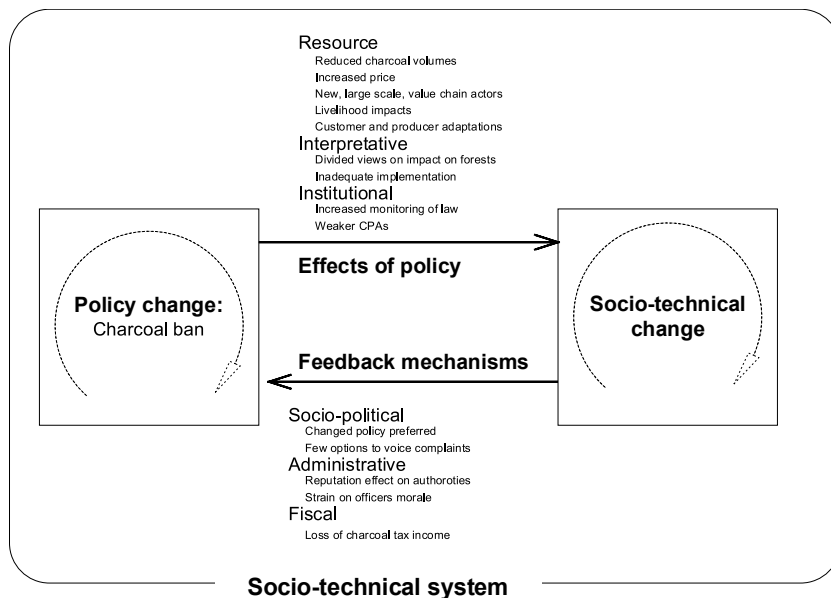


Fig. 12. Dynamic interactions between charcoal ban and the socio-technical system.

of charcoal is too high for them to afford and, moreover, the informal fees charged to allow for the illegal movement and trade of charcoal is a widespread problem. Institutional shifts include the weakened roles of CPAs' and increased workload for the enforcement agencies particularly KFS to take over some of the responsibilities that were previously undertaken by CPAs as well as to ensure that the charcoal ban is fully enforced.

Charcoal actors along the value chain described the desired change that typically involved a legal, regulated charcoal sector based on sustainable forest management. Complaints and opposition to the ban have also been stated by producer groups, intermediaries, and customers. However, respondents were afraid to express their concerns publicly due to lack of fair platform to engage the concerned authorities. Furthermore, there are indications of decreased motivation among staff of the enforcing agencies because charcoal is a regular cooking energy for the majority of the households. Finally, tax revenues stemming from most charcoal trade have been lost and the fees being charged for movement of charcoal are illegal (Haysom et al., 2021).

Our analysis of the immediate perceptions and developments indicate that the current policy may have succeeded in the short term in reducing forest degradation and deforestation from charcoal production, although this effect remains to be verified. However, in line with the argument by Edmondson et al. (2019), the current policy represents a change that may be associated with inconsistency, low public support, and continued illegal charcoal production and trade, which reduces policy support over time. As a result, few tangible positive effects on key actors, negative perceptions, and reduced revenue to the government and waning commitment of personnel of the enforcement agencies could eventually create a negative loop for the policy in question, and hence an impediment for the expected sustainability transition that the policy was meant to achieve (Table 4).

An alternative policy approach for a sustainability transition in the charcoal sector in Kenya is presented in the right column in Table 4. Beginning with resource effects, regulated charcoal production based on sustainable forest management approach would secure long-term availability of raw materials, taking advantage of rotational harvests, coppicing and other reforestation practices. Moreover, at the production stage, improved, and more efficient charcoal production technologies would reduce wastage. However, to achieve some levels of success, efficient production technologies should not involve high investment costs or have technical capacity limitations that reduces their comparative economic advantages. The technologies must also be compatible with current resources and charcoaling practices. Furthermore, to address adverse livelihood effects, alternative income sources for charcoal-dependent producer families should be explored. In the case of consumers, alternative, clean and affordable cooking stoves and fuels should be promoted to cushion them against potential negative effects attributed to the reduced flow of charcoal to urban and peri-urban households. The multiple and subtle factors that influences households' adoption of cleaner cooking energy should be thoroughly understood and addressed to enhance adoption. All these initiatives combined, if well-coordinated could create a positive feedback loop by reducing the decline of forests without negatively impacting on people's livelihoods.

Besides, it is possible that an initial consultation process with all relevant stakeholders in which consequences of the ban are thoroughly analyzed can increase the prospects for effective policy implementation as provided for in the Public Participation Act 2018 (Republic of Kenya, 2018c). This could also lead to a better understanding of the underlying reasons for the policy and the insights of how charcoal actors can avoid negative by-effects, like those on livelihoods. For the institutions, a more long-term view where several policies are combined and synchronized towards achieving the goal of cleaner household energy and forest restoration would be selected. This policy could involve returning the responsibility of regulating harvesting of trees in the forests/woodlands, organizing tree planting in harvested sites, and monitoring of illegal activities to the CPAs (PISCES, 2012; Republic of Kenya, 2013). This would reduce the workload and costs for relevant government agencies involved in regulating charcoal production and trade.

In this scenario key stakeholder groups would support and defend the policy mix, while fees and taxes charged on charcoal movement and trade would support public finances as well as environmental conservation and sustainability-related investments. These interactions could generate more positive feedback mechanisms in which the actors in part accept the policy since it also includes means to cushion unwanted resource effects and allows both producers and customers to find alternatives or even new

**Table 4**  
Policy mix change effects and feedback.

Policy effect/Feedback mechanism	Description of the current feedback	Alternative positive feedback
Resource effect	Income loss for producers Increased customer costs Livelihood effects Illegal supply chains Reduced charcoal quality	Combined policy mix (forest, energy) Improved adoptable charcoaling and stove technologies Legal and regulated charcoaling Promote alternative livelihoods
Interpretative effects	Discontent with repressive policy and informal fees	Consultations with stakeholders on the policy Explain and prepare for policy implementation
Institutional effects	Reduced role of community organization Control and monitoring require resources	Involvement of CPAs Accountable and transparent governance of policy mix
Socio-political feedback	Preference for alternative policies Voiced opposition	Create opportunities for constituency and agenda feedback
Fiscal feedback	Reduced taxes and fees	Legalize charcoal activity and let it be monitored and taxed
Administrative	Reduced commitment over time Negative reputation	Consultative/participatory policy development and its effective implementation will create public policy ownership, trust and sense of purpose among staff

investment opportunities. A well thought synchronization of a mixture of policy instruments could lead to more long-term sustainable charcoal production based on the principles of sustainable forest management, opportunities for the actors to switch to other professions, and the gradual implementation of clean and sustainable cooking energy. Hence, a regulated, transparent charcoal value chain would professionalize the trade and prepare it for a systematic improvement of both quality as well as economic and sustainability-related performance.

#### 4.2. Implications of the charcoal ban

The charcoal ban in Kenya is facing challenges in attaining its envisioned objectives. The present study investigated in-depth stakeholders' concurrent reactions and adaptations as the charcoal ban was being implemented. The selected approach, based on the model by Edmondson et al. (2019) provided a framework to anticipate the dynamic impacts after the charcoal ban was imposed in February 2018. The present findings indicate that a range of impacts and consequential feedback loops can compromise policy effectiveness. The charcoal ban may become irrelevant with a continued illegal, untaxed, and uncoordinated charcoal sector. However, there is also a possibility that the policy could be revised based on the experience gained over time.

The findings of this study are consistent with previous studies and views that policies banning charcoal production and trade are rarely effective owing to a range of factors mainly poverty, unemployment, the size of the industry, and administrative weaknesses (Zulu and Richardson, 2013; FAO, 2017; Smith et al., 2017). Previous studies have instead suggested that formalizing charcoal sector based on sustainable forest management principles and the successful introduction of improved cooking stoves at household level could improve the performance of the sector, arrest deforestation and have less impact of the livelihoods of people who depend on it for survival - making the sector sustainable in the long term (Kammila et al., 2014). Similarly, previous findings by the FAO (2017), indicated that tax revenues from a previous charcoal ban in Kenya in 2005 were lost yet the ban did not achieve the expected objectives. Infact, the charcoal ban of 2005 implemented under Forest Act 2005 caused the state to lose billions of Shillings in revenues annually (FAO, 2017).

Further, the findings of the present study indicate that the actors along the value chain lost income, and the loss of income had negative impacts on livelihoods of the rural poor resulting into increased poverty and reducing their ability to meet food, health and education needs. The loss of income reported in this study agrees with earlier reports by FAO (2017) and Haysom et al. (2021) that charcoal bans generally result into loss of incomes at all levels from producers to retailers as well as the government in terms of revenue generated from licenses and movement permits.

The observation that a coherent policy mix that incorporates the needs of the most vulnerable groups (the rural poor) may be more effective for a sustainability transition than one isolated change has been supported in previous studies (Zulu, 2009; Njenga et al., 2013; Smith et al., 2015; Ndegwa et al., 2016; Doggart and Meshack, 2017; FAO, 2017; Smith et al., 2017; Taylor et al., 2020). In this regard, an inclusive policy process would be instrumental in providing space for inclusion of all stakeholders including vulnerable groups (Njenga et al., 2013). Furthermore, as reported by Zorrilla-Miras et al. (2018), charcoal operators may be a heterogeneous group that is distinctly influenced by regulations. The present study reveals the complexity of the charcoal sector (Chidumayo and Gumbo, 2013; Ndegwa et al., 2016; Sola et al., 2017), which influences the multi-dimensional impacts of radical policy changes. The present findings also are analogous to those of studies on sustainability transitions in Europe indicating that best results are achieved when policies reach across domains that promote efficient resource use with support of research and development (Edmondson et al., 2019; Ladu et al., 2020), and this could also concern the low development rate of efficient and convenient cooking stove technologies (Carvalho et al., 2016; Bailis et al., 2017; Mehetre et al., 2017; Karanja and Gasparatos, 2019; Wassie and Adaramola, 2019). The application of the model on sustainability transitions by Edmondson et al. (2019) was useful as the model could be used for both the current impacts and feedback mechanisms as well as the examination of alternative features in the model.

This study's analysis should however be interpreted with caution. Although a range of stakeholders along the charcoal value chain were interviewed, the study did not include external large scale charcoal producers and transporters. It is possible that large scale business actors are handling considerable quantities of charcoal destined for large market centres. Furthermore, the study did not include producers and dealers of improved cooking stoves based on charcoal or other biofuels, nor providers of alternative and permitted charcoal types, like briquettes, or biogas. However, LPG, electricity, and kerosene currently still constitute only a marginal quantity of the energy used at household level in Kenya (Republic of Kenya, 2019). Moreover, this analysis cannot be seen as a complete national evaluation of a policy change; this would warrant more diverse data collection and assessment of traded charcoal quantities. In addition, the policy's impact on forest conditions is yet to be inventoried and determined. However, the charcoal industry's current situation and illegal nature complicates quantitative assessments of volumes and reported economic impacts.

## 5. Conclusions

This study analyzed impacts, perceptions, and feedback reactions of the charcoal ban in Kenya, which was introduced in February 2018. The key novelty of this particular study is the fact that it collects information about multiple stakeholders that include producers, transporters, vendors, different categories of customers, organizations, and administrative officers. It was conducted simultaneously as the first impacts of the ban were noticed in 2018 and extensively studied towards the end of 2019. The study identified several perceived effects of the ban, ranging from economic, behavioral, attitudinal, and institutional effects, which together led to socio-political, fiscal, and administrative feedback mechanisms. The results show characteristics of a "negative feedback loop" of policies, which could compromise policy effectiveness due to adverse side effects, and inconsistencies, which are not offset by positive developments. Based on the results and the selected theory, possible alternative "policy mix" approaches may promote positive and long-



term effectiveness of policies for sustainability transitions.

The study found that first, actors are mainly adversely affected by the charcoal ban, and a range of strategies to manage the effects have been employed. The effects also entailed negative interpretations of the ban and institutional changes. Secondly, the effects of the charcoal ban created feedback mechanisms—policy opposition, decreased morale and commitment among staff of enforcement agencies and fiscal losses—all of which eroded policy effectiveness. Some effects manifested immediately, whereas others are likely to be more gradual. The study concludes that policies that embrace innovative solutions, takes into considerations the effects on the most vulnerable groups of the population, and promote cleaner cooking technologies and protection of forests should be developed for implementation.

## 6. Recommendations

1. The current policy on charcoal ban should be reviewed for its effectiveness and revised based on the experience gained over time. The review and revision should be participatory involving all key stakeholders in the charcoal industry.
2. There is need for a consultation process with all relevant stakeholders in which consequences of proposed policies on forests are thoroughly analyzed before being implemented as this could enhance long-term effectiveness of policies for sustainability transitions.
3. Future research on charcoal bans could cover large scale charcoal traders. It would also be critical to conduct retrospective comparisons of the effects of the ban in different regions of the country.

## Author statement

All the authors conceptualized the study, participated in data collection, analysis and writing of the manuscript.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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## Appendix A1

### *Key informant interviews and focus group discussion guides*

Perceived impacts of charcoal ban on:

- Forest cover.
- Forest harvests.
- Charcoal prices.
- Producers', transporters' and vendors' incomes.
- Other impacts on producers, transporters and vendors.
- Other stakeholder groups.
- Households' fuel use.
- Trans-border trade.
- Actors' business decisions.
- Perceptions on the ban.
- Administrative bodies and agencies.
- Perceptions on the implementation of the ban.
- Support of/opposition to the ban.
- Authorities costs for control, monitoring, information etc.?
- Tax revenues.
- Officer morale.

## Customers mombasa

Perceived impacts of charcoal ban on:

Charcoal price.

Energy expenditure.

Charcoal expenditure.

Cooking behavior.

Household economy.

Forest condition.

View on implementation of the ban.

Have you opposed or supported the ban. How?

## Café owner interviews

Perceived impacts of charcoal ban on:

Charcoal price.

Energy expenditure.

Charcoal expenditure.

Cooking behavior.

Business economy.

Household economy.

Forest condition.

View on implementation of the ban.

Have you opposed or supported the ban. How?

## References

- Bailis, R., Wang, Y.T., Drigo, R., Ghilardi, A., Masera, O., 2017. Getting the numbers right: revisiting woodfuel sustainability in the developing world. *Environ. Res. Lett.* 12.
- Bell, E., Bryman, A., Harley, B., 2019. *Business Research Methods*. Oxford, U.K.
- Carvalho, R.L., Jensen, O.M., Tarelho, L.A.C., 2016. Mapping the performance of wood-burning stoves by installations worldwide. *Energy Build.* 127, 658–679.
- Chidumayo, E.N., Gumbo, D.J., 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. *Energy for Sustainable Development* 17, 86–94.
- Chiteculo, V., Lojka, B., Surovy, P., Verner, V., Panagiotidis, D., Woitsch, J., 2018. Value chain of charcoal production and implications for forest degradation: case study of bie province, Angola. *Environments* 5, 113. <https://doi.org/10.3390/environments5110113>.
- DFID, 1999. *Framework of Sustainable Livelihoods*. Department for International Development, UK.
- Dillon, J., Reid, A., 2004. Issues in case-study methodology in investigating environmental and sustainability issues in higher education: towards a problem-based approach? *Environ. Educ. Res.* 10 (1), 23–37. <https://doi.org/10.1080/1350462032000173689>.
- Doggart, N., Meshack, C., 2017. The marginalization of sustainable charcoal production in the policies of a modernizing African nation. *Front. Environ. Sci.* 5, 27.
- Edmondson, D.L., Kern, F., Rogge, K.S., 2019. The co-evolution of policy mixes and socio-technical systems: towards a conceptual framework of policy mix feedback in sustainability transitions. *Res. Pol.* 48 (10), 103555.
- Eisenhardt, K.M., Graebner, M.E., 2007. Theory building from cases: opportunities and challenges. *Acad. Manag. J.* 50 (1), 25–32.
- FAO, 2014. *State of the World's Forests*. FAO, Rome.
- FAO, 2020a. FAOSTAT. <http://www.fao.org/faostat/en/#data/FO>. (Accessed 11 February 2021). accessed.
- FAO, 2020b. Sustainable charcoal production. African Wildlife and Forestry Commission.
- FAO, 2017. In: Rome, J. van Dam (Ed.), *The Charcoal Transition: Greening the Charcoal Value Chain to Mitigate Climate Change and Improve Local Livelihoods*. Food and Agriculture Organization of the United Nations.
- Flyvbjerg, B., 2006. Five misunderstandings about case-study research. *Qual. Inq.* 19 (2), 219–245.
- Freeman, R.E., 1994. The politics of stakeholder theory: some future directions. *Bus. Ethics Q.* 4, 409–421.
- Geels, F.W., 2004. From sectoral systems of innovation to sociotechnical systems: insights about dynamics and change from sociology and institutional theory. *Res. Pol.* 33 (6–7), 897–920.
- Haysom, S., McLaggan, M., Kaka, J., Modi, L., Opala, K., 2021. *Black Gold: the Charcoal Grey Market in Kenya, Uganda and South Sudan*. Global Initiative Against Transnational Organized Crime, Geneva, Switzerland, p. 48.
- IEA, 2019. *Africa Energy Outlook 2019*. International Energy Agency, Paris.
- International Society of Ethnobiology, 2006. *ISE code of Ethics (with 2008 additions)*. Online: <http://ethnobiology.net/code-of-ethics>.
- Johnson, R.B., Onwuegbuzie, A.J., Turner, L.A., 2007. Toward a definition of mixed methods research. *J. Mix. Methods Res.* 1 (2), 112–133.
- Jones, D., Ryan, C.M., Fisher, J., 2016. Charcoal as a diversification strategy: the flexible role of charcoal production in the livelihoods of smallholders in central Mozambique. *Energy Sustain. Dev.* 32, 14–21.
- Kammila, S., Kappen, J.F., Rysankova, D., Hyseni, B., Putti, V.R., 2014. Clean and Improved Cooking in Sub-Saharan Africa. World Bank Group, Washington, D.C.
- Karanja, A., Gasparatos, A., 2019. Adoption and impacts of clean bioenergy cookstoves in Kenya. *Renew. Sustain. Energy Rev.* 102, 285–306.
- Kiruki, H., van der Zanden, E.H., Zagaria, C., Verburg, P.H., 2019. Sustainable woodland management and livelihood options in a charcoal producing region: an agent-based modelling approach. *J. Environ. Manag.* 248.
- Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wiecek, A., Alkemade, F., Avelino, F., Bergeck, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Pel, B., Raven, R., Rohrer, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: state of the art and future directions. *Environ. Innov. Soc. Transit.* 31, 1–32.
- Ladu, L., Imbert, E., Quitzow, R., Morone, P., 2020. The role of the policy mix in the transition toward a circular forest bioeconomy. *For. Pol. Econ.* 110 <https://doi.org/10.1016/j.forpol.2019.05.023>.

- Leiserowitz, A.A., Kates, R.W., Parris, T.M., 2006. Sustainability values, attitudes, and behaviors: a review of multinational and global trends. *Annu. Rev. Environ. Resour.* 31 (1), 413–444. <https://doi.org/10.1146/annurev.energy.31.102505.133552>.
- Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. *Res. Pol.* 41 (6), 955–967.
- Mehetre, S.A., Panwar, N.L., Sharma, D., Kumar, H., 2017. Improved biomass cookstoves for sustainable development: a review. *Renew. Sustain. Energy Rev.* 73, 672–687.
- Analysis of the Charcoal Value Chain in Kenya, 2019. MEWNR, Nairobi, Kenya, p. 98.
- Miles, M.B., Huberman, A.M., 1994. *Qualitative Data Analysis – an Expanded Sourcebook*. SAGE.
- Mitchell, R.K., Agle, B.R., Wood, D.J., 1997. Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. *Acad. Manag. Rev.* 22 (4), 853–886.
- Mwampamba, T.H., Ghilardi, A., Sander, K., Chaix, K.J., 2013. Dispelling common misconceptions to improve attitudes and policy outlook on charcoal in developing countries. *Energy Sustain. Dev.* 17, 75–85.
- Ndegwa, G., Anhuf, D., Nehren, U., Ghilardi, A., Liyama, M., 2016. Charcoal Contribution to Wealth Accumulation at Different Scales of Production Among the Rural Population of Mutomo District in Kenya, vol. 33. *Energy for Sustainable Development*, pp. 167–175.
- Njenga, M., Karanja, N., Munster, C., Iiyama, M., Neufeldt, H., Kithinji, J., Jamnadas, R., 2013. Charcoal production and strategies to enhance its sustainability in Kenya. *Dev. Pract.* 23, 359–371.
- Nunes, L.J.R., Meireles, C.I.R., Gomes, C.J.P., Ribeiro, N.M.C.A., 2020. Forest contribution to climate change mitigation: management oriented to carbon capture and storage. *Climate* 8 (2), 21. <https://doi.org/10.3390/cli8020021>.
- NYDF, 2014. *New York Declaration on Forests*. <https://forestdeclaration.org/about>. (Accessed 29 June 2020). accessed.
- PISCES, 2012. *The Kenya Charcoal Policy Handbook - Current Regulations for a Sustainable Charcoal Sector*. Colin Pritchard, Thomas Molony. University of Edinburgh.
- Republic of Kenya, 2009. *The Forest (Charcoal) Rules, 2009*. Government Printers, Nairobi, Kenya.
- Republic of Kenya, 2013. *Analysis of the Charcoal Value Chain in Kenya*. Ministry of Environment, Water and Natural Resources 2013, Nairobi, Kenya.
- Republic of Kenya, 2016. *National Forest Program of Kenya*. Ministry of Environment and Natural Resources, Nairobi, Kenya.
- The Kenya Gazette, CXX, 2018. Republic of Kenya, Nairobi, Kenya. No. 28, 26 th February, 2018.
- Republic of Kenya, 2018b. *Press Statement: Extension of the Moratorium on Logging Activities in Public and Community Forests*. Ministry of Environment and Forestry 16<sup>th</sup> of November 2018, Nairobi, Kenya.
- Republic of Kenya, 2018c, 2018c. Kenya Gazette Supplement No. 17 (Senate Bills No. 4), vol. 2018. *The Public Participation Bill, NAIROBI. SENATE BILLS 5 th March 2018*.
- Republic of Kenya, 2018d. *County Integrated Development Plan 2018-2022*. County Government of Taita-Taveta, Kenya.
- Republic of Kenya, 2018e. *Second County Development Plan 2018-2022*. County Government of Mombasa, Kenya.
- Republic of Kenya, 2018f. *Kwale County Integrated Development Plan 2018-2022*. County Government of Kwale, Kenya.
- Republic of Kenya, 2019. *Kenya Household Cooking Sector Study. Assessment of the Supply and Demand of Cooking Solutions at the Household Level*. Ministry of Energy, Nairobi, Kenya.
- Roos, D., Mutta, D., Mahamane, L., Wekesa, C., Kowero, G., 2021. Operations and improvement needs in the informal charcoal sector – a participatory value stream analysis. *Int. For. Rev.* 23 (3), 351–364.
- Scoones, I., 1998. *Sustainable Rural Livelihoods: A Framework for Analysis*. IDS Working Paper 72, Brighton, UK.
- Silverman, D., 2013. *Doing Qualitative Research*. SAGE, Thousand Oaks, U.S.
- Smith, H.E., Eigenbrod, F., Kafumbata, D., Hudson, M.D., Schreckenberg, K., 2015. Criminals by necessity: the risky life of charcoal transporters in Malawi. *For. Trees Livelihoods* 24 (4), 259–274. <https://doi.org/10.1080/14728028.2015.1062808>.
- Smith, H.E., Hudson, M.D., Schreckenberg, K., 2017. Livelihood diversification: the role of charcoal production in southern Malawi. *Energy for Sustainable Development* 36, 22–36.
- Smith, H.E., Jones, D., Vollmer, F., Baumert, S., Ryan, C.M., Woollen, E., Lisboa, S.N., Carvalho, M., Fisher, J.A., Luz, A.C., Grundy, I.M., Patenaude, G., 2019. Urban energy transitions and rural income generation: sustainable opportunities for rural development through charcoal production. *World Dev.* 113, 237–245.
- Sola, P., Cerutti, P.O., Zhou, W., Gautier, D., Iiyama, M., Schure, J., Shepherd, G., 2017. The environmental, socioeconomic, and health impacts of woodfuel value chains in Sub-Saharan Africa: a systematic map. *Environ. Evid.* 6 (1).
- Taylor, R., Wanjiru, H., Johnson, O., Johnson, F., 2020. Modelling stakeholder agency to investigate sustainable charcoal markets in Kenya. *Modelling stakeholder agency to investigate sustainable charcoal markets in Kenya. Environ. Innov. Soc. Transit.* 35, 493–508.
- The Nation, 2018. *Charcoal Traders Complain of Massive Job Losses*. May 19 2018. The Nation. <https://www.nation.co.ke/kenya/counties/kilifi/charcoal-traders-complain-of-massive-job-losses-45282>. Accessed August 3, 2020.
- The Standard, 2018. *Many families left hopeless after ban on logging, opt for alternative solutions*. The Standard March 28th 2018. Accessed March 20, 2022). <https://www.standardmedia.co.ke/business/article/2001274708/households-bear-brunt-of-skyrocketing-charcoal-prices>.
- Tong, A., Sainsbury, P., Craig, J., 2007. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int. J. Qual. Health Care* 19 (6), 349–357. <https://doi.org/10.1093/intqhc/mzm042>.
- UN, 2015. *Transforming Our World: the 2030 Agenda for Sustainable Development*. Resolution Adopted by the General Assembly on 25 September 2015. United Nations, New York.
- Wassie, Y.T., Adaramola, M.S., 2019. Potential environmental impacts of small-scale renewable energy technologies in East Africa: a systematic review of the evidence. *Renew. Sustain. Energy Rev.* 111, 377–391.
- Yin, R.K., 2013. *Case Study Research – Design and Methods*. SAGE.
- Zorrilla-Miras, P., Mahamane, M., Metzger, M.J., Baumert, S., Vollmer, F., Luz, A.C., Woollen, E., Siteo, A.A., Patenaude, G., Nhantumbo, I., Ryan, C.M., Paterson, J., Matediane, M.J., Ribeiro, N.S., Grundy, I.M., 2018. Environmental conservation and social benefits of charcoal production in Mozambique. *Ecol. Econ.* 144, 100–111.
- Zulu, L.C., 2009. Politics of scale and community-based forest management in southern Malawi. *Geoforum* 40, 686–699.
- Zulu, L.C., Richardson, R.B., 2013. Charcoal, livelihoods, and poverty reduction: evidence from sub-Saharan Africa. *Energy for Sustainable Development* 17 (2), 127–137.