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ASSESSING THE EFFECT OF CHARCOAL PRODUCTION AND USE ON THE TRANSITION TO A GREEN ECONOMY IN KENYA[1]

[EVALUANDO EL EFECTO DE LA PRODUCCIÓN DE CARBÓN VEGETAL EN EL USO EN LA TRANSICIÓN A UNA ECONOMÍA VERDE EN KENIA]

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SUMMARY

The purpose of this study was to assess the effect of charcoal production and use on the transition to a green economy in Kenya. This study identified the target tree species that are a source of charcoal consumed in Nairobi city, determined quantity of charcoal consumed in the city of Nairobi and estimated forest cover depletion from charcoal production and use. The study adopted a research survey design involving the use of semi-structured questionnaire, with a target of 100 respondents (20 large scale charcoal traders and 80 charcoal users) sampled through person-to-person interview, selected using a purposive/systematic random sampling technique. Descriptive statistical data techniques were used to analyze the field data. The findings revealed that about 1264 ha and 15174 ha of forest cover are depleted on monthly and yearly basis respectively. Forest cover depletion is predicted by charcoal consumption. The study also revealed that Kenya would lose about 65.6% of its forest cover to charcoal production and use by 2030. Taking measures to propagate the most preferred Acacia species and ensuring massive tree planting exercise especially in order to protect arid areas of the country is important. Legislations on charcoal, reforestation/afforestation should be reinforced nation-wide if Kenya hopes to transition to a green economy within its vision 2030 agenda.

Key Words: Charcoal production; Charcoal use; Green economy; Forest cover depletion; Kenya.

El propósito de este estudio fue evaluar el efecto de la producción y uso de carbón vegetal en la transición hacia una economía verde en Kenia. Este estudio identificó las especies de árboles que son una fuente de carbón consumido en la ciudad de Nairobi, la cantidad determinada de carbón consumido en la ciudad de Nairobi y el agotamiento de la cubierta forestal debido a la producción y uso del carbón vegetal. El estudio adoptó un diseño de encuesta que incluyó el uso de cuestionario semiestructurado, con un objetivo de 100 encuestados (20 comerciantes de carbón a gran escala y 80 usuarios de carbón vegetal). Mediante entrevistas persona a persona, seleccionadas utilizando una técnica de muestreo aleatorio intencional/sistemático. Se utilizaron técnicas descriptivas para analizar los datos de campo. Los hallazgos revelaron que alrededor de 1264 ha y 15174 ha de cobertura forestal se agotan mensual y anualmente, respectivamente. El agotamiento de la cubierta forestal se predice por el consumo de carbón. El estudio también reveló que Kenia perdería alrededor del 65,6% de su cubierta forestal para la producción y uso de carbón vegetal para 2030. La adopción de medidas para propagar las especies de Acacia más preferidas y asegurar la plantación de árboles especialmente para proteger las zonas áridas del país es de máxima importancia. Las legislaciones sobre el carbón vegetal, la reforestación y la forestación deben reforzarse a nivel nacional si Kenya espera pasar a una economía verde dentro de su agenda de visión 2030.

Palabras clave: Producción de carbón vegetal; Uso de carbón vegetal; Economía verde; Abatimiento de la cubierta forestal; Kenia.

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INTRODUCTION

The United Nations Environment Program (UNEP, 2008) defined green economy (GE) as an economy that will result in improved human well-being and social equity and in the meantime significantly reducing environmental risks and enhancing ecological services positively. The term "green economy" saw the light of the day 25 years ago following its appearance in the "Blueprint for a Green Economy" (Pearce et al., 1989). Many countries and especially in the western world developed interest in a transition to a green economy (Montmasson-Clair, 2012). These interests however intensified following the market and financial crisis of 2008, with the UNEP's call in 2009 for nations to embrace a Global Green New Deal - GGND (UNEP, 2013; Barbier, 2010). The GGND put forth three main objectives including economic recovery, poverty reduction, and reduced carbon emissions and ecosystem degradation (Musango et al., 2014). Thus the whole essence of the green economy is to combine economic development with social welfare and environmental protection (Montmasson-Clair, 2012) to achieve sustainable economic development (SED).

The green economy though still rudimentary in Sub Saharan Africa (SSA), is a relevant concept for the Region (Klein, et al., 2013), as it presents a plethora of opportunities that can cause significant changes in most African economies. According to UNEP (2013), a new growth path on the green economy context will create over 300,000 new jobs in South Africa within a period of five years. These views are supported by Montmasson-Clair (2012) who notes that South Africa will have about 255,000 formal green jobs between 2013 and 2017, and as much as 462,000 part time green jobs created between 2018 and 2025. UNEP (2013) holds that investments in a green economy will increase water supply, increase crop yields, and reduce energy demand and CO_2 emissions, as well as lower GHG emissions.

Despite these opportunities embedded in the green economy, it still faces some serious challenges especially in most parts of SSA. Though Africa seems to be making economic strides with respect to increasing GDP growth rates, it still grapples with poverty and unemployment (Grieg-Gran et al., 2015; UNEP, 2015). One of the greatest challenges to transitioning to green economy in Africa is the over reliance on woodfuel (charcoal and firewood) for energy. This is so since the transition to GE places more emphasis to reducing carbon emission and use of clean energy (NEMA, 2012). Over 90% of harvested wood in Africa goes to meet the energy demand of more than 60% percent of households who use it for cooking and heating (UNEP, 2015). UNEP's 2015 study on "Growing a green economy in Africa: why forests matter" establishes that over-harvesting of the forest for charcoal is damaging forests and this has caused Africa's forest to become a major source of carbon emissions UNEP (2015).

The targeting of particular tree species for the production of charcoal has made charcoal production and use a major driver of forest cover depletion. Local tree species are the target for majority of the charcoal produced in SSA, including Kenya. Njenga (2013) notes that closed to 100 tree species are targeted by charcoal producers in Kenya, with *Acacia tortilis*, *A. nilotica, A.senegal, A. mellifera, A. polyacantha and A. xanthophloea* being the most preferred. Apart from these, charcoal producers also target other hardwood species like Croton, Olea, Manilkara, Mangifera, Eucalyptus and Euclea, which according to (Mugo et al., 2007) are preferred due to their high density and calorific value. However, the Kenya Forest Service and the Kenya Charcoal Regulations prohibit the use of sandal wood, *M. africana* and Acacia species in charcoal production except in special cases, where permit must be obtained from KFS (KFS, 2013). Majority of the harvested hardwood species like *A. tortilis* (umbrella thorn) and *T. indica* (tamarind) are not grown in Kenya. The species are obtained from natural forest, and where planted as woodlands, they are most of the time poorly managed as they suffer from unsustainable harvesting practices (Mugo and Ong, 2006). According to Mugo and Ong (2006), unplanned, unmanaged and unsustainable charcoal production will lead to forest cover depletion especially in the drier areas characterized by very low regenerative capacity. They also noted that charcoal legislations are not properly coordinated in most African countries, a factor that makes charcoal extraction very unsustainable. In the context of a green economy, the negative effects of charcoal production and use are unavoidably associated to the slow growth of particular tree species that are harvested for charcoal, wasteful use of the harvested wood, environmental pollution and poor working conditions of those involved in the production process (Mugo and Ong, 2006).

As a result of limited access to, or the absence of cleaner, more convenient and more affordable types of energy, especially in the African context, the best alternative for many people in the towns and cities has been charcoal. Recent studies indicate that there is a steady increase in charcoal production and use in Tanzania, Mozambique, Madagascar and Kenya (Mugo and Ong 2006). In Kenya, just like in Tanzania, about 10% and 80% respectively of the charcoal produced is used by urban households. This is enough evidence that charcoal has gradually taken the place of firewood in most urban, as well as in some rural households in the world (Njenga et al., 2013).

Globally, charcoal production trends between 1965 and 2005 show increasing production levels with Africa topping the chart. Africa's charcoal production has moved from about 18.5 million tonnes in 1965 to about 49 million tonnes in 2005. Africa is closely followed by Latin America and Caribbean, while Asia tails the chart, producing less than five million tonnes in 1965 and about 5.5 million tons in 2005 (Ghilardi and Steierer, 2011). According to Ghilardi & Steierer (2011), seven out of the world's top ten countries in charcoal production are from Africa. They hold that Nigeria and Ethiopia each produce eight percent, Democratic Republic of Congo, and Mozambique each produce four percent, while Tanzania Ghana and Egypt each produce three percent of the global annual charcoal production. On the other hand Brazil tops the chart country wise with 11%, while China and India each produce three percent.

The above statistics may be contradictory as quite a good number of in-depth studies on charcoal have qualified Kenya as one of the biggest charcoal user in SSA. Njenga et al. (2013) hold that majority of charcoal produced in Kenya is consumed in urban areas, a fact they argued is reflected throughout SSA. According to Njenga et al. (2013), the demand for charcoal will be twice the current demand by 2030. Their findings hold that about 72% of the population in SSA depends on woodfuel for their energy needs and sampled two countries in East Africa and one country in South Africa to come out with annual consumption figures shown in Table 1 below.

Table 1. Annual consumption of charcoal (million tonnes) in East and South African Regions

Region	Country	Consumption	Year
East Africa	Kenya	1.6 – 2.4	2005
	Ethiopia	0.23	2002
South Africa	Zambia	0.70	2002

Source: Njenga et al. (2013); Njenga (2013)

Kenya is projected as the biggest consumer of charcoal in Eastern and Southern Africa. Njenga et al. (2013) and Njenga (2013) concluded that 10% of the annual national charcoal consumption of Kenya is consumed in Nairobi.

Forest cover depletion as well as forest degradation is of global and national concern. This is because forest cover depletion is likely to lead to a reduction in stream discharges, increased erosion and loss of biodiversity, which in turn may distort the proper functioning and values of affected ecosystems (Gichuho et al., 2013). In their study on "Land cover change and deforestation in gazetted Maji Mazuri Forest, Kenya", they used three Landsat images of 1975, 1986 and 2005 to determine land cover changes and likely environmental impacts in Maji Mazuri in Kenya. Gichuho et al. (2013) found that natural forest decreased by about 42.31% in the period between 1975 and 2005. They attributed this forest cover change to uncontrolled and unsustainable human activities amongst which was charcoal production. Studies have shown a strong positive correlation between forest cover depletion and population growth perhaps because of aggressive harvesting of forest to meet energy demands of the growing population (Gichuho et al., 2013). Kapkiai (2006) supports this view with his findings on a study of South Mau Forest. According to the study, natural forest cover was 60%, 45%, and 10% in 1970, 1990 and 2000 respectively due to forest encroachment which had moved from 10% in 1970 to 50% in the year 2000 as a result of population increase (Gichuho et al., 2013). This current study therefore set out to: (i) identify the target tree species which are a source of charcoal consumed in Nairobi City; (ii) determine the quantity of charcoal consumed in Nairobi City; and (iii) estimate the forest cover loss resulting from charcoal production and use.

MATERIALS AND METHODS

Study Area

The study was carried out in Nairobi which is the capital city of Kenya. Nairobi is located in southern Kenya on 10 00'' N and 300 00''E at an elevation of 1,670m above sea level. It is the most populated city in East Africa with an estimated population of 3,138,369 (KNBS, 2013). According to Njenga (2013) the population growth rate of Nairobi is estimated at 2.8% annually. As the political, administrative and business capital of Kenya, Nairobi is a centre of industry, education and culture occupying an area of 696.1 km^2 and hosting about 25% of Kenya's urban population. Charcoal usage in Nairobi is widespread with 10% of the estimated 2.4 million tonnes of charcoal produced annually (Mutimba and Baraza, 2005) consumed in the capital city, Nairobi (Njenga et al., 2013).

Data Collection and Processing

Semi-structured questionnaires were used as the data collection tools for this study. Prior to data collection, research assistants were imparted with training on the questions to answer the objectives of this study. After the training, a pre-test of the questionnaire was done to validate the tool and also ensure that all the researchers had clearly understood the issues to probe from the respondents. Yin (2003) deems questionnaires as one of the most important sources of information useful for understanding complex phenomena and gaining insights from the respondents on a given matter. The study also used Key Informant Interviews to beef up information collected through the personal interviews. This involved the lead researcher having discussions on the topic with five Kenya forestry officers in the selected sub-locations. The data collected was validated to get the relevant data from the study. The validated data was coded for easy classification in order to facilitate tabulation. The tabulated data was then analyzed quantitatively by calculating various percentages where possible. To analyze statistical data, the study used Microsoft Excel and the Statistical Package for Social Science (SPSS version 20).

To estimate forest cover loss from charcoal production and use, the formula put forward by Msuya et al. (2011) was used as follows: Fs = Ms x Ek x 1/S. Where: Fs = Forest needed to produce a single sack (35Kg) of charcoal; Ms = Mass of a single sack (kg charcoal sack); Ek = Kiln efficiency (kg of wood per kg of charcoal); S = Stock density (ton of wood/ ha forest). The formula is based on a number of assumptions: (1) the assumption of 93% stem harvest, (2) the charcoal is produced from traditional (inefficient) kilns. The study considered 10% efficiency. Results obtained were presented in the form of tables.

RESULTS AND DISCUSSION

Target of Specific Tree Species for Charcoal Consumed in Nairobi City

The study findings of traders' preference for specific tree species for charcoal sold revealed that 70% of them insisted on the particular tree species used in the production of the charcoal that they sell, while 30% did not insist on any particular tree species. This 30% can be explained by the fact that some wholesale traders are interested in always having charcoal to trade such that insisting on particular tree species may cause them to go for two or three days without doing business. Those who insist on particular tree species may have built a strong customer base with their customers who insist on particular tree species for their charcoal. This makes it difficult for the traders to accept charcoal that is not produced from tree species preferred by their customers. Transport costs and recurrence of police checks may cause traders to insist on particular tree species. For instance a trader will insist on acacia species coming from Ukambani and Kajiado because of proximity, which reduces transport costs and increases his profits. Again most traders are able to identify their preferred tree species and will not like to start learning the characteristics of new tree species.

Tables 2 and 3 below present some of the preferred tree species for charcoal, and the sources of these tree species respectively. Amongst the different tree species preferred by these traders, Acacia species was the most preferred (45%), followed by *Prosopis juliflora* and *Prunus africana* (10% each). Six traders (30%) never insisted on any particular tree species.

Table 2. Preferred Tree Species for Charcoal by Respondents

Preferred Tree Species	Percent
Olea africana	5
Prunus africana	10
Prosopis juliflora	10
No Preference	30
Acacia species	45
Total	100

Most of the charcoal traders sampled preferred Acacia tree species in order to satisfy their consumers' preference for the same. A few traders said they preferred Acacia species because it can be stored for long periods. The 10% who preferred *Prosopis juliflora* said it was profitable. They also hold that *Prosopis juliflora* is a permitted tree species for charcoal production in Kenya and as such they do not suffer from frequent controls from KFS officers and policemen while in the meantime making good profits. According to them, because this species is permitted, overhead cost is greatly reduced as they don't need to spend huge sums of money bribing policemen and KFS officers.

Fifty percent of charcoal users preferred Acacia species because it produces strong heat and lasts longer while another 20% said that they preferred Acacia species because it produces less ash. Thirty percent of the users sampled did not have any particular preference on tree species used to produce their charcoal. According to them they buy what is available because they know it will still serve the purpose for cooking and heating. They seem not to think that charcoal from particular tree species may produce more heat or produce less smoke or more ash. About 95% of the charcoal traders said they always had regular supplies while 5% reported experiencing irregular supplies sometimes. Such traders engage themselves in other income generating activities during such periods.

Majority (35%) of the charcoal sold in Nairobi comes from Narok while 20% each comes from Kajiado and Ukambani. Other sources of charcoal include

Baringo, Mombassa, and Mwingi, each accounting for just five percent of the total quantity (Table 3).

Table 3. Source of Tree Species used for Charcoal Production and Use in Nairobi

Sources/origin	Percent
Narok	35
Ukambani	20
Kajiado	20
Tana River	10
Baringo	5
Mwingi	5
Mombassa	5
Total	100

The study revealed that most (70%) of the charcoal traders preferred charcoal made from particular tree species especially the Acacia and *Prosopis juliflora* species. This is similar to the findings of Njenga et al., 2013; KFS, 2013; Njenga, 2013; Mugo et al., 2007, as well as a study carried out in Ethiopia by Melaku and Zenebe (2014). It is also very similar to findings of Njenga (2013) who reported that though closed to 100 tree species are targeted by charcoal producers in Kenya, *Acacia tortilis, A. nilotica, A.senegal, A. mellifera, A. polyacantha and A. xanthophloea* were the most preferred. In line with Mutimba and Baraza, (2005), Acacia species are widely preferred because of the availability of the species. With respect to the sources of charcoal consumed in Nairobi, the study revealed that most of the charcoal consumed in Nairobi comes from Narok. This is similar to the findings of Tesot (2012). However two other very important sources of charcoal for the Nairobi markets include Kajiado (Kajiado County) and Ukambani (Machakos County). These areas are found in the rangelands which have been found as major suppliers of charcoal to the Nairobi Market (Mugo et al., 2010). Besides proximity to Nairobi markets, poverty in source areas, livelihood patterns and demand for the charcoal accounts for the different quantities of charcoal supplied to Nairobi. The implication of this finding is that Acacia species will suffer massive harvesting. Njenga (2013) supports this view by noting that since there is particular consumer preference for Acacia tree species used to produce charcoal, increase demand will mean massive harvesting of the Acacia species.

Quantity of Charcoal Consumed in Nairobi City

Table 4 below presents the quantity of charcoal consumed by charcoal users in Nairobi city in sacks of 35kg per month.

Consumption levels are highest in Ngara with 992 sacks perhaps due to the proximity of Ngara to the Nairobi CBD, where most mid-level restaurants operate to cater for the large population that visit the city on daily basis. It is closely followed by Embakasi and Kangemi with a monthly consumption of 862 and 700 sacks respectively. Consumption levels in these two towns can be explained by the fact that they host a huge number of Nairobi’s population, most of whom are low income earners. The lowest average monthly consumption was recorded in Langata (26.3 sacks). This may be due to the fact that majority of the inhabitants of this area do not depend on these mid-level restaurants given their status in the society compared to Kibera and Kangemi inhabited by people of the lower class. It could also be because there are many affluent families that prefer cleaner and more convenient cooking fuels (LPG and electricity) to charcoal. Such families may also be smaller in size and their level of education gives them the awareness of the negative effects of using charcoal especially for indoor cooking. Also affluent homes in Langata can afford solar panels that are suitable for heating.

Table 4. Quantity of Charcoal Consumed (Sacks of 35kgs) in Nairobi City in a Month

Towns (Sub-Counties)	Sampled No.	Total Quantity (Sacks)	Minimum Quantity (Sacks)	Maximum Quantity (Sacks)	Mean Quantity (Sacks)
Kibera	16	638	4	70	39.9
Kangemi	16	700	4	70	43.8
Langata	16	421	2	60	26.3
Embakasi	16	862	4	110	53.9
Ngara	16	992	2	150	62.0

The variations in consumption go from a minimum of two sacks to a maximum of 150 sacks per month. The total quantity of charcoal consumed in one month by the 80 charcoal users sampled stood at 3,613 sacks (an equivalent of 126.5 tonnes). The average quantity consumed by users stood at 45.2 sacks (an equivalent of 1.58 tonnes). Respondents were also sampled on the expenditure they incur on other energy sources. Table 5 presents the monthly expenditure of respondents on charcoal, electricity and Liquefied Petroleum Gas (LPG).

At an average price of 1,500 Kenyan shillings per sack, most (32.5%) of the respondents spend 20,000 shillings and below per month on charcoal. However, the large scale users accounted for about 47.3% of those who spend between 100,000 and 240,000 shillings every month on charcoal. When charcoal expenditure was compared to expenditure on electricity and LPG, results were very dismal. On the one hand, 51.3% of respondents spent less than 1,000 shillings, while 8.8% spent between five and six thousands shilling on electricity. On the other hand 75% of the respondents said they spent 1,000 shillings or less, while another 10% spent between five and six thousand shillings on LPG per month.

This result is explained by the findings of Njenga (2013) and Njenga et al. (2013) who found that Nairobi consumes about 10% of the total amount of charcoal produced in Kenya. This quantity is however far less than the findings of Mugo et al. (2010) in which they reported that restaurants and kiosks consume 428,025 tonnes annually. The reason could be that most modern restaurants and kiosks are gradually adopting other energy sources like LPG and electricity, while some households take advantage of falling prices of electricity, LPG and Kerosene (Tunde et al., 2013). The findings of this study may be less due to variations that may occur in weights of sacks as some sacks may weigh above 35kg. This can be justified by the FAOSTATS estimates for 2013, in which Kenya was reported to have consumed 1.006.148 tonnes.

Estimate of Forest Cover Depletion from Charcoal Production and Use

All 20 (100%) charcoal traders sampled said that the charcoal which they sell is produced from traditional kilns. This means that the charcoal is produced from inefficient kilns. This data was used together with the quantity of charcoal consumed per month to estimate forest cover depletion using the formula:

Fs = Ms x Ek x 1/S.

Where; Fs= Forest needed to produce a single sack (35Kg) of charcoal;
Ms= Mass of a single sack (kg charcoal sack);
Ek= Kiln efficiency (kg of wood per kg of charcoal);
S= Stock density (ton of wood/ ha forest).
Therefore, the following calculation was adopted.
Fs = Ms x Ek x 1/S
Fs = 35 x (10/100 x 1000/10000) = 0.35 Ha

Thus 0.35 hectares of forest are depleted for production and use of one sack (35kg) of charcoal. This means that the monthly and yearly charcoal consumption in Nairobi alone is responsible for the loss of 1,264.5 Ha and 15,174.6 Ha of forest cover monthly and annually respectively. The rate of forest cover depletion could be reflected in the tree species and even their growth rate, their spatial distribution on the land surface, as well as the production methods used in the production of charcoal i.e. earth mound kilns.

Table 5. Monthly Expenditure by Respondents on Charcoal, Electricity and LPG

Expenditure for charcoal, electricity and LPG					
Charcoal		Electricity		LPG	
Expenditure (000 Ksh)	% of Respondents	Expenditure (000 Ksh)	% of Respondents	Expenditure(000 Ksh)	% of Respondents
1 – 20	32.5	0.1 – 1.0	51.3	0.1 – 1.0	75
21 – 40	8.8	1.1 – 2.0	17.5	1.1 – 2.0	2.5
41 – 60	6.3	2.1 – 3.0	13.6	2.1 – 3.0	2.5
61 – 80	5.1	3.1 – 4.0	6.3	3.1 – 4.0	5.0
81 – 100	20	4.1 – 5.0	2.5	4.1 – 5.0	5.0
101 – 120	13.3	5.1 – 6.0	8.8	5.1 – 6.0	10
121 – 140	6.3				
141 – 160	1.3				
161 – 180	3.8				
181 – 200	1.3				
201 – 220	0.0				
221 – 240	1.3				
	100		100		100

This means that about 151,746 hectares of Kenya's forest is depleted by charcoal production and use in just one year. The assertion ties with that of Vuyiya et al. (2014) who asserted that human activities particularly charcoal production and use constitute a tangible threat to tree species and forest cover depletion. The forest cover depletion figures obtained from the study is slightly higher than that of Njenga (2013) and KFS (2013) which stood at 135,000 hectares, although it is lower than that of Mugo et al. (2010) which estimated that about 298,000 hectares was harvested in a year for the production of charcoal. The study findings also relate well with those of Mwampamba (2007) who found that consumption levels, poor kiln efficiencies, and low replenishment of harvested forest would completely deplete public forest in Tanzania by 2028. In the long term, his study findings indicate that about 2.28 million hectares of forest will be needed to satisfy charcoal demand in Tanzania by 2030. This is almost similar to the projections of Iiyama et al. (2013) which stand at 4.4 million hectares of forest to be harvested to meet charcoal demand in Kenya by 2050. They arrived at these projections with the assumption that the charcoal will be produced in kilns with 10% efficiency, which is exactly the assumption that was made in this study.

Human activities particularly charcoal production and use constitute a tangible threat to tree species and the forest cover depletion (Vuyiya et al., 2014; Mwampamba, 2007). Njenga (2013) adds that charcoal production will remain a serious threat to the forest because it targets particular tree species from both the natural forests and other woodlands. Forest cover depletion driven by charcoal production in Africa in 2009 alone stood at 29,760 Km^2 (Chidumayo and Gumbo, 2012). This figure is eight times that of Oceania, Central America, South America and Asia put together. Reason why governments of Tropical Africa must adopt smart interventions is curbing forest depletion (Mwampamba, 2007). A good number of studies have presented charcoal as constituting a threat to environmental degradation and forest cover depletion, which is highly supported by the findings of this study. A study by Mwampamba (2007) found that consumption levels, poor kiln efficiencies, low replenishment of harvested forest could almost completely deplete public forest reserves in Tanzania by 2028. This scenario is highly mirrored in the findings of the present study.

In Kenya, as a result of inefficient kilns used in the production of charcoal, about 85-91% of biomass is wasted, which also emerged to be the major production technique in this study. As a result about a vast area of the forest is required to provide for annual demand of charcoal. The estimate of this study may even be lower as other studies have it that as at 2008, the gazetted forest cover of Kenya was barely 14 million hectares, representing only about 1.7 percent of the total land area (Gichuho et al., 2013). Although this assertion compares squarely with an earlier estimate made in 2001 by UNEP (2001), it however differs with the estimate of the Kenya Indigenous Forest Conservation Programme – KIFCON (Wass, 1995), which holds that forest cover accounted for 2.17% or 1.24 million hectares of Kenya's total land area in 1995. Very recently in 2010 the Forest Resource Assessment Report reported that Kenya's forest cover had increased to about six percent in 2010 (FAO, 2010). This report however, did not state the factors that were responsible for this increase as it is widely held that charcoal production and use brings pressure to bear on the drylands which are responsible for over 75% of hardwood used in the production of charcoal (Iiyama et al., 2013). The sentiments support the observed preference for hard wood for charcoal by traders in this study.

A green economy is undoubtedly powered by a healthy forest, which will increase water supply, crop yields, reduce energy demand and CO_2 emissions, lower GHG emissions as well as provide more green and decent jobs. However, disregard or ignorance of the intrinsic forest value, slack forest management and scant environmental laws are some of the factors blamed for the ever increasing rate of forest cover reduction, resulting in warming of the globe and varying climatic conditions in Kenya. Very high demand for charcoal by the urban users like the case of Nairobi is a serious driver of massive charcoal production, which has left the trees endangered and the ground almost bare. If present rate of forest cover loss as observed in this study remains the same, Kenya will lose 65.6% of its forest by 2030.

CONCLUSIONS

From the analyses and discussions, the study therefore concluded that increased charcoal production and use constitutes a serious setback to transitioning to a green economy in Kenya. This is especially so as charcoal production and use in Nairobi alone will contribute to the depletion of 15,174.6 Ha of Kenya's forest cover in just one year, a quantity responsible for the depletion of 4.37% (151,746 Ha) of forest in Kenya annually. With continuous depletion of the forest cover, it will be very difficult, if not impossible for Kenya to attain its Vision 2030 objective (particularly the second / social pillar) to increase Kenya's forest cover to 10% by the year 2030 as it would be losing about 65.6% of its forest cover by 2030 making it very difficult to transition to a green economy.

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