IOSR Journal Of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 19, Issue 4 Ser. 1 (April. 2026), PP 28-33
www.Iosrjournals.Org

The Economic Landscape Of Charcoal Trade In Juba County, South Sudan: Developmental Vs. Environmental Constraints

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Abstract
In South Sudan, charcoal remains a cornerstone of the national energy matrix and a critical livelihood strategy for both rural and urban populations. This study examines the socio-economic dynamics of the charcoal trade in Juba County, exploring its role as a financial lifeline and its subsequent environmental toll.
Utilizing a mixed-methods approach involving 100 respondents across three Payams (Kator, Munuki, and Rajaf), the study identifies a high dependency on charcoal for both income 53% and domestic energy 71%. Findings highlight that while the trade mitigates unemployment, it accelerates deforestation, specifically targeting Acacia seyal and Acacia Senegal due to weak regulatory enforcement and a lack of viable energy alternatives. The paper concludes by recommending integrated policy interventions, including the promotion of agroforestry, investment in solar and LPG technologies, and community- led conservation initiatives to balance economic survival with ecological sustainability.

Keywords: *Charcoal trade, charcoal, environmental, energy alternatives, environmental dilemma*

Date of Submission: 13-04-2026 Date of Acceptance: 23-04-2026

I. Introduction

Forest aboveground biomass estimation and mapping are pivotal in understanding and managing carbon stocks and contributing to global efforts in climate change mitigation. (Abass et al.,2020, Bordoloi et al., 2022 et Sedano, 2020).

Natural forests are the most stable, diverse, and structurally complex terrestrial ecosystems in nature; they play an irreplaceable role in responding to climate change, protecting biodiversity, and maintaining ecological balance (Duan, 2022& Hu, and Hu *et al*, 2021).

Charcoal has ceased to be a mere commodity and has rather become an economic need in South Sudan, due to the structural weakness of its economy and the conflicts that recur regionally. It provides a source of employment both directly and indirectly for thousands across the country, particularly when there are no sustainable alternatives and unemployment rates are high.

Forests also supply the poor with alternative sources of income and a range of subsistence benefits, giving them unofficial rights to employment and a home, especially in rural areas (Sayer and Maginnis, 2005). The poor people have, therefore, been able to use the forest for food, fuel, and other saleable items (Camacho, Gevana, Carandang, and Camacho, 2015).

The role of forests and trees in the lives of many people appears obvious through the many uses made of tree products for food, medicines, fodder, fibers, and fuels, and for construction, fencing, and furniture (FAO 2010).

Charcoal is one of the major sources of energy in the urban centres of Africa; 80% of the population uses it as the main source of energy for cooking.

Production of charcoal wood has tripled over the last 50 years, ranging from 17.3 million tons in 1964 to 53.1 million tons in 2014 (FAO, 2016). Sixty-one percent of the current global production falls in Africa (FAO, 2016), mainly for meeting the demand of cooking fuel from the urban and peri-urban households (Mwampamba et al., 2013; Agostino et al., 2015).

Charcoal is one of the major byproducts of forest fires and is produced from the incomplete combustion of biomass and detrital materials (Preston & Schmidt, 2006).

Charcoal is the main source of household-level energy in Juba, the capital of South Sudan, on which the majority of its citizens depend to cook food and provide heat, while the country lacks infrastructure for electricity and other alternative sources of energy.

However, the pressure on forests makes them degrade and dwindle enormously, according to Adetula (2001) and Chukwuone, Adeosun & Chukwuone (2020).

In fact, there will be increased pressure from the growing urban population on the forest resources of rural areas. Others include Barnes et al., 2004; Arnold et al., 2006; and Grimm et al., 2008. However, this essential economic activity is at a crossroads, facing increasing environmental pressures such as unsustainable exploitation of forest resources, deforestation, land degradation, and loss of biodiversity.
Socio-economic activities include hunting, grazing, logging, firewood, bush burning, mining, and others.

Account for the loss of forest resources and forest degradation (Ohwo & Nzekwe-Ebonwu, 2021). Forests provide food to one billion people. For example, 20 percent of proteins in the diets in 62 countries are supplied by forests (FAO 2013).

In light of the above, the charcoal trade in South Sudan represents a two-edged sword: on one hand, it is an economic lifeline providing employment and income to a significant part of the population; on the other, this takes place amidst a weak formal economy and in the absence of reliable energy alternatives.

On the other hand, it is associated with unsustainable production and consumption practices that cause deforestation, soil degradation, and air pollution, placing the local environment under ever-increasing threats. To understand this juncture of economic imperatives and environmental dilemmas is, therefore, a key step toward initiating integrated policies that improve livelihoods without affecting the sustainability of natural resources for future generations.

Problem statement

Energy sources in rural areas, mainly including charcoal and firewood, continue to be vital in household cooking and heating, while remaining fairly affordable with limited modern energy infrastructure.

This paper, therefore, highlights that charcoal trading in the study area is a complex, multidimensional phenomenon, whereby economic considerations are closely linked to environmental issues. Economically, it is an important source of cash income, with opportunities for employment for many households, which cements its position as a significant financial lifeline. However, overdependence on charcoal trading results in serious environmental degradation, characterized by deforestation, land and soil degradation, and loss of biodiversity, which has negative implications for sustainability in terms of natural resources and livelihoods in the long term. These, however, are not confined to the study area but cut across the country due to the pervasive nature of the charcoal trade.

Although it was officially on charcoal export and in line with international recommendations for a reduction of deforestation, these measures have not been able to regularize the sector or reduce the environmental degradation. This is attributed to weaknesses in governance, duplication of roles between civilian and military actors within the chains of charcoal production, and the absence of viable alternatives in the local energy market.

Research objectives

This study intends to analyze the charcoal trade in Juba from an economic, environmental, and developmental point of view by accomplishing the following:

1- Analyze the economic role of charcoal trade in Juba concerning employment generation and supporting livelihoods, focusing on low-income rural and urban communities.

2. Examine ways that could offer the potential for transition into more sustainable alternatives, including cleaner production technologies and renewable energy sources.

3- To make actionable recommendations to policymakers for balancing the need for economic development with the requirements of environmental conservation in the post-conflict and fragile context of South Sudan.

II. Study Area And Research Methodology

Study area

The study was conducted in Juba, the administrative and economic hub of South Sudan. A field survey approach was employed, utilizing structured questionnaires and semi-structured interviews.

Research Methodology

This study adopted a field survey approach to collect and analyze data in line with the research objectives. A structured questionnaire was employed as the primary tool for gathering quantitative data, in addition to several semi-structured interviews with members of the local community to provide qualitative insights that enhance understanding of the research problem and support interpretation of findings.

A purposive sample of 100 respondents was selected to ensure socio-economic diversity across kator, Munuki, and Rajaf. The methodology aimed to capture both quantitative trends and qualitative insights regarding the perceptions of charcoal producers, traders, and consumers.

III. Results, Discussion, And Analysis

Distribution of respondents by gender

Table 1: The distribution of respondents by gender.

Gender	Number of respondents	Percentage%
Male	73	73
Female	27	27
Total	100	100

Source: field survey, 2025

Results in Table 1 indicate the trade is heavily male-dominated 73%, likely due to the physical intensity required for felling, logging, and long-distance transportation.

This distribution indicates, from an economic point of view, the central role men play in the value chain of the charcoal trade, since they control most of the production and marketing processes. From an environmental perspective, male predominance in this activity could contribute to the perpetuation of intensive patterns of production that increase the pressure on forest resources and deepen the environmental problem of deforestation and desertification.

The findings add weight to the involvement of more women in alternative activities that are less harmful to the environment and to strengthening environmental awareness in order to balance economic gains with the preservation of natural resources.

Educational level of respondents in the study area

Table 2: Educational level of the respondents in the study area

Educational level	Number of respondents	Percentage %
Illiterate	67	67
Literate (basic or higher)	33	33
Total	100	100

Source: field survey, 2025

Data in Table 2 A significant majority, 67% of those involved, are illiterate. This lack of formal education restricts access to alternative employment and limits awareness of sustainable harvesting techniques or government conservation programs.

Low education levels limit alternative sources of livelihood other than the charcoal trade, and the inability to read and write consequently drives individuals back to the charcoal sector due to its low entry barriers and reduced requirements for formal training. This reinforces the community's dependence on an unsustainable long-term economic activity.

Illiteracy diminishes an individual's capacity to acquire information on safer or more environmentally friendly work practices, as well as their ability to engage with formal institutions or benefit from support programs led by both government and NGOs.

Low education levels or limited environmental awareness could lead to the continuation of practices that contribute to indiscriminate tree cutting without reforestation plans or the neglect of environmental regulations, which contribute to accelerated deforestation and desertification.

Given that the charcoal trade represents both an economic opportunity and, at the same time, an environmental challenge, illiteracy becomes a barrier to balanced solutions between economic benefits and the preservation of natural resources. Improvement in the level of education or targeted environmental awareness programs among this group might contribute to a shift in production and changes in consumption patterns toward more sustainable practices.

Household size in the study area

Table 3 shows that most households in the study area are medium or large in size, with medium households standing at 53% and large households at 26% compared to only 21% classified as small. This has clear economic, social, and environmental implications in regard to the charcoal trade.

Table 3: Household size in the study area

Number of members	Number of respondents	Percentage %
Small 1- 7 members	21	21
Medium 7- 10	53	53
Large, more than 10 members	26	26
Total	100	100

Source: field survey, 2025

This means that large households have to spend more to satisfy their daily needs and might, therefore, be pushed toward depending on the charcoal trade as a main source of income due to its accessibility and quick financial returns compared to other limited employment opportunities in the area.

A larger household membership usually implies that there is more labour available within the family to promote participation and marketing. This might also lead to the intergenerational transfer of the trade, hence increasingly embedding it in community livelihoods.

Larger households, with more energy needs for cooking and heating, increase the local demand for charcoal, placing additional pressure on forest resources and thus increasing the rate of deforestation and desertification.

The charcoal trade, therefore, takes on the dual nature of an economic opportunity and an environmental dilemma. The prevalence of large households further heightens the challenge of balancing livelihood needs with environmental conservation. This emphasizes the need to introduce sustainable economic and energy alternatives that reduce overdependence on charcoal.

Main sources of household income in the study area

Table 4 below shows that the charcoal trade provides the main source of income for almost half of the households, 53%, in the study area, followed by agriculture at 24%, livestock rearing at 15%, and other activities at 8%.

High dependence on the charcoal trade reflects its importance as a primary source of livelihood in the area, especially considering the limited other work opportunities and poorly developed economic infrastructure. This puts households in a very vulnerable position if production is limited or forest resources are depleted.

Relying on only one source of income makes the community highly vulnerable to environmental or economic catastrophes linked to that activity. Besides, heavy reliance on charcoal may further entrench traditional trade roles; thus, switching to other livelihoods is difficult for many.

Increasing dependence on the charcoal trade accelerates tree cutting, hence fastening forest cover loss, desertification, and soil degradation. This presents a serious challenge to attaining a balance between livelihood needs and environmental protection.

Table 4: Main sources of household income in the study area

Main source of income	Number of respondents	Percentage %
Charcoal trade	53	53
Agriculture	24	24
Livestock rearing	15	15
Trade, daily labour, etc.	8	8
Total	100	100

Source: field survey, 2025

Energy sources for cooking in the study area

Data in the following Table 5 indicate that a majority of the households in the study area rely on charcoal as their main cooking energy source, standing at 71%, followed by firewood, which stands at 20%. Only 7% are using liquefied petroleum gas, and a small proportion, 2%, use other sources.

This high reliability of charcoal indicates its relatively low cost and easy accessibility as compared to liquefied gas or electricity, particularly in those locations that have insufficient modern infrastructure. Locally accessible charcoal and firewood do not require any special equipment for cooking, making them relatively viable options for poor households.

Table 5: Cooking energy sources in the study area

Cooking energy source	Number of respondents	Percentage %
Charcoal	71	71
Firewood	20	20
Liquefied Petroleum Gas	7	7
Other sources (electricity)	2	2
Total	100	100

Source: field survey, 2025

High demand for charcoal and firewood directly contributes to the cutting of trees, thereby increasing deforestation and desertification. It also contributes to air pollution, especially in enclosed cooking areas, thus creating health risks to residents.

While the charcoal trade is an important economic opportunity for producing households, high consumer demand raises environmental challenges by putting added pressure on natural resources. Indeed, striking a balance between household needs and conservation requires the introduction of more affordable, cleaner energy alternatives, such as LPG or solar energy.

The primary tree species used for charcoal production in the study area

Results in Table 6 show that Acacia seyal (Telih) constitutes the highest proportion of 45% tree species used for charcoal production in the study area, followed by Acacia senegal (Hashab) at 27%, as compared to *Balanitis aegyptica* at 21%, while a smaller percentage goes to *Ziziphus sp*. (Sider) at 7%.

Table 6: Main tree species used for charcoal production in the study area

Tree type	Scientific name	Family	Percentage %
Telih	*Acacia seyal*	Fabaceae	45
Hashab	*Acacia senegal*	Mimosoideae	27
Heglig	*Balanitis aegyptica*	Zygophyllaceous	21
Sider	*Ziziphus sp*	Rhamnaceae	7

Source: field survey, 2025

Households depend on these specific species because they are relatively abundant, fast-growing, and resilient, hence preferred options for charcoal production. Availability of these species is a significant determinant for the continuity of charcoal trade as a main source of income, since the alternatives are limited.

Environmental awareness levels among respondents in the study area

Results in Table 7 below show that more than half of the respondents, 57%, have a low level of environmental awareness, 28% with moderate level, and only 15% a high level of understanding.

Table 7: Environmental awareness levels among respondents in the study area

Level of environmental awareness	Number of respondents	Percentage %
High awareness	57	57
Moderate awareness's	28	28
Low awareness	15	15
Total	100	100

Source: field survey, 2025

Intensive exploitation of natural resources, which might in the future pose a threat to the very source of income if environmental degradation occurs.

Low levels of environmental awareness imply that a majority of respondents may strive for immediate private economic gains from the charcoal trade, without taking into consideration the future environmental costs. This tendency encourages intensive exploitation of natural resources, which could eventually threaten the very source of income once ecological degradation occurs.

Since the charcoal trade is both an economic opportunity and an environmental dilemma, low environmental awareness becomes one of the prime obstacles. Improving environmental awareness could steer the population toward less harmful economic and energetic alternatives through training programs and community campaigns. Respondents' opinions on the use of alternatives to charcoal in the study area

Results in Table 8 below show that the majority of the respondents, 74%, are in support of using alternatives to charcoal either strongly or conditionally, while the remaining percentage, 26%, were opposed to the use of alternatives due to habits or availability issues.

Table 8: Respondents' preferences for the use of charcoal alternatives in the study area

Opinions on charcoal alternatives	Number of respondents	Percentage %
Strongly support using alternatives	31	31
Support if alternatives are available	53	53
Do not support due to habit or lack of alternatives	26	26
Total	100	100

Source: field survey, 2025

This significant support reflects not only improving economic conditions but also the community's desire to improve environmental conditions. Price and availability remain, however, critical factors in both the acceptance and the adoption of these initiatives. Offering affordable, sustainably available alternatives is thus crucial to the success of any alternative energy program.

IV. Conclusion And Recommendations

The findings of this study reveal that charcoal trading in Juba town is an important economic activity that has significantly contributed to the livelihoods of a great number of households, especially in the absence of adequate alternative income sources. On the other hand, this activity also situates the town in the midst of an increasing environmental dilemma due to the high reliance on local vegetation resources, particularly those of high-value indigenous tree species.

The data indicate that this reliance on certain species, such as *Acacia seyal* and *Acacia senegal*, is causing them to diminish faster than natural regeneration can support, thus threatening ecological balance and increasing the dangers of desertification.

This dual challenge-economic viability versus environmental degradation -requires an integrated approach: natural resource management policies, strict regulations that can help prevent overharvesting, and community awareness of alternative sustainable options. Added to this is the need to encourage investment in environmentally friendly alternative sources of energy. These measures would ensure that the economic benefits to local communities from charcoal production are sustained into the future while environmental resources are conserved.

The study, therefore, recommends the following to address these dual challenges between economic viability and environmental conservation:

- Carrying out effective policies of natural resource management and setting very strict regulations to limit overharvesting.

Community-based environmental awareness programs on the long-term risks and available alternatives of sustainable energy.

- Promoting reforestation of species which are targeted for charcoal production.
- Invest in alternative and eco-friendly energy sources to reduce dependency on charcoal gradually.

The implementation of these recommendations will allow local communities to sustainably benefit economically from the charcoal trade while still conserving environmental resources for generations to come.

Acknowledgment

I acknowledge with appreciation the support, data, and guidance provided by colleagues and institutions that made this study on the economic dynamics of charcoal trade in South Sudan possible.

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