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RURAL HOUSEHOLD ENERGY IN THE NUBA MOUNTAINS – REPUBLIC OF THE SUDAN: TRENDS OF USE AND IMPACTS*)

With 3 figures and 3 tables

ABDEL BAGI A. G. BABIKER

Zusammenfassung: Energieversorgung ländlicher Haushalte in den Nuba-Bergen, Republik Sudan: Tendenzen und Auswirkungen

Handhabung und Nutzung natürlicher Ressourcen durch den Menschen haben nachweislich bestimmte regionale und globale Entwicklungs- und Überlebensprobleme verursacht. Im Sudan sowie in den meisten Entwicklungsländern bestehen diese Probleme sowohl im modern-städtischen als auch im traditionell-ländlichen Wirtschaftsbereich. Das Anliegen dieses Aufsatzes ist es, die Hauptprobleme der Nutzung von Holz als Energiequelle im ländlichen Sudan am Beispiel der Region der Nuba-Berge aufzuzeigen. Als Teil der semi-ariden Zone des Sudan mit unterschiedlichen Gebietstypen gelten die Nuba-Berge von jeher als bevorzugter Siedlungsraum. Das Angebot von Holz, der Hauptenergiequelle, wird daher in zunehmendem Maße überbeansprucht. Infolge der hohen Kosten und begrenzten Verfügbarkeit anderer Energiequellen wird das Gebiet, in dem Holz zum Kochen, zur Beleuchtung, zum Heizen und zu anderen Haushaltszwecken genutzt wird, immer weiter ausgedehnt, während Holzkohle und Kerosine nur in begrenzten Maße gebraucht werden. Sobald das Angebot von Holz knapp wird, stellt die Versorgung der Haushalte mit Energie eine ständig dauernde, wachsende Last dar. Neben der Notwendigkeit, mehr Arbeitskraft für das Sammeln von Holz einzusetzen, zeigt diese Arbeit durch die erhöhte Anstrengung auch Auswirkungen auf die Gesundheit der Frauen im ländlichen Bereich, die für die Versorgung mit Brennholz oder anderer traditioneller Energie verantwortlich sind. Die Untersuchungen über Angebot und Verbrauch, die im Gebiet der Nuba-Berge durchgeführt wurden, zeigen im allgemeinen eine unvernünftige Nutzung der natürlichen Ressourcen, d. h. ineffiziente Methoden des Holzschlagens, der Herstellung von Holzkohle (Erdöfen) und des Verbrauchs im Haushalt.

The Sudan is essentially an energy-poor country. The energy consumption for the Sudan in 1980 (including all forms of energy used) is estimated at 4.1×10^9 c.eq. In international terms it is low. However, energy consumption showed a very high rate of growth during the last twenty years. In 1962 the energy use in the Sudan was only 0.62×10^9 c.eq. Compared to the present use there has been a 700% increase (ABAYAZID 1975).

The main sources of energy are imported fossil fuels (21%), wood fuel (75%), and, to a much lower extent, hydroelectric power (1%). Fossil fuels and electricity generated thermally or hydro-electrically constitute the only commercial sources of energy. These are consumed mainly as energy inputs for the modern sector of the economy, in transport, agriculture, industry, and for domestic use in large urban areas. The supply of the increasing domestic demand combined with the rising oil prices puts more pressure on the balance of payment. Currently the oil bill is running at about 95% of the total value of export earnings.

Wood-based energy sources are mainly used in rural areas. More than 90% of the households in the Sudan use wood as a primary source of energy. From the total amount of 10.65 million tons of firewood consumed in 1979/80, 98% was

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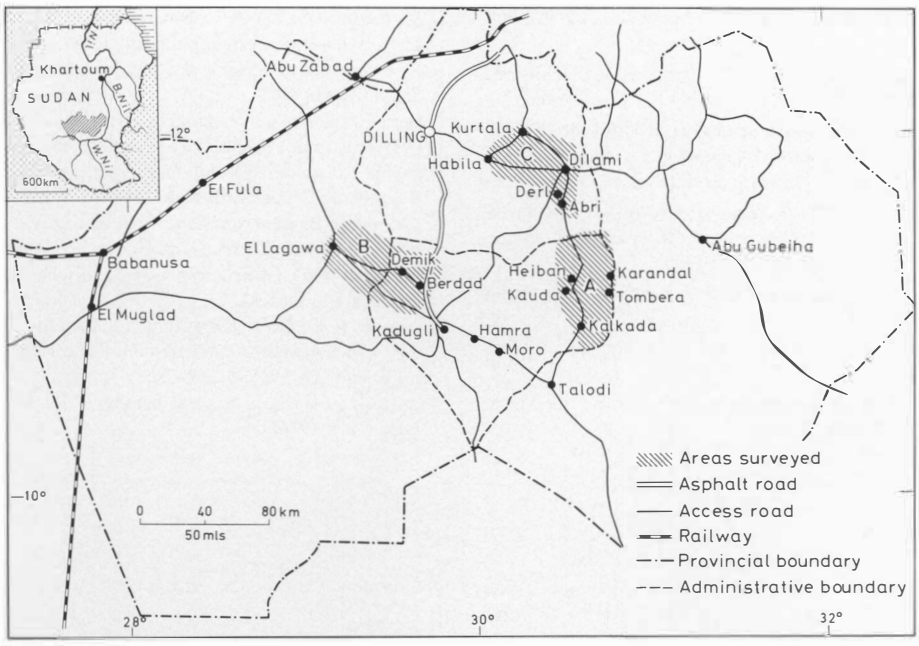

Fig. 1: Location of the study area

utilized as household fuels and domestic services, whereas 2% was consumed as energy inputs for rural and small urban industries. Charcoal, on the other hand, represents the main household fuel in urban centres. The amount consumed in 1979/80 was about 550,000 tons produced mainly by primitive methods with a very low recovery rate (below 15%) (*Ministry of Energy* 1980).

Almost all the firewood and charcoal are obtained from natural forests which occur in the Sudan under different eccological conditions. The estimated annual increment of the whole growing stock is about 67 million m³. This amount is subjected to annual losses from bush fires, drought, grazing, and expansion of mechanized agriculture which constitutes about 4.75 million m³. From the remainder about 8.7 million m³ are used for sawn timber, round timber and poles which leaves about 53.6 million m³ for wood fuel.

However, the available wood resources are unevenly distributed within the country, as it is evident from table 1.

If we compare this distribution with the distribution of population and the rate of urbanization of the Sudan it becomes quite evident that there is an inverse relationship between population distribution and the rate of urbanization on the one hand and the distribution of wood resources on the other: the regions with stronger concentrations of population and higher rates of urbanization (regions I and II) at the same time are lacking enough wood resources to satisfy their growing demands. This, in turn, means that more pressure will be extended and exerted on the resources of the relatively resource-rich areas, especially that of region III because of its relative accessibility and because it lies

Table 1: The percentage distribution of wood fuel resources in the Sudan

Region	Percentage
Region I: Red Sea, Kassala, Northern, Nile and Khartoum Provinces	5.04
Region II: Blue Nile, Gezira and White Nile Provinces	22.38
Region III: North Kordofan, South Kordofan, and North and South Darfur Provinces	29.29
Region IV: Eastern and Western Equatoria, Bahr el Ghazal, Lakes, Upper Nile, and Jonglei Provinces	43.29

Sources: Uhart 1976, Mukhtar 1978

within the economic-energy sphere of the area of major concentration of population and the highst rate of urbanization (Nile corridor with main concentration in Khartoum Conurbation). It is in this region (III) that the study area is situated (Province of Southern Kordofan, see fig. 1).

Population growth in rural areas, on the other hand, leads to the destruction of forests and in some cases to the removal of all trees and scrub cover. The results of this process are exemplified in deforestation and desertification. As supplies of wood become scarce, providing fuel for the household becomes an increasingly arduous burden, hence more rural labour has to be diverted to gathering wood, dung and crop residues. More important perhaps, than the question of rural labour, is the drudgery and fatigue that such work imposes, and its health effects on rural population, especially female

population, the major gatherers and users of rural energy (BABIKER, ABDU 1981).

The aim of this study is to identify the major problems of wood fuel resource use in rural Sudan, as exemplified by the area of Nuba Mountains. The area in general represents an uplifted part of the crystalline basement complex surrounded over most parts by Umm Ruwaba Graben, filled with unconsolidated sediments of riverain and lacustrine origin. It is characterized by a number of hill masses, mostly quite isolated, covering a few sq. km., but including a number of internal valleys and clay plains. As part of the semi-arid areas of the Sudan and with various types of terrain, the Nuba Mountains area provides a favourable site for human habitation and signifies a rather potentially rich area in the country.

The study has been concentrated in three different regions, varying in physical as well as in human aspects (fig. 1). The eastern region (Region A) is an example of a traditional community in a hilly country. The northern region (Region C) is a clay plain with the dominance of modern mechanized agricultural activity. The western region (Region B) is dominated by the *Gardud* type soil and modernized agriculture. In the three regions a systematic survey of energy use was carried out in 1980/81 through direct interviews and a questionnaire for households, wood cutters, charcoal producers and sellers and also through participant observation. In most cases the random sample technique has been applied.

Modelling energy-resource use in rural Sudan

An attempt towards modelling the environmental impacts of resource use, especially that of energy, has been carried out in fig. 2 and 3. From fig. 2 it is clear that the environment provides certain components to be used by rural population. The major ones of those are listed as: forest land, pasture land and water resource. In their search to satisfy their needs in form of food, shelter and others, rural individuals reflect certain behavioural patterns of use: in form of, for example, procurement of wood for fuel or building, fodder and forage for livestock, clearance of land for cultivation, etc. Imbalance between the degree of use and the rate of regeneration of resources can lead to one or more of the listed impacts. These are identified and categorized into two groups: the ecological impacts such as deforestation, overgrazing, soil erosion, etc., which in turn also lead to the socio-economic impacts.

Certainly the general pattern of use as well as the impacts are affected by the other elements of the environment and the socio-economic level of the society and these again affect each other.

Different symbols are used for the pattern of use to indicate the prevalence of female or male activities. It is clear that the female in rural areas through her numerous and varied activities has more contact with the environment than has the male. This alone is an important point for the planners to consider: the more attention is paid to the rural woman, the more they conserve the resources and release much pressure from the deteriorated arid land environment.

Fig. 3 shows rural energy use and its probable impacts upon the environment. Input into the system is the demand of the household, which is governed by the family size and income. Depending upon the availability of the resource and access to it, the individual may have certain alternatives to choose. The choice of one or more than one source of energy has in turn certain effects on the environment. These could be negative, such as deforestation, soil erosion, etc., which would affect the regrowth or the rate of regeneration. This

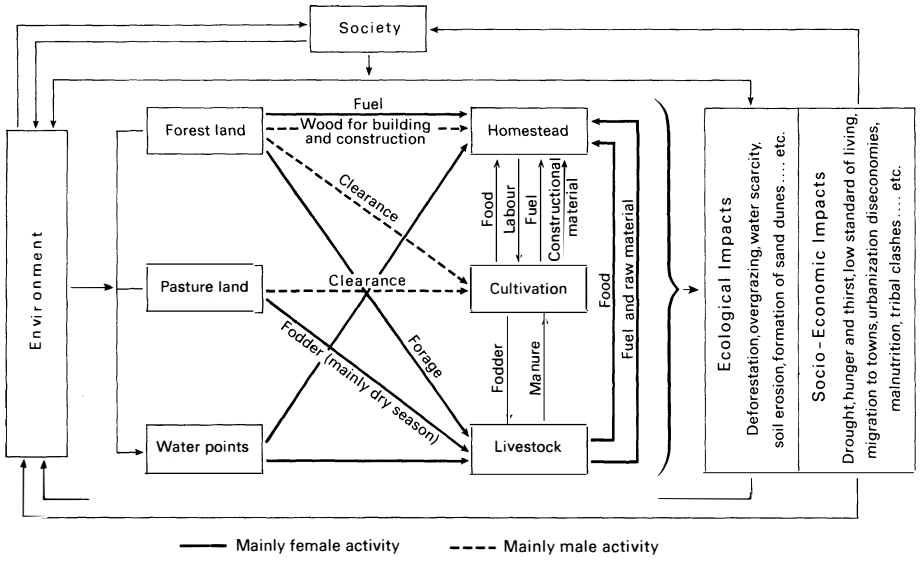

Fig. 2: Resource use in rural Sudan

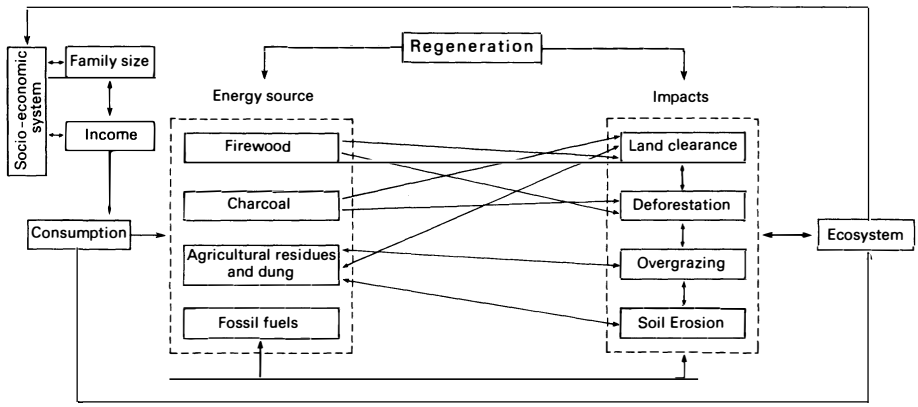

Fig. 3: Rural energy use and its environmental impacts

in the end would have its effect upon the choice again. The general pattern of use and the degree of pressure on the resources are again affected by the environment and the socio-economic level of the society. This system is entirely dominated by the woman, since she is the only gatherer and user of energy at the same time. Again this is an important point to note for environmental planning.

Available wood fuel resources in the area

Generally most of the area is covered with thin forests consisting of various species. Due to many reasons these trees are mostly young, thin and short. The joint effect of traditional shifting cultivation, widely practised in the area, and fire are responsible for the reduction of wide tracts of the original forest to fire-swept woodland. The introduction and expansion of mechanized farming in the area has led to the total destruction of a vast area, nearly half a million feddan (1 feddan = 0.42 ha), especially in regions B and C. Intensified grazing, due to the increasing invasion from both cattle and camel owners from areas seriously affected by desertification in the north, increasing consumption of wood resources for fuel and building purposes due to the increase in population and more settlement and urbanization in the area and the destructive effect of wood termites in infected regions – all these represent further reasons for this deterioration.

Batches of thick forests, if they do exist, are very distant from settlements, agricultural fields, and traffic routes. Here various acacia species of tall and relatively big trees with tall grass, usually *Cymbopogon nervatus* (Naal) and *Sorghum vergatum* (Adar) are to be found. The survival of those forests is explained by either protection, inaccessibility or lack of drinking water. The existence of some tall trees within or near settlements and areas of human activity can only be related to one or the combination of the following factors:

a) Resistance of the species to fire, whether bush fire or that associated with the method of cultivation.
b) The limited technology available to the local inhabitants, which makes it impossible for them to cut these special species.
c) Intentional preservation for other important uses. These may include:
   - Local pharmaceutical preparations and medical use (species like *Tamarindus indica* (Aradeib), *Adansonia digitata* (Tebeldi), *Balanites aegyptiaca* (Hejlij), etc.).
   - Use of certain parts of the tree as a raw material for rural and traditional industries, e.g. fruits and barks of *Adansonia digitata*, leaves of *Hyphaene thebaica*, *Acacia nilotica* (Sunut), etc.
   - Use of the nutritional value of the fruit or other parts of the tree, such species may include *Balanites aegyptiaca*, *Adansonia digitata*, *Hyphaene thebaica*, etc.
   - Use for shade and community meetings, etc. This applies in particular to broad-leaved or covered types of trees.
d) Forest department activity in the area, such as transplantation or forest reserves. In both cases cutting by local inhabitants is prohibited and the areas are well guarded.
e) *Kujur's* (local religious and medicine man) or *Sheikh's* (tribal chief) intervention to prevent their cutting for religious, spiritual or communal purposes.

In the light of the above-mentioned points differences of availability and intensity of stands of natural woody vegetation could be imagined and understood. Generally, the higher the technological devices adopted in human activity the more intensive is the pattern of deterioration of wood resources. One would, therefore, expect the northern region to be associated with more destruction and deterioration than the other two regions.

The distribution of the existing tree species is generally associated with the type of soil. On the clayey cotton soils, *Acacia seyal* (Talih) is the dominant type. Because of its

relative resistance to fire it is also found in both abandoned and cultivated fields, though the trees in the latter are usually younger and thinner. *Acacia seyal,* on the other hand, diminishes on the approaches to settlements – an indication of the high consumption of this species by the local people. Throughout the whole area it is regarded as one of the best types for firewood and charcoal-making.

Relatively deformed types of *Anogeissus leicarpus* (Sahab), *Combretum cordofanum* (Habil), *Balanites aegyptiaca* (Hejlij), *Tamarindus indica* (Aradeib), *Dalbergia melanoxylon* Babanus), *Ziziphus spinachristi* (Sidir) and *Sclerocaryea birrea* (Hummeid) are associated with gardud soils and the shallow gravely types on the piedmont. Here *Adansonia digitata* (Tebeldi) is sometimes found, but it is generally more available and dominant on the more sandy loamy soils of the western and northern regions.

Most of the slopes of the isolated hill masses are bare of vegetation either because they are bare of soil or because they were cleared for settlement and terrace cultivation dominant in those parts. But on the sides of the wadis and dry streams, especially in the hilly areas, *Hyphaene thebaica* and *Borassus aethiopum* are dominant, while other types like *Combretum cordofanum* and *Acacia seyal* could also be found. *Hyphaene thebaica* and *Borassus aethiopum,* an indication of more availability of water, are mostly associated with settlements – both originating in places of available surface water. The dominance of the two types is mainly due to a tradition of conservation, as has already been explained, whereas the fuel and building use of other types limits their existence.

In the abandoned mechanically cultivated fields and within or near certain settlements, where intensive cutting and browsing is dominant, *Calotropis procera* (Ushar) dominates. Thorny and non-thorny bushes, like *Acacia nubica* (Laot), *Ziziphus spinachristi* (Sidir) and *Capparis decidua* (Tundub) are found in many areas, but they are very limited in extension and distribution.

The plantations of the forestry department include such species as *Techona grandis* (Teak), *Eucalyptus spp* (Kafur) and *Azadirachta indica* (Niem) together with some other acacia species, like *Acacia senegal* (Hashab). These are mostly restricted to the plantation areas like Kalkada, Faggug, Umm Abdalla, Dilling, Kailak, etc. *Azadirachta indica* was introduced by the British during the early Condominium times and it is therefore always associated with service centres and big villages, where it is grown in abundance.

Wood fuel consumption in the study area

The present per capita consumption in the area, as revealed by the analysis of the 396 questionnaires, is 1.24 m^3. Slight variations are found between the different regions. But in general, wood fuel consumption seems to be far less than the estimated per capita for the Sudan (1.83 m^3 – Mukhtar 1978). Of the total amount of wood fuel used within the study area 73% were used as firewood and the remaining 27% were converted and consumed as charcoal. These rates also differ from the general estimated consumption of each in the Sudan (67.8% and 32.2% respectively). It is important to note that these rates do not reflect the actual rate of consumption of each source of energy. Due to the inferior types of charcoal produced through traditional methods in the area, more wood per unit of charcoal is converted here than in other regions of the Sudan with relatively better methods of production.

Firewood

Firewood is the most important source of fuel in the area. 89.1% of the people interviewed in the study area revealed that they are either totally dependent on firewood, or to a large extent dependent on it, in the sense that it accounts for more than 50% of their fuel needs. It serves all household purposes such as cooking, marisa-making (marisa is a drink similar to beer made of sorghum), heating – if necessary –, repelling of biting flies and lighting. But dependence on firewood according to each purpose differs from one area to another. It is mostly high in areas with lower technological devices, like the eastern region. Here all cooking and fuel needs are met by firewood. Moreover, owing to the limited cash available and the difficulty in obtaining kerosine and gasoline from legal sources together with the increasing prices of both, firewood is becoming more important than the others even for lighting purposes (about 80% of the respondents in the eastern region light with firewood). The use of kerosine and gasoline is limited to the urban centres, government institutions, such as schools, dispensaries etc., and the houses of government officials and traders who can afford to buy it or manage to acquire it officially or from the black market. Even in the urban and service centres of the eastern region firewood is the most important source of household energy. Only 4.9% here use wood in small quantities and other sources, especially charcoal in large quantities. The remainder are either totally dependent (26.8%) or to a large scale dependent on firewood for household purposes (68.3%).

In the other two regions, there is less dependence on firewood for cooking, but it still represents the main source of energy. Only 7.03% in region B and 18.3% in region C revealed that wood comprises less than half of their fuel requirements. Most of these are found in urban areas (77.8% and 76.1% respectively). On the other hand, the larger percentages of these still dependent or to a larger extent dependent on firewood in urban areas (78.1% in region B and 65.2% in region C) explain just how important this fuel source is in this area.

The importance and the widespread use of firewood can only be explained by the fact that it is the cheapest and the easiest fuel source available. In fact nearly all of the firewood in the rural areas and most of it in the service centres is collected from the neighbouring woodlands free of charge. Even when it is marketable in urban and service centres, it is always much cheaper and easier to obtain than charcoal or kerosine.

In the whole area, be it rural or urban, firewood collection is a female activity. Males usually regard it as a degrading activity to the extent that they feel insulted when asked whether they take part in it. Females usually collect dead dry wood which has fallen due to insect or pest damage or other infections, the effect of wind, thunderstorms and running water. In this respect, the activity is regarded as a rational one, since they do not cut green or living trees and bushes. Female engagement in this activity is in itself a fact leading to greater rationality of resource use. Since women are responsible for the collection and transportation of wood on their heads and at the same time they are responsible for cooking at home, it is in their interest to minimize the effort needed for new collection and transportation. In this respect they usually try to collect and keep the charcoal produced after burning wood to be used for further cooking purposes, especially for tea and coffee-making. In the rare cases, when they do cut wood they usually use the selective coppice method and only cut the small and medium branches. The primitive technology they possess helps in the conservation of trees, since their tools are not capable of cutting mature tree stems. This is more clearly evident in the rural parts of the eastern region, whereas in the other two regions more intensive wood-cutting, even in rural areas, is quite frequently practised.

The collected firewood is usually tied in bundles of a head load weight *(Rass)*, each of which consists of 10–15 branch pieces of 1–2 metres in length and an average of 10 cm in diameter. The bundle is then transported on the head, therefore referred to as *Rass* (arabic word for head), from the area of collection to the village, a distance varying from an average of less than 1 km in the eastern region to an average of 3 km in the big villages of the northern region. This may mainly be due to the following facts:

a) Larger size of population than in the eastern region.
b) Higher consumption due to higher standards of living and different dieting habits.
c) Availability of more and bigger urban settlements and service centres.
d) Role of advanced agricultural and wood-cutting technology in destroying large areas of forest.
e) Associated with (b) and (c) is the presence of more bakeries, boarding schools and other large firewood consuming institutions.

Although all dead, dry or fallen wood may be collected and used, the preferable species are *Acacia seyal* (Talih), *Anogeissus leicarpus* (Sahab), *Dalbergia melanoxylon* (Babanus). They give more heat, remain burning for a longer time, give more charcoal as a by-product and their smoke, particularly that of *Acacia seyal* is tolerable. In fact the burning of *Acacia seyal* by married women for its smoke, in the belief that it is a way of attracting their husbands for sexual intercourse, is a widespread tradition in the arid areas of the Sudan. Yet it is not a popular one among those of the study area in particular. The other two types of wood, moreover, can easily be broken into small manageable pieces when dried, a matter which facilitates its transportation and handling.

Firewood-cutting and marketing

Firewood-cutting in the area is to a greater extent associated with marketing. Both are linked more or less with urban settlements and service centres. In rural areas, in general, firewood-cutting is not commercial, and it is limited to villages, where modern agricultural activities are practised, especially in the northern region. Here because of the clearance of large areas for cultivation, wood collection in an area with such limited resources would not suffice the needs.

Commercial firewood-cutting takes place not far away from the settlements, usually 2–5 km. In contrast to firewood collection, it is to a greater extent an adult male activity. Cutters who are at the same time wood sellers, are of different tribes and their ages range between 20 and 50 years. They include tribes of Arab origin, mostly nomads, like Shanabla, Hamar and Kawahla, as well as Dinka and proper Nuba. The latter constitute a small percentage among them. The nomads, who are engaged in such practices usually have only small flocks of animals. They usually leave them with a brother, a cousin or any member of the family after visiting the area, and carry out the activity during the dry season in the urban centres to acquire cash for buying grain, sugar, tea and other commodities. Selling is usually to consumers at their homes. A nomad would normally sell a camel or a donkey load per day, although he can sell two if he has a staple customer like a bakery or a restaurant, and therefore need not waste time moving around the streets looking for buyers. Dinka and Nuba sellers could do the same, but they bring lesser quantities, since they use donkeys and their heads for transporting the firewood. Females and children are engaged in the activity on a limited scale and come from the same tribes, but mostly Nuba. They transport wood on their heads and they usually sell it in the market place and per piece. An average head load piece of *Acacia seyal* is sold for 3–4 piasters (1 £S = 100 p.t.).

Most of the wood cutters interviewed referred to *Acacia seyal* as being the preferable wood cut, because it brings more money, 10 p.t. per camel load more than other types. Other types preferred include *Dalbergia melanoxylon* (Babanus), *Anogeissus leicarpus* (Sahab), *Acacia mellifera* (Kitir) and *Albizia amara* (Arad). In certain urban centres, e.g. Lagawa, Habila and Dellami, *Acacia seyal* is not available because of the intensive cultivation and cutting. Firewood cutters now content themselves with any types found in the neighbourhood, saving themselves time and effort cutting *Acacia seyal* from distant areas.

Although most of the firewood-cutting is of the selective coppice type, cutting by certain nomadic tribes, like Shanabla and Hamar, is a destructive process. They cut the whole tree and they prefer younger ones (2–3 years old). They believe that it requires less effort in cutting and can be sold in logs rather than cut into further small pieces. However, this seems to reflect a particular perception of the tree in their homelands. Faced with the relative rarity of trees there, they always try to cut whatever they find for

Table 2: The per capita rural and urban firewood consumption in the study area by regions (in m³)

Region	Rural	Urban	Average
A	1.01	0.83	0.92
B	1.11	0.81	0.96
C	0.90	0.70	0.80
Study Area	1.01	0.78	0.89

Source: Fieldwork 1980/81

Table 3: The per capita rural and urban charcoal consumption in the study area by regions (eq. to m³)

Region	Rural	Urban	Average
A	0.004	0.45	0.227
B	0.060	0.71	0.385
C	0.095	0.80	0.448
Study Area	0.053	0.65	0.353

Source: Fieldwork 1980/81

firewood. Moreover, since only bushes and small thin trees are available in their homelands they have little experience with the cutting of the old and large-sized trees.

Commercial firewood-cutting is regarded among those engaged in it as a secondary activity for supplementary income. It takes place only during the dry season. That is because with the first spells of rain the nomads move northwards and the settled tribes move to their fields, usually in the clay plains, to prepare them for cultivation. During the wet season the urban consumers either collect wood themselves, use amounts stored from the dry season, or meet their demand by buying wood from the Forestry Department's centres, where reliable amounts are always available. The fact that an average of 46% of those interviewed in urban areas showed that they are usually in the fields during this time and do not need a supply of firewood from the urban settlements, shows the strength of the agricultural function of the urban centres in the study area.

Firewood consumption

In table 2 the amounts of firewood consumed are derived from the different interviews carried out in each region. Variations between the regions in per capita consumption pattern are significant. It is higher in the eastern and lower in the northern region. The urban consumption is generally much lower than the rural one in the whole area, although different patterns also exist here between the different regions. The highest consumption pattern in the eastern region is a reflection of the availability and facility of collection and the lower prices of firewood, if bought, in the region in general. It is also a general reflection of a relatively richer environment and a relatively lower pressure on the available resources. The lower per capita consumption patterns in the western and northern regions are counteracted by higher charcoal consumption (see table 3).

A mean per capita annual consumption of 0.89 m³ of solid wood shows a much lower rate than both the general Kordofan – Darfur Region's rate (estimated at 1.36 m³ of solid wood – FAO/ECA 1976) and the general Sudan's rate of 1.35 m³ of solid wood (Mukhtar 1978). The average urban annual consumption per person (0.78 m³) is also much lower than that of the urban centres just northwards in the Province of Northern Kordofan, as exemplified by Bara town (1.32 m³ – Digernes 1977).

Money spent on buying wood in the urban areas range between 10–75 p.t. weekly in the area in general. Differences according to region do exist.

Charcoal

With an average annual household consumption in the area as a whole of 2 big sacks (equivalent to 100 kg) charcoal does not represent an important phenomenon in household energy consumption. Yet, it gains more importance in urban and service centres, where its production and use are continuously increasing. In the rural areas, and especially in the eastern region, nearly all cooking and other heating activities are carried out using firewood. The only amounts of charcoal are those remnants left after burning and using firewood at home.

In the rare cases where charcoal is produced in the villages both wood collection and/or cutting and burning are the work of the female. Small amounts are usually produced, less than half a sack, and it is mainly for home consumption, although a minor part is directed towards the local village market. Charcoal production such as this is noticed particularly in the villages near the service centres, where it is mainly directed to their markets. After production it is usually carried on the head and sold there per tin or in small quantities per heap *Koum*. Whereas wood-cutting and burning is the women's activity, children, but again especially girls, are also engaged in selling it in the near markets.

The increasing importance and use of charcoal in the urban and service centres may be related to the following factors:

a) The overusage of the firewood resources in the vicinity of those centres. Collection and cutting of firewood from distant areas mean unnecessary waste of time and effort.
b) The ease of transportation and handling of charcoal as compared with firewood.
c) The other advantages of the use of charcoal, for example it gives more heat and it is almost smoke-free.

There are four different types of charcoal suppliers in the service centres. The female villagers referred to above, the supply through male nomads and Nuba on a bigger scale, the illegal wide-scale burning designed for supply of distant markets and lastly the supply through Forestry Department burners. Although the four sources are oper-

ating in the different regions with different intensities, the illegal type seems to be characteristic of both the western and nothern regions. It is clear that because of the relatively small amounts consumed in the eastern region only the first two types are widespread there, whereas Forestry Department selling of charcoal is only restricted to the region's two main urban centres Heiban and Talodi (fig. 1). In the service centres of the whole area in general, burning and selling of charcoal by adult males seems to be dominant.

The charcoal burners are of different ethnic groups, different classes of Nuba, Dinka and Arab nomads, who usually visit the area in the dry season and usually have small flocks of animals. Generally, the people engaged in the industry are between 35–50 years old. They usually collect dead dry wood and the actual cutting for this purpose is very limited. Only about 10% of the burners in this category who where interviewed indicated that they cut wood and even then they tended to cut *Acacia seyal* for charcoal-making. The reason for this is that they need a special quality of charcoal and therefore cut the suitable wood for it. Burning takes place in traditional small earthen kilns of a capacity of 2–3 medium scale sacks (45–50 kg). A kiln will take about 15–18 m^3 of air-dried wood, thus giving a small yield of only 8–12%. After three days of burning, the kiln is opened, the fire put out and the charcoal is left to cool for a whole day. The product is then put into sacks and transported on donkey backs to the nearest market.

For all the people of this category, who are engaged in charcoal production and marketing, the activity is a supplementary and a seasonal one. In the wet season the local inhabitants are engaged in cultivation away from the settlements and the nomads move northwards often loaded with wood, charcoal, and pottery to sell in the northern areas. Charcoal production and dealing is therefore very much limited during this season and asociated with other channels of production.

Although all types of available dead dry wood are collected, *Acacia seyal* and *Anogeissus leicarpus* are preferred for charcoal production for the following reasons:

a) The two types are available and can easily be found in big blocks.
b) Their smoke is tolerable.
c) The type of charcoal produced has many advantages, for example it is easily burnable, gives more heat, relatively few ashes and does not produce irritating sparks.

Illegal charcoal-burning on a wider scale is very difficult to trace and to estimate its real extent, simply because the people responsible for or engaged in it are not prepared to reveal anything about the volume and areas of production, or even their engagement in it. Interviews with charcoal sellers in the capital town of the province – Kadugli – showed that there are at least five illegal burning camps not far away from the town, whose owners are traders, rich dealers and building contractors living in Kadugli. The camps are usually located inside wooded forests, on subsidiary and rarely used routes. Workers are responsible for both cutting wood and burning it in relatively big earthen kilns of 40–50 m^3 capacity. The average production is about 200 sacks per week per unit of production. The charcoal is transported in the employers' own trucks. A certain amount is destined for Kadugli, but the larger part is for towns in northern Kordofan, such as El Obeid and En Nahud. From these camps charcoal has even been transported and sold in Khartoum during the charcoal crisis there in 1978/79. The principal initiations for the development of the industry seem to be both demand in the north and the newly constructed tarmac road linking Kadugli – Dilling – El Obeid.

Charcoal production takes place here also mainly in the dry season and is very limited during the wet season owing to difficulties of transportation through the forest and of firing the kilns. Wood for charcoal is exclusively cut. Mature trees are chosen (10 years and above). *Acacia mellifera, Acacia seyal* and *Anogeissus leicarpus* are preferred.

Charcoal production by the Department of Forestry in the province as a whole yielded about 13,494 sacks in 1979. This constituted almost 3% of the total amount consumed in the area. Although this is an insignificant proportion, it is six times higher than the department's share in charcoal production in the whole country (MUKHTAR 1978). It also gains importance from the fact that it is of a better quality and higher yield (15% recovery rate), thereby lesser consumption of wood resources and it is to be found in the market when most of the traditional native production ceases, that is during the wet season. More important is that no wood is cut for this purpose, but they use the wood of trees intentionally being cleared for cultivation in the mechanized and modernized agricultural areas.

The production is also carried out in earthen kilns by experienced burners employed on a monthly basis by the department. This production is mainly oriented towards large important centres in the area: Kadugli, Dilling, Lagawa, Talodi, Rashad and Abu Gubeiha. This public section unit, like many others of its kind in the area as a whole, is faced with certain difficulties in the course of production and marketing, the most important of which are shortage of equipment necessary for production as well as of spare parts for transport vehicle trucks.

Consumption of charcoal

The consumption of charcoal in the study area is shown in table 3, which has been prepared from the answers given relating to comsumption by all people interviewed and checked against the money spent in buying charcoal. The annual per capita consumption of charcoal of almost half a sack, equivalent to 0.35 m^3 of solid wood, seems to be higher than that estimated for the whole region of western Sudan in 1976 (0.05 m^3) as revealed by MUKHTAR (1978). It seems that the latter estimation considered only the official production of the Department of Forestry referred to above, but that in small-sized kilns (of natives and nomads) seems to be an industry which is usually scattered in and outside the rural settlements and therefore difficult to trace and

survey. Due to the primitive traditional methods of production, inferior types and low yields of charcoal are produced and therefore a great amount of wood is used. This may help in explaining the fact that the per capita consumption of wood needed for production of charcoal is as much as one third of that of firewood, although charcoal does not play such an important role in household energy consumption of the area in general and especially in the rural areas.

Marked differences in consumption can be noticed from table 3 among different regions as well as among the rural and urban dwellers. Again a decreasing tendency with the increasing effects of underdevelopment is noticeable.

The prices of charcoal range between 18–20 p.t. for a tin and 100–150 p.t. for a medium sack of charcoal. The prices seem to have increased enormously during the last five years. An average increase of 250% for the whole area can be noticed. Moreover, higher prices in the urban centres during the wet season are becoming a common occurrence. An average urban household in the area spends in fact about LS 15 annually for only one third of its fuel requirements. Reasons for this high rise in prices must include the general rise in the cost of living and the increasing demand with decreasing supply on the other hand. About 68% indicated that they can still afford further increase in prices, while about 29% cannot and the remainder gave no reply. Nearly all those who cannot afford further increase suggested the use of firewood as a substitute, the reason being that it is available, easy to collect and very cheap. In fact 8% of the respondents in service centres said that formerly they had been using charcoal, but had changed to firewood because of the high prices of the former. However, charcoal consumption will further increase in the future as a result of the increasing wood-felling and collection and the general environmental deterioration in the vicinities of the major towns of the area.

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