Charcoal in Africa

Importance, Problems and Possible Solution Strategies

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In Africa over 90 % of the wood taken from forests is woodfuel[1] [2]. The majority is consumed directly as fuelwood, however, a varying but substantial amount is transformed into charcoal. More than 80 % of it is used in urban areas making charcoal the most important source of household energy in many African cities. From 1997 to 2000 in the city of Dar-es-Salaam people used as much as 471.000 t of charcoal per year and in Mozambique the urban area in of Maputo uses about 130.000 t of charcoal per year[3], whereas between 200.000 and 230.000 t have been reported for the town of Kampala, Uganda. For the latter an increase of consumption of about 50 % was observed during the last decade[4]. Annual production in Kenya is estimated to be around 1.6 million t and households are consuming between 350 and 600 kg annually. It is estimated that about two million people are economically dependent on charcoal production, transport and trade[5]. Studies have shown that its popularity has increased among households in Dar-es-Salaam from 1990 to 2000[6]. There are several reasons for this:

- it has double the energy content of fuelwood;
- it is lightweight and thus easy to transport;
- it easy to store over long period of time;
- it produces less fumes and noxious compounds when burned;
- in most cities it is cheaper compared to kerosene, LPG or electricity;
- it has the image of "modern" energy.

Or in the words of a Mozambique retailer: "*it sells well, it doesn't go rotten and children don't steal it*"[7]. Another example of an experienced charcoal user from Kenya illustrating the aspect of convenience is shown in the following box:[8]

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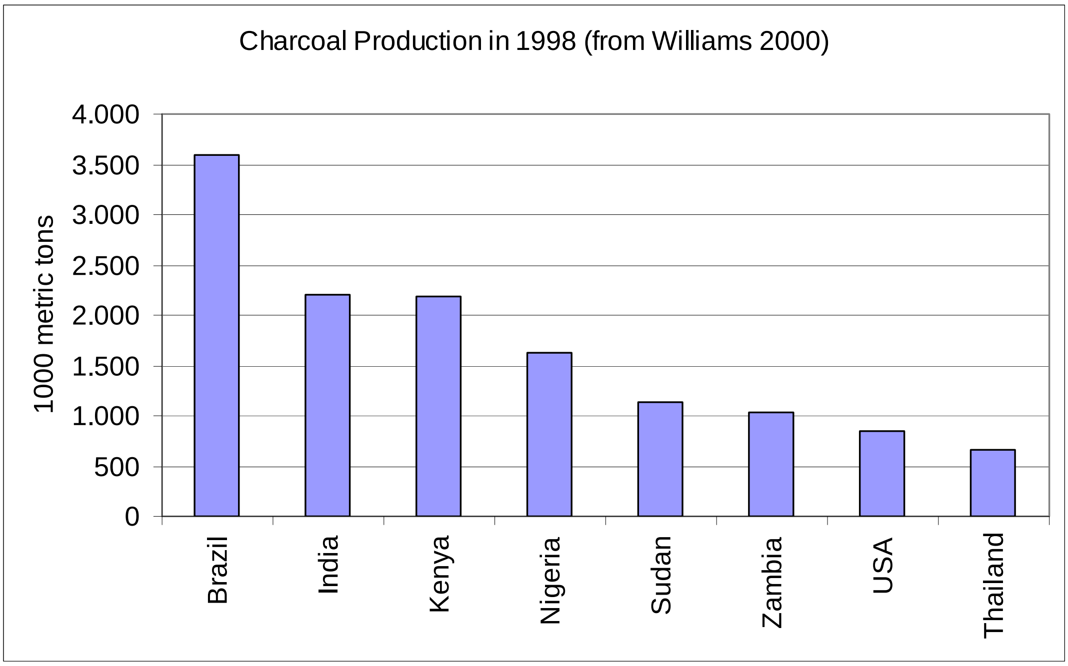
[1] www.mongabay.com
[2] Amous, Samir: The Role of Wood Energy in Africa. WETT Regional Studies, FAO 1997
[3] Pereira, C.: Charcoal Potential in Southern Africa Research Project; Mozambique Final Report p. 7 2001
[4] Knöpfle, Markus: A Study on Charcoal Supply in Kampala. Ministry of Energy and Mineral Development (MEMD); Energy Advisory Project (EAP) 2004
[5] Mutimba, Stephen: National Charcoal Survey of Kenya 2005, available at www.esda.co.ke
[6] Malimbi, R.E.: Charcoal Potential in Southern Africa Research Project; Final Report for Tanzania .p. 57, 2001
[7] Pereira, C.: Charcoal Potential in Southern Africa Research Project Mozambique Final Report p. 46, 2001
[8] Modified from www.biocoal.org/10.html

Why is charcoal a widely accepted fuel in Southern Countries?

…..in Malindi/Coast of Kenya a lady wants to cook beans. She needs about 20€ cents or 20 Kshillings to buy some charcoal to cook her beans. Once the charcoal is burning, she puts the pot with beans on the stove and she can leave the place and take care for other things. The charcoal stove does not need regular attention. After 1.5 hours the beans are readily cooked.

Much different however, if she would use a wood fire. She regularly needs to attend and feed the fire. If she does not carefully and constantly feed the fire with wood in a proper stove, she may use and burn more wood- compared with the wood which is needed to produce the charcoal used.

The importance of charcoal is also reflected by the fact that four African countries rank among the eight countries with highest charcoal production world wide[9].



Economic Aspects of Charcoal

"We do not produce charcoal as some sort of business, but simply do it for survival".[10]

In many African countries charcoal production, transport and sale are of great economic importance. However, a large part of the activities is done in the informal sector almost exclusively in rural areas. This makes it difficult to estimate its role in the national economy. FAO has included charcoal production in its FORESTAT database, unfortunately, for many African countries the data are inconclusive. However, since in most countries charcoal is

[9] Williams, Eric: Global Production Chains and Sustainability: The case of high-purity silicon and its applications in IT and renewable energy United Nations University/Institute for Advanced Studies, 2000. Available at www.ias.unu.edu

[10] Statement of a Resident of Ganda location, Malindi, Kenya, during a survey in 2005; from Mutimba, Stephen: National Charcoal Survey of Kenya 2005, available at www.esda.co.ke

produced and marketed in an industrial-like manner a number of projects and studies have focussed on it. In the following four countries in Eastern and Southern Africa have been selected to demonstrate the economic importance of charcoal. In three countries of Southern Africa a large amount of data has been collected from 1998 to 2001 by the CHAPOSA project (www.sei.se/chaposa).

Tanzania

Two comprehensive studies on the "charcoal industry" of Tanzania have been performed. According to CHAPOSA in the city of Dar-es-Salaam about 2 million consumers use 471.000 t of charcoal per year. Assuming a value of 100 US$ for 1 ton of charcoal[11] this represents a value of about 47 million US$[12]. It is estimated that in the region around the capital a total of 125.000 jobs depend on production, transport and sale of charcoal. In the region of the CHAPOSA project village households obtained 50 to 70 % of cash income from the woodlands with charcoal being the most important commodity. A study performed by the Dutch-funded PREM-Project estimated that the total revenue generated by charcoal (estimated nationwide consumption 1.2 million t per year in 2002) was around 200 million US$ (the charcoal industry directly provides employment for about 70.000 workers) in 2002 and recent calculations ended up with an estimated value of 350 million US$ and employment for about 1 million workers[13]. Charcoal consumption of the capital was estimated to be around 300.000 t per year; however, according to the authors this figure represents a rough estimate only. The large difference in numbers could partly be due to different dimensions and definitions ("total revenue" vs. "value of product") used in the different studies. In any case, charcoal production and trade has been found to be a major source of income to both rural and urban dwellers in the country.

Mozambique

The urban area of Maputo uses about 130.000 t of charcoal per year. About one million consumers are served and about 40.000 jobs depend on charcoal. Like in Tanzania charcoal is an important source of income in rural areas around the capital and may contribute about 65 % to the annual income of households. Both men and women are involved in charcoal production.[14] During the last decades charcoal production areas had to be extended and nowadays charcoal is transported on average 150 to 200 km by truck or train to the cities.

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[11] CHAPOSA - Charcoal Potential in Southern Africa Research Project; Final Report p.28 (2001)
[12] Malimbi, R.E.: Charcoal Potential in Southern Africa Research Project Final Report for Tanzania .p. 56 (2001)
[13] Beukering, P. van et al.: Optimization of the Charcoal Chain in Tanzania. PREM-Working Paper 03-07 2007; available at www.prem-online.org
[14] Pereira, C.: Charcoal Potential in Southern Africa Research Project Mozambique Final Report; 40ff 2001

There are even several reports that charcoal is transported over 600 km by train after a railway had been restored after the end of the civil war. The reason for this is overuse of the forests in the vicinity of Maputo, which have a rather low regeneration capacity compared to other forests types. Surprisingly, despite the fact that this causes increased costs of transportation the charcoal price has remained rather stable during the last years, if inflation is taken into consideration.

Zambia

Total charcoal consumption of Lusaka was 174.000 t in 1990 and 245.000 t in 2000, serving 144.000 and 179.00 households, respectively[15]. This represents an economic value of about 25 million US$ per year[16] and makes charcoal production the second most important economic activity in the study area after agriculture. Per capita income from charcoal production was about twice the income from agriculture in 1990 about five times in 2000 respectively. About 48 % of the producers make charcoal throughout the year, whereas 52 % produce during the dry or wet season only. It is estimated that about 78.000 jobs depend on charcoal business.

Kenya

About 1.6 million t of charcoal is consumed annually in Kenya (2.4. million t in 2000 according to UNEP[17]). The charcoal industry contributes an estimated 400 million US$ to the Kenyan economy making it an important economic factor[18]. Several 100.000 people are involved in production and trade of charcoal making it number 4 in employment generation after Agriculture and Forestry, Manufacturing and the Public Sector and services. It is estimated that a total of about 2 million people are dependent on charcoal industry directly or indirectly.

From the above it becomes clear that at present it is very difficult if not impossible to obtain conclusive figures on the African charcoal industry. Nevertheless it also becomes clear that charcoal is an important factor in many African economies. However, the importance of charcoal should not be limited to its economic role. The figures do not necessarily reflect the fact that in many countries charcoal is the fuel of the urban poor and provides employment in rural and urban areas for both men and women.

[15] Chidumayo, E.N.: Charcoal Potential in Southern Africa Research Project; Final Report for Zambia p. 37, 2001

[16] CHAPOSA - Charcoal Potential in Southern Africa Research Project; Final Report p.28, 2001

[17] UNEP: Integrated Assessment of the Energy Policy 2006

[18] Mutimba, Stephen: National Charcoal Survey: Summary Report June 2005 ESDA, Nairobi, Kenya

Charcoal Production

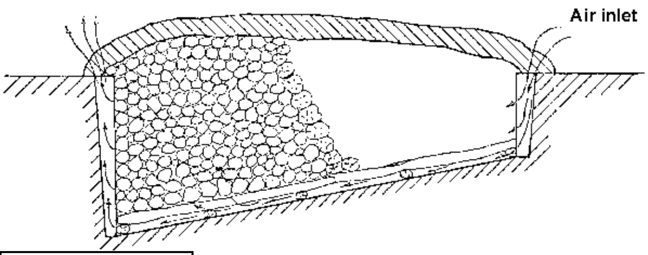
Charcoal is produced from wood by a complex process called carbonization. Carbonization occurs at temperatures between 450 to 600 °C in absence of air. Under these conditions organic vapours and gases are lost and part of the organic substances polymerizes, all of which increase the carbon content of the product. After the process is finished, charcoal is the final remains. One of the factors affecting quality as well as the yield is temperature. At relatively low temperatures around 300 °C a high yield of charcoal is obtained. This charcoal has a high content of volatile material, which is undesirable because it produces noxious fumes during use. Temperatures around 600 °C give lower yields but the charcoal has a low content of volatiles making it a preferred fuel.

Charcoal can be made from both hardwood and softwood. However, hardwood is usually preferred because the charcoal has higher energy content and is easier to handle.

Kiln Types[19] [20] [21]

Earth Pit Kilns[22]

Earth pit kilns are the traditional way of making charcoal in many parts of the world and may represent the simplest technology for charcoal production. In brief, wood is stacked in a pit, sealed with a layer of grass and soil and carbonisation is started by igniting the wood at one end. Pit kilns can also be built in small size and thus they are suitable for families and even individuals. In pit kilns also large pieces of wood can be used. However, ventilation may be difficult to control and frequently carbonisation is incomplete, producing only low quality charcoal. Further, efficiency is lower than in earth mound kilns. To improve efficiency, pit kilns can be equipped with a chimney which allows the use of biomass other than wood such as coconut shells. Nevertheless, even the improved pit kiln is less efficient than a well managed earth mound kiln. In addition, pit kilns are labour intensive since a pit must be dug into the ground.



Source: FAO

[19] Mahu, Seth Agbeve: Charcoal Production and Use with Special Focus to Africa GTZ, 2006
[20] Simple technologies for charcoal making FAO Foresty Paper 41, 1982
[21] Improved Charcoal Production. Application of Biomass Energy Technologies. HABITAT Publication United Nations Centre for Human Settlements Nairobi, 1993
[22] Kimaryo, B.T. and Ngereza, K.I.: Charcoal Production in Tanzania Using Improved Traditional Earth Kilns IDRC Manuscript Report 216e, 1989

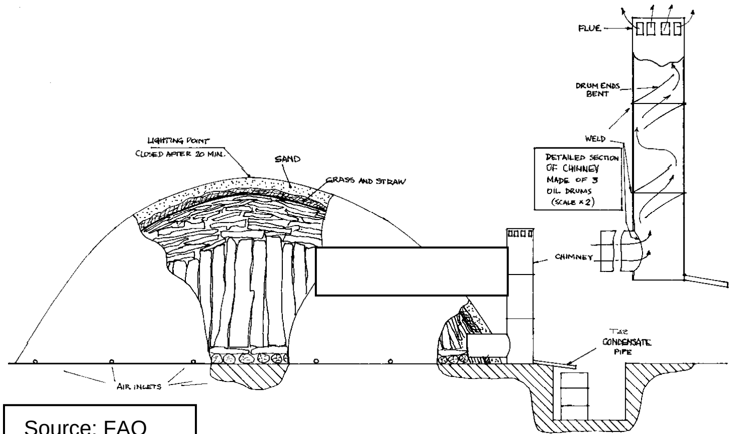
Earth Mound Kiln

This is also a common kiln used for charcoal production. It can be constructed from locally available material. In brief, wood is collected and stacked in the polygonal shape of kiln. The wood is then covered with a layer of grass and the construction is sealed with soil. A small opening allows the control and monitoring of the process. When the kiln has been lit, it requires continuous attention for 3 to 15 days depending on the size. After the kiln has cooled down charcoal can be harvested. The main advantage of this type of kiln is that it can be constructed easily without cost at the harvest site. However, carbonization takes rather long and the process requires continuous attention. In addition, charcoal quality is rather low and efficiency is only between 8 and 15 %. Therefore charcoal production using traditional kilns is associated with high consumption of wood.

Source: FAO

The Casamance Kiln – an improved Earth Mound Kiln

The Casamance kiln was developed in Senegal and is an earth mound kiln equipped with a chimney. This chimney, which can be made of oil drums, allows a better control of air flow. In addition, the hot flues do not escape completely but are partly redirected into the kiln, which enhances pyrolysis. Due to this reverse draft carbonisation is faster and more uniform giving a higher quality of charcoal and efficiency up to 30 %. Disadvantages of this kiln type are that it requires some capital investment for the chimney and it is more difficult to construct.



Source: FAO

Brick Kilns

Unlike the kilns discussed so far brick kilns are usually stationary. They have an efficiency of up to 30 % and are suitable for semi-industrial production of charcoal. One type is the truncated pyramid kiln, which is used in Chad mainly in the informal sectors. However, it has a lower efficiency than other brick kilns. The most notable type is the Argentine half orange Kiln, which has been adopted by the Malawi Charcoal Project. It is made entirely out of brick and mud as mortar. Loading and unloading is performed through two opposite doors, which are sealed before the kiln is ignited. The carbonisation cycle is much quicker and allows harvesting of charcoal after 13 – 14 days. Using a kiln of about 6 m diameter up to 15 t of high quality charcoal can be produced per month. However, as brick kilns are stationary once built, they can only be used in areas with easy supply of wood. Furthermore, the wood has to be cut with some precision and water supply is required for preparation of mortar. Kilns can also be produced using concrete instead of bricks; however, as their construction is very cost-intensive they have not succeeded in Africa.

Source: FAO

Steel Kilns

A large number of different types of steel kilns have been developed which are considered as one basis of modern charcoal production. They are capable to carbonise even poor quality wood and can easily be transported when necessary. However as the annual output of a typical demountable steel kiln is about 100 – 150 t, they are not suitable for high-volume production. Furthermore, the investment costs may be as high as 1.000 US$, which limits the use of steel kilns considerably. Nevertheless, since efficiency is high (27 – 35 %) and carbonisation is very quick (16 to 24 hours after ignition) steel kilns have been promoted as community kilns in Kenya.

Mark V Steel Kiln. Source: FAO

Adam-Retort

The Improved Charcoal Production System (ICPS)[23], also called Adam-Retort after its inventor, may be presented as an example of retort technology[24]. The kiln returns the wood gases back to the carbonisation chamber, burns the volatile a higher proportion of the tar components almost completely and uses the heat for the carbonisation process. Efficiency can be as high as 40 % and noxious emission are reduced by 70 %. In addition the production cycle is completed within 24 to 30 hours. The retort is suitable for semi-industrial production. However, it's a stationary kiln, investment costs are about 300 to 400 US$ (for Kenya a pay back rate of about 3 months has been calculated) and special skills are required for construction. Nevertheless the Adam-retort has been introduced in Kenya on a pilot basis. Currently, the method is further refined in order to make it portable.

Pictures by Chris Adam

The use of improved kilns can be considered as a crucial step in achieving sustainable charcoal and therefore it is highly desirable. However, only the Casamance kiln has been locally successful so far. Although improved kilns were in the 1960s introduced in Uganda[25] they are virtually still unknown in the country today[26]. In Kenya more than 90 % of charcoal producers use inefficient traditional kilns[27].

There are several reasons for this.

- Brick and concrete kilns are stationary, whereas charcoal is frequently produced in a manner which requires mobile kilns or kilns constructed on site for the duration of production.
- Investment costs for many improved kilns are too high especially for metal kilns which are transportable
- Special skills are required to construct and to operate improved kilns.

[23] Low-cost retort kiln called „adam-retort"or ICPS (Improved Charcoal Production System) available at www.biocoal.org/3.html

[24] ICPS Improved Charcoal Production System available at www.crest.org

[25] Sebbit, A.M.: Traditional Use of Bioenergy 2005, available at http://folk.ntnu.no/lekangso/kurs2005/presentations/Day4-6_Bio-Energy/

[26] Turyareeba, P. and Drichi, P.: Plan for Development of Uganda's Energy Strategy. Study conducted for the Ministry of Energy and Mineral Development p. 21, 2001

[27] Mutimba, Stephen: National Charcoal Survey of Kenya 2005, available at www.esda.co.ke

Transport of Charcoal

Since charcoal is produced in rural areas and mainly used in the cities transport is an essential component of the "charcoal chain". Frequently production sites are several hundred km apart from the consumers in urban areas due to depletion of nearby resources and a broad variety of transport is used. Generally charcoal is transported by road, however; water transport may be important where the necessary infrastructure exists. In most cases the bulk of charcoal is transported by trucks and picks ups, but for shorter distances also animal transport, bicycles or push carts are used. In the case of Maputo significant amounts of charcoal are transported by rail over distances up to 600 km[28] [29], which is the longest distance reported so far. A survey in Kenya has shown that more than twice as many people are involved in charcoal transportation than in production[30]. For the capitals of Mozambique, Tanzania and Zambia, which consume the majority of charcoal produced in the countries, figures ranging between 350 and 1200 have been reported[31].

The characteristics of charcoal transport have been studied in detail in the city of Dar-es-Salaam[32] and many facts may also apply for other African urban areas. The bulk of charcoal (88 %) is transported by truck. A survey among 10 prominent truck owners showed that they run their business for ten years or longer. Furthermore, they live in Dar-es-Salaam and operate from there. None of them owned a truck but hired it on a need basis.

Charcoal transport, Malawi. Source: GTZ

However, the most frequent means of charcoal transport are bicycles, which account for around two thirds of the daily means of transport.

It provides an important source of income and this is reflected by the fact that in a survey of 10 villages in peri-urban and rural areas around Dar-es-Salaam more than 80 % of the households owned a bicycle. Bicyclists transport a load of 100 to 140 kg of charcoal to the edge of the city, where they sell it to customers, mainly small charcoal traders.

[28] Pereira, C.: Charcoal Potential in Southern Africa Research Project Mozambique Final Report 2001
[29] Charcoal Transport and Marketing; Chaposa Working Paper 2004; available at www.sei.se/chaposa
[30] Mutimba, Stephen: National Charcoal Survey of Kenya 2005, available at: www.esda.co.ke
[31] CHAPOSA Final Report p. 28, 2001
[32] Malimbi, R.E.: Charcoal Potential in Southern Africa Research Project. Final Report for Tanzania 2001

Smaller loads of 25 to 85 kg have been reported from Kenya[33]. Bicyclists involved in charcoal transport are mainly poor people, who cannot afford a better means of transport.

> A typical charcoal cyclist is male whose age is between the mid twenties and mid thirties. Transporting and selling charcoal at the inner edges of the city is his job and the bicycle is the main asset. He either owns the bicycle or rents it at TZS 500/= a day. He has to service it twice to thrice a week. He is often resident in the peri-urban or rural areas adjacent to the city and he finds this job much more beneficial to cultivating. If he has a family some members of his household will be engaged in subsistence agriculture. He can make between TZS 1,300/= to TZS 5,200/= per day. Income is not constant, on a good day when his cycle is in order and he is in good health, and the market prices are good, then he can make the maximum. On a bad day, he will just make between TZS 800/= and TZS 1,300/=. On a very bad day he will not make a sale, but will leave the bag to middlemen and return the next day to fetch a minimum of TZS 800/=.
>
> He works for six days a week, with a typical workday beginning at 5:00 am and ending at 10:00 pm. This time includes transporting charcoal twice a day to town and returning late at night. The distance to charcoal source being 7 – 15 km, the bicycle transporter covers as much as between 30–60 kilometres per day. He tries hard not to take meals in town so as to keep costs down. When he is ill, income is affected drastically, so cooperation, in the form of social and capital sharing with other cyclists and middlemen is important in the event that he needs to borrow cash to start over. His major concern about deforestation is the fact that distances to charcoal sources are getting longer and that one day there may be no charcoal to transport!

Profile of a typical charcoal cyclist along Pugu Road, Dar-es-Salaam, Tanzania[34]

Transport costs may be the major factor determining the price of charcoal making up 60 – 70 % of the final price[35] [36]. Another problem associated with transport is the losses of charcoal due to breakage during packaging and transport. It is estimated that about 20 % of charcoal is lost. As a matter of fact, the charcoal fines could be used to produce good quality briquettes, as it is done in developed countries. In African countries this technique is rarely if at all applied.

Distribution of Charcoal

Charcoal is sold though a variety of channels sometimes involving a complex system of wholesale retailer and retailers. Little charcoal is sold at the production site. Some is delivered directly to the consumers by charcoal bicyclists[37], although this is of minor importance. The bulk is sold either at the roadside, at markets or in small shops. Unlike in

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[33] Mahu 2006
[34] Malimbi, R.E.: Charcoal Potential in Southern Africa Research Project Final Report for Tanzania .p. 48, 2001
[35] Mahu, Seth Agbeve: Charcoal Production and Use with Special Focus to Africa. GTZ 2006
[36] Teplitz-Sembitzky, W. and G. Zieroth: The Malawi Charcoal project – Experience and Lessons. Energy Series Paper No. 20; Industry and Energy Working Paper. The World Bank 1990
[37] Malimbi, R.E as above .p. 47

production and transport of charcoal, which are dominated by men, women are involved in selling to a larger extent and may even outnumber men.

Charcoal Use[38] [39]

Traditional charcoal stoves

The majority of charcoal is used by urban households, however, also there may be a significant institutional (schools, hospitals etc.) and industrial demand (curing tobacco, smoking fish etc.) in some countries. Most households use traditional stoves, which are cheap (from 1.5 to 2 US$ up) and can be afforded even by poorer households. Examples are traditional stoves from Ghana, Kenya, Madagascar and Uganda. Usually they are made of metal without insulation, which allows most of the heat to escape. Although these stoves are slightly more efficient (10 – 25 %) than the three stone fire using wood, their use wastes a lot of charcoal. Further some traditional stoves emit large quantities of noxious fumes. Besides in charcoal stoves, frequently charcoal is also used in stoves that also burn fuelwood. Traditional charcoal stoves are very common in African cities, used by up to 80 % of the households.

Traditional charcoal stove. Source: GTZ

Improved charcoal stoves

The efficiency of charcoal use can be considerably enhanced by improved stoves. Their distinguishing features are a ceramic liner as insulation, an enclosed fire to retain the heat and ventilation gates to control the air flow. They burn charcoal with an efficiency of 30 to 50 % above the traditional stoves and emit much less or even no noxious fumes. Charcoal consumption per capita is reduced between 27 and 42 %[40].There is a number of different models, however, the most successful is the Kenyan Ceramic Jiko (KCJ), which was sold about 1.6 million times between 1997 and 2001 and became a model for a number of other stoves like the Lakech stove in Ethiopia.

Lakech stove. Source: GTZ

[38] Westhoff, B. and Gerrmann, D .: Stove Images GTZ 1995 available at http://www.gtz.de/en/themen/umwelt-infrastruktur/energie/20674.htm
[39] Mahu, Seth Agbeve: Charcoal Production and Use with Special Focus to Africa. GTZ 2006
[40] Barnes, D.F., Openshaw, K., Smith, K.R. and R. van der Plas: What makes people cook with improved biomass stoves? World Bank Technical Paper Number 242, Energy Series 1994

Although the benefits of improved stoves are obvious, to date they were not as successful as one would expect. One reason is that the price of an improved stove is about 2 to 10 times the price of a traditional one. Since charcoal is usually rather cheap, the payback rate due to charcoal savings is at least 1 to 3 months (for a stove with a lifetime of approximately one year). For details see leaflet "Cookstoves" from BTG Biomass Group[41]. The influence of the charcoal price may be illustrated by the case of Rwanda. Like in other African cities households in Kigali rely on charcoal. The charcoal price is higher compared to other countries, which is an incentive for the use of charcoal saving stoves. In 1990 ESMAP has trained artisans to produce an improved charcoal stove and in 1991 it was estimated that between 20.000 and 30.000 stoves had been sold. A recent survey showed that about 40 % of the households in Kigali are using an improved charcoal stove, which uses 33 % less charcoal than traditional stoves.[42]. It was calculated the payback period is only two weeks and thus much shorter than in other countries. Charcoal savings amounted to about 113 US$ per year for an average family[43].

Problems associated with charcoal production, use, and strategies for solution

One major problem related to charcoal production is deforestation. Although Chidumayo denies that charcoal is a cause of deforestation,[44] most scientists agree that charcoal production contributes to an overuse of forests. Whether or not this could be avoided by adequate forest management[45] is still debated. One cause of the problem is the use of traditional kilns with very low efficiency which may require as much as 10 kg of wood for 1 kg of charcoal. In addition, traditional kilns release large amounts of greenhouse gases during carbonisation. On the consumption side burning of charcoal in traditional stoves is very inefficient and results in an increased demand. As a response to the negative effects of charcoal production some African states have banned charcoal as a fuel (e.g. Malawi, Mauritania, Kenya, and Tanzania). However, this has proven to be counterproductive as the producers were forced to burn charcoal in secrecy, which prohibited the use of improved technologies. The use of charcoal was not significantly affected; however, frequently the price went up and remained at a higher level after the ban was lifted[46].

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[41] Leaflet cookstoves. Pdf available at www.btgworld.com
[42] Implementation plan for increasing the adoption and use of efficient charcoal cookstoves in urban and peri-urban Kigali. Winrock: USAID 2007
[43] Barnes, D.F., Openshaw, K., Smith, K.R. and R. van der Plas: see above
[44] Chidumayo, E.N.: Woodfuel and Deforestation in Southern Africa – a misconceived association. Renewable Energy in Development Vol. 10 No. 2; July 1997
[45] Girard, P.: Charcoal production in Africa: what future? Unasylva No. 211, 2002
[46] Chained to Charcoal: The Market for Forest Fuels in Tanzania, PREM Policy Brief No. 16, 2007

Numerous projects have started to solve the problems associated with charcoal as a fuel. Basically there are three different approaches:

- improving the supply of wood by afforestation projects and sustainable natural resource management;
- increasing the efficiency of charcoal production by promotion of improved kiln technology;
- improving the use of charcoal by introduction and promotion of fuel efficient stoves

In the following three projects will be presented, which deal with the problem in different ways. The GREEN-MAD project in Madagascar seeks to achieve a sustainable way if charcoal production through an integrated approach intervening at the levels of forestry as well as improved kiln and fuel-efficient stoves. The Malawi Charcoal Project tried to establish a production and marketing system for charcoal made from softwood. The “Charcoal Potential in Southern Africa” (CHAPOSA) projects focussed on research and strategy development which can lead to a more sustainable production of charcoal in three countries in Southern Africa.

Numerous attempts have been made in the past to improve wood supply for charcoal production. In the Antsiranana district in Madagascar the GREEN-MAD project is implemented since 1995 with support from GTZ. In this area forest resources are dramatically depleted due to overuse leading to deforestation even in protected areas. Charcoal is the main fuel for households; each family uses 590 kg per year in average. The capital of the district has an annually charcoal demand of about 8.400 t which is about 70 % of the total regional demand. Charcoal is produced in traditional kilns with efficiency between 8 and 14 %.[47] The objective of the project is to promote a sustainable use of forest resources and at the same time to ensure the supply of fuel of the region. All measures were accompanied by ecological and socio-economic studies.

To achieve this goal the project intervenes at several levels. To enhance wood fuel supply plantations were established using fast growing species such as eucalyptus. The plantations are managed by local communities which are also entitled to use certain forest areas provided that utilisation is sustainable. After training communities developed plans for natural resources management, and it showed that there is a great demand for afforestation. To date about 3.500 ha of wood fuel plantations have been established.

[47] Le reboisement villageois individuel. Stratégies, techniques et impacts de GREEN-MAD (MEM-GTZ dans la région d’Antsirana Madadgascar GTZ/GREEN-MAD 2007

To improve charcoal production the project introduced kiln with an efficiency of 16 – 20 %. They are equipped with a chimney and require 25 % less wood to produce the same amount of charcoal. Dissemination of these kilns proved to be difficult because they are economically only attractive when wood has to be bought.

Dissemination of improved charcoal stoves was more successful. They require about 24 % less charcoal[48] than traditional stoves and are produced by local artisans. So far about 36,000 improves stoves have been sold and about 50 &% of the families of the district capital use one. Currently, annual sales are about 4.000 stoves. In addition, solar cookers are introduced to further reduce fuel consumption.[49]

Recent figures indicate that this concept of enhancing production of charcoal by increasing wood supply and more efficient charring in conjunction with reducing consumption by introduction of improved stoves is working. Thus, in 2007 for the first time in Africa charcoal is produced on a sustainable basis[50] [51].

The Malawi Charcoal Project was implemented from 1986 to 1989 as a special component of the Energy I Project of the World Bank[52] [53]. It focused on semi-industrial production of charcoal and was unusual because it had government plantations of soft wood as resource base. At its time the project was the largest charcoal production programme implemented in Sub-Saharan Africa.

The resource base was a plantation of Pine trees (Pinus patula) of 51.000 ha and an estimated productivity of 200.000 t per year. It was located in the northern part of Malawi and except for Mzuzu the larger cities were between 280 and 630 km away. The Viphya plantation was the largest of a number of government softwood plantations with an estimated annual supply of 231.000 to 387.000 t per year. The project established a production system for charcoal using Half-Orange brick kilns which had an efficiency of 31 %. The total capacity was, 9.500 t per years, however, it was never fully exhausted during the time of the project. Charcoal demand of urban households and industry was estimated to about 90.000 t per year. In theory, this charcoal demand could be covered by the softwood supply of the plantations. Charcoal was transported by trucks; transport costs contributed about 70 % of the charcoal price.

[48] GREEN-MAD: La diffusion des Foyers Améliorés dans la région d'Antsirana. Rapport Final ; Nov 2001
[49] Eukalyptus in Metallherden. Akzente 3 p. 20 – 22, 2006
[50] Marlis Kees, personal communication, 2007
[51] Sepp: Energy Concept for Biomass. 2007
[52] Teplitz-Sembitzky, W. and G. Zieroth: The Malawi Charcoal project – Experience and Lessons. Energy Series Paper No. 20; Industry and Energy Working Paper. The World Bank 1990
[53] Application of Biomass Energy HABITAT Publication; United Nations Centre for Human Settlements Nairobi 1993

The project had to solve a number of problems. Charcoal from softwood has a lower energy content per volume and is more fragile than charcoal from hardwood. The latter caused difficulties during handling and storage, which could be overcome. Further it is more hygroscopic. During wet conditions it absorbs significant amounts of water which reduced its heating value and makes it more difficult to ignite. However, these problems do not appear when the charcoals is stored in a dry place during rainy season. Customers complained about the lower heating value of the charcoal (compared to the “usual“ charcoal from hardwood) and marketing campaigns were implemented informing the public about the characters of the product. Furthermore, the lower energy content was more than compensated by the lower price making it economically competitive to hardwood charcoal. However, transport costs were the crucial cost factor and finally contributed to the failure of the project.

In 1989 conditions got worse due to several reasons. A nearby coal mine increased its output and required more transport capacities. Secondly, about 600.000 people fled from the Mozambique civil war to Malawi and had to be supplied. Both led to a doubling in transport costs and made softwood charcoal economically unviable. In addition, marketing remained a problem. The project tried to sell charcoal through gas stations and supermarkets but with varying success. An independent retail system for softwood charcoal could not be established by the project. Furthermore, the industrial market, especially the tobacco industry, could not be penetrated. The extension of a nearby cement factory, which was expected to use several thousand t of charcoal per year, was cancelled. Politically, a ban of traditional hardwood charcoal by the Malawian government could not be enforced and traditional charcoal remained popular among urban dwellers.

Finally a project is presented which does not focus on technical aspects but rather on research and the development of strategies and policies to contribute to sustainable charcoal production. From 1998 to 2001 the Swedish Environmental Institute (SEI) as a coordinator and the universities of Stuttgart, Lusaka, Maputo and Dar-es Salaam implemented the project “Charcoal Potential in Southern Africa” (CHAPOSA). Its objectives were to “investigate the trends in deforestation and forest depletion in areas supplying three urban centres in Southern Africa: Lusaka in Zambia, Maputo in Mozambique and Dar-es-Salaam in Tanzania. Additional objectives were to identify indicators of over-exploitation and increase the understanding for the reasons of charcoal production.”[54] The methods applied included remote sensing analysis, field surveys, participators appraisals, computer modelling and building of scenarios to foresee the future development.

[54] CHAPOSA - Charcoal Potential in Southern Africa Research Project; Final Report p.5, 2001

The project generated a vast amount of data regarding production, transport and use of charcoal including its socio-economic aspects. The key findings were

- Currently forests are overused in all areas studied. This has led to a reduction of forested area during the last decade of about 25 % in Lusaka and Dar-es-Salaam. In Maputo the loss of 66 % is much more pronounced (from 3 to 1 %). This reduction is partly due to charcoal production, and partly due to cultivation.
- Model calculations show that forest areas will stabilise on a low level by 2015. In Maputo the problem is aggravated by the low productivity of the forest type, whereas the Miombe woodland in Lusaka has a higher productivity and regeneration of forests is faster.
- Introduction of improved technologies can reduce the amount of wood used for charcoal below today's level by 2020. However, this can only be achieved when both, improved kilns and stoves are introduced on a large scale.
- Charcoal production is one of the major income sources for rural people in study areas in Tanzania and Mozambique. In Zambia it is it is virtually the only source of income after the collapse of the agricultural market. Charcoal prices did not increase in real terms during the last two decades. In Mozambique prices were higher during the war, but have normalized since the end of the war.

The following recommendations were made by the project:
Resource management should be introduced and promoted in all areas to reduce the overuse of forests. Part of this should be the introduction of a licensing system for charcoal, although this is politically difficult as it leads to loss of income and increases the price of charcoal. However price increases could be compensated by introduction of fuel efficient stoves. To reduce the economic dependency from charcoal employment should be created in the fields of natural resource management and agriculture.

From the above it has become clear that in Africa charcoal is a two sided issue. On the one hand it still remains an indispensable, clean burning fuel, especially for the urban poor, and its production provides labour and income in rural areas. On the other hand its inefficient production contributes to the problem of deforestation. In the past projects addressing the problem of sustainable charcoals production failed. However, recently in Madagascar the GREEN-MAD project has achieved a sustainable production of charcoal using a commercial approach which combines sustainable forestry measure and introduction of improved kiln as well as improved stoves. Whether this promising approach is transferable to other regions and countries remains to be seen.

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