The Sudan Institutional Capacity Program: Food Security Information for Action

Policy Brief

April 2012

The burning issue

Woodfuel balance and policy options in Sudan

A summary brief based on WISDOM analysis

The Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) analysis was carried out in the framework of the Sudan Institutional Capacity Programme: Food Security Information for Action (SIFSIA) FAO OSRO/SUD/620/MUL

Food and Africulture Organization of the United Nations
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WOOD ENERGY IN THE SUDAN

Woodfuel supply/demand balance in the new geopolitical context

The division of Sudan in two separate nations imposes new challenges and the need for new strategies concerning the management of natural resources in the new geopolitical context.

One of such challenges is the sustainable management of biomass resources, which are the prime source of energy for households and for small-scale industries and important sources of revenue as timber products. This is particularly serious and urgent in Sudan, due to the separation from the traditional woodfuel supply regions of the South.

The rational and sustainable management of the woody biomass resources of the Sudan and their protection from excessive exploitation is now more important than ever, given the likely increase in demand. In turn, reliable knowledge on the sustainable production capacities and on the areas under high risk of deforestation and degradation due to marked deficit conditions will support the formulation of wise energy policy options and woodfuel import regimes.

In order to achieve such knowledge, SIFSIA applied the FAO methodology "Woodfuel Integrated Supply/Demand Overview Mapping" (WISDOM) to Sudan. The scope of the WISDOM analysis was to provide reliable knowledge on the sustainable production potential and on the areas under high risk of degradation, and to strengthen Sudan wood energy planning capacities, inter-sectoral and interdisciplinary decision making processes, strategic planning and policy formulation.

WISDOM-Sudan was based on the 2012 Land-cover map produced by Land and Water Division (NRL) mapping unit of FAO and the Remote Sensing Authority (RSA) of Sudan using the latest Land Cover Classification System (LCCS) and using available information related to the sustainable productivity and consumption of woody biomass in Sudan .

The WISDOM analysis was implemented in the framework of the Sudan Institutional Capacity Program: Food Security Information for Action (FAO-SIFSIA) and the Food Security Technical Secretariat (FSTS-MoAI) in collaboration with the Sudan's Forests

DEMAND FOR WOODY BIOMASS

The last comprehensive woodfuel use survey in Sudan was done in 1994 (FNC/FAO 1994). Considerable additional knowledge was accreted by forestry and energy institutions in recent years that permitted to assess and spatially distribute the current woodfuel demand. The results of the analysis supported the following main findings:

The role of woodfuels in the energy mix of the Sudan has changed considerably since 1994. Overall, the total consumption in 2011, estimated at 16.9 million m^3, is 28% less than the amount that could be expected for the same year if no change had intervened in consumption pattern, with a "saving" of some 6.7 million m^3.

The main element of change has been the rapid increment of LPG as a substitute to charcoal and fuelwood in urban households, bakeries, oil and soap factories (see Figures 3 and 4). The most remarkable change appears in the reduced woodfuel consumption in Khartoum and Gezira states, where the estimated annual consumption, i.e. 0.73 and 0.56 million tons, respectively, is only 30% and 40% of the expected woodfuel consumption if no change had intervened, as shown in Figure 5.

Its distribution, however, is unbalanced geographically and socially:

- high in central states and marginal in peripheral states partly due to transport costs;
- marginal in rural areas where there is more access and tendency to use fuelwood;

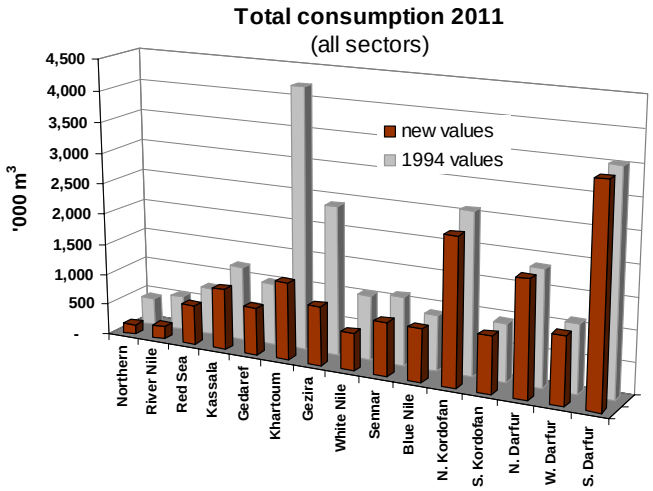
1 The Sudan Integrated Food Security Information for Action (SIFSIA) is a GoNU/GoSS programme funded by EU STABEX funds and implemented by the Food and Agriculture Organisation of the UN (FAO). This policy brief is one of a series of briefs designed to better inform decision makers in Sudan of emerging food security related issues. This brief was prepared by Rudi Drigo.

The views expressed herein can in no way be taken to reflect the official opinion of the EU or the UN.

- marginal in poorest segments of the society who cannot afford the cost of LPG.

In fact, the states with highest woodfuel consumption are South Darfur (2 million tons per year), North Kordofan (1.3 million tons) and North Darfur (1 million tons), which are the populous states where LPG distribution is still marginal.

State-wise consumption of woody biomass



Note: New estimates based on recent references (new values) are in color, while the grey values in the background represent the expected consumption levels if no change had intervened in the consumption pattern since the1994 survey.

Consumption of woody biomass in 2011 by Administrative Units.

The success of LPG distribution in replacing charcoal and fuelwood gives a clear indication of what would be the impact of a drastic reduction of LPG availability. It is most probable that LPG users, in case of absence or excessive price increase, would revert to charcoal and fuelwood. In such case the increase in woodfuel demand would be immediate and proportional to the gap created by the missing LPG.

WOODY BIOMASS SUPPLY POTENTIAL

Land cover data

The analysis of woody biomass supply potential was done on the basis of the new Sudan Land Cover Map of the Sudan(completed in February 2012), produced by Land and Water Division (NRL) mapping unit of FAO and the Remote Sensing Authority (RSA) of Sudan using the latest Land Cover Classification System (LCCS). This new map well represents the continuous gradient of low density vegetation types that characterize the Country.

Stock and productivity data

The last forest inventory was carried out in 1995-1998 by FNC, covering 2/3 of the forest areas of today's Sudan. That inventory is still a useful reference for the estimation of woody biomass stock, when combined with the new land cover map.

More challenging remains the estimation of the sustainable supply potential, because the 1995-98 inventory did not produce field data on the annual growth rates of the various vegetation types, providing only generic indication of the allowable cut. For this, the present estimation of the annual sustainable supply potential was based on generic references and on data from similar situations in other countries.

In order to support operational and locally-tailored sustainable forest management it is necessary to conduct a nation-wide survey of woody biomass stock and productivity.

Supply potential

Summary results of state-wise stock and potential productivity of woody biomass are shown in Table 1. Major findings include the following:

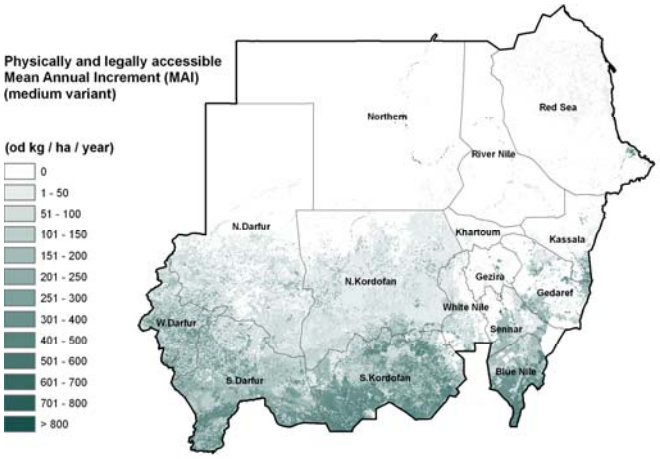
- The woody biomass stock estimated for the whole of Sudan is 164 million oven-dry tons (or 278 million m^3), which is approximately 15% less than the 1995 stock [3]..

[3] When comparing new and old estimates for the area covered by the 1995 survey.

- The total annual productivity of woody biomass (physically and legally accessible) is estimated at 10.9 million tons (18.5 million m^3), or 6.7% of the stock, which is in line with the value of allowable cut indicated by the 1995 NFI inventory report (7%).
- South Kordofan and South Darfur are the states with the highest supply potential, with 3.4 and 2.7 million tons (5.8 and 4.5 million m3), respectively.

The stock of woody biomass stored in the natural and planted formations should not be confused with the mean annual increment (MAI), which is the basic parameter for estimating the sustainable supply potential. The MAI helps to determine the length of the rotation period and the annual allowable cut, while the stock provides a realistic indication of what may be the resource available for harvesting at the end of the rotation period and therefore qualifies the suitability of the resource for commercial supply chains.

Sustainable woody biomass supply potential



Sudan is a vast country but its wood resources are relatively dense only in the southernmost formations, where the annual rainfall exceeds 600 mm, while the formations at higher latitudes (and lower rainfall) are very open or sparse.

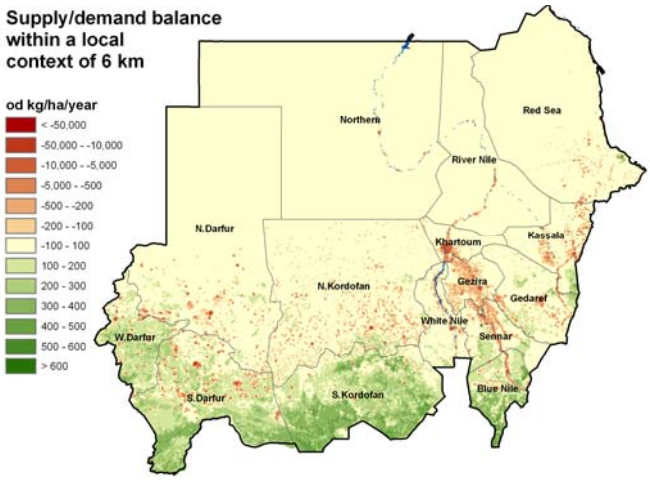
The average stock is 2.1 tons /ha (or 3.6 m^3), which is quite low under any production forestry standard. Considering the states with large areas covered by natural formations, those with wood formations with relatively high density are South Kordofan (4.4 t/ha) and Blue Nile (4.2 t/ha), followed by South Darfur (2.7) and West Darfur (2.4). North Kordofan and North Darfur have large natural formations but their density is so low (0.6 t/ha) to present negligible commercial forestry value

SUPPLY / DEMAND BALANCE

Local balance

The "local" balance shows an overall national surplus of 0.97 million tons (1.65 million m^3), but shows deficit conditions in all states of Sudan except for Blue Nile, South Kordofan, West Darfur and South Darfur. The local balance, calculated within a 6-km horizon, represents well the rural context but cannot represent the urban context where supply chains are always commercial and the production sites are often far apart. Local balance is particularly suited for the analysis of subsistence energy status of rural populations and for the assessment of surplus amounts potentially available for commercial supply.

Woody biomass supply/demand balance



Commercial balance

Scope of "commercial" balance analysis is to indicate the quantity and the distribution of biomass resources potentially available, and suitable, for commercial woodfuels production. In the absence of true economic parameters relative to the minimum economically viable stock levels, a preliminary "sensitivity" analysis was done by applying minimum surplus thresholds. The results show that, assuming a minimum surplus of 150 kg/ha/yr remaining after local consumption (that may produce 2.25 od t or 3.8 m^3 per hectare on a 15-years rotation), the "commercial" balance shows an overall deficit of 1.97 million od tons (3.3 million m^3). This indicates that, in

principle, if all national wood resource that guarantee more than the set threshold are put under intensive management, the country's production could satisfy 80% of its demand on a sustainable basis, while at least 20% should be imported or replaced by other fuels. The productive areas are located in the southern part of West Darfur and South Darfur, the whole of South Kordofan and Blue Nile.

It is now necessary to verify the economic viability of the various situations with local operators and managers and to define the true "economically viable" resource potential.

State-wise summary of supply, demand and balance statistics

State	Total stock	Annual supply potential	Demand 2011	Local balance	Commercial balance
	Mln t	'000 t	'000 t	'000 t	'000 t
Northern	0.8	37	92	-54	-66
River Nile	0.5	20	120	-101	-107
Red Sea	0.9	63	392	-331	-361
Kassala	1.8	110	580	-469	-502
Gedaref	4.7	320	450	-128	-258
Khartoum	0.1	7	734	-726	-727
Gezira	0.7	36	559	-529	-533
White Nile	1.7	192	358	-171	-275
Sennar	6.0	278	507	-223	-300
Blue Nile	16.0	922	499	422	319
N. Kordofan	10.9	1,196	1,386	-189	-941
S. Kordofan	61.1	3,410	550	2,859	2,503
N. Darfur	6.7	749	1,090	-327	-894
W. Darfur	12.8	905	599	290	46
S. Darfur	39.3	2,679	2,036	643	123
Tot Sudan	163.9	10,926	9,954	967	-1,974

Note: Units are oven-dry (od) woody biomass in thousand tons (million t for stock).
1 m^3 = 0.589 od tons. 1000 odt = 1698 m^3. "Commercial" balance values assume surplus thresholds of100, 150 and 200 kg/ha/year.

PRIORITY TARGET AREAS AND COMMUNITIES

Subsistence energy issue

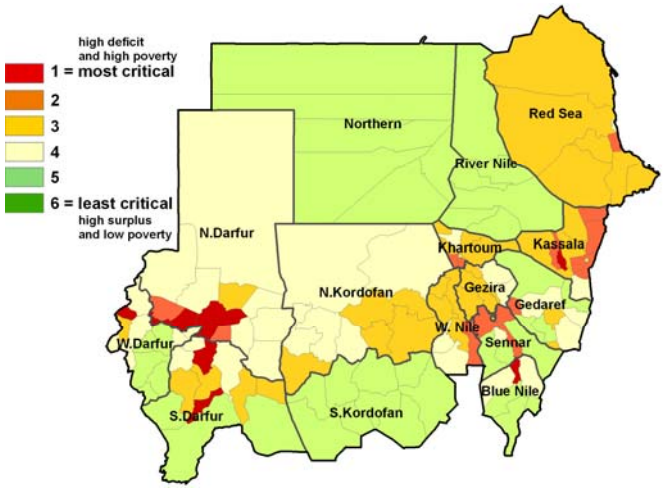
The integration of supply/demand balance with multi-dimensional poverty-related indicators (SIFSIA 2011) permitted the stratification of the population of the Sudan into what we may call subsistence energy categories. This analysis permitted the identification of communities that suffer from concomitant conditions of serious woodfuel deficit and high poverty, which are causes of extreme vulnerability and of structural food insecurity problems.

The rural communities that cannot afford commercial fuels and that depend primarily on the gathering of locally available wood resources for their daily needs are those that suffer most from a negative local balance. The analysis permitted to quantify the deficit that need to be filled in and to identify the target communities that need to be assisted with priority through fuel efficient stove programmes and subsidized alternative fuels. Results of this analysis, showed that:

- 7.6% of the rural population of the Country, i.e. some 1.6 million people, live simultaneous conditions of extreme poverty and high to critical woodfuel deficit. Main locations are in the southwestern part of North Darfur and neighboring areas of South Darfur.

- Another 13.3 % (2.8 million) live marked poverty conditions and medium-high woodfuel deficit. This analysis clearly shows structural problems as poverty is related to many underlying causes, including energy consumption. Located mainly in North Darfur, northern Sennar and neighbor areas in White Nile and Gedaref, and central-eastern Kassala.

Map of poverty and wood energy balance



Woodfuel balance categories	Multi-criteria poverty categories				
	critical	very high	high	medium	low
Critical deficit	1	1	1	2	3
High deficit	1	1	2	2	3
Medium deficit	2	2	2	3	4
Light deficit	3	3	3	4	5
Light surplus	4	4	4	5	6
High surplus	5	5	5	6	6

The role of imported woodfuels

Prior to separation, it is estimated that some 50% of the charcoal and fuelwood sold in the main urban markets of Khartoum State were produced in today's South Sudan. If this fraction is applied to the consumption of urban households and to that of commercial and industrial sectors of the "low-forest" states of central and eastern Sudan, it may be estimated that the flow from southern states prior to separation was in the order of 0.33 million tons of charcoal, (equivalent to 1.5 million m^3 of wood).

Considering that the situation of Sudan's forests and woodlands before the separation was far from sustainable even with such south-born flow, it is clear that the future import quantities should be well above and probably in the order of 648,000 tons of charcoal (3 million m^3 wood equivalent).

Woodfuel import potentials.

South Sudan. There is no doubt that South Sudan remains the most obvious source of supply. According to the regional WISDOM analysis based on Africover data (Drigo, 2005) it appears that the South Sudan has an annual surplus potential of woody biomass (in excess of its own consumption) that could double, or even more, the whole consumption of the Sudan.

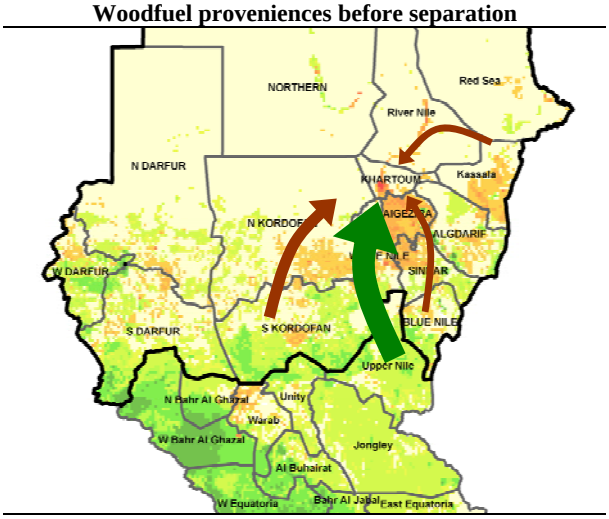
Ethiopia. According to the Ethiopia biomass survey of 2002, the zones along the border with Gedaref and Kassala presented a significant annual surplus of woody biomass in 2000 (Amhara Regional State, 2002; Tigray Regional State, Ethiopia. 2003). Such surplus was estimate to be approximately 1.5 million tons in North Gonder (Semen Gonder) of Amhara Region and approximately 0.2 million tons in Western and Nortwestern Tigray. It is likely that such surplus may be at least in part available for export to Sudan.

Central Africa Republic. According to the Rapid WISDOM Appraisal done over C.A.R. (FAO 2009), the provinces of Ouadda and Yalinga, in the Haute-Kotto, show a surplus potential of approximately 2.5 million tons, (or 4.2 million m^3). These resources could be, at least in part, available for export to South Darfur, although they are located at 300 to 500 km from the Am Dafok border point.

The above shows that the "technical" potential in neighboring countries is more than adequate to fill the sustainable production gap of the Sudan. The main problem is the economic accessibility of these supply sources and, most important, their political accessibility. One more issue that would greatly benefit from peace and stability along the southern borders of the Country.

Main proveniences of woodfuel (charcoal and fuelwood) feeding Khartoum and Omdurman markets

Woodfuel proveniences before separation



Woodfuel proveniences after separation

MAIN CONCLUSIONS

The secession of Sudan magnified Sudan's energy security issues. Wood energy has always been a major issue in Sudan, being the only affordable energy for the majority of its people, especially in rural areas, and being the most important product of Sudan's forests and woodlands. The Sudan/South Sudan separation made this issue far more serious. For the Sudan, the separation and the current impasse on border traffic means the disconnection from its traditional supply sources.

The preliminary evaluation of the economically accessible resources indicates that there is a large gap between the woody biomass that the country can presently produce on a sustainable basis and the current demand for woodfuels.

Such gap is in the order of 2 million tons, or 3.3 million m^3, which is approximately 1/5 of the current consumption. This is cause of a series of negative consequences, including: overexploitation of forest and woodlands, high carbon emission rates, increasing price of woodfuels and subsistence energy scarcity and increased vulnerability for the poorest segments of the population in deficit areas.

Regional characters and policy options

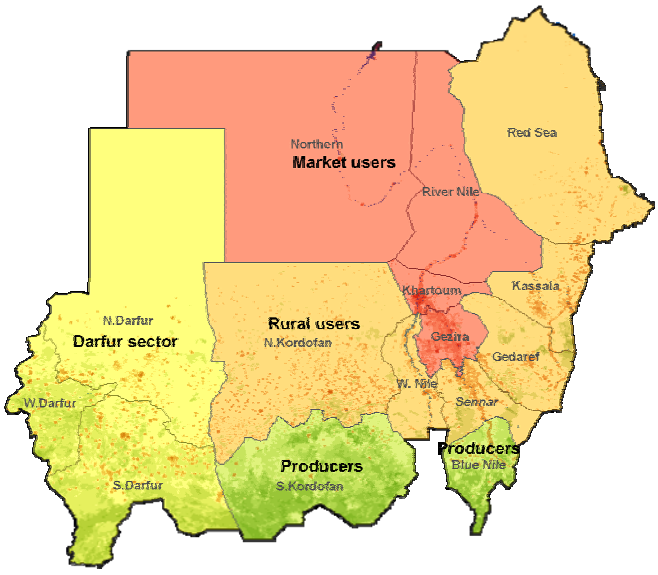
It is evident from the analysis conducted that there is no single-variable solution to the wood energy equation. The situation is so tight that the efforts aiming at sustainable wood energy must be oriented in all possible directions with clear territorial priorities and wide institutional synergies.

The geo-referenced results of the WISDOM analysis support the formulation of locally tailored strategies, down to Locality or even to IDP camp context. However, for broad policy orientation, the grouping of states by homogeneous wood energy features may help the definition of main policy options.

As shown in the Figure, the states may be grouped into four categories, representing quite distinct supply and demand characteristics and requiring diverse policy objectives. The rationale for the regional grouping of states may be summarized. as follows:

Market users: These states (Northern, River Nile, Khartoum and Gezira) have marginal production capacities (unless massive irrigated plantations are established) and a decreasing demand for woodfuels.

Grouping of states by homogeneous wood energy features



They depend entirely on marketed fuels and the saturation of LPG is highest in both rural and urban areas. The woodfuel gap is estimated at 1.4 million tons or 2.4 million m^3. Main policy options for these states is to continue in the promotion of LPG and of renewable energy alternatives (hydro-electricity, solar, wind) and to secure imported charcoal. The main risk is that a decrease of the LPG fraction due to dwindling availability or price increase would immediately turn into a steep increase in charcoal demand.

Rural users: These states (Red Sea, Kassala, Gedaref, White Nile, Sennar and N. Kordofan) have very high demand for woodfuels but limited supply potential represented in good part by sparse vegetation below market value. LPG penetration is significant in urban areas but still low in rural areas. The woodfuel gap is estimated at 2.6 million tons or 4.5 million m^3.The Main policy option for these states is to reduce the demand through stronger promotion of LPG and of renewable energy alternatives (hydro-electricity, solar, wind), dissemination of fuel-efficient stoves (FES) and to secure imported charcoal and fuelwood from "Producers" states, South Sudan and from Ethiopia. The biomass resources in these states are under high risk of degradation and the main management objectives should be protection, regeneration of depleted forest zones and plantations establishment.

Producers : These states (Blue Nile and S. Kordofan) have a relatively low demand and a high supply

potential. The penetration of LPG is minimal in urban areas and non-existent in rural areas. The estimated commercial surplus is 2.8 million tons or 4.8 million m^3. The main policy option for these states is to strengthen the sustainable and participatory management of their forests for production purposes. From the demand side, FES dissemination programmes are recommended, in view of the health benefits more than to the reduced consumption.

Darfur sector : The Darfur states present different balance situations (negative in the North and positive in the West and South) but they are part of the same common context and somehow secluded from the rest of the Country. Both demand and supply potential are very high. LPG penetration is marginal in urban areas and non-existent in rural areas. The overall (commercial) balance shows a deficit of 0.7 million tons or 1.2 million m^3. The main policy options for these states are to strengthen the sustainable and participatory forest management in the South and West and to reduce the demand in the North (but also in urban areas of West and South) through strong promotion of LPG and of renewable energy alternatives (solar, wind), dissemination of fuel-efficient stoves (FES) and to secure imported charcoal and fuelwood from South Sudan and from C.A.R. The biomass resources in North Darfur (but also some areas of South and West) are under high risk of degradation and the main management objectives in these areas should be protection, regeneration of depleted forest zones and plantations establishment.

MAIN RECOMMENDATIONS

All Sudan States must join efforts for a common Wood Energy Strategy (no separate solutions seem feasible), keeping in due consideration the variety of local conditions.

An effective Strategy must address all sectors of use in all states: they all compete for the same resource.

Major concerted and simultaneous efforts are needed, including :

- Improving the sustainability of production.
- Reducing the demand for woodfuels
- Maximize wood import potentials.

All actions must be pursued concurrently, but their positive effects come at different points in time.

Recommended actions effective in the short/medium term:

Importing of woodfuels from neighboring countries seems the most efficient measure to keep the pressure on internal resources within manageable limits. S.Sudan has traditionally been the main and major source of woodfuels, but import routes from Ethiopia and Central Africa Republic should also be developed.

The promotion of LPG to urban households of all states may be relatively rapid, if financial resources are adequate to maintain subsidies and to guarantee distribution costs at a minimum. In this respect, seen the current unequal distribution of LPG among the states, it is recommended to review the subsidy system in order to benefit equally all potential consumers. However, the future availability of large amounts of LPG is very uncertain, given present oil supply constraints.

The short-term impacts that different LPG Distribution and Woodfuel Import regimes would have on wood energy in Sudan are summarized in Annex 1.

Brick making is the industrial activity that consumes large quantities of fuelwood. It is highly recommended, and urgent, to promote alternatives to clay bricks as building materials, such as SSB and cement bricks

Undertake Fuel Efficient Stoves programs in rural and urban areas, giving priority to the areas showing marked deficit conditions. The impact of FES programmes in rural and periurban areas may be more time demanding, although the benefits on health in this case go well beyond the simple reduction of fuelwood consumption.

Recommended actions effective in the medium/long term:

Participatory forest management is an absolute priority, as it aims at protecting the resource from current threats while assuring the continuity of the benefits to both producers and consumers. Sustainable woodfuel production practices should be pursued in connection to returnees and resettlement programs, where resources are adequate (WISDOM surplus areas), aiming at the creation of rural woodfuel markets as sustainable source of livelihood.

It is a major challenge, requiring considerable investments for a variety of actions, including:

- conflicts resolutions in many areas and particularly in good part of the potentially productive areas;
- definition of land tenure and access rights policies at local scale in all intervention areas;
- local biomass inventories based on the new land cover data (in alternative to a new National Forest Inventory);
- awareness raising (including cultural changes), participative planning and training of local operators; etc.

Plantations and private woodlots establishment and agro-forestry programs to increment local self-sufficiency are highly recommended. New planting and agro-forestry programs should be undertake in the areas surrounding IDP camps (hopefully abandoned) and urban areas which were degraded and deforested due to woodfuel overexploitation.

Prepare cross-sectoral resource management master plans including forestry, livestock and agriculture, energy and poverty reduction, and other relevant planning sectors. Local operational management plans should be prepared in the framework of the comprehensive master plan and in synergy with local stakeholders

In order to cope with these major challenges it is essential to reduce the current pressure on the resource as much as possible and as soon as possible through all actions aiming at reducing the demand.

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ANNEX 1

Overview of the short-term impact of LPG Distribution and Woodfuel Import regimes on sustainable wood energy in Sudan.

LPG distribution regime **Woodfuels Import regime**	**Halt to LPG distribution due to non-availability and/or to prohibitive price** Current woodfuel users would rapidly revert to charcoal and fuelwood: Increased woodfuel demand from 16.9 to 23.7 mln m^3	**Maintain current LPG distribution and price regime** LPG distribution: LPG 270,000 tons / year (average 2006-2010) Stable woodfuel demand (16.9 mln m^3)	**Strong increase in LPG distribution and more equitable subsidies** LPG distribution: 376,000 tons / year (current 270,000 tons + 76,000 tons for 70% of urban HH, + 30,000 tons for 70% of commercial, kalwas and bakeries). Reduced woodfuel demand from 16.9 to 13.5 mln m^3
Closed borders, no import of woodfuels from S. Sudan	• Balance = **deficit of 10.1 mln m^3** • Dramatic increase in forest degradation and deforestation rates; • Forest management extremely difficult due to high pressure on resources • Steep increase of charcoal price • Steep increase of subsistence energy problems for poorest populations	• Balance = **deficit of 3.4 mln m^3** • Slight increase in forest degradation and deforestation rates; • Forest management difficult due to high pressure on resources • Increase of charcoal price • Slight increase of subsistence energy problems for poorest populations	• Balance = **surplus of 0.06 mln m^3** • Slight decrease in forest degradation and deforestation rates; • Forest management and protection become feasible • Slight decrease of charcoal price • Decrease of subsistence energy problems for poorest populations
Pre-separation import rate, approx. equivalent to 1.5 million m^3 of wood (900.000 tons of woody biomass or 330,000 tons of charcoal)	• Balance = **deficit of 8.6 mln m^3** • Serious increase in forest degradation and deforestation rates; • Forest management extremely difficult due to high pressure on resources • Steep increase of charcoal price • Steep increase of subsistence energy problems for poorest populations	• Balance **= deficit of 1.9 mln m^3** • Stable forest degradation and deforestation rates; • Forest management difficult due to high pressure on resources • Stable charcoal price • Stable subsistence energy problems for poorest populations	• Balance = **surplus of 1.5 mln m^3** • Decrease in forest degradation and deforestation rates; • Woodfuel production may be limited to well stocked forests; • Successful forest protection and regeneration • Strong decrease of subsistence energy problems for poorest populations
Strong increase in the import rate equivalent to 3 million m^3 of wood (1,780,000 tons of woody biomass or 648,000 tons of charcoal)	• Balance = **deficit of 7.1 mln m^3** • Increase in forest degradation and deforestation rates; • Forest management extremely difficult due to high pressure on resources • Increase of charcoal price • Increase of subsistence energy problems for poorest populations	• Balance = **deficit of 0.4 mln m^3** • Slight reduction of forest degradation and deforestation rates; • Forest management and protection start to be feasible • Stable charcoal price • Stable subsistence energy problems for poorest populations	• Balance = **surplus of 3 mln m^3** • Strong decrease in forest degradation and deforestation rates; • Woodfuel production may be limited to well stocked forests; • Successful forest protection and regeneration • Disappearance of subsistence energy problems

Note: The box in color describes the current situation, assuming that inflow from S. Sudan is interrupted and the LPG distribution is as in recent years.
All supply/demand balance estimates refer to the "commercial" balance , assuming a minimum harvesting of 3.8 m^3 of wood per hectare on a 15-years rotation.