

# Wood fuel, Households and Climate in Kaduna State/Nigeria

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## National Consumption.

Nigeria is a country with large fuel wood deficit zones mainly in the north, while in some southern areas production exceeds consumption. These areas supply the deficit zones. Therefore, a balance between annual re-growth and consumption has to be struck on a national level. According to the FRA Country Report Nigeria 2005 (FAO 2005); total wood removals from forests in 2005 amounted to 86'626'797 m<sup>3</sup>, and removals for wood fuel from forests in the year 2005 were 72'710'935 m<sup>3</sup>, the difference being made up by industrial roundwood, which accounted for 13'915'862 m<sup>3</sup>. (table 1).

However, wood may also come from areas outside forests, like shrubland, savannah and grassland. As no data are available on these sources in Nigeria, a reasonable estimate has to be made, based on figures from neighbouring countries. But neither from neighbouring Benin, Cameroon, or from Ghana data are available. The "FRA 2005 country report Senegal" however presents data on the Growing stock on "other wooded land" (Autres Terres Boisées, volume sur pied), which allows to conclude that the Growing Stock on "other wooded land" is about 7 % of the Growing Stock in forests. We assume the same percentage to be true for Nigeria.

Adding 7 % to 86'626'797 m<sup>3</sup> gives us 92'690'673 m<sup>3</sup> as the total harvest of wood from forest & other wooded land combined. In Nigeria, the shares of fuel wood proper and wood for making charcoal is not known. We assume it to be about the same as in Chad, that is 78 % and 22 % respectively of all the wood used energetically.

Removals according to purposes in Nigeria in Nigeria are as follows:

Category	m <sup>3</sup> /year	tonnes/year
Total removals	92'690'673	64'883'471
Of which for wood fuel	72'711'000	50'897'700
Of which for fuel wood proper	56'714'580	39'700'206

## National wood fuel consumption per head.

Dividing the total fuel wood consumption of 39'700'206 t/y – through the number of inhabitants, which is 140'003'542 (Census 2006) we get about 0.284 t/person/year, i.e. about 0.776 kg /day. The project displaces a part of fuel wood directly, and may displace charcoal indirectly. Charcoal must not be used in the Save80.

Similar figures are reported in several publications. Rex Aruofor mentions 0.256 t/person/year for urban households and 0.393 t/person/year for rural households, but he gives no national mean (<http://www.fao.org/DOCREP/004/AB592E/AB592E01.htm>). The difference between urban and rural households may be explained by the fact that urban households often have additional sources of energy at their disposal, like kerosene, gas, charcoal and electricity.

Von Maydell (“Trees and Shrubs of the Sahel” 1986, 1990), writing about Burkina Faso, counts with 1 kg of fuel wood for cooking alone. “Within villages, however, approximately the same quantity will have to be added for small-scale industries”.

### **Consumption in Kaduna State.**

As state-specific consumption figures are not available, we multiply the national per-head wood fuel consumption (national average) of 0.284 t/person/year with the number of inhabitants of Kaduna State, which is 6’066’562, and we get a consumption of 1’722’904 t/year.

### **Differentiation between Non-Renewable (NRB) and Renewable Biomass (RB).**

However, emission reductions can only be claimed in proportion to the reduction of non-renewable biomass, and an adjustment has to be made for its share. The relevant document on the Methodology of differentiation between NRB and RB is described in the document:

[http://cdm.unfccc.int/public\\_inputs/emis\\_reduc4SSC\\_PA/cfi/U3FFP4DCVRZNRAT8IOUD9WB68ZCTM0](http://cdm.unfccc.int/public_inputs/emis_reduc4SSC_PA/cfi/U3FFP4DCVRZNRAT8IOUD9WB68ZCTM0)

It allows a qualitative and a quantitative approach. Both are used here, with stress on the latter.

**Qualitative indications** of the consumption of NRB in Kaduna State are:

- The fact that wood exports have been banned in Nigeria since 1976, in order to allow priority supply of the national internal market,
- Price increases for fossil fuels have led to a massive return of households to fuel wood (Abiodun Raufu: “Price Hike spells Doom for Nigeria’s Forests”),
- Important road transport of fuel wood from southern supply zones to Kaduna State and other northern fuel wood deficit areas.

**Quantitative indications** of the consumption of NRB in Kaduna State are:

These are derived from figures published in the Global Forest Resources Assessment 2005 country report Nigeria (FAO)

- on increasing removals of wood from forests (table 1),
- decrease of forested areas (table 2),

- diminution of woody biomass in forests (table 3)
- diminution of carbon bound up in forests (table 4),
- Important reduction of the growing stock in forests, slight increase of the growing stock in plantations (table 5)
- A parallel diminution of the annual increment takes place in absolute terms (increment in million m<sup>3</sup> as a proportion of the growing stock). For the annual increment, see table 6, for the balance between annual increment and consumption, see table 7).
- Fuel wood and, to a lesser degree, charcoal provide the bulk of household energy needs (table 8)

### **National annual sustainably harvestable volume.**

Data on the annual increment of woody biomass (yield) are lacking for Nigeria as a whole, and for Kaduna State in particular. Estimations may be based on the “Growing Stock” (comparable to the “capital” in banking) as presented in the “FRA 2005 country report Nigeria” on the one hand, and on a rule of thumb about the annual yield or increment (comparable to the interest rate in finance) mentioned by v. Maydell in his book “Trees and Shrubs in the Sahel”, 1986, 1990). He reckons that the annual increment is about 2 % of the “Growing Stock” in natural forests. We assume the same value for other wooded lands. According to v. Maydell, the yield in plantations may be 5 times higher, i.e. about 10 %.. The contribution of plantations is, however, seldom geared to the production of fuel wood, but rather of pulp and timber. The sum is 41’529’000 m<sup>3</sup>, see table 5.

### **The share of NRB in biomass consumption in Kaduna State**

According to the Methodology document, two conditions must be assessed in order to determine whether woody biomass is renewable or non-renewable:

*a) In the reachable harvesting area, does the consumption of woody biomass exceed the sustainable forest growth?*

As data on the reachable forest area, the mean annual increment/ha (m<sup>3</sup>/ha/y) and on the average density of wood (tonnes/m<sup>3</sup>) from Kaduna State are lacking, the answer has to be based on national averages. The answer is yes, because:

Mean annual increment < Total annual woody biomass consumption (table 7).

*b) Does woody biomass consumption for fuel by the type of energy users associated with the project (e.g. households) constitute a significant share of total woody biomass consumption?*

*Three conditions have to be met:*

– *Household woody biomass consumption > Annual increment.*

For Nigeria as a whole, the annual increment is 41'529'000 m<sup>3</sup>, while wood fuel consumption (including charcoal) is 72'711'000, resulting in a coverage of 51.12 % and (table 7). If fuel wood consumption proper (i.e. excluding charcoal) is considered, the coverage is 26.78 %. This difference reflects the high energy losses in charcoal making.

– *Household woody biomass consumption is the largest biomass consumption sector.* Table 8 shows that the residential share of biomass consumption is over 97 % in Nigeria.

– *Share of household woody biomass consumption as a proportion of total woody biomass consumption is greater than 30 %.*

With over 97 % of biomass in residential energy consumption the required 30 % are by far exceeded. Therefore, the answer to question b) is again yes.

### **Wood fuel & fuel wood.**

We have to distinguish between wood fuel and fuel wood. The first includes wood for charcoal making, the latter does not. Fuel wood can easily be measured at the household level, but this is not the whole story, and may lead to an underestimate. In the case of the charcoal cycle, a part of the energy consumption takes place outside the residential sector in the kiln. A household which does not consume charcoal, does in fact not claim its statistical share of wood energy consumption, whereas a household which shifts from fuel wood to charcoal, increases the total wood energy consumption and the share of NRB.

We have to decide, whether wood fuel consumption or fuel wood consumption should be taken as the basis for calculations of emissions. In my view, it should be wood fuel. The methodology document uses the term “woody biomass”, which is equivalent to wood fuel, not to fuel wood. But there is a problem of monitoring. The amount of charcoal that is not consumed, cannot be measured. Therefore in my view, households which have reverted from charcoal to fuel wood, and households which always use fuel wood exclusively, should be counted in the same way.

Evaluating the reduction of the NRB share of fuel wood alone means that only 26.78 % out of a household consumption of 1.982 tonnes/year/device (or household) could be claimed, that is 0.531 tonnes/year. This would make VERs uninteresting for project activities.

If however wood fuel counts, 42.88 % out of 2.545 tonnes/year/device (or household) could be claimed, that is 1.142 tonnes/year/ household. This looks more realistic and would not preclude success of the project.

**Conclusion:** For the success of the project, it is essential that wood fuel (“woody biomass”) be selected as the parameter for the calculation of emission reductions, and not fuel wood.

**Assumptions:**

1. Wood density (t/m<sup>3</sup>) 0.7
2. Growing Stock outside forests: 0.07 % of Growing Stock inside forests
3. Annual increment as a percentage of growing stock:
  - a) Natural forest: 2 %
  - b) Other wooded land 2 %
  - c) Plantations 10 %
4. The share of fuel wood in wood fuel in total removals is 78 % throughout Nigeria
6. Wood fuel consumption in Kaduna State is the same as the national average
7. Family size: 7 persons
8. One Save80 /household
9. Primary wood consumption for charcoal making: 0.25 kg/p/d

**Figures:**

Population of Nigeria	140'003'542 (Census 2006)
Wood fuel from Nigerian forests	72'711'000 m <sup>3</sup> (FRA 2005)
Wood fuel removals from other wooded lands	equals 7 % of removals from forests
Assumed wood density	0.7 kg/m <sup>3</sup>
Wood fuel consumption in Nigeria	50'897'700 tonnes/year
Wood fuel consumption per head	0.3635 tonnes/year
Fuel wood consumption in Nigeria	39'700'206
Fuel wood consumption in Nig. per head	0.2804 tonnes/person/year, 0.777 kg /day
Population of Kaduna State:	6'066'562 persons
Fuel wood consumption. in Kaduna State,	4'707'652 t/year
Wood fuel consumption of a family of 7 persons	2.545 tonnes/year
Fuel wood consumption of a family of 7 persons	1.9823 tonnes/year
Fuel wood consumption of a family of 7 persons	
Assumed efficiency of the stove	80 %
Fuel wood savings per stove	1.586 tonnes/year
Carbon fraction of wood (IPCC default value)	0.5 dimensionless
Reduction of C emissions from NRB combustion	t/device/y
Conversion factor from C to CO <sub>2</sub> :	1.833

## Tables.

**Tabl. 1, Wood Removals, Data for National reporting table T11 (FRA 2005)**

FRA 2005 Categories	Volume in 1000 cubic meters of round wood over bark						
	Forest			Other wooded land			Forest & other wooded land in 2005
	1990	2000	2005	1990	2000	2005*	
Industrial round wood	4'660	10'830	13'916				
Wood fuel	59'096	68'172	72'711				
<b>Total for Country</b>	63'756	79'003	86'627			6063.89*	92690.89*

Figures in this column are estimates based on the assumption, that removals from “other wooded land” correspond to 7 % of removals from forests.

**Tabl. 2, Decrease of forested areas:  
Data for National reporting table T3 (taken from FRA 2005, shortened)**

FRA 2005 Categories / Designated function	Area (1000 hectares)		
	1990	2000	2005
Production	6'203	4'110	3'065
Conservation of biodiversity	5'502	5'502	5'502
No or unknown function	5'529	3'523	2'522
<b>Total - Forest</b>	17'234	13'137	11'089
Other wooded land			
Production	0	0	0
Conservation of biodiversity	2'993	2'993	2'993
No or unknown function	6'724	3'909	2'502
<b>Total – Other wooded land</b>	9'717	6'902	5'495

**Tabl. 3, Forest biomass, data taken from FRA 2005 table T6**

FRA 2005 Categories	Biomass (million metric tonnes oven-dry weight)					
	Forest			Other wooded land		
	1990	2000	2005	1990	2000	2005
Above-ground Biomass	3'459	2'660	2'261	ID	ID	ID
Below-ground biomass	830	638	543	ID	ID	ID
Dead wood biomass	601	462	392	ID	ID	ID
<b>Total</b>	<b>4'890</b>	3'760	3'195	ID	ID	ID

**Tabl. 4, Decreasing Carbon Stock in Forests, data for National reporting table T7 (taken from FRA 2005)**

FRA 2005 Categories	Carbon (million metric tonnes)					
	Forest			Other wooded land*		
	1990	2000	2005	1990	2000	2005
Carbon in above-ground biomass	1730	1330	1130			
Carbon in below-ground biomass	415	319	271			
<b>Sub-total: Carbon in living biomass</b>	2145	1649	1402			
Carbon in dead wood	300	231	196			
Carbon in litter						
<b>Sub-total: Carbon in dead wood and litter</b>						
Soil carbon to a depth of ___ cm						
<b>Total Carbon</b>	2'445	1'880	1'598			

**Table 5, Growing Stock in m<sup>3</sup>**

Category	1990	2000	2005
Natural forest	1'953'000	1'474'000	1'235'000
Other wooded land	136'710	103'180	86'450
Plantations	108	137'000	151'000
<b>Total</b>	2'089'818	1'714'180	1'472'450

**Tabl. 6, Estimation of the Annual Increment, based on the Growing Stock in Nigeria as a whole**

Category	Growing Stock in 2005	annual increment in % of Growing Stock	Estimated annual increment in m <sup>3</sup>
Natural Forest	1'235'000'000	2	24'700'000
Other wooded land	86'450'000	2	1'729'000
Plantations	151'000'000	10	15'100'000
<b>Total</b>	1'472'450'000		41'529'000

These figures are only indicative; as Forest Reserves, Game Reserves and National Parks, which should be off limits for wood fuel harvesting, are included. In addition, plantations supply pulp and timber rather than fuel wood.

**Table 7, Balance between Annual Increment (AI) and consumption for Nigeria.**

Fuel wood consumption	Annual Increment in m <sup>3</sup>	Total removals in m <sup>3</sup>	Removals for wood fuel in m3	Removals for fuel wood proper in m3
National	41'529'000	92'690'673 (44.80 % covered by AI)	72'711'000 (57.12 % covered by AI)	56'714'580 (73.22 % covered by AI)

This means, that 42.88 % of wood fuel and 26.78 % of fuel wood consumption stem from NRB.

**Table 8, Importance of the residential sector, taken from the National GHG Inventory**  
(by courtesy of Prof. Obioha, shortened and modified)

Annual Energy consumption for the Residential Sector, in PJ								
	Domestic Autogeneration		Domestic cooking and lighting					Total**
	PMS	Diesel	Kerosene	LPG	Charcoal*	Fuel wood	Fuel wood in % of total	
1998	2.87	0.34	46.17	2.61	15'796*	631'961	97.56	647'764
1999	4.55	0.50	67.46	3.05	16'112*	649'609	97.57	665'797
2000	4.51	0.62	69.09	0.97	16'434*	667'798	97.59	684'308

Remarks: \*The amount of primary wood energy for charcoaling is about 6 times higher. The inclusion of this amount would increase the total as the denominator for the calculation of shares & percentages.

PMS = premium motor spirit; LPG = Liquefied pressurized gas.

\*\*The contribution of the different fuels does not exactly add up to the totals in the last column, probably due to rounding effects in earlier stages.

#### **Steps followed in Data collection and calculation of the share of NRB in consumption::**

1. Search for wood fuel data on Kaduna State: no result.
2. Procurement of wood fuel data for Nigeria,
3. Selection of data on the Growing Stock in forests,
4. Estimation of Growing Stock outside forests
5. Estimation of the annual increment of woody biomass as a percentage of the Growing Stock in forests,
6. Estimation of the contribution “other wooded lands” to wood fuel supply and summing up with the contribution of forests to give total wood fuel supply,
7. Estimation of the share of fuel wood proper (excluding wood used for charcoal making),
8. Division of the national fuel wood consumption through the number in inhabitants of Nigeria to determine the per-head fuel wood consumption..
9. Multiplication the per-head fuel wood consumption with the number of inhabitants of Kaduna State to determine total fuel wood consumption in Kaduna State.
10. Establishment of a balance between annual consumption and annual increment of woody biomass to determine the share of NRB for total removals, removals for wood fuel (including charcoal) and for fuel wood.