

Generation, Management Challenges and Prospects of Wood Waste in Ilorin, Nigeria.

Figure 2: Wood Wastes Disposed along a Drainage System

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ABSTRACT

Timber processing operations generate enormous amount of wood wastes which need to be efficiently managed. This study presents the findings of a fieldwork conducted to determine the amount of wood waste generated from sawmills and plank markets, and an appraisal of the wood waste management technique in Ilorin, Nigeria. The study revealed that 394.8m³ of planks offload weekly at plank markets, 179.2m³ of planks are produced from logs that offload at the sawmills, while 119.52m³ of wood waste is generated daily. The current wood waste management technique was found to be ineffective, unsustainable, and environmentally unsound. Alternative means of disposal by direct combustion of wood wastes in dedicated power systems for energy generation or conversion through the Torrefaction and Pelletization Process (TOP) to torrefied pellets is proposed.

Keywords: wood waste, management, torrefaction, fuel pellets, power systems

INTRODUCTION

Waste generation is a concomitant aspect of living which cannot be banished but can only be managed [1]. Similarly, wood wastes generation is inevitable either during felling of trees for log production in the forest or diverse sawing processes of logs/planks at the mills. Wood residues (wastes) produced during milling and re-sawing activities include tree barks, cut slabs, sawdust, plain shavings, and strips and their generation can be traced back to the 18th century [2]. Locally, these residues are often used as filling material, poultry/animal bedding material, mulch, raw material for particle board making, and cooking fuel. However, as the demand for wood products rises in a quest to meet the developmental drive of the society, the generated wood waste also increases and this increase overwhelms its present utility. The increase in the quantity of unutilized wood wastes have over the years impacted negatively on the environment while crude management techniques have posed

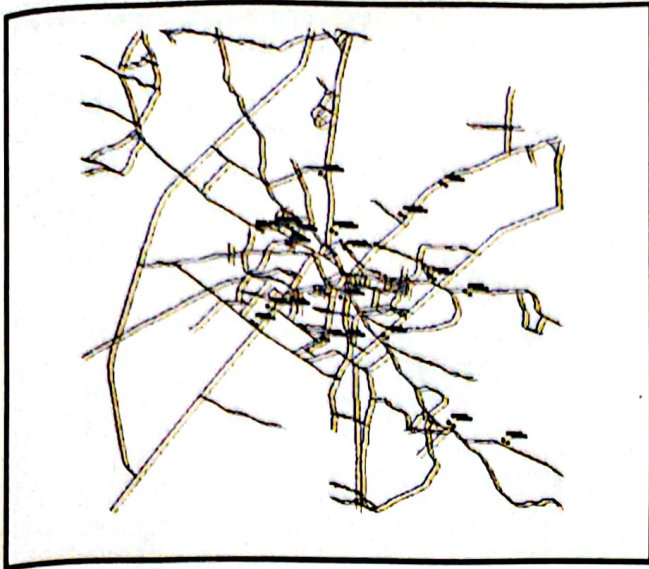


Figure 1: Location of Sawmills (SM) and Plank Markets (PM) in Ilorin Metropolis

health hazards in addition to air and water pollution. A huge volume of wood residue is generated annually from timber processing activities around sawmills, plank markets, and furniture making factories in cities within Nigeria. For instance, about 294,798 tons of wood waste is generated yearly in the city of Lagos [3], while about 2288m³ is generated daily in Abeokuta and a total of 104,000m³ of wood waste is generated daily in Nigeria [4]. Ilorin is the capital of Kwara State and it is located on Latitude 8° 30'N and Longitude 4° 35'E [5]. The population figure of Ilorin metropolis according to 2006 Census is 777,667 [6]. The unique geographical location of Ilorin makes it the "gateway" between the northern and southern parts of the country; hence, lumbers/planks heading for the northern parts pass through Ilorin, while the ones for local consumption are processed (re-sawed) at various plank markets in Ilorin metropolis. Also, the proximity of Ilorin to some rainforest states (Oyo, Osun and Ekiti) confers on her the opportunity of regular supply of logs for saw milling and lumbers/planks for further processing prior to marketing.

The focus of this study is to estimate the total volume of waste generated at sawmills and the plank markets within Ilorin metropolis, appraise the existing wood waste management methods, and determine the potentials of wood wastes.

MATERIALS AND METHODS

The study was essentially a fieldwork in which the prominent sawmills and plank markets within the city of Ilorin were identified and studied. Six sawmills (SM) and fourteen plank markets (PM) were used for the study. Figure 1 shows the major road network of Ilorin metropolis and the locations of sawmills and plank markets. Data was also collected through structured questionnaires which were

administered to plank marketers and other stakeholders in the industry. The questionnaires were designed to determine the number of trucks of log and plank that offload at sawmills and plank markets. Personal interviews were conducted with the saw millers, and wood waste users. Field measurement was also undertaken to obtain the variables necessary to calculate wood waste generation.

A. 2.1 Volume of Plank Offloading Weekly (V_w)

The quantity of the wood waste generated is a function of the volume of planks offloading at the various plank markets at any given time. The volume (V_p) of a plank is given as $V_p = LBT$ where L is the length, B is the breadth, and T is the thickness of the plank. The total volume of plank offloading weekly (V_w) is $V_w = N_L V_p$ where N_L is the average number of lumber per week.

2.2 Volume of Wood Waste Generation

200 pieces of 1"x12" planks can be produced from a truckload of logs. From equation 1, the volume of planks from a truckload of logs (V_{PT}) is: $V_{PT} = 200V_p$

The total volume of planks that can be produced from logs offloaded daily in Ilorin (V_{TI}) is: $V_{TI} = N_{TR} \cdot V_{PT}$ where N_{TR} is the number of trucks that offloads at the sawmill daily.

Based on a six-working day per week schedule, the average volume of plank offloaded daily in Ilorin is: $VW/6$

About 20 to 50 percent of sawmill timbers end up as wood waste during processing [7] and taking an average value of 35 percent, and using Equation (4), 65 percent represents V_{TI} , and 35 percent would have been lost as wood waste. Using proportionate ratio calculation, 35 percent waste is $(35V_{TI})/65$ or $0.538V_{TI}$. 35% of Equation (5) would eventually become waste i.e $0.35(VW/6)$

The total volume of wood waste (V_{ww}) generated daily from both sawmills and plank markets in Ilorin metropolis is therefore the sum of Equation (6) and Equation (7), $V_{ww} = 0.538V_{TI} + 0.35(VW/6)$

Assuming 50% moisture content and a specific gravity of 0.56, and density of wood; $\rho_{wood} = 840\text{kg/m}^3$ [8], the tonnage of wood waste (T_w) is:

$$T_w = (840V_{ww})10^{-3}$$

RESULTS AND DISCUSSION

Table 1 shows the average volume of wood waste generated daily at plank markets in the city of Ilorin. The estimated volume of wood waste generated daily at the plank markets shows that the highest volume of 7.840 m³ was obtained from PM3, which is the oldest and largest plank market in Ilorin. PM3 is

geographically located within the city centre and this unique feature has contributed to its market potentials thereby having the highest number of planks offloaded daily. PM6 and PM10 have the lowest output of wood wastes (0.082 m^3) because the average number of lumber offloaded daily is low. Both plank markets are relatively new and are situated at the periphery of the city. A truckload contains an average of 400 pieces of 1" x 12" plank. The total estimate of lumber that offloads in the city weekly is 14,100 pieces, translating to a volume of 65.8 m^3 daily.



Figure 3: Wood Residues Heaped at a Plank Market

Table 1: Average Volume of Wood Waste Generated Daily at Plank Markets in Ilorin Metropolis

PLANK MARKET (PM)	AVERAGE NO. OF TRUCKS PER WEEK (NT)	AVERAGE NO. OF LUMBER PER WEEK (NL)	AVERAGE VOLUME OF WASTE GENERATED DAILY (m^3)
PM 1	2	800	1.307
PM 2	2	800	1.307
PM 3	12	4,800	7.840
PM 4	2	800	1.307
PM 5	3	1,200	1.960
PM 6	1/8	50	0.082
PM 7	2	800	1.307
PM 8	½	200	0.327
PM 9	½	200	0.327
PM 10	1/8	50	0.082
PM 11	3	1,200	1.960
PM 12	2	800	1.307
PM 13	3	1,200	1.960
VII PM 14	3	1,200	1.960
VIII TOTAL	35.25	14,100	23.03

*A truck load contains an average of 400 pieces of 1"x12" plank

Table 2 shows that the average volume of wood residue produced daily at sawmills within the city. SM1 has the highest number of band mills; hence the volume of wood waste generated is the highest. SM3, SM4, SM5, and SM6 have only one band mill and the daily output of wood waste is 9.046 m^3 . In totality, 23.03 m^3 and $96,492 \text{ m}^3$ of wood waste is generated daily respectively from plank markets and sawmills in Ilorin.

I. Table 2: Average Volume of Wood Waste Generated Daily at Sawmills in Ilorin Metropolis

SAWMILL LS (SM)	NUMBER OF TRUCKS PER DAY (N_{tr})	NUMBER OF BANDMILL PER SAWMILL	AVERAGE VOLUME OF WASTE GENERATED DAILY (m^3)
SM 1	12	5	36.185
SM 2	8	2	24.123
SM 3	3	1	9.046
SM 4	3	1	9.046
SM 5	3	1	9.046
SM 6	32	11	96.492

* 200 pieces of 1" x 12" plank can be produced from a truck load of logs

Applying Equation (9), 100.4tons of wood waste is produced daily in the city of Ilorin. Going by a six-working day per week, and a 52-week calendar, the annual tonnage of wood waste generation in Ilorin is estimated as 31,324.3tons.

MANAGEMENT CHALLENGES

Wood wastes pose several challenges to the environment and health of citizens. When its utilization is low, saw millers use several crude ways to dispose the generated wastes within the vicinity of sawmills and plank markets. Most prone areas are the low-lying areas such as the bank of rivers and valleys. It is therefore common for wood wastes to find their way into drainage systems and river channels either advertently or inadvertently thereby causing obstruction to water flow as shown in Figure 2. This no doubt contributes significantly to flooding during the rainy season. Wood residues are often dangerously heaped at different spots within sawmills and plank markets, and when it rains, the floor becomes slippery. In fact these residues are stacked close to the machines as depicted in Figure 3, making manoeuvrability around workspace extremely difficult thereby compromising occupational safety. In addition, over time they also become breeding spaces for worms and germs liberating obnoxious odour [3] and exposing workers to unhygienic working environment.



I. Figure 4: Air Pollution From Burning Of Wood Waste

The general populace is not spared from the health hazards that may arise from an unsafe method of managing wood wastes. In an effort to reduce the volume and size of the recurring huge amount of wood wastes, oftentimes they are burnt in open air. During burning in open air, as shown in Figure 4, the smoke given off pollutes the air with carbon monoxide, which is undesirable to health. Carbon monoxide has affinity for haemoglobin and as it circulates into the respiratory system, it blocks oxygen transfer thus putting strain on the heart [9]. Sometimes pits are dug but they fill up in no time or they are dumped inside the drainage systems. Unfortunately, none of these methods are quite environmentally friendly thereby necessitating the need to develop alternative means and efficient management system for generated wood wastes.

PROSPECTS

Two alternative wood waste utilization techniques are proposed for the management of wood wastes. First is the establishment of dedicated power systems running on these wood wastes directly as fuel for steam boilers. It has been estimated that one ton/hour of wood waste can produce approximately one megawatt of electricity [8]. This represents a huge potential for energy generation in terms of electricity production and from this study, 100.4MW of electricity is expected to be generated daily at Ilorin. The benefits include enhanced energy security due to less susceptibility to power grid interruptions, low emissions of oxides of nitrogen and sulphur, no net emissions of carbon (IV) oxide (CO₂), curbing of deforestation and progress towards the Federal Government of Nigeria's goal of increasing the share of renewable energy in the national energy mix [10].

Secondly, the use of energy conversion technology of Torrefaction and Pelletization (TOP Process) is capable of transforming wood wastes into useful renewable energy product, that is, torrefied fuel pellets. The merit of this method includes lower moisture content, higher energy content, higher energy bulk density, and stability during storage.

CONCLUSION

The study revealed that the average volume of wood wastes generated daily at sawmills and plank markets in Ilorin metropolis is 119.52m³ (100.4tons). Therefore, based on a six-working day per week schedule, an estimated 31,324.3 tons would be produced yearly in the city of Ilorin. This huge volume of wood waste generated poses environmental and health challenges. The generated wood wastes can be utilized directly as fuel in dedicated power systems to power public and private facilities. They can also be converted through the technology of Torrefaction and Pelletization (TOP Process) to useful renewable energy product, that is, torrefied fuel pellets. These pellets can find application in domestic and industrial purposes such as cooking, barbecue fuel, and co-firing of steam boilers.

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