The Effects of Temperature and Relative Humidity on Wood Storage in Nsukka, Nigeria.

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ABSTRACT

The unique characteristics and comparative abundance of wood has made it a natural material for multitude of usages including furniture, tools, vehicles, decorative objects, and structural material. Therefore, wood should be processed and stored adequately to uphold the value of the biomaterial. This work exposes the effects of temperature and relative humidity of the tropical seasons in the storability of wood.

Five of the most available wood samples derived from a questionnaire, were collected, fresh from the mill, and used for laboratory and field experiments to determine the moisture content and storage effects of wood as seen in conventional storage patterns adopted by regional timber dealers. A simple percentage statistical tool was used to analyze data from our questionnaire. An analysis of variance (one-way ANOVA) with Duncan ranking test was used to analyze the results.

The results show that timber dealers had a considerable level of education with 57% and 41.1% primary and secondary education respectively. The moisture content of the wood samples were determined at percentage wet basis for Akpu, Agba, Obeche, Mahogany and Gmelina, the results are 13.2, 9.3, 9.5, 10.8 and 9.4%, respectively. From the mean separation tool adopted, at 5% probability level, temperature has significant effect on wood volume (size) while relative humidity has no significant effect on wood volume (size). Also there was an increase in field temperature with respect to laboratory temperature at constant relative humidity. There was significant difference in wood volumes (size) between field and laboratory woods due to shrinkages/enlargements. Also some wood types with respect to input variables have no influence over temperature and relative humidity but with volumes of different woods.

Season (months) had a significant effect with temperature, with February showing the highest temperature. The season also determined the volume (shape) of the wood.

(Keywords: wood, Nigeria, temperature, local timber, relative humidity, shrinkage, enlargement)

INTRODUCTION

Throughout history, the unique characteristics and comparative abundance of wood have made it a natural material for homes and other structures, furniture, tools, vehicles, and decorative objects. Today, for the same reasons, wood is prized for a multitude of uses. All wood is composed of cellulose, lignin, hemicelluloses, and minor amounts (5% to 10%) of extraneous materials contained in a cellular structure. Variations in the characteristics and volume of these components and differences in cellular structure make woods heavy or light, stiff or flexible, and hard or soft. The properties of a single species are relatively constant within limits; therefore, selection of wood by species alone may sometimes be inadequate. However, to use wood to its best advantage and most effectively in engineering applications, specific characteristics or physical properties must be considered.

Historically, some species have filled many purposes, while other less available or less desirable species served only one or two needs. For example, because white oak is tough, strong, and durable, it was highly prized for shipbuilding, bridges, cooperage, barn timbers, farm implements, railroad crossties, fence posts, and flooring. Woods such as black walnut and cherry were used primarily for furniture and cabinets.

Hickory was manufactured into tough, hard, and resilient striking-tool handles, and black locust was prized for barn timbers.

What the early builder or craftsman learned by trial and error became the basis for deciding which species were appropriate for a given use in terms of their characteristics. It was commonly accepted that wood from trees grown in certain locations under certain conditions was stronger, more durable, more easily worked with tools, or finer grained than wood from trees in other locations. Modern research on wood has substantiated that location and growth conditions do significantly affect wood properties. The gradual reductions in use of old-growth forests in the United States have reduced the supply of large clear logs for lumber and veneer. However, the importance of high-quality logs has diminished as new concepts of wood use have been introduced. Second-growth wood, the remaining old-growth forests, and imports continue to fill the needs for wood in the quality required. Wood is as valuable an engineering material as ever, and in many cases, technological advances have made it even more useful.

In Nigeria, wood uses and applications follow the same concept of purpose to the extent that the demands have been so high resulting in export and domestic uses. These have resulted in rapid depletion on the forest resources. The inherent factors that keep wood in the forefront of raw materials are many and varied, but a chief attribute is its availability in many species, sizes, shapes, and conditions to suit almost every demand.

Wood has a high ratio of strength to weight and a remarkable record for durability and performance as a structural material. Dry wood has good insulating properties against heat, sound, and electricity. It tends to absorb and dissipate vibrations under some conditions of use, and yet it is an incomparable material for such musical instruments as the violin, also component part of drums, wooden gong and “ekwe”. The grain patterns and colors of wood make it an aesthetically pleasing material, and its appearance may be silky enhanced by stains, varnishes, lacquers, and other finishes. It is easily shaped with tools and fastened with adhesives, nails, screws, bolts, and dowels.

Damaged wood is easily repaired, and wood structures are easily remodeled or altered. In addition, wood resists oxidation, acid, saltwater, and other corrosive agents, has high salvage value, has good shock resistance, can be treated with preservatives and fire retardants, and can be combined with almost any other material for both functional and aesthetic uses.

The timber business encompasses any lumber that is bought or sold in the normal channels of commerce. These may be found in a variety of forms, species, and types, and in various commercial establishments, both wholesale and retail. Most commercial lumber is graded by standardized rules that make purchasing more or less uniform throughout the country.

When sawed, a log yields lumber of varying quality. Wood-users buy the quality that best suits their purposes. Lumber is graded into use categories, each having an appropriate range in quality. Generally, the grade of a piece of lumber is based on the character, number, and location of features that may lower the strength, durability, or utility value of the lumber. Among the more common visual features are knots, checks, pitch pockets, shake, and stain, some of which are a natural part of the tree. Some grades are free or practically free from these features. Other grades, which constitute the great bulk of lumber, contain fairly numerous knots and other features.

With proper grading, lumber containing these features is entirely satisfactory for many uses. The grading operation for most lumber takes place at the sawmill. Establishment of grading procedures is largely the responsibility of manufacturers’ associations. Because of the wide variety of wood species, industrial practices, and customer needs, different lumber grading practices coexist. This work tends to showcase the effect of environmental parameters such as temperature and relative humidity as well as time of the seasons on the availability of woods and its influences on the nature of wood and its future uses.

OBJECTIVES

The objectives of the work cover the following:

1) To sample the wood available in Nigeria: a case study of Nsukka Timber shade in a view to isolate five samples.

2) To substantiate the effect of temperature and relative humidity on the storage pattern adopted by timber dealer in Nsukka.

3) To analyze and evaluate the storage effects on physic-structural properties of woods as a raw material for construction works.

JUSTIFICATION

Most of the construction works carried out with wood as a raw material usually experience failures as a result of the nature of wood, environmental factors, loads, deformations, characteristic decay and termite attacks, etc. These factors work in synergy to the extent of observable engineering structural failures and raw material wastages. These are the features of practices of a developing country like Nigeria- where there are no strict standards of material selections and testing as well as specifying the particular work that should be done with a particular wood material rather all these works/functions are performed resulting from experience and common practices over time. Therefore there are no real data meant for Nigerians to use as a guide. There are also many wood varieties available in Nigeria as well as some imported types for uses.

This work showcases the need to know some of the wood varieties that are locally obtained, their local names, and some engineering properties of these woods. This is to enable wood users the opportunity to know the quantity and quality of the wood to be used in carry out a particular function. Fundamentally, it is necessary to combat the incessant structural failures as witnessed in our society today.

SCOPE OF STUDY

This study covers the analysis and evaluation of storage effects on temperature and relative humidity of woods, nature of woods, available wood sources in Nigeria, as well as common practices in Nigeria (a case study of Nsukka timber shade). The works is time dependent and is expected to be carried out /last for four months each for both wet and dry season.

MATERIALS AND METHODS

Survey Area

Nsukka Timber Shade located at Owerri-enu village in Ihe/Owerre community, Nsukka local government area of Enugu State, lies within longitude 5^0 5^1 and 7^0N and latitude 7^0 12.5^0 36^0E (Oformata, G.E., 1975). The climatic conditions are typically low relative humidity for most parts of the year. There are wet and dry seasons. The wet season extends from April to October while dry season is between November - March. The annual rainfall ranges from 1680mm to 1700mm (Ademuluyi, M.U. 1992). The topography of the area is characterized across communities hills and gullies. The vegetation is mostly derived savannah.

Sampling Techniques

The techniques adopted for this work is that of complete randomized design sampling on the experimental plot (timber shade with over 10 lines and over 200 shops with more than 80 members).

Data Collection

A questionnaire was developed for this study were distributed to the timber dealers in line with the set objectives of these studies.

The questionnaire has two parts – part A which contains the personal/preliminary data of the members investigated, and part B – contains items drawn from the research questions, justification of studies as well as objectives. Interactions/interviews during the administration of questionnaire expanded the scope of the study but was not covered by the questionnaire as such it was not noted.

Data Analysis

1) The data generated in this study was analyzed using a method of simple percentage. The percentages of each type of the responses were sorted out in relation to the total responses to a given questionnaire.

The percentage was calculated using the formula and corresponding chart showing the relationship therein.

$$\left[\% = f/_N \times \frac{100}{1}\right] \quad \textbf{(2)}$$

Where f= frequency of responses to a particular item, N = number of respondents, % = percentage of the total response.

2) Analysis of variance (ANOVA) will also be used to establish the effects of the environmental factors understudy.

EXPERIMENTATIONAL SETUP

Sampling

In a sample space of over fifty common wood varieties available at the site (Nsukka Timber Shade), five most common woods available that are used for construction/structural works were collected and used for this sttudy. They include: Akpu, Akpa, Mahogany, Obeche, and Gmelina.

Sawed planks (12 feet [3657.6mm] x 12 inches [304.8mm] x 2 inch [50.8mm]) of these woods were collected fresh from mill, after thorough examination to make sure they had no defects and were of high quality for examination.

The specimens (wood sample) were divided into three equal sections A, B, and C (4 ft [1219.2mm] each). However, section A, B and C were further divided longitudinally into A_1 and A_2 (2ft [609.6mm] x 4 inches [101.6mm] x 2 inches [50.8mm]), respectively for B and C.

Subsection A_2 B_2 and C_2 were kept in under laboratory environmental conditions. A cut sample (200 × 100 × 50 mm) was taken from the subsection A_2, B_2; C_2 for laboratory testing and analysis. Table 1 shows the experimental sampling schedule/design carried out in this work.

- Where A_1 in and A_2 out = subsection A_{in} controlled environmental storage and subsection A_{out} – under-environmental influence.
- Where samples 1, 2, 3, 4 and 5 are Akpu, Agba, Mahogany, Obeche and Gmelina, respectively.
- Where T, RH, MC and S stands for Temperature, Relative Humidity, Moisture Content, and Shrinkage (volume reduction or elongation).

Instrumentation

The instrument used to carry out this work includes: liquid-in-glass thermometer, anemometer, electric oven model Y147893/17, digital venier clipper, hand gloves, steel ruler/ tape, t-square, pencil, pen and paper.

Moisture Content Determination of Wood

The moisture content of the wood samples are determined using oven-drying method-samples are taken from the specimens (piece of timber) with timber dimension (1 [25.4mm] × 1 [25.4mm] × 1 [25.4mm] inch) . The sample should be free from roots, bark, checks, pitch pockets and other irregularities. These are completely randomized. Each sample should be weighed immediately fresh from source, before any drying and if the sample cannot be weighed immediately, it is usually placed in a plastic bag or tightly wrapped in metal foil to protect it from moisture loss until it can be weighed.

After weighing, the sample is placed in an oven heated to 105^{0}C and kept there until no appreciable weight change occurs in 4 hours weighing intervals. Measurements are complete when constant weight is achieved by the sample, for 12 hours. The constant weight or oven dry weight and the weight of the sample will be used to determine the percentage of moisture content using the formula:

$$\text{moisture content(\%)} = \frac{\text{weight when cut-oven dry weight}}{\text{oven dry weight}} \times \frac{100}{1} \quad \textbf{(2)}$$

From Figure 1, we see that 57.6% of the members had primary school level of education and about 41.1% had secondary school level of education and none of the population (timber dealers) attended tertiary education with 1.1% subscribing for informal education. However, 100% of the population are Nigerians.

Table 1: The Design of Experiments for Both Wet and Dry Season.

Wet season: *4 months → 4 weeks, → 1 week → 1 day (May – August)*

Sample	Section	May Subsection	June	July	August
Sample 1	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 2	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 3	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 4	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 5	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S

Dry Season: *4 month → 4weeks, → 1 week → 1 day (November – February)*

Sample	Section	November Subsection	December	January	February
Sample 1	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 2	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 3	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 4	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S
Sample 5	Sample A	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S	A_1 in T,RH,MC,S
		A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S	A_2 out T,RH,MC,S
	B	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S	B_1 in T,RH,MC,S
		B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S	B_2 out T,RH,MC,S
	C	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S	C_1 in T,RH,MC,S
		C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S	C_2 out T,RH,MC,S

RESULTS AND DISCUSSIONS

From the questionnaire distributed to staff of Nsukka timber shade, data was collected as follows:

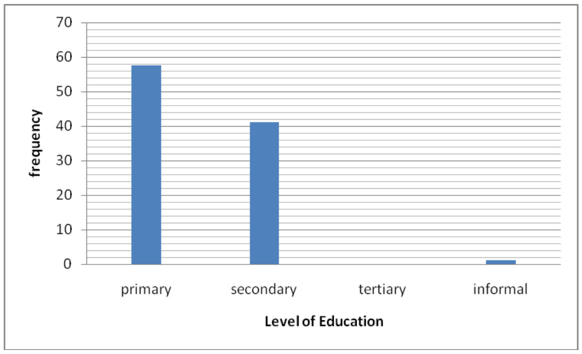

Figure 1: Level of Dealer Education.

Figure 2, shows that 86.1% of the population had agreed that they have in stock such wood as gmelina, white afara, akpu, okwen, mansonia, abura, and agba. 70% had owewe, 21.1% had antiaria, and less than 5% had canarium, camwood, ebony, sapele, celtic, etc.

The moisture content of the wood samples are determined to be 13.2, 9.3, 9.4, 10.8, and 9.4 percent for akpu, agba, obeche, mahogany, and gmelina, respectively at percentage wet basis as seen in Table 2. Akpu wood retained more moisture after oven drying at 105^0c for 12 hours when compare to the other wood types. The loss in moisture of the five woods sample types are in the increasing order: gmelina > mahogany > obeche > akpa > akpu.

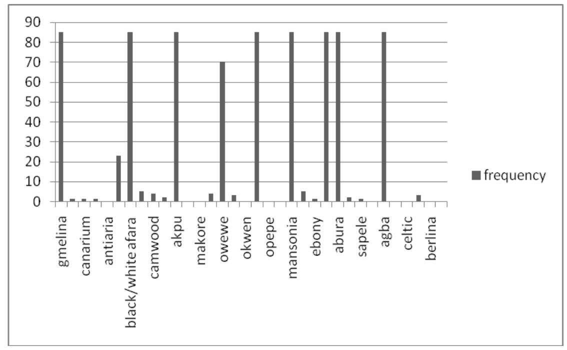

Figure 2: Some Wood Available in Stock.

Tables 3a-b through 7a-b, show wood samples exposed to envoironmental factors-temperature and relative humidity (field), as well as samples kept in laboratory (controlled) conditions. It can be seen that there are temperature and relative humidity variations across the seasons (wet and dry) as well as volumetric differential across different wood samples. These data was further analysed using SPSS for analysis of variance to ascertain the effect of temperature and relative humidity on the wood samples.

Table 2: Moisture Content of Five Common Wood Species Isolated for the Study.

S/N	Wood types	CAN Wt(g)	CAN Wt and wood	Wt of wood	Wt of CAN after drying	Moisture Content (g)	Percentage Moisture content wet basis
1	Gmelina	16.0	578.8	400.0	560.0	37.6	9.4
2	Mahogany	16.1	530	351.6	511.0	38	10.8
3	Obeche	15.90	554.0	396.0	535.0	38	9.5
4	Agba	15.94	575.0	397.5	556.5	37	9.3
5	Akpu	16.0	571.0	390.0	545.0	52.0	13.3

Table 3a: Field-Experimental Data for Environmental Factors and Volumetric Differentials for Akpu Wood.

Month	Temperature (^{o} c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	29.5	21.1	83.0	200.00	100.00	50.00	1000000.00
June	29.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	30.1	21.6	88.0	200.00	100.00	50.00	1000000.00
August	27.1	21.6	88.0	200.00	100.00	50.10	1002000.00
November	31.4	20.0	85.0	200.10	100.00	50.10	1002501.00
December	31.6	19.1	35.0	200.00	100.00	50.10	1002000.00
January	31.9	18.9	35.0	200.00	100.00	50.10	1002000.00
February	33.4	22.2	62.0	200.00	100.10	50.00	1001000.00

Table 3b: Laboratory-Experimental Data for Environmental Factors and Volumetric Differentials for Akpu Wood.

Month	Temperature (^{o} c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	25	21.1	83.0	200.00	100.00	50.00	1000000.00
June	26.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	25.1	21.6	88.0	200.00	100.00	50.00	1000000.00
August	27.1	21.6	88.0	200.00	100.00	50.30	1006000.00
November	25.4	20.0	85.0	200.10	100.00	50.30	1006503.00
December	24.6	19.1	35.0	200.00	100.00	50.10	1002000.00
January	24.9	18.9	35.0	200.00	100.00	50.10	1002000.00
February	24.4	22.2	62.0	200.00	100.10	50.10	1003002.00

Table 4a: Field-Experimental Data for Environmental Factors and Volumetric Differentials for Agba Wood.

Month	Temperature (^{o} c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	29.5	21.1	83.0	200.00	100.00	50.00	1000000.00
June	29.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	30.1	21.6	88.0	200.10	100.10	50.00	1001500.50
August	27.1	21.6	88.0	200.10	100.00	50.00	1000500.00
November	31.4	20.0	85.0	200.10	100.00	50.00	1000500.00
December	31.6	19.1	35.0	200.00	100.00	50.00	1000000.00
January	31.9	18.9	35.0	200.00	100.00	50.00	1000000.00
February	33.4	22.2	62.0	200.00	100.00	50.00	1000000.00

Table 4b: Laboratory-Experimental Data for Environmental Factors and Volumetric Differentials for Agba Wood.

Month	Temperature (^{o} c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	25	21.1	83.0	200.00	100.00	50.00	1000000.00
June	26.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	25.1	21.6	88.0	200.00	100.00	50.30	1006000.00
August	27.1	21.6	88.0	200.00	100.00	50.10	1000200.00
November	25.4	20.0	85.0	200.10	100.00	50.00	1000050.00
December	24.6	19.1	35.0	200.00	100.00	50.00	1000000.00
January	24.9	18.9	35.0	200.00	99.00	49.00	970200.00
February	24.4	22.2	62.0	200.00	100.00	49.00	980000.00

Table 5a: Field-Experimental Data for Environmental Factors and Volumetric Differentials for Mahogany Wood.

Month	Temperature (°c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	29.5	21.1	83.0	200.00	100.00	50.00	1000000.00
June	29.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	30.1	21.6	88.0	200.00	100.00	50.10	1002000.00
August	27.1	21.6	88.0	200.00	100.00	50.10	1002000.00
November	31.4	20.0	85.0	200.00	100.00	50.10	1002000.00
December	31.6	19.1	35.0	200.00	100.00	50.10	1002000.00
January	31.9	18.9	35.0	200.00	100.00	50.10	1002000.00
February	33.4	22.2	62.0	200.00	100.00	50.00	1000000.00

Table 5b: Laboratory-Experimental Data for Environmental Factors and Volumetric Differentials for Mahogany Wood.

Month	Temperature (°c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	25	21.1	83.0	200.00	100.00	50.00	1000000.00
June	26.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	25.1	21.6	88.0	200.00	100.00	50.00	1000000.00
August	27.1	21.6	88.0	200.00	100.00	50.10	1002000.00
November	25.4	20.0	85.0	200.10	100.00	50.00	1000500.00
December	24.6	19.1	35.0	200.00	100.00	50.00	1000000.00
January	24.9	18.9	35.0	200.00	100.00	50.00	1000000.00
February	24.4	22.2	62.0	200.00	100.00	50.00	1000000.00

Table 6a: Field-Experimental Data for Environmental Factors and Volumetric Differentials for Obeche Wood.

Month	Temperature (°c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	29.5	21.1	83.0	200.00	100.00	50.00	1000000.00
June	29.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	30.1	21.6	88.0	200.00	100.00	50.10	1002000.00
August	27.1	21.6	88.0	200.00	100.00	50.10	1002000.00
November	31.4	20.0	85.0	200.00	100.00	50.10	1002000.00
December	31.6	19.1	35.0	200.00	100.00	50.00	1000000.00
January	31.9	18.9	35.0	200.00	100.00	50.00	1000000.00
February	33.4	22.2	62.0	200.00	100.00	50.00	1000000.00

Table 6b: Laboratory-Experimental Data for Environmental Factors and Volumetric Differentials for Obeche Wood.

Month	Temperature (°c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	25	21.1	83.0	200.00	100.00	50.00	1000000.00
June	26.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	25.1	21.6	88.0	200.00	100.00	50.00	1000000.00
August	27.1	21.6	88.0	200.00	100.00	50.00	1000000.00
November	25.4	20.0	85.0	200.10	100.00	50.00	1000500.00
December	24.6	19.1	35.0	200.00	100.00	50.00	1000000.00
January	24.9	18.9	35.0	200.00	100.00	50.00	1000000.00
February	24.4	22.2	62.0	200.00	100.00	50.00	1000000.00

Table 7a: Field-Experimental Data for Environmental Factors and Volumetric Differentials for Gmelina Wood.

Month	Temperature (^{o} c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	29.5	21.1	83.0	200.00	100.00	50.00	1000000.00
June	29.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	30.1	21.6	88.0	200.00	100.00	50.10	1002000.00
August	27.1	21.6	88.0	200.00	100.00	50.10	1002000.00
November	31.4	20.0	85.0	200.00	100.00	50.00	1000000.00
December	31.6	19.1	35.0	200.00	99	50.00	990000.00
January	31.9	18.9	35.0	200.00	99	49	970200.00
February	33.4	22.2	62.0	200.00	100.00	49	980000.00

Table 7b: Laboratory-Experimental Data for Environmental Factors and Volumetric Differentials for Gmelina Wood.

Month	Temperature (^{o} c) Max.	Min.	Relative Humidity %	Dimensional Measurements (mm) Length	Width	Breath	Volume (mm^3)
May	25	21.1	83.0	200.00	100.00	50.00	1000000.00
June	26.1	22.1	83.0	200.00	100.00	50.00	1000000.00
July	25.1	21.6	88.0	200.00	100.00	50.00	1000000.00
August	27.1	21.6	88.0	200.00	100.00	50.00	1000000.00
November	25.4	20.0	85.0	200.10	100.00	50.00	1000500.00
December	24.6	19.1	35.0	200.00	100.00	50.00	1000000.00
January	24.9	18.9	35.0	200.00	100.00	50.00	1000000.00
February	24.4	22.2	62.0	200.00	100.00	50.00	1000000.00

To determine the temperature, relative humidity, volumetric differential, and seasonality (time) effect on wood samples, analysis of variance was conducted and Duncan ranking test was conducted to separate the means. Table 8, shows the analysis of variance for temperature, relative humidity and volume. At 5% significant level, temperature and volume are significant; relative humidity was non-significant for the experiment.

From the Duncan ranking test, our results show that temperature for the month of February was highest, but it was not significant. Also it shows that volume of wood samples changed significantly for the month of August, as seen in Tables 9 and 10.

Table 8: An Analysis of Variance for Temperature, Relative Humidity and Volume.

Sources of Variation		Sum of Squares	df	Mean Square	F.cal	F.tab(5%)
MEAN TEMP	Between Groups	28.583	7	4.083	1.745	.112
	Within Groups	168.507	72	2.340		
	Total	197.090	79			
RH	Between Groups	37248.750	7	5321.250	.	.
	Within Groups	.000	72	.000		
	Total	37248.750	79			
VOLUME	Between Groups	4.665E8	7	6.665E7	2.012	.065
	Within Groups	2.385E9	72	3.312E7		
	Total	2.851E9	79			

Table 9: Duncan Ranking for Different Months with Respect to Mean Temperature.

MONTH	N	Subset for alpha = 0.05	
		1	2
December	10	23.600	
January	10	23.650	
may	10	24.165	24.165
November	10	24.200	24.200
august	10	24.350	24.350
July	10	24.600	24.600
June	10	24.850	24.850
February	10		25.550
Sig.		.120	.079

Table 10: Duncan Ranking for Different Month with Respect to Volume of the Wood.

MONTH	N	Subset for alpha = 0.05	
		1	2
january	10	9.95E5	
febuary	10	9.96E5	9.96E5
december	10	1.00E6	1.00E6
may	10	1.00E6	1.00E6
june	10	1.00E6	1.00E6
july	10		1.00E6
november	10		1.00E6
august	10		1.00E6
Sig.		.066	.070

CONCLUSIONS

Wood has been known for multitude of uses. But with the facts over how different types of wood behave when subjected to harsh weather condition, especially in the tropics, wood should be processed, preserved, handled and stored appropriately such that it will retain its quality irrespective of the time of usage.

RECOMMENDATIONS

With the above findings, it can be establish that wood users, especially those involved in construction works, should take into account the apparent behavior of wood with respect to environmental influences, inherent moisture content, and adsorptive moisture content. Therefore, the authors recommend that there should be standards and codes for the use of different types of wood in Nigeria. Also from the findings, the types of wood under consideration have the tendency of enlarging or shrinking depending on the environmental conditions of the wood in service with akpu, mahogany, obeche, agba, and gmelina susceptible to deformation. As such, design factors should be given when using these materials as a building and construction components.

Before the conversion of timber to wood, the age of timber should be known, to avoid lumbering of under aged timber.

There should be strict adherence to forest regulations on timber-wood conversion as well as specific wood usage for a particular work function.

There should be government intervention in terms of research and development and training in wood production and the industry to support private sector initiatives in wood production especially in particle board, ply-wood, veneer production, and other wood conversion strategies.

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