The effect of two different rainfall zones in wood properties of *Balanities aegyptiaca* growing in Sudan

Tropentag 2021
Towards shifting paradigms in agriculture for a healthy and sustainable future

Hanadi Mohamed Shawgi Gamal[1] , Majdaldin Rahamtallah Abualgasim[2] Ashraf Mohamed Ahmed Abdalla[1]
[1]University of Khartoum, Faculty of Forestry, Department of Forest Products and Industries, Khartoum, Sudan
[2]Environmental, Natural Resources and Desertification Research Institute, National Centre for Research, Khartoum, Sudan

Introduction

Modern research on wood has substantiated that the climatic condition where the species grow has significant effect in wood properties. Understanding the extent of variability of wood is important because the uses for each kind of wood are related to its characteristics; furthermore, the suitability or quality of wood for a particular purpose is determined by the variability of one or more of these characteristics. With the great variation on the climatic zones of Sudan, great variations are expected in wood properties between and within species. This variation need to be fully explored in order to suggest best uses for the species.

The present study is an attempt to investigate the effect of rainfall zones in some wood properties of *Balanites aegyptiaca* growing in Sudan. For this purpose, thirty healthy trees were collected randomly from two rainfall zones (relatively low rainfall zone of 273 mm annually and relatively high rainfall zone of 701 mm annually). The investigated anatomical properties were fiber and vessel diameter, lumen diameter and wall thickness as well as fiber length. Wood basic density was investigated as physical property, while Brinell hardness strength was investigated as mechanical property.

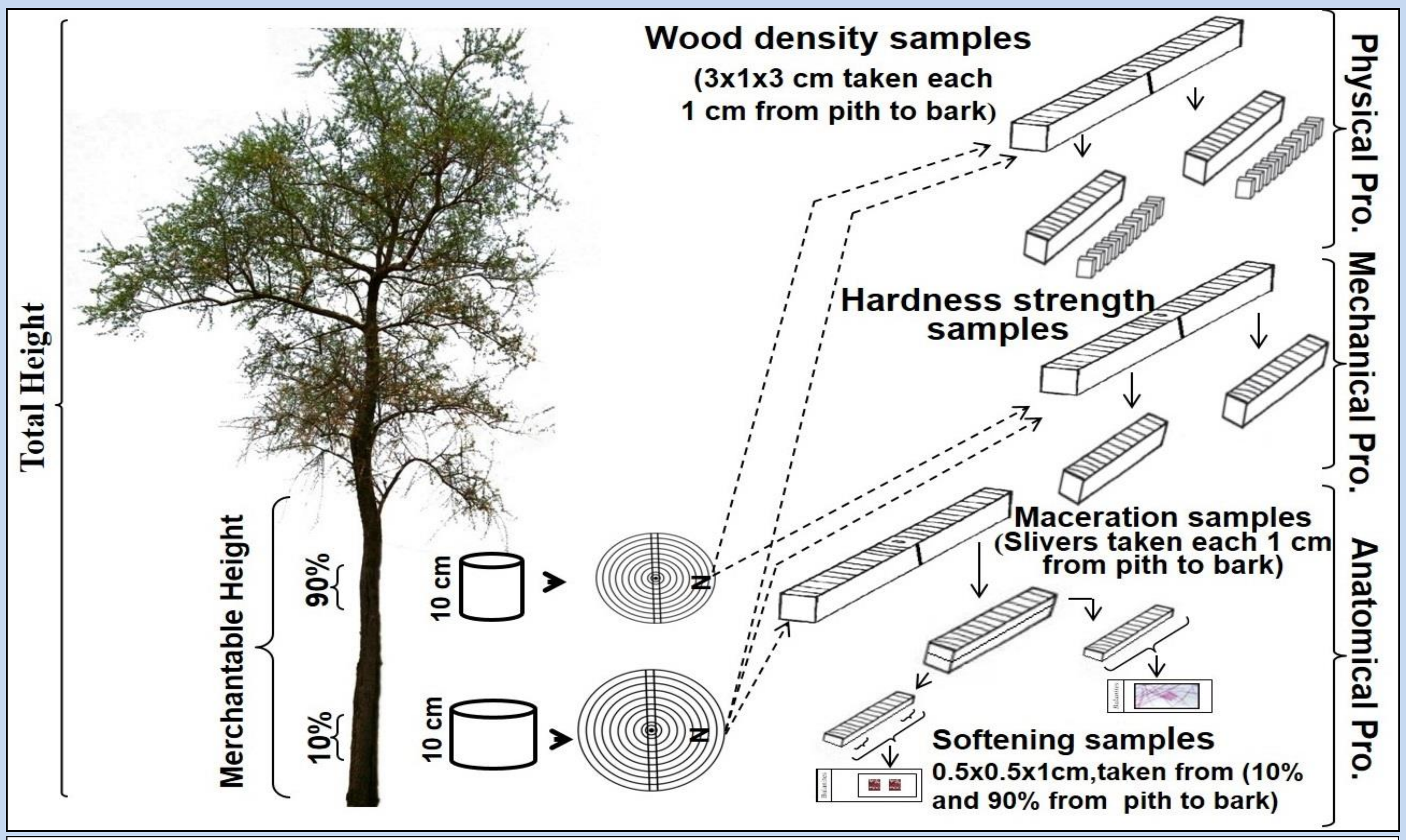


Figure 2: Sampling procedure (Pro.=Properties).

Materials and Methods

Materials:

The wood raw materials were collected from two rainfall zones in Sudan. Each zone was represented by 15 trees collected randomly from 5 natural stands located in two different states. The location and characterization of the study areas are summarized in Figure 1, while sampling procedure is presented in Figure 2.

Methods:

Fiber and Vessel Dimensions (µm)

In order to measure fiber length, Shultze maceration method was adopted to macerate the woody materials into individual cells. A number of 40 fibers length were measured microscopically. In order to measure fibers and vessels diameter and lumen diameter, wood specimens of 0.5 x 0.5 x 1 cm were softened. Transverse sections were prepared with the aid of a GSL1 microtome. A number of 40 fibers and 30 vessels diameter and lumen diameter were measured using ImageJ-software**.** Both fibers and vessels wall thickness were calculated using the following equation:

$$WT = \frac{D - LD}{2}$$

Where: WT = wall thickness; D = diameter and LD = lumen diameter

Wood Basic Density (kg/m³)

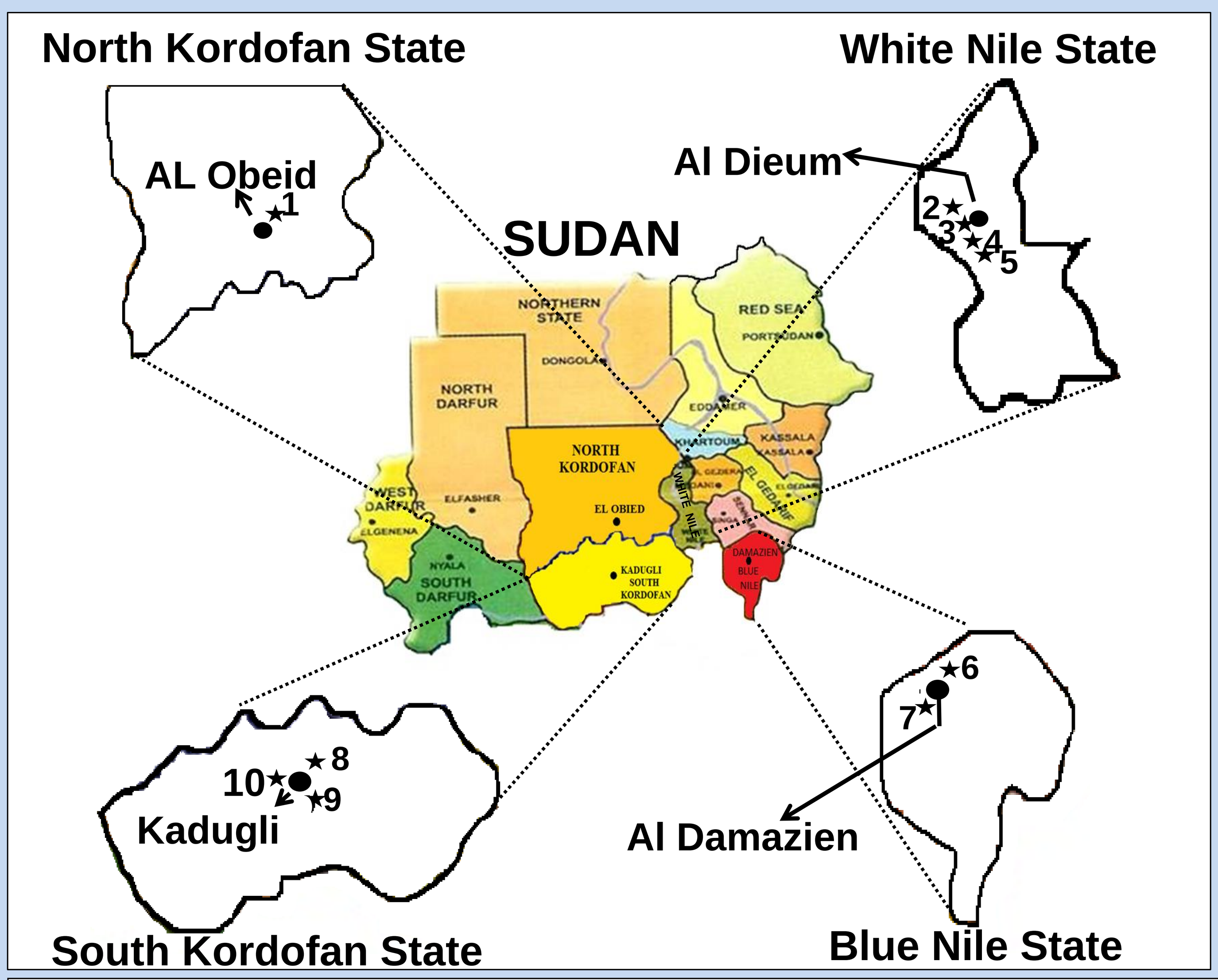
The density was measured as oven-dry mass/green volume. The Wood specimens were dried at a temperature of 103 ± 2 ºC and then weighted. The green volume was measured using water replacement method.

Hardness strength (N/mm²)

Brinell hardness test was conducted on the basic of DIN EN 1534. The TIRA test 28100 machine was used to perform the hardness test in the transverse and radial surfaces. The following equation has been used to get the hardness:

$$H = \frac{2F}{g.\pi.D.(D-(D^2-d^2)^{1/2})}$$

where:
H= hardness; g= acceleration due to gravity (m/s²); π= factor „pi" (≈ 3.14); F= nominal force in Newton; D= ball diameter (mm) and d= diameter of impression point (mm).



Zone	City	Forest
One (273 mm*)	Al Obeid	[1]Al Tainat
	Al Dieum	[2]Habila
		[3]Al Homora
		[4]Aum Top
		[5]Goz Fagor
Two (701 mm*)	Al Damazien	[6]Tawla
		[7]Khor Donia
	Kadugli	[8]Al Sheheata
		[9]Al Homara
		[10]Al Bardab

Figure 1: Location and characterization of the study areas (*= Zone's mean annual rainfall of 10 years from 2000 to 2009).

Results

The study result reveals significant differences between zones in juvenile and mature wood vessels dimensions as well as in wood basic density and hardness strength in transverse surface of juvenile wood. The higher values were detected in the drier zone in all the affected properties with the exception of mature vessels dimensions where lower values were detected in the drier zone. Table 1, 2 and 3 represent the study species wood properties mean values per zone, while figure 3 summarizes the effect of rainfall zones on the study species wood properties.

Table 1: Fibers and vessels dimensions mean values (Means with * in the same row are significantly different from each other at 0.05 probability level)

Sample	Dimensions	Fibers Dimensions Mean Values (µm)		Vessels Dimensions Mean Values (µm)	
		Zone1	Zone2	Zone1	Zone2
Juvenile (J)	Diameter	12.39	12.67	112.05*	97.91*
	Lumen diameter	4.83	5.00	92.82*	80.78*
	Wall thickness	3.66	3.74	9.36*	8.39*
Mature (M)	Diameter	13.65	13.33	139.56*	151.42*
	Lumen diameter	5.72	5.56	115.04*	124.70*
	Wall thickness	3.91	3.91	12.09*	12.88*
Mean of J and M	Diameter	13.02	13.00	125.73	124.25
	Lumen diameter	5.27	5.29	103.88	102.28
	Wall thickness	3.78	3.83	10.71	10.64

Table 2: Fiber length and wood density mean values (Means with * in the same row for each radial position are significantly different from each other at 0.05 probability level)

Wood Property	Radial Position (%) mean values										Mean of radial P	
	10		30		50		70		90			
	Z1	Z2	Z1	Z2	Z1	Z2	Z1	Z2	Z1	Z2	Z1	Z2
FL (mm)	1.00	1.00	1.14	1.13	1.20	1.19	1.22	1.22	1.24	1.23	1.15	1.15
BD (Kg/m³)	652*	616*	658*	631*	674*	651*	683*	666*	688	676	672*	649*

FL= Fiber length, BD= Basic density, Z1= Zone 1, Z2= Zone 2 and P= Position.

Table 3: Hardness strength mean values

Sample		Mean (N/mm²)	
		Zone1	Zone2
Transverse surface	inner	82.59*	73.97*
	outer	92.42	89.07
	Mean	88.69*	84.64*
Radial surface		45. 84	44.63

(Means with * in the same row are significantly different from each other at 0.05 probability level).

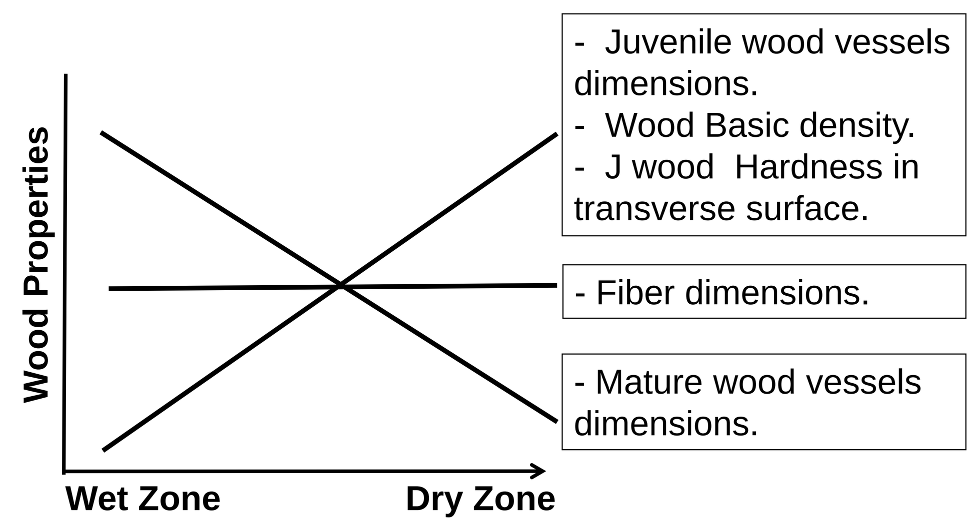


Figure 3: The effect of rainfall zones on the study species wood properties (J=Juvenile).

Conclusion

The result confirms several trends reported in the literature, especially in the increasing wood density and hardness strength in the drier zone. From these results, *Balanities aegyptiaca* seems to be well adapted with the change in rainfall and may survive in any rainfall zone. However, the detected significant variation in wood properties lead to expected variation also on its suitability for industrial utilisation. The thing which needs to be fully explained to promote the optimal uses of wood resource in Sudan.

Poster presented at Tropentag 2021
September 15 - 17, 2021,
organised by University of Hohenheim, Germany.

Hanadi Mohamed Shawgi Gamal
University of Khartoum, Faculty of Forestry
Department of Forest Products and Industries.

University of Khartoum
Postal Code 13314, Shambat,
Khartoum, Sudan.

Tel.: 00249114699181
Email:
hanadishawgi1979@yahoo.com