

METEOROLOGICAL CONDITIONS OF THE REGIONS OF KOSOVO THAT INFLUENCE TECHNOLOGICAL PARAMETERS FOR DRYING WOOD

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Abstract:

The living trees contain an amount of water. Most of the water must be evaporated before the lumber obtained from a tree can be converted into products. The lumber from which most wood products are manufactured must be dried. In this study, the effects of meteorological conditions in some regions of Kosovo on drying of wood were examined. Of all the methods to remove large quantities of water from wood, air drying has the least capital costs, especially in the early stages of drying. The studying of the temperature, raining, wind, relative humidity and the all other meteorological factors in the surrounding air for a long period of time there have been able to know about the air drying of the wood in different regions of Kosovo. Timber will reach constant equilibrium moisture content by specific value of temperature and relative humidity. The temperature and relative humidity of the air varies from month to month and from region to region in the territory of the country. The study of meteorological factors showed that the territory of Kosovo has favorable conditions for air drying process of the wood.

Key words: wood drying; regions; meteorological factors; temperature; raining; wind; relative air humidity.

INTRODUCTION

Kosovo has a very favorable geographic position because it stretches over the central parts of the Balkan Peninsula and the Southeast Europe (Meha 2000).

Within the macro-factors having an impact on the climate of Kosovo, the following are the most important: the position of Kosovo vis-à-vis the land masses, water masses and the air space, its position concerning the baric or pressure systems, the relief, waters, the land and the plants. Among the main types of climate are: continental, mountains and the Mediterranean climate (Çavolli 1997).

Forestry fund of Kosovo is 482.000ha or 47% of its territory. Of this, to the state sector belong 60%, while in private hands is 40%. The forestry is composed mainly of a high mountains (16,7%), mid-forests (7,1%), low-level forests (61,7%), bushes (12,3%) and thin forests (2,2%) (FAO 2003, Bajraktari *et al.* 2011).

Forests in Kosovo are above the sea level of 500÷2000 meters. Overall, Kosovo is surrounded by the high mountains such as Sharr Mountains, Pashtrik, Koretnik, Albanian Alps etc. The main mountains of Kosovo are: *Carpinus Orientalis*, *Fraxinus Ornus*, *Acer Platanoides*, *Acer Monspenssulanum*, *Acer Compastre*, *Quercus Pubescens*, *Quercus Cerris*, *Quercus Farineto*, *Quercus Petrea*, *Tilia Platiphyllus*, *Carpinus Betulus*, *Juglans Regia*, *Cartanea Sativa* (FAO 2003). Factors that speed up or slow down the process of food-dry are: the temperature of the environment, the amount, speed and the intensity of the configuration of the atmospherics, the relative humidity of

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air, the direction of winds, sun-shine, geographic space and the position of the location where the trees are deployed for drying, geology of the terrain, other micro-climatic factors of the region and the environment itself, physical features of the wood that needs drying, the type of the tree and its physical volume, as well as the initial and final humidity of the wood in need of drying (Pllana 1973, Bertorelli 1986).

The importance of air drying in the region has to do a lot with economical development, the region is not in the level to continue only with kiln drying, also the general conditions of the metrological factors due to the starting time of the drying of the lumbers, spring is the best time to start with drying and in about three months the water in wood is under fiber saturation point. Kosovo has the continental climatic conditions where the temperature during the summer is up to the 39 Celsius. Also the other factors like average temperature, sun exposure, relative humidity, wind speed, prevailing winds per season in the country are in favor to have air drying for all dimensions of the lumbers and timbers.

THE AIM OF THE STUDY

The aim of this research was to study the climate factors in order to see what can be expected in terms of final moisture in air drying conditions, in different seasons and regions of Kosovo. The study was to search for the climate factors that speed up and slow down the wood-drying process, as well as the determination of the values of the these factors and their mutual relationship within the region of the country. The impact of the relative air humidity in the humidity of the wood and their values during the four seasons and over certain zones and regions, their meteorology and climate included, have as well been the objective of the study.

METHODS OF THE STUDY

For the study of the meteorology of the Kosovo region influencing the parameters of the drying technology, the following have been taken into account: data concerning the region's meteorology over the period of 63 years. These data have been collected from all meteorology stations. Further, other studies were taken into account, especially those concerning the Balkan Peninsula undertaken by various scholars, some observations and synopsis maps (undertaken also by the synopsis centers of Kosovo and Albania all over various centers of Kosovo's territory). The literatures about the technical conditions of the wood drying in the state of nature have also been used. To this effect the calculation of the wood humidity in function of the air temperature and its humidity. We made some expertise in order to precisely define the timing of the wood drying already used and to know the equilibrium of the level of humidity, all being in function of the air temperature and its humidity (Kalo & Marjani 1983, Dimoshi & Rjepaj 1971).

According to the gathered data we have graphically displayed the calculation of the wood humidity and its equilibrium for most of the regions of Kosovo.

While studying the various meteorological factors we had into consideration the fact that they stretchy over the whole territory of Kosovo and for this reason we took the date from 11 meteorology stations (Table 1).

The equilibrium moisture content (EMC) is the moisture content at which the wood is neither gaining nor losing moisture; this however, is a dynamic equilibrium and changes with relative humidity and temperature. EMC is defined as the point where wood stops absorbing moisture from or bleeding moisture into the surrounding air. At this point, the material is said to have reached equilibrium with the atmosphere. Equilibrium moisture diagram (Keylwerth and Noack 1964). (Table 2).

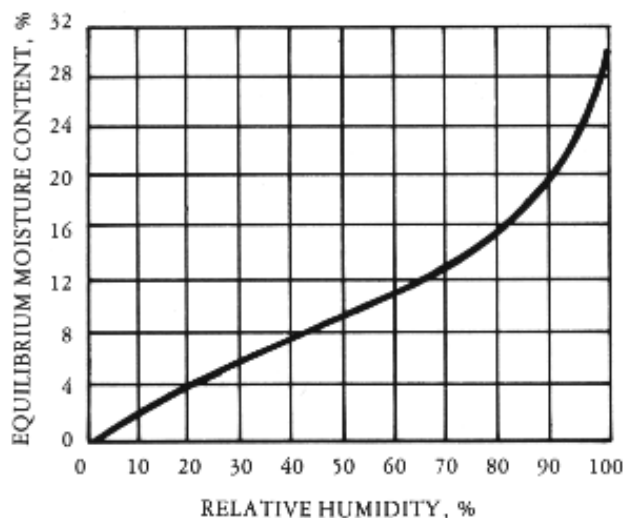
Table 1

List of meteorological stations

No.	Station Name	Sea Level	Geographic Coordinates	
			Width	Height
1	Pejë	498	42°40'	20°18'
2	Klina	385	42°38'	20°34'
3	Gjakova	360	42°22'	20°26'
4	Theranda	420	42°21'	20°49'
5	Prizren	402	42°13'	20°44'
6	Mitrovica	510	42°53'	20°52'
7	Besiana	620	42°55'	21°12'
8	Prishtina	573	42°39'	21°09'
9	Gjilan	520	42°28'	21°18'
10	Ferizaj	580	42°23'	21°10'
11	Sharri	1060	42°04'	20°39'

Table 2

Equilibrium moisture diagram (Keylwerth and Noackm 1964)



The average value of the climate elements, such as the monthly average temperature, yearly average raining, the direction of the winds and their speed, relative air humidity etc., collected and studies have as well been analyzed while drawing the needed conclusions about the influence of these factors in the natural drying process of the wood (Table 3).

Table 3

Monthly and annual average temperature of the air in the territory of Kosovo

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
Peja	-0.4	2.1	6.1	11.1	15.7	19.2	21.0	20.9	17.0	11.6	6.9	1.7	11.1
Klina	-1.0	2.2	6.2	10.8	15.4	18.8	20.4	20.0	16.0	10.8	6.4	0.7	10.6
Gjakova	-0.5	1.9	5.8	10.6	15.6	18.9	20.6	19.5	16.3	10.2	6.9	1.6	10.6
Theranda	-0.2	2.7	6.2	11.0	16.0	19.4	21.5	21.2	17.5	12.0	7.0	2.0	11.4
Prizreni	0.2	3.0	6.6	11.6	16.5	20.2	22.1	22.0	17.8	12.0	7.4	2.3	11.8
Mitrovica	-0.9	1.9	5.0	9.9	14.6	18.0	20.0	19.8	15.8	10.4	5.9	1.2	10.1
Besiana	-2.0	0.6	4.2	8.9	13.8	17.2	19.0	18.9	15.0	10.0	5.3	0.5	9.5
Prishtina	-1.2	1.3	4.8	9.8	14.4	18.0	19.7	19.8	15.8	10.5	5.8	0.7	9.9
Gjilani	-1.1	1.7	5.2	10.0	14.8	18.2	20.0	19.7	15.6	10.8	6.2	1.2	10.2
Ferizaj	-1.4	1.1	4.7	9.8	14.5	18.1	19.8	19.7	15.7	10.3	5.5	0.6	9.9
Sharri	-1.4	0.2	3.3	6.8	12.0	15.8	17.6	17.1	13.6	8.5	3.9	0.6	8.2
Monthly Average	-0.9	1.7	5.3	10.0	14.8	18.3	20.2	19.9	16.0	10.6	6.1	2.4	

From the above data it results that the coldest period for the whole territory of Kosovo is January with negative temperatures of about -0,9÷-1,4°C, while the warmest is July with 22,1°C. The highest temperature in average is in Prizeren (11,8°C), Therandë (11,4°C), Gjakovë (10,6°C), Gjilan (10,2°C), Mitrovicë (10,1°C), Ferizaj (9,9°C), Prishtinë (9,9°C), Besianë (9,5°C). The lowest temperature per year is in Sharr (8,2°C only). The highest temperatures over all seasons are recorded in Prizren and the lowest in Ferizaj.

The relative air humidity is one of the main factors affecting the wood drying. This factor in connection with the air temperature determines the humidity of the wood for the exposed area. The lowest relative humidity (in values 47÷77%) is recorded in June-July-August, while the highest during autumn and winter (80÷92%) (Table 4). This phenomenon is closely connected with the air temperature, raining, winds and sun-shining.

Table 4

Average monthly values (φ), the maximum (φ_x) and minimum (φ_n) the relative air humidity in Peja, Prizren, Pristina and Ferizaj

Stacioni	$\varphi\%$	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
Pejë	Φ	82	77	68	63	65	64	61	61	67	73	81	83	70
	φ_x	92	86	84	72	76	77	75	76	87	90	90	90	76
	φ_n	69	68	59	51	52	57	52	50	54	58	73	78	66
Prizren	Φ	82	76	69	64	64	62	59	59	67	73	79	83	70
	φ_x	89	84	79	72	77	70	70	74	77	82	90	90	75
	φ_n	75	68	58	50	51	53	46	49	58	64	77	76	66
Prishtinë	Φ	83	78	71	65	68	68	64	62	68	74	80	84	72
	φ_x	88	88	82	74	86	74	72	75	79	83	92	87	96
	φ_n	76	72	60	54	56	60	55	51	51	62	72	79	68
Ferizaj	Φ	85	81	75	68	72	70	67	67	73	79	84	85	76
	φ_x	90	88	84	78	81	80	76	80	85	84	94	90	81
	φ_n	81	72	62	65	64	63	54	47	60	67	73	80	72

Sun light and the sunny days and months influence the warmth of the environment, that is, the rise in the air temperatures. Apart from this, their direct fall into the wood surface warms it and, consequently, brings in the humidity and the moisture of the wood. This process, in turn, shortens the dry-timing. It has been noticed that the longest sunny period for all regions is April-November period reaching the maximal values in June, July and August. The highest lightness is recorded in Prizreni, Prishtina and Ferizaji, while the lowest in Peje. In Kosovo there are per average 2066 sunny hours or 5,7 hours per day. The yearly average of the sunrise for the whole territory of Kosovo is 49%. The yearly average is the highest in Prizren and Prishtinë and the lowest in Pejë with 47%. The most sunny days for Prishtinë are the months of August (70%), July (68%) and September (62%). The highest values of the sunny days are reached in Prizeren (74% during August, 72% in July, and 64% in September), while for Pejë they are in August (69%), July (64%) and September (61%) (Table 5).

Table 5

The average amount of radiation (insalacianit) of sun per hour in the main meteorological stations in Kosovo

Stacioni	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
Pejë	68	97	137	172	202	224	283	283	216	156	76	56	1968
Prizren	70	100	146	185	222	259	301	291	224	170	93	65	2126
Prishtinë	70	102	147	184	221	258	299	289	222	168	94	66	2120
Ferizaj	74	99	147	176	215	247	294	276	213	162	92	57	2053
Monthly Average	70	99	144	179	215	247	294	284	218	164	89	61	2066

In general the territory of Kosovo is well lit and favorable in terms of the wood drying throughout the year except for January, February, November and December. During these months, the values of the light are lower.

In Kosovo there exist all sorts of raining, such as: rain, snow, foggy winds etc. The amount of raining increases with the rise in the level of the sea, as well as in the directions of East and West (Fig. 1). The raining is the main climate factor that affects the temperature of the environment, the air humidity, and the slow-down or the speed up of the time needed for wood drying process. If the rain hits directly the uncovered wood materials than this raises the speed of the humidity process.

The largest amount of rain is during January, February, May and October, and the smaller in June, July and August. The largest amount of rain is recorded in Gjakove (1,027mm) and Jazhincë (1,021mm), while lesser in Prishtinë (608mm), Gjilan (603mm). In other areas, the rain-fall is less uniform and centers around (700÷900mm) (Table 6).

Table 6

The average monthly quantities and annual quantities of rainfall in mm at selected stations in Kosovo

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	The annual rainfall
Peja	99.0	72.7	69.9	64.7	72.9	61.0	52.3	47.1	54.5	91.7	119.7	101.9	907
Klina	73.9	47.5	55.9	60.9	83.3	50.8	64.3	50.1	57.4	77.4	104.5	96.0	822
Gjakova	108.7	94.1	76.9	75.7	78.3	49.1	49.0	47.1	76.7	99.5	140.5	131.3	1027
Theranda	57.1	46.5	46.6	53.6	76.1	62.0	46.8	45.1	58.2	61.9	73.0	68.1	695
Prizreni	69.0	57.3	59.5	60.7	76.9	58.3	56.2	40.9	62.8	69.0	84.8	75.2	771
Mitrovica	42.3	44.5	39.5	48.0	63.2	61.6	47.6	41.8	47.1	59.2	73.5	59.4	628
Besiana	41.5	45.7	41.2	54.2	79.2	68.5	54.2	41.6	53.0	66.4	80.6	56.9	683
Prishtina	36.7	36.8	35.3	51.4	75.3	56.9	48.6	46.2	47.5	56.1	64.2	53.5	608
Gjilani	40.2	39.3	38.4	44.1	70.4	64.9	48.2	43.5	41.7	55.9	63.3	53.0	603
Ferizaj	50.1	45.3	46.8	51.3	83.2	70.9	63.0	54.8	52.5	63.7	67.2	55.4	704
Bud. e E.	41.6	37.5	43.8	49.8	76.4	56.5	51.3	51.9	47.2	53.1	62.4	57.3	629
Jazhinca	86.8	72.3	79.2	80.9	111.1	92.7	81.7	62.2	75.5	83.7	98.8	95.6	1021
Breznia	93.5	86.9	82.7	79.0	89.7	78.8	60.8	47.3	66.6	73.4	108.7	107.9	975
Borçani	37.4	39.8	38.2	62.0	98.0	78.0	68.1	67.4	57.7	73.1	60.7	57.6	728
Rudina	36.9	34.7	38.7	43.4	70.8	68.8	63.0	53.2	53.7	62.0	62.3	55.6	643

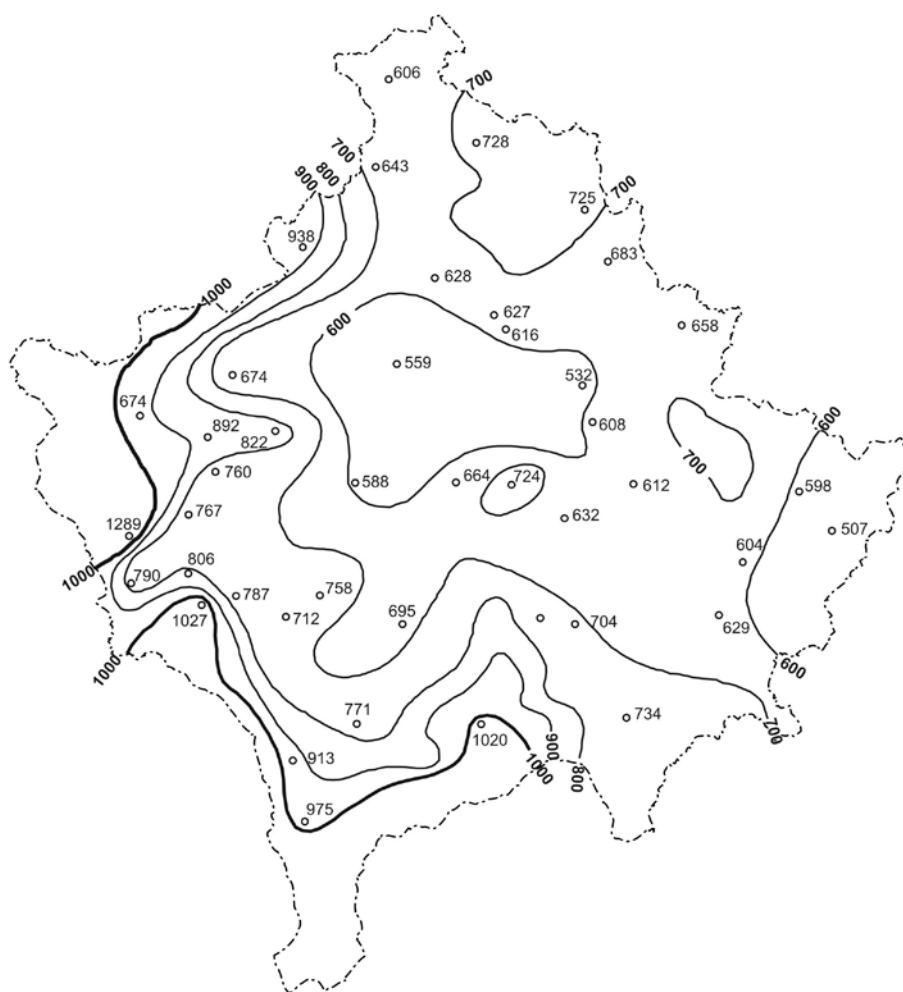


Fig. 1.
The annual rainfall (mm) in the territory of Kosovo

According to the available data, it results that the largest amount of snow is in Pejë region reaching the width of 130 cm and the smallest in Ferizaj (64cm during January and February). The snowing period is January-April and October-December.

The maximum values of fog are reached during March and November-December, while lesser ones over June and September. The mist is not recorded at all during July and August.

The winds are one of the most important factors, especially their speed, which positively affects the horizontal streams of the woods and their materials used for water supply. The average speed of the winds in Kosovo varies between 1,3m/s in Pejë up to 2,4m/s in Ferizaj. The most extreme speed can reach up to 31m/s during March and April (Table 7).

Table 7

The participation of the main directions of winds in %

City	Continental Winds					Sea Winds					Overall Winds	Quietly
	NW	N	NE	E	In total	SE	S	SW	W	In total		
Sharrë	5,1	25, 2	9, 4	4, 2	43, 9	9, 6	18, 1	6, 8	3, 5	38, 0	81, 9	18, 1
Prizren	7,7	9, 7	14,0	4, 0	35, 4	7, 4	5, 3	16, 6	5, 2	29, 5	64, 9	35, 1
Rahovec	2,3	11, 8	6,2	1, 7	22, 0	0, 4	1, 4	2, 4	5, 0	9, 2	31, 2	68, 8
Therand	1, 3	5, 1	19, 2	8, 2	33, 8	2, 3	3, 3	8, 2	5, 9	19, 7	53, 5	46, 5
Pejë	4, 2	5, 9	7, 8	5, 5	23, 4	5, 8	7, 5	11, 3	12, 2	36, 8	60, 2	39, 8
Gjakovë	7, 9	12, 3	12, 8	2, 7	35, 7	3, 2	5, 5	17, 7	4, 3	30, 7	66, 4	33, 6
Besianë	1, 8	28, 9	11, 1	1, 3	43, 1	1, 4	26, 3	3, 5	2, 3	33, 5	76, 6	23, 4
Prishtinë	6, 0	19, 4	20, 3	4, 0	49, 7	7, 3	6, 3	9, 0	5, 0	27, 6	73, 3	22, 7
Lipjan	11, 2	24, 6	5, 1	7, 7	48, 1	10, 3	13, 6	9, 9	11, 2	45, 0	93, 1	6, 9
Ferizaj	25,0	13,5	7,5	3,3	49,3	24,0	4,0	4,2	6,0	38,2	87,5	12,5

RESULTS

Minimal values of wood humidity for the whole territory of Kosovo are reached during July and August (from 10,5 to 12,5%). The lowest among these are in the zone of Prizrenit (10,5%). The average humidity per year varies from 13 to 14,7%) and again the lowest is in Prizren (13%) and the highest in Ferizaj (14,7%). The level of humidity is lower in summer (10,7÷12,5%) and the lowest in Prizren (10,7%). The maximum value of the humidity is during January and December (17÷19,5%), while lower ones are recorded for other months, reaching the minimal values during July, August and September.

Under these circumstances, it results that the whole territory of Kosovo is favorable for wood drying. This means that the climate allows for a natural wood drying process to develop, having a very high effectiveness. The most favorable zones for this are Pejë, Prishtinë and Prizren, where the percentage of the humidity reaches minimal values.

In order to maximally evade the defects in wood, especially concerning the splits in the head of a wood material, the direction of the wood box should be the following: in Ferizaj (the Southwest and Northeast direction) in Prizren (the Northwest direction and Southeast direction), in Prishtinë (the East, Southeast and West, Northwest direction), in Pejë (the North-South direction).

CONCLUSIONS

The air temperatures in Kosovo are favorable for a natural drying process of the wood. The highest average values are recorded in Prizren (+16,9°C). The monthly average temperatures are positive for all months apart from January. The number of days with temperatures higher than 25°C is high for the whole territory of Kosovo. This means that Kosovo has temperatures to be applied for a natural wood-drying process.

The relative air humidity in Kosovo has an average of 72% per year. Sunshine in Kosovo has high values (in average 2000 hours per year for the whole territory). The relative longevity of the sun

shines (from sun rise to sun set) has average values of 49%. The amount of raining in Kosovo is low. The winds have high values for all Kosovo and different speeds and direction. The position of the wood boxes in Kosovo should be done using various directions of the region.

In conclusion, the region of Kosovo has a good climate favoring the natural wood drying for the whole region. For this reason, the results of this study show that this natural method should be used for the whole Kosovo region. Further, the research should be directed towards the determination of the dry-timing for some of the pinned and barbed forests in Kosovo.

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