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INSTITUT ZA ŠUMARSTVO  
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SUSTAINABLE FORESTRY

ODRŽIVO ŠUMARSTVO

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## THE POSSIBILITY OF THE OCCURENCE OF ARID PERIODS OF THE ALTITUDINAL REGION OF SOUTHWEST SERBIA USING THE PEŠTER PLATEAU AS AN EXAMPLE

*Ljubinko Rakonjac<sup>1</sup>, Mihailo Ratknić<sup>1</sup>, Milutin Dražić<sup>2</sup>, Milorad Veselinović<sup>1</sup>*

**Abstract:** Whether the unusually frequent turbulence of the climate events with the unpredicted occurrence of arid periods is the result of the global warming of the Planet, or they are the usual cycles of the arid and rainy years which, amongs other things, occur in the Middle European region, the science has not provided the accurate answer yet. Nevertheless, it is a fact that during 1985/86 year there was the partial dry of the forest cultures aged between one and six years on some sites, as the consequence of the long absence of the atmospheric precipitation in the summer period. Provided that the arid period is the period with the days devoid of precipitation, we analysed this phenomenon according to the data obtained by the meteorological station Sjenica.

**Key words:** climate changes, global warming, dry of the forest cultures

### MOGUĆNOST POJAVE SUŠNIH PERIODA VISINSKOG REGIONA JUGOZAPADNE SRBIJE NA PRIMERU PEŠTERSKE VISORAVNI

**Izvod:** Da li je neuobičajena češća turbulentnost klimatskih manifestacija sa nepredviđenim pojavama sušnih perioda rezultat globalnog otopljanja Planete ili su to uobičajeni ciklusi sušnih i kišnih godina koji se, između ostalog, javljaju u srednjeevropskom području, nauka još uvek nije dala egzaktn odgovor.

No, činjenica je da je tokom 1985/86. godine došlo do parcijalnog sušenja šumskih kultura starih od 1 do 6 godina na određenim staništima, kao posledica dužeg odsustva atmosferskih padavina u letnjem periodu. Ako prihvatimo da je sušni period vreme sa

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danima bez padavina, analizirali smo tu pojavu na osnovu podataka meteorološke stanice Sjenica.

**Ključne reči:** klimatske promene, globalno otopljanje, sušenje kultura

## 1 INTRODUCTION

The great areas of the eroded skeleton barrens which are the result of the uncontrolled frequent fellings and burning of the forests in the previous historic period are exposed to the destructive erosional processes and torrents with the immeasurable ecological and economically harmful effects.

The only way to stop the above destructive process is the re-establishment of the forest ecosystems by reforestation of the eroded skeleton barrens in the hilly-mountainous regions. These reforestations were started in Serbia in the late 19<sup>th</sup> and in the early 20<sup>th</sup> centuries, and were intensified after the Second World War.

There was an uneven trend in the average annual scope of the reforestation of barrens, since it varied from 6,562 ha in the period 1945-1954, to 19,560 from 1980 to 1985, i.e. over 20,000 ha annually for the period 1978-1986, during the reforestation by the voluntarily actions of the young forest campaigners of the settlement type.

From 1945 to 1990 the total of 483,880 ha was reforested, i.e. averagely 10,512 ha annually.

It should be emphasized that the “gold period of reforestation” was the period when the regional associations for forestry were established in 1977 according to the Forest Law, and the financial means for the infrastructural investement in the improvement of forestry was obtained by the nonbudget contributions of the all direct and indirect beneficiaries of the forest functions, i.e. all the work organisations and the citizens of Serbia.

By managing nonbudget means without the interference of the state, these associations were able to devise long-term plans for the infrastructural works in forestry, to finance the completion of the performative projects of reforestation, construction of the forest communications, non-commercial care and thinning of the forest cultures, safer planning of the production of seedling material by the application of the new technologies in the production of the seedlings with the protected root system, which enable the reforestation in vegetation season as well, by the application of certain methods and technology of reforestation.

The Institute of Forestry, with the financial support of the infrastructural means intended for forestry, carried out a great number of the performative projects of reforestation by the use of team multidiclipine activities of the researchers of the different profiles, in the aim of the ecological determination of the site conditions necessary for the selection of trees for reforestation, selection of the optimal methods and reforestation technologies adapted to the constitutional skills of the youth – reforestation contractor.

The first performative project with the participation of team work of the researchers of the suitable specialties led by the main project-maker (M. D r a ž i ć), by the application of the new reforestation method “on cells” and planting of the seedlings with the root protected by the peat cork produced in the appropriate containers, was made in 1977 and carried out in the area of 1,000 ha in the Pešter Plateau during the vegetation season in 1978 by the voluntarily action of the young forest campaigners of the settlement type, with the participation of the young forest campaigners brigades from all the republics

of the Former Yugoslavia. The Institute of Forestry also made the performative projects of the same methodology for the barrens of Ibarska Gorge, Vlasina Region, Zlatibor, the barrens of Southeast Serbia and other areas.

Beside project-making activities, the Institute took an active role in the production of the quality seedlings with the protected root. The experts from the Institute were also engaged in the professional training of the brigadiers, operative instruction, and monitoring during the actions of reforestation.

The voluntarily actions of the young forest campaigners of the settlement type with the brigades of the young pupils, students and workers from all the republics of the Former Yugoslavia were organized until 1988. During this time by their activities an area of over 120,000 ha was reforested. Nowadays in these regions instead of the past greyness of the eroded stone barrens of Pešter, Ibarska Gorge, Vlasina Region and other localities, the majestic anthropogenic forests are present. In the area of Southwest Serbia, around 50,000 ha of the forest cultures, which are in the phase of the intensive development and need care, were established in the previous decades.

Beside the previous successful reforestation in the region of Southwest Serbia, there are still the great areas of the unreforested eroded skeleton barrens, particularly in the domain of the private estates. These areas and the other barrens are part of the long-term strategy which includes the reforestation of over million of hectares of the current eroded barrens in Serbia by the end of this century, in order to increase the area covered by forests in Serbia to around 41%, by which the relatively harmonious ratio of the forest, agricultural and other ecosystems will be established, and the ecological balance in nature will be achieved.

## **2 THE IMPORTANCE OF RESEARCH**

Man by his activities influenced the vast increase of carbon-dioxide in the air and the increase of the other gases which cause the occurrence of the phenomenon of “glass house”, the cause of the accelerated global warming of the Planet, as well as the gases which cause the decay of the ozone layer and occurrence of the so-called “ozone holes”, which have an adverse effect on man and the other living world. Since the above phenomena, reflected in the climate change, can endanger life on the Earth, the international community led by the United Nations by the numerous resolutions, declarations and other international acts made it obligatory for the signatories of these documents to significantly reduce the emission of carbon-dioxide and other gases of “glass house”, as well as the gases which destroy the ozone layer.

At the same time, the effort was made to stop the unreasonable destruction of the tropic rain forests in regions which are of the vital ecosystemic importance to the preservation of the balance between oxygen and carbon-dioxide in the atmosphere. Therefore, these forests are deservedly called “The Lungs of the Planet”.

Whether the catastrophic floods on one hand and the occurrence of the long-lasting droughts in the vast areas on the other hand, as well as the other meteorologically unusual turbulences, which occurred in the last few decades, are caused by the global increase of warming of the atmosphere, it has not been accurately determined by the scientists yet, owing to the fact that the scientists from this domain are not united. However, it is a fact that relatively numerous plant species, as well as some zoo species disappear from their former sites. There are still no visible practical signs whether the nature forest

and other ecosystems under the influence of climate change move from their sites to the boreal geographical regions or from the low orographic area to the high altitudes.

The scientific researches should timely point out whether it is possible by the measures taken by the international community to permanently establish the balance between the oxygen and carbon-dioxide in the atmosphere and thereby stop the accelerated warming of the Planet and reduce it to the scope of the geological-historical trend of the mild moving under the influence of nature forces.

In the light of the possible macro-climate events, influenced by the further increase of the global warming of the Earth, amongst other things, the forestry science also faces up with the problem whether in the long-term projections and reforestation strategies, which will last at least by the end of this century, until the achievement of the projected percentage of the area covered by forests from 41 to 42 %, it should rely on the current climate-edaph site conditions during the long-term projection of the selection of the forest tree species, or the introduction of the species which now thrive in the arid parts of the continents should be investigated and taken into consideration? The vast macroecological problems would influence the survival of the living world on our Planet if the drastical ecological changes occurred faster then the living world would be able by a long process to genetically and in other ways adapt and preserve the survival under the newly-formed global ecological conditions.

### **3 THE AIM OF RESEACH**

The aim of reseach is to analyse the atmospheric precipitation, the number of the days devoid of rain and other meteorological parameters which can influence the dryness of the plants in the forest cultures established by the reforestation in the vegetation season from 1978 to 1986, according to the data obtained by the meterological station in Sjenica, which is situated at 1,030 meters above the sea level.

### **4 WORK METHOD**

Since no uniform, general method for the definition of drought has been accepted so far, we decided to analyse the application of two methods of research.

By the first method, it is considered that the arid period occurred if at least 20 days in a row were devoid of atmospheric precipitation, observing by the season (spring, summer, autum and winter), with the rule that if the arid period from one season extended to another, it is attributed to the season with more arid days, and if the number of the arid days was identical in two neighbouring seasons, it is attributed to the previous season. The arid periods are divided by classes (days of duration) in 6 classes - timestamps, i.e.the periods of the average duration between 20 and 30 days, 31-40, 41-50, 51-60, 61-70 and over 70 days in a season, with the condition that the total sum of the daily precipitation in a class is up to 0.5 mm, i.e. the total in the class of ten days is up to 5mm.

By this method, the number of the possible frequencies of the arid periods by the classes and seasons according to the multi-annual observation was analysed (Table 1), the mean duration of the arid periods by the seasons for each class (Table 2), as well as the probability of the occurence of the arid period by the seasons expressed in percentages (Table 3).

In the aim of the determination of the type of meso-climate according to the long-term observation the mean ombro-hysto-thermal constellation (hydric balance) by the method of Thornthweit, according to the data of the meteorological station Sjenica, were analysed.

Another research method is based on the analysis of the climate indexes (abstracts of Thornthweit) in the aim of the determination of the dominant climate in the years of reforestation of the Pešter Plateau, according to the excerpts of Thornthweit's analyses of the determination of the water surplus and deficit by the months and years of reforestation from 1978 to 1986, as well as on the survey of the series of at least 10 days without precipitation, i.e. with the precipitation less than 1 mm, by the years 1978-1986 in the vegetation season, and at the end on the survey of the influence of arid year 1985/86 on the dry of the forest cultures in the Pešter Plateau.

## 5 RESEARCH RESULTS

The frequency of arid periods is defined by seasons (winter, spring, summer, autumn; since these period lasts for 10 days at least, the monthly frequencies would not provide a clear picture as seasonal. The frequency of the arid period by seasons is calculated in the following way: if the arid period extended from one to another season it is attributed to the season in which the period lasted longer. If the number of days was equal in both seasons, the period is attributed to the previous season. Since the arid periods are divided in six groups (classes), the possible arid period frequencies are represented in the following Table:

*Table 1 - The frequency of the arid period*

Classes	Spring	Summer	Autumn	Winter
20–30 days	28	18	25	25
31–40 days	12	5	10	10
41–50 days	3	1	1	1
51–60 days	1	1	1	2
61–70 days	1	1	1	3
>70 days	–	–	1	1
Total	45	26	39	42

The arid periods which last from 20 to 30 days are the most frequent, which is logical. They occur mostly in spring, autumn and winter, whereas they are rarer in summer. However, periods without precipitation lasting for more than 70 days occur only once in autumn and winter. Although winter droughts do not have any direct influence on the dryness of the cultures, they are of a great indirect significance, since they may cause humidity deficit in soil at the beginning of the spring.

### *Duration of the arid periods*

Beside the frequency, the average duration was determined by the seasons for every above group: 20-30, 31-40, 41-50, 51-60, 61-70, and over 71 days. The mean durations of the arid periods for each group were derived from their frequency in the observed period. The values are shown in the Table 2:

*Table 2- The mean duration of the arid periods*

Classes	Spring	Summer	Autumn	Winter
20–30 days	24.3	23.3	23.7	24.1
31–40 days	34.8	35.2	35.9	33.2
41–50 days	43.6	41.0	48.0	46.0
51–60 days	52.0	55.0	60.0	55.5
61–70 days	62.0	61.0	69.0	67.3
>70 days	–	–	69.0	73.0

The data show that the mean duration of the arid periods by the classes is approximately at the level of the arithmetic mean of the range of the days in the class.

***Probability of the occurrence of the arid periods***

In order to represent the drought conditions in a clear way, the probability of the occurrence of the arid period was calculated for the analyzed intervals, as well as the frequencies and durations.

*Table 3- The probability of the occurrence of the arid periods (%)*

Classes	Spring	Summer	Autumn	Winter
20–30 days	75	48	67	67
31–40 days	32	13	27	27
41–50 days	8	2	2	2
51–60 days	2	2	2	5
61–70 days	2	2	2	8
>70 days	–	–	2	2

It can be seen from the Table that the highest probabilities of the occurrence are found in the intervals from 20-30 days, and from 31-40 days, which is logical, since in these intervals the largest frequencies occur as well. Nevertheless, it can be noted that values considering the number of the arid days are very high as well, particularly in spring, the period which is very important to the growth and development of forest cultures.

***The hydrological balance according to Thornthweit***

The Table of the hydrological balance shows that if the above mean monthly air temperature and precipitation amounts are present, not a month during the vegetation season has water deficit in active absorption layer, and that there are water reserves in the months when the mean monthly temperature is the highest. In the first six months, as well as in the last three months, the active absorption layer is saturated with water, and the surplus drains freely. The water surplus value is approximately 300 mm. The mean ombro-hygro-hysto thermal constellation of meso-climate of the Pešter Plateau is characterized by the moderate humidity, by the winter period with snow which lasts for five months, and by the possibility of the occurrence of frost in all months of the vegetation season (except July).

The analysis of Tables 1, 2, and 3 by the application of the first method of the possibility of the drought occurrences based on the multi-annual observation, points to the

fact that the frequency of the drought occurrences lasting from 20 to 30 days is possible in most cases, but the occurrence of it is lowest in the summer period when the unfavourable influence is the greatest. The possible mean duration of the arid period is within the limits of the logical arithmetic mean values, and it is logical that the possibility of the occurrence expressed in the percentages is the greatest in the class the duration of 20-30 days, and it is significant that there is the lowest probability during summer season.

The analyses only point to the possibility of occurrence of arid periods, but the applied method does not provide the answer when and under which concrete climate conditions we might expect arid periods with the negative ecologic consequences to vegetation i.e. dryness of the forest cultures.

The hydrological balance according to Thornthweit, based on the analysis of mean values of the multi-annual observation, shows that meso-climate based on the data from meteorological station Sjenica, showed the deficit in the soil humidity in no month.

Only in VII, VIII and IX months it did not show either deficit or surplus of humidity in soil, while in the all other months it showed the surplus of water, with the total surplus of 300 mm during the year, which is the characteristic of the moderate humid climate (Table 4).

The presented data of the hydrological balance according Thornthwet, which are based on the multi-annual mean values, do not provide us with the satisfying results in relation to the possibilities of the determination of the climate, as the ecological factor in certain years.

Therefore, we decided to analyze the climate phenomena by the years and months for a period from 1978 to 1985. The arid period is defined by the continuous rows of at least ten days with precipitation less than 1mm a day during the vegetation season. In order to get the insight into the changeability of the climate of the Pešter Plateau, the hydrological balance according to Thornthweit by the years from 1978 to 1985 was analyzed, which was followed by the analysis of the excerpt from the analysis of the water surplus and shortage by the months and years according to Thornthweit, which indicates the occurrence and duration of arid period influencing the dryness of the forest cultures.

*Table 5- The hydrological balance according to Thornthweit*

Year	Climate indexes			Definicija klime
	ih	in	Im	
1978	60.4	3.5	56.9	(B2) mild humid
1979	74.5	0.0	74.5	(B3) increased humid
1980	64.0	11.2	57.3	(B2) mild humid
1981	25.7	1.7	24.7	(B1) mild humid
1982	8.1	22.1	-5.1	(C1) sub-humid drier
1983	15.8	6.9	11.5	(C1) sub-humid moister
1984	21.9	12.8	14.2	(C2) sub-humid moister
1985	54.5	26.2	38.8	(B1) mild humid
1986	29.9	10.1	23.8	(B1) mild humid

The analyzed climate indexes show that the climate in the Pešter Plateau is rather changeable from year to year. It ranges from increased humid (B3) to sub-humid drier variant (C1), but in no year it was of the arid-xerotherm character. On the contrary, in

Table 4- Hydrological balance (Thornthweit)

Characteristic	MONTH												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
T	-5.4	-2.5	0.8	6.2	11.2	13.8	15.3	14.6	11.7	7.2	3.3	-2.5	6.1
I	0.0	0.0	0.06	1.39	3.39	4.65	5.44	5.07	3.62	1.74	0.53	0.0	25.89
(PE)	0.0	0.0	1.7	2.20	46.6	62.0	68.0	65.0	50.0	27.5	10.6	0.0	343.3
PE	0.0	0.0	1.73	25.65	58.72	79.36	87.72	78.00	52.00	26.12	8.58	0.0	427.88
P	48	36	41	49	80	81	72	61	62	62	71	55	712
R	100	100	100	100	100	100	84.28	67.28	77.28	100	100	100	1118.84
SE	0.0	0.0	17.3	25.65	58.72	79.36	87.72	78.00	52.00	26.12	8.58	0.0	427.88
M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V	48	36	39.27	23.35	21.28	1.54	0.0	0.0	0.0	13.6	62.42	55	300.46

the years when the plants dried (1985/86), climate indexes show that a variant of the mild humid climate was diagnosed. By the analysis and calculation of the other parameters of hydrological balance, we approached to determination of the surplus and deficit of water by the months and years, as it is represented in the excerpt of the analysis by Thornthweit in the survey of the Table 6.

From the review of humidity deficit and surplus according to Thornthweit, it can be seen that the deficit of humidity frequently occurs in the summer months in all analyzed years, except in 1979, which is climatically defined as humid increased.

From the Table 6 it is seen that the row of arid years with the humidity deficit during the summer period started in 1982 and with smaller oscillations, lasted to 1986, and the greatest deficit was reported in 1985.

The humidity deficit in 1981 was reported only in August, 10.1 mm. However, during the whole vegetation season the humidity surplus was not determined, but the characteristic of the climate index, as the mild humid climate, is mostly the consequence of humidity surplus of 149.7 mm in the period from January to March, and from November and December i.e. in the non-vegetation season.

The following year (1982) is marked as sub- humid drier (C1) and has soil humid deficit of 128.4mm in VII, VIII, IX and X months, while humidity surplus during vegetation season was not determined.

In 1985, when the dry of the cultures was the most intensive on the soils of II and III categories in south exposures and ridge parts subjected to insolation and wind, the humidity deficit of 153.6 mm was continuously registered from July to October, when the plants needed it most.

The analysis by the application of Thornthweit's hydrological balance is only relatively suitable method for the interpretation of the climate phenomena, as it was devised for relatively deep, structured climatogenic soils, and in this case reforested areas are of significantly more unfavourable pedo-climate, dominantly represented in the areas of II and III category i.e. skeleton eroded shallow soils. Although the pedo-climate is significantly more unfavourable than the analysis of the hydrological balance shows, it points to the causes of the influence of the arid period on the dryness of the plants from the certain sites.

Beside the analysis of the humidity deficit presented in the Table 6 and influence on the dry of forest cultures in certain micro-site conditions, since the reforestations were conducted on skeleton eroded soils of rather unfavourable hydrological capacity, the crucial influence on the dry of the plants is the continuous number of days devoid of precipitation by the months during vegetation. These continuous periods with precipitation less than 1mm within 24 hours are presented in the following review:

*Table 7 - Rows of at least 10 days with precipitation less than 1 mm daily*

Year	Time intervals with the number of days in a row devoid of precipitation, i.e. with the precipitation less than 1mm	The total number of days without the precipitation
1978	2/06-11/06(10); 29/06-15/07(17); 23/07-4/08(13); 7/10-20/10(14)	54
1979	30/7-8/08(10); 8/10-18/10(11)	21
1980	12/09-24/09(13); 27/09-9/10(14)	27
1981	16/09-30/09(13)	13

Table 6- Excerpt from the Thornthwait's analysis of the water surplus and deficit by the years and month

Month	Years (D =humidity deficit ; S =humidity surplus)																							
	1978		1979		1980		1981		1982		1983		1984		1985		1986							
	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	M	S						
I	0.0	53.2	0.0	94.3	0.0	53.0	0.0	31.4	0.0	0.0	0.0	8.6	0.0	39.3	0.0	65.2	0.0	47.9						
II	0.0	70.3	0.0	23.9	0.0	29.3	0.0	15.3	0.0	0.0	0.0	68.0	0.0	35.4	0.0	66.2	0.0	118.6						
III	0.0	53.4	0.0	0.0	0.0	37.3	0.0	14.9	0.0	27.7	0.0	12.0	0.0	34.5	0.0	27.9	0.0	9.2						
IV	0.0	7.3	0.0	2.7	0.0	27.9	0.0	0.0	0.0	19.7	0.0	0.0	0.0	13.5	0.0	17.6	0.0	0.0						
V	0.0	70.7	0.0	2.7	0.0	19.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
VI	0.0	0.0	0.0	41.5	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
VII	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.9	0.0	0.0	0.0	71.6	0.0	77.4	0.0	0.0						
VIII	17.7	0.0	0.0	8.5	21.2	0.0	10.1	0.0	0.0	0.0	35.6	0.0	0.0	0.0	27.3	0.0	4.2	0.0						
IX	0.0	13.2	0.0	0.0	41.3	0.0	0.0	0.0	46.7	0.0	0.0	0.0	0.0	0.0	45.5	0.0	54.6	0.0						
X	0.0	0.0	0.0	49.7	0.0	4.8	0.0	0.0	7.7	0.0	3.7	0.0	0.0	0.0	3.4	0.0	0.0	0.0						
XI	0.0	0.6	0.0	155.9	0.0	92.6	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.3	0.0	0.0						
XII	0.0	63.2	0.0	51.3	0.0	93.3	0.0	77.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.9	0.0	0.0						
Annual	19.4	331.9	0.0	430.5	62.5	357.8	10.1	149.7	128.4	47.4	39.3	88.6	71.6	122.7	153.6	319.1	58.8	175.7						
Annual sum of precipitation	861.9		1.008.3		841.1		722.2		501.4		618.1		595.5		551.1		704.3							
The sum of precipitation in the vegetation season (IV-X)	542.6		591.3		465.2		476.6		377.0		315.2		359.2		262.4		432.4							

From the Table 7, it can be seen that in each analyzed year there were 10 or more days in a row without the rain during the vegetation season, which is qualified as arid period, which is accompanied with relatively high maximum temperatures during VI-IX months in south exposures, relatively low air humidity in the midday hours, and warm wind, which accelerated the evaporation, and had negative ecological influence on the vitality of forest cultures established on skeleton eroded shallow soils of II and III categories.

The most intensive dry of the forest cultures occurred during 1985, when in the period from July to the beginning of October the total of 70 rainless days were registered in three periods in the rows lasting from 18 to 30 days, and in 1986 when the total of 74 rainless days were registered in three periods from July to the beginning of October in the row lasting from 11 to 41 rainless days.

The negative ecological consequences during two successive years, i.e. 1985/86, were reflected in the dry of the of forest cultures established in south exposures and ridge parts exposed to insolation and dry summer winds.

The high temperature on the surface of the ground in the midday hours, which even exceeded 50°C, the warm wind and shallow unstructured skeleton soil, frequently only up to 20 cm deep with compact rock in the "C" horizon, without the possibility of gravity water retention during atmospheric precipitation, and the absence the of ascendant capillary rising, contributed to the drop of the humidity in the rhizospheric zone below the point of dryness. Therefore, under such circumstances the dryness of the certain percentage of the sown plants in the forest cultures up to five-year old occurred.

Out of the total reforested area of 9,025 ha in the vegetation season, on 3,837 ha (42.5%) the optimum canopy was preserved, as the above arid period did not damage the cultures, since the plant survival rate was over 90%.

On the remaining 5,188.5 ha (57.5%) the 1985/86 drought caused the dry of 12% of 82% planted plants, 54% in average. The project aimed at the supplement established the reduced area of 2,789 ha or 31% of the total reforested area.

It is important to mention that on the all 5,188 ha of forest cultures established from 1980 to 1985, and damaged by the 1986 drought, after the first vegetation upon the planting during colaudation, the established survival rate was over 89%.

This fact serves as the proof of the fact that the applied method and the technology of the reforestation by the voluntarily actions of the young forest campaigners, as well as the planting in the vegetation season are not the causes of the dry of the forest cultures, since the first vegetation after planting is the most critical for the survival of the plants, and in the Pešter Plateau the mean level of the thriving of the planted seedlings after the first vegetation upon the planting was 89.9%.

The above arid years did not only caused damage to forestry, but the enormous damages were also recorded in agriculture, particularly in cattle breeding, the dominant agricultural activity of the region, since the production of the grass was decimated on the pastures, as well as hay production on meadows, which has considerably endangered cattle stock.

## 6 CONCLUSIONS

The climate characteristics of an area are beside edaph conditions, the most significant environmental factors for successful survival and development of forest cultures upon the reforestation of the eroded skeleton area of hill-mountainous region in Serbia.

In the period 1978-1988, in the area of Southwest Serbia, 120,000 ha were reforested, and only in the Pešter Plateau over 9, 000 ha were reforested in the vegetation season in the period 1978-1986 by planting the seedlings produced in containers with the protected root.

The arid period which occurred in 1985/86 influenced the partial dry of the plants in forest cultures on shallow skeleton barrens of south exposures, subject to insolation and the warm winds.

In the area of the Pešter Plateau, as the representative of altitudinal region of Southwest Serbia, by the use of the data from the meteorological station located in Sjenica, the researches of the possibilities of the occurrences of the arid periods and the influence of them on the dryness of the plants in the forest cultures were conducted.

The analysis based on the multi-annual processes of the climate phenomena, point to the real possible occurrence of arid periods, but not to the determination of arid period in time and space.

Thus, it necessary to analyze the climate parameters by the years and months, since it enables the accurate determination of the frequency and periodicity of the occurrence of the arid period in a row by the years, as well as the value of the certain climate parameters, during which it is most important to determine the intensity of the precipitation in the vegetation season less than 1 mm, as well as to analyze the water surplus and deficit in the soil by the years and months of the analysis according to Thornthweit.

Forest cultures established in the south-exposed areas of steep inclinations and ridges with the eroded skeleton shallow poorly-structured soils with the "C" horizon of the compact rock, owing to the inability to retain gravity water and due to the absence of capillary rising, when there is the increased evaporation on exposed micro-localities, the humidity in the rhysosphere zone drops below the point of dryness, causing the dry of the sowing plants.

Since the long-term strategy envisages reforestation of over a million of hectares of eroded skeleton barrens of hilly-mountainous region by the end of the century, it is necessary to find by the researches the technical-technological solutions to deepening of the pedologic profile, by the penetration to the rocky "C" horizon, which would enable the penetration of root system to deeper skeleton layers with incrustated smaller particles of soil.

The success of the reforestation in the vegetation season by planting the seedlings with roots protected by moist peat corks produced in containers, performed in the most unfavourable stone-skeleton and eroded areas on lime and serpentine mountain massifs of the barrens in Southwestern Serbia and other regions, ensures the successful reforestation of vast areas of barrens in Serbia.

## LITERATURE

- Gajić, M. (1987): Floristic Elements of Republic of Serbia. Forest botany with anatomy of trees, Faculty of Forestry, 287-345. Article 378-445, Belgrade. (*Original- Florni elementi SR Srbije. Šumska botanika sa anatomijom drveta, Šumarski fakultet, 287-345. Prilog 378-445, Beograd*)
- Dražić, M. (1990): Particularities of projection and selection of technology of reforestation for successful organization of voluntarily work actions of the young forest campaigners. Special edition: Reforestation of barrens and improvement of forest-

- ry of Serbia in the period 1972-1989. The Institute of Forestry and The Republican Federal Executive Institute (FEI) of Forestry. (*Original- Specifičnosti projektovanja i izbora tehnologije pošumljavanja za uspešno organizovanje omladinskih radnih akcija. Posebno izdanje: Pošumljavanje goleti i unapređenje šumarstva Srbije u periodu 1972-1989. Institut za šumarstvo i Republički SIZ šumarstva*)
- Dražić, M. (1990): Mass reforestation and problem of desiccation of forest cultures. Special edition: Reforestation of barrens and improvement of forestry of Serbia in the period 1972-1989. The Institute of Forestry and The Republican Federal Executive Institute (FEI) of Forestry. (*Original- Masovna pošumljavanja i problem sušenja šumskih kultura. Posebno izdanje: Pošumljavanje goleti i unapređenje šumarstva Srbije u periodu 1972-1989. Institut za šumarstvo i Republički SIZ šumarstva*)
- Dražić, M. (1997): The origin of barrens and reforestation in Serbia. Forestry number 6. (*Original- Postanak goleti i pošumljavanja u Srbiji. Šumarstvo br.6*)
- Dražić, M. et all. (1981): The problem of reforestation of barrens of sand of Ram-Golubac sand by the seedlings with balled and bare roots. The Collection of Papers of The Institute of Forestry, volume XVI-XVIII, pp. 17-28. (*Original- Problem pošumljavanja peskova Ramsko-Golubačke pešćare sadnicama sa baliranim i golim korenom. Zbornik radova Instituta za šumarstvo, tom XVI-XVIII, str. 17-28*)
- Dražić, M. et all. (1988): Performative project of reforestation of barrens and supplement of the cultures by Youth Work Action "Peshter". The Institute of Forestry. Belgrade. (*Original- Izvođački projekat pošumljavanja goleti i popunjavanja kultura ORA „Pešter“. Institut za šumarstvo. Beograd*)
- Kolić, B. (1978): Forestry ecoclimatology - micro climate of forest sites. University in Belgrade - Scientific book, Belgrade. (*Original- Šumarska ekoklimatologija – mikroklima šumskih staništa. Univerzitet u Beogradu – Naučna knjiga. Beograd*)
- Milosavljević, M. (1963): Climatology, Scientific book, 1-258, Belgrade. (*Original- Klimatologija, Naučna knjiga, 1-258, Beograd*)
- Ratknić, M., Dražić, M. (1989): Analysis of the climate conditions as the ecological factor which influence the survival of plants in the cultures of Peshter plateau. The Institute of Forestry and Wood Industry. The Collection of Papers, number 32-33. 59-70, Belgrade. (*Original- Analiza klimatskih prilika kao ekološkog faktora od uticaja na preživljavanje biljaka u kulturama Peštarske visoravni. Institut za šumarstvo i drvnu inustriju. Zbornik radova, br. 32-33, 59-70, Beograd*)
- Ratknić, M., Šmit, S. (1999): Demarcation of agricultural and forest land and optimal use of the areas in forestry using Peshter plateau as the example. The Institute of Forestry, Special edition, Belgrade. (*Original- Razgraničenje poljoprivrednog i šumskog zemljišta kao i optimalno korišćenje površina u šumarstvu na primeru Peštarske visoravni. Institut za šumarstvo, Posebno izdanje, Beograd*)
- Rakonjac, LJ. (1995): Thriving of forest cultures of black pine in Peshter plateau depending on the technological methods of reforestation and site conditions. The Institute of Forestry, Collection of Papers, numbers 36-37, 29-41, Belgrade. (*Original- Prijem šumskih kultura crnog bora na Peštarskoj visoravni u zavisnosti od tehnoloških postupaka pošumljavanja i stanišnih uslova. Institut za šumarstvo, Zbornik radova, br. 36-37, 29-41, Beograd*)

## THE POSSIBILITY OF THE OCCURENCE OF ARID PERIODS OF THE ALTITUDINAL REGION OF SOUTHWEST SERBIA USING THE PEŠTER PLATEAU AS AN EXAMPLE

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### Summary

From the end of the Second World War to 1990 over 400,000 ha of the eroded skeleton barrens of the hilly-mountainous region in Serbia were reforested.

By the long-term reforestation strategy, by the end of the century the area of around 1.3 million hectares should be reforested, in order to increase the percentage of the area covered by forests in Serbia from the current 27.5 % to around 41% and thereby the approximate ecological ratio in nature would be established and the quality of the environment would be improved.

Man by his activities influenced the vast increase of carbon-dioxide in the air and other the increase of the other gas pollutants, which cause the occurrence of the phenomenon of “glass house”, the accelerated global warming of the Planet, which have an adverse effect on the changes of the macro-climate events and the living world.

The science warned the world about the necessity of the reduction of the carbon-dioxide emission in the atmosphere, of limiting of the destruction of the forest ecosystems, particularly “rain forests” in the tropic regions and of the reforestation of the areas in which the forest used to exist and thereby, by the increase of oxygen emission, the balance with carbon-dioxide should be established, in order to decelerate, if not to stop the fatal warming of the Earth and destruction of the living world.

Forestry science has the task to study whether the changes occur in the sites of the current forest ecosystems owing to the possible advance of the arid-xerotherm climate on boreal regions, which would cause the move of the numerous tree species and other plants from the current sites to the boreal areas and high altitudes.

The researches and practice show that in the area of Serbia as well the climate is changeable and that the arid periods occur in cycles, which should be taken into account during the planning of the reforestation of the barrens of the hilly-mountainous region.

Reforestation projection should be preceded by the researches and analyses of the climate characteristics of the region which is being reforested – edaph environmental conditions, and according to these data the selection of the species for reforestation and optimal selection of the methods and technologies of soil preparation for the planting of the seedlings should be performed.

The degree of success of the reforestation in the vegetation cycle by the plantation of the seedlings with the root protected by the moist peat cork produced in containers, performed in the most unfavourable stone-skeleton and eroded areas in the limestone and serpentine mountain massifs of the barrens of Southwest Serbia and other areas, ensures the successful reforestation of the vast areas of barrens in Serbia.

## MOGUĆNOST POJAVE SUŠNIH PERIODA VISINSKOG REGIONA JUGOZAPADNE SRBIJE NA PRIMERU PEŠTERSKE VISORAVNI

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### Rezi me

Od završetka II svetskog rata do 1990. godine, u Srbiji je pošumljeno preko 400.000 hektara erodiranih skeletnih goleti brdsko-planinske regije.

Dugoročnom strategijom pošumljavanja, do kraja ovog veka treba pošumiti još oko 1,3 miliona hektara kako bi se stepen šumovitosti Srbije sa sadašnjih 27,5% povećao na oko 41% i time uspostavila približna ekološka ravnoteža u prirodi i povećao kvalitet životne sredine.

S obzirom da je čovek svojim aktivnostima doprineo enormnom povećanju ugljen-dioksida i drugih gasovitih polutanata, uzročnika pojave fenomena "staklene baste" i ubrzanog zagrevanja naše Planete sa negativnim uticajem na promene makroklimatskih manifestacija i živi svet.

Nauka je upozorila svet o neophodnosti smanjenja emisije ugljendioksida u atmosferu, ograničenje uništavanja šumskih ekosistema, posebno „kišnih šuma“ u tropskim predelima i reforestaciju prostora na kojima su šume postojale i na taj način, povećanjem emisije kiseonika u atmosferu uspostaviti balans sa ugljendioksidom, kako bi se usporilo ako ne i zaustavilo fatalno zagrevanje Zemlje i uništavanje živog sveta.

Šumarska nauka bi imala zadatak da istražuje da li nastupaju promene u staništima sadašnjih šumskih ekosistema zbog eventualnog nadiranja aridno-kserotermne klime na borealnim predelima, što bi dovelo do pomeranja brojnih vrsta drveća i drugih biljaka sa sadašnjih prostora njihovih staništa ka borealnim predelima i većim nadmorskim visinama.

Istraživanja i praksa pokazuju da je i na području Srbije klima promenljiva i da se ciklično pojavljuju sušni periodi o čemu treba voditi računa kod planiranja pošumljavanja goleti brdsko-planinske regije.

Projektovanju pošumljavanja treba da prethode istraživanja i analiza klimatskih karakteristika regije koja se pošumljava – edafskih uslova sredine i na osnovu tih saznanja vršiti izbor vrsta za pošumljavanje i optimalan izbor metoda i tehnologija pripreme zemljišta za sadnju sadnica.

Uspešnost pošumljavanja u vegetacionom periodu sadnjom sadnica sa korenom zaštićenim vlažnim tresetnim čepom proizvedenim u kontejnerima, izvršenih na najnepovoljnijim kamenito-skeletnim i erodiranim površinama na krečnjačkim i serpentinским planinskim masivima goleti jugozapadne Srbije i drugih predela, obezbeđuje uspešnu reforestaciju ogromnih površina goleti na području Srbije.

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