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ANALYSIS OF ARIDITY INDICATORS IN THE DELIBLATO SANDS

Abstract: Deliblato Sands are located in the southern part of Banat region in Vojvodina province. According to the estimated changes of basic climate parameters in this part of the Republic of Serbia during past decades very strong rise in annual air temperatures (T) was registered, an average of 0.52°C per decade. This rise in temperature increased the potential evapotranspiration (PET), which together with precipitation can increase the degree of aridity of climate in the study area. However, in the same period an increase in annual precipitation sum (P) was observed, an average of about 35 mm per decade, which may somewhat slow the aridisation of desert sands. Considering the nature, origin and significance of Deliblato Sands ecosystem, the main goal of this paper is to analyse the drought and aridity index ($AI = P / PET$), analyse the trend of aridisation process and its possible impact on ecosystems of this special nature reserve. Aridity index analyses were performed in meteorological stations Banatski Karlovac, Vrsac and Bela Crkva for the period 1981 – 2010 at the annual values and for the growing season. Results showed that Deliblato desert sands (Banatski Karlovac) stand at a higher frequency of arid years ($AI < 0.65$) compared to locations of Vrsac and Bela Crkva. On the other hand, the level of aridity has considerably increased during the vegetation period in desert sands as well in its surroundings. This intensified aridity is the result of considerable increase of potential evapotranspiration (PET) connected to season precipitation.

Key words: Deliblato Sands, aridity indicators, soil degradation, forest ecosystems

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АНАЛИЗА ИНДИКАТОРА АРИДНОСТИ НА ПОДРУЧЈУ ДЕЛИБЛАТСКЕ ПЕШЧАРЕ

Извод: Делиблатска пешчара се налази у јужном делу Баната у Војводини. Према процењеним променама основних климатских параметара у овом делу Републике Србије током протеклих деценија регистрован је веома изражен раст годишњих температура ваздуха (Т), у просеку, $0,52^{\circ}\text{C}$ по деценији. Овај пораст температуре повећао је потенцијалну евапотранспирацију (РЕТ), која заједно са падавинама може повећати степен аридности климе у истраживаном подручју. Међутим, у истом периоду забележен је пораст годишњих сума падавина (Р), од у просеку око 35 mm по деценији, што може донекле успорити аридизацију песка у пешчари. С обзиром на природу, порекло и значај екосистема Делиблатске пешчаре, основни циљ овог рада је да анализира сушу и индекс аридности ($AI = P/RET$), тренд процеса аридизације и њен могући утицај на екосистеме овог посебног резервата природе. Анализе индекса аридности су извршене у метеоролошким станицама у Банатском Карловцу, Вршцу и Белој Цркви за период 1981 – 2010, узимајући годишње вредности за период вегетације. Резултати су показали да Делиблатска пешчара (Банатски Карловац) има већу фреквенцију аридних година ($AI < 0,65$) у односу на локалитете Вршац и Бела Црква. Са друге стране, ниво аридности се значајно повећао током вегетационог периода у пешчари, као и у њеној околини. Ова интензивирана аридност је резултат значајног повећања потенцијалне евапотранспирације (РЕТ) која је повезана са сезонским падавинама.

Кључне речи: Делиблатска пешчара, индикатори аридности, деградација земљишта, шумски екосистеми

1. INTRODUCTION

The United Nations Convention to Combat Desertification (UNCCD, 1995) defines desertification as “land degradation in the arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities”. The main processes in soil desertification are water and wind erosion, as well as chemical, physical and biological degradation. Each form of soil degradation has its own specificity.

The problem of desertification is more prominent not only in arid regions in the world but also in humid regions. The increase in frequency and intensity of numerous hydro-meteorological extremes (drought, heat waves, forest fires, floods, storms...) was the consequence of global climatic changes in the regions of the Balkan Peninsula, and wider region of the Mediterranean, and South-East Europe. These extreme natural occurrences directly influence the process of desertification and together with inadequate human activities (which are the main causes of desertification) cause great damages to economy and society as a whole.

Climate factors play an important role in soil degradation by wind erosion. The climate factors mainly include wind regime, precipitation, temperature, and humidity, among which wind speed is the primary factor because it is the most direct power source

of soil wind erosion. Temperature and precipitation are also important factors affecting soil degradation. These two factors determine the drought degree of a region, and a drier soil is more feasible for wind erosion.

The analysis of annual temperatures in the second half of the 20th century showed that the increase in temperature occurred in most parts of Serbia, whereas the most prominent increase occurred in the last two decades of that century (Spasov *et al*, 2002). On the other hand, general reduction in annual precipitation for the given period of 50 years was recorded in the territory of the Republic (with the exception of mountainous areas in West Serbia). Those climate changes, the consequence of which is temperature increase and precipitation reduction, create more favourable conditions for soil degradation in these areas.

The research on other degradation and desertification factors which are not of climatic origin showed that the land use in Vojvodina, which has only 7.1% of forest cover, creates favourable conditions for strong wind erosion processes (Kostadinov S, Spasov P, 2006). Deliblato Sands are particularly jeopardized by this process in a certain part of the year, when strong east and south-east winds occur.

Extreme habitat conditions (edaphic and climate) and the origin of forest cultures are the reason for instability of these ecosystems. As a consequence, vitality and stability of forest ecosystems weaken, and harmful factors appear in succession and have impact on irreversible devastation and degradation processes.

2. MATERIALS AND METHODS

2.1. Field of Study

The field of study of this paper is the special nature reserve (SNR) Deliblato Sands located in the southern part of Banat covering the area of approximately 348 km² (Fig. 1) Deliblato Sands with its mighty eolian sand deposits and distinct dune relief, sand, steppe, and forest ecosystems, as well as distinct mosaic of animal communities and typical representatives of flora and fauna, is a natural phenomenon unique in Europe.

The climate of Deliblato Sands is generally semi-arid. However, on dune slopes which are south oriented, during summer and particularly in the

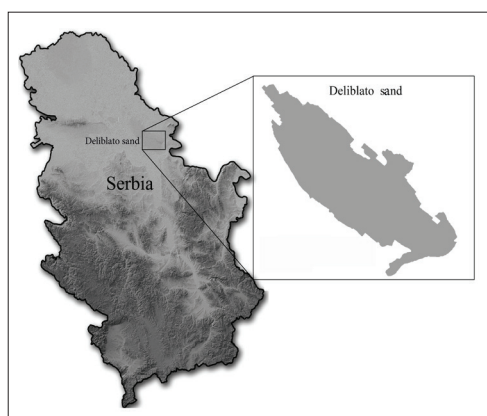


Figure 1. Study area - Deliblato Sands
Слика 1. Истраживана област - Делиблатска пешчара

hottest month (August), climate conditions show the tendency toward aridity since soil temperatures can go almost above 60°C during the day, and water loss in the soil of about 25% of the total precipitation can occur (Vuleta *et al*, 2009).

Antić and associates (1969) gave the genetic classification of soil in Deliblato Sands, where the initial phase is syrozem and the final phase is sand pararendzina. There are great numbers of transitions between the initial and final phases with the quantitative character which acquire qualitative properties only at a certain level of evolution.

Sand evolution into soil, which occurs by the influence of vegetation, starts by biotization in Deliblato Sands. Vegetation, especially forest vegetation, plays a positive role in the process of pedogenesis in the area of Deliblato Sands. Forest trees with their root systems reinforce the sand and with their crown mitigate the habitat extremes, creating unique microclimate. Grass communities also have positive influence on soil, but their influence on microclimate is considerably reduced (Košanin, 2001).

2.2. Methods

Vulnerability of Deliblato Sands to hydro-meteorological disasters (floods, storms, snowdrifts, droughts...), which have an unfavourable influence to soil degradation processes and potential desertification, was analysed on the basis of the climate factors most commonly used in soil degradation studies. Those are primarily precipitation (P), temperature (T), wind (V) and their extremes, potential evapotranspiration (PET), and aridity index (AI). Immediate parameters and derived quantities were acquired from three meteorological stations, out of which Banatski Karlovac is located on the northern border of Deliblato Sands, and Vrsac and Bela Crkva somewhat more east from the Sands.

The assessment of aridity degree in Deliblato Sands was performed on the basis of annual precipitation regime (P) and potential evapotranspiration (PET) bearing in mind their ratio P/PET. This ratio is named **Aridity Index** and marked as **AI**. The Thornthwaite's method (1948), used by UNEP (1992) for the classification of aridity/humidity at the global level on the basis of P/PET ratio, was chosen out of many methods for calculating the potential evapotranspiration. Aridity zones which were defined on the basis of this ratio were shown in Table 1.

Table 1. Aridity zones defined by P/PET ratio (UNEP 1992)

Табела 1. Зоне аридности дефинисане односом P/PET(UNEP 1992)

No. / Број	Climate zone / Климатска зона	P / PET
1.	Arid / Аридна	0.05 – 0.20
2.	Semiarid / Семиаридна	0.21 – 0.50
3.	Sub-Arid / Суб. аридна	0.51 – 0.65
4.	Humid / Хумидна	> 0.65

3. RESULTS

3.1. Climatic Factors in Soil Degradation

The data on monthly and annual precipitation for Banatski Karlovac and other stations were analysed for the period 1981 – 2010 (Diagram 1). Average annual precipitation (Table 2) varies from 31.6 mm in February to 87.4 mm in June, with the annual average of 618.6 mm. This month is characterized by the highest monthly maximum precipitation of 356.1 mm registered in 1999. Very high precipitation was recorded in other months: May 1987 (219 mm), June 1995 (195.3 mm), September 2001 (159.8 mm), etc. The absolute minimums of monthly precipitation which in 9 out of 12 months does not exceed the sum of 10 mm. When it comes to extremes in annual precipitation sum, two years stand out: 1999 with the maximum precipitation of 1038.7 mm and 2000 with only 295.2 mm of precipitation.

Table 2. Average annual rainfall and temperature of meteorological stations B. Karlovac, Bela Crkva and Vrsac

Табела 2. Просечне годишње падавине и температуре у метеоролошким станицама Б. Карловац, Бела црква и Вршац

	B. Karlovac	Vrsac	Bela Crkva
P_{annual} ±Sd	618,6±147,5	649,7±157,1	643,7±133,7
Rang	295,2-1038,7	327,2-1009,0	315,7-964,4
T_{annual} ±Sd	11,5±0,74	11,9±0,78	11,6±0,86
Rang	10,1-13,2	10,4-13,4	10,1-14,2

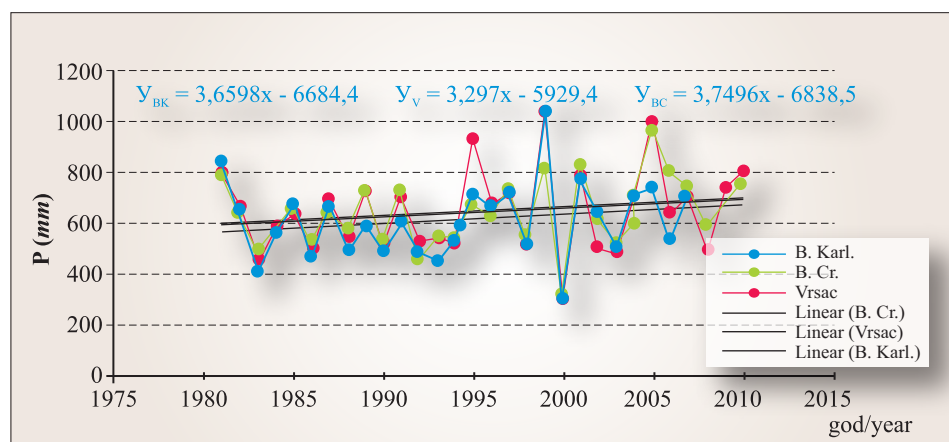


Diagram 1. Annual precipitation trend in Banatski Karlovac, Vršac and Bela Crkva for the period 1981–2010

Графикон 1. Годишњи тренд падавина у Банатском Карловцу, Вршцу и Белој Цркви за период 1981–2010

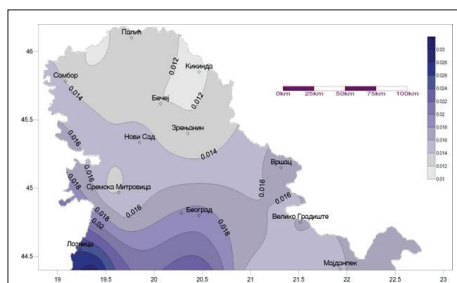


Figure 2. The probability of the number of days with precipitation $> 20 \text{ mm}$
Слика 2. Вероватноћа броја дана са падавинама $> 20 \text{ mm}$

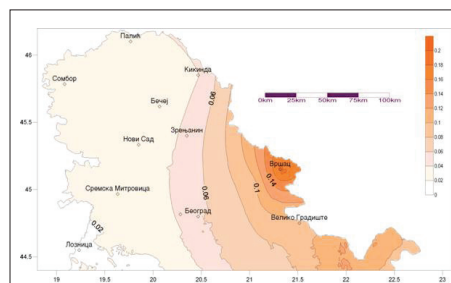


Figure 3. The probability of storm wind occurrence $> 17.2 \text{ m/s}$
Слика 3. Вероватноћа појаве олујног ветра $> 17.2 \text{ m/s}$

The month with most rain on average is June (84.6 mm), and the month with the least rain is February (35.5 mm). Absolute maximum in monthly precipitation occurred in July 1999 (214 mm). Driest year was 2000, but the highest precipitation in Vrsac was measured in 2005 (1009 mm) not in 1999 (Figure 2).

Absolute daily precipitation maximum in Bantski Karlovac for the period 1981 – 2010 was 92 mm (July 1999) and was lower than the maximum of 126.7 registered in July 1974. Considerably higher maximum was registered in Vrsac which in July 1995 reached 189.7 mm .

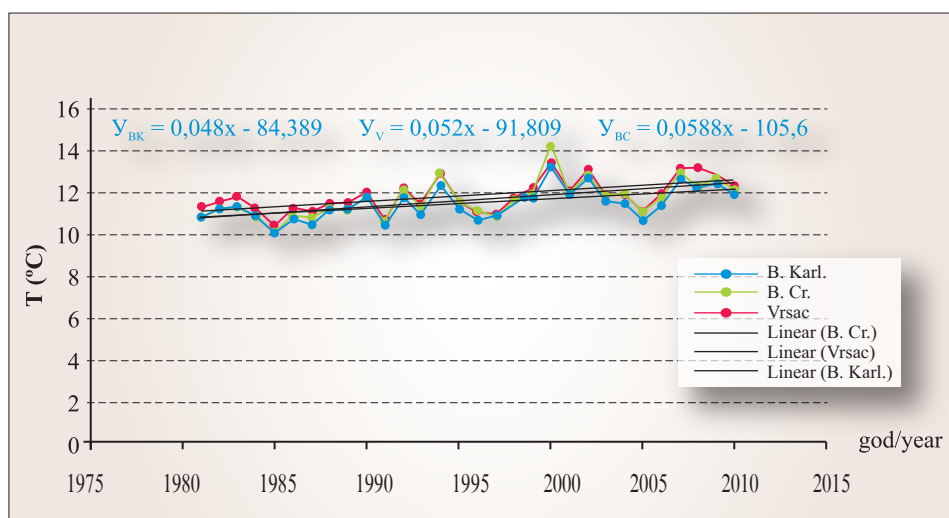


Diagram 2. Annual air temperature trend in Banatski Karlovac, Vršac and Bela Crkva for the period 1981–2010

Графикон 2. Годишњи тренд температуре ваздуха у Банатском Карловцу, Вршцу и Белој Цркви за период 1981–2010

The data on the average number of days with wind storms, i.e. days when wind speed exceeds 17.2 m/s , which indicates that Deliblato Sands and south Banat as a whole are the parts of Serbia most likely to deal with storm winds. The map (Figure 3) shows that the probability, which is most prominent in Vrsac (0.183) slowly decreases towards Belgrade. The probability of storm wind occurrence in Banatski Karlovac is 0.091 (9.1%), i.e. half the probability for Vrsac (18.3%).

During the studied 30-year period (1981 – 2010) significant increase in annual air temperature was recorded in the area of Deliblato Sands (Diagram 2). The average temperature increase in the decade was 0.52°C , ranging from 0.48°C in Banatski Karlovac to 0.57°C in Bela Crkva. The annual temperature increase for the 30-year period was more than 1.5°C .

At the same time, (unexpectedly) the increase in annual precipitation (P) was registered; an average of 35 mm per decade (Figure 2), i.e. 100 mm for the whole period.

3.2. Aridity Index

Calculation results showed that the average annual sum of PET in Banatski Karlovac is 770.6 mm , varying from 639 mm (in 2006) to 1083 mm (in 2000). The highest monthly values of PET are mainly during summer months, from 132 mm in June to 150 mm in July. The absolute maximum value was registered in August 2000. Vrsac and Bela Crkva have somewhat lower values of PET compared to the above mentioned locality, i.e. 725 mm and 719 mm annually. Moreover, these two stations show less variability in annual sums of PET.

Table 3: Aridity index for the year and the growing season in the period 1981-2010.г.

Tabela 3: Индекс аридности годишњи и за период вегетације 1981-2010 год.

	B. Karlovac	Vršac	Bela Crkva
AI (I - XII)±Sd	0,82±0,22	0,90±0,23	0,90±0,20
AI (I V- IX)±Sd	0,56±0,19	0,63±0,19	0,61±0,20

Diagram 3 and figure 4 summarize the results of aridity index for a year (January-December) and vegetative period (April – September). It can be noticed that only the year 2000 belongs to the category of **semi-arid** at the annual level with the values of $\text{AI} < 0.5$. It can also be noted that Banatski Karlovac, which is located at the north-east border of Deliblato Sands, is distinguished by the frequency of years (6) in the category of **dry sub-humid** with the $\text{AI} = 0.5 - 0.65$, compared to Vrsac (3) and Bela Crkva (2).

Diagram 5 summarizes the results of aridity index for the June-July-August period. It can be noticed that for Banatski Karlovac 16 years, and 15 years for Vršac and 18 years for Bela Crkva, belongs to the category of **arid and semi-arid** on JJA level with the values of $\text{AI} < 0.5$.

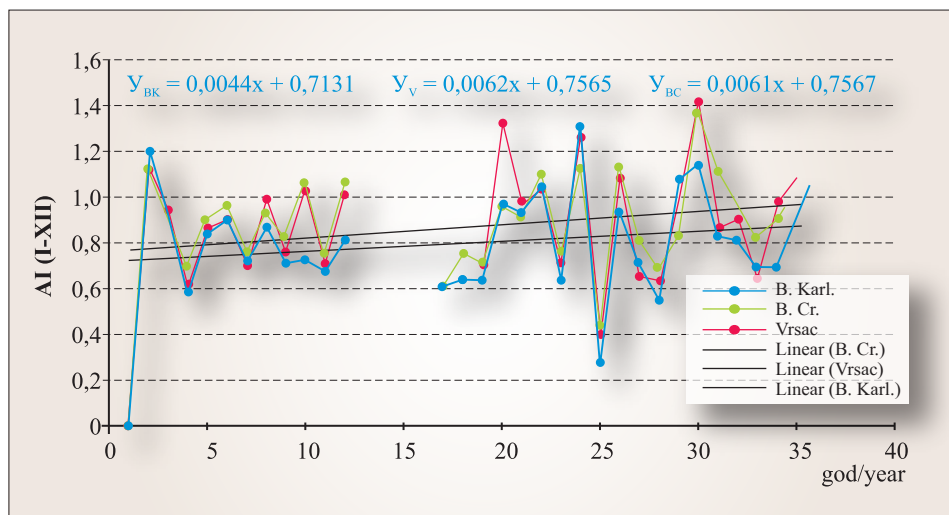


Diagram 3. Aridity index series for the reference periods January-December in Banatski Karlovac, Vršac and Bela Crkva for the period 1981 – 2010

Графикон 3. Серије индекса аридности за референтни период од јануара до децембра у Банатском Карловцу, Вршцу и Белој Цркви за период 1981–2010

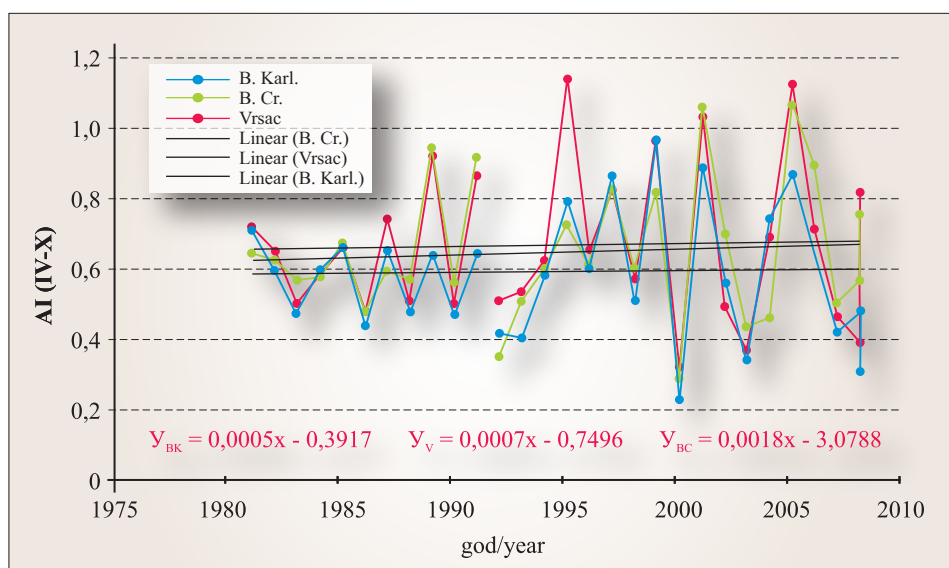


Diagram 4. Aridity index series for the reference periods April- September in Banatski Karlovac, Vršac and Bela Crkva for the period 1981–2010

Графикон 4. Серије индекса аридности за референтни период од априла до септембра у Банатском Карловцу, Вршцу и Белој Цркви за период 1981–2010

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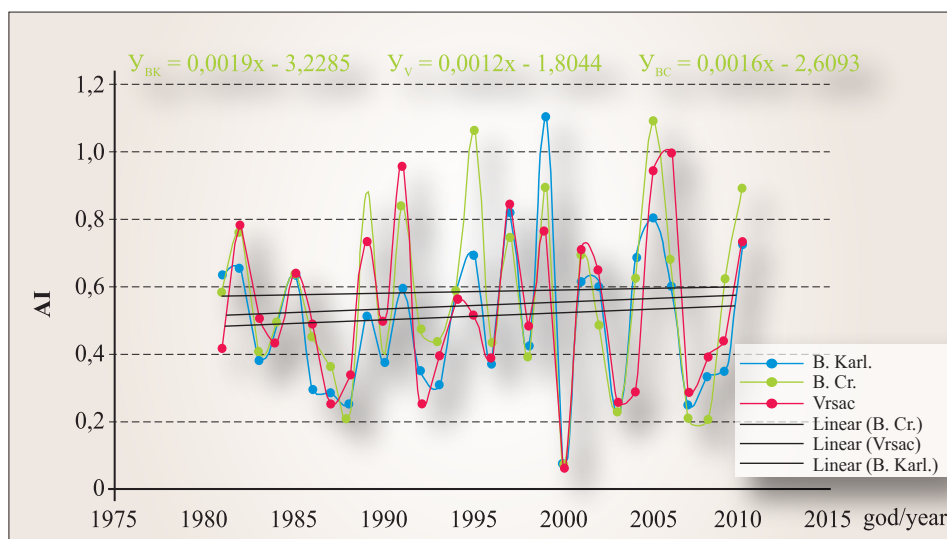


Diagram 5. Aridity index series for the reference period JJA in Banatski Karlovac, Vršac and Bela Crkva for the period 1981–2010

Графикон 5. Серије индекса аридности за референтни период ЈЈА у Банатском Карловцу, Вршцу и Белој Цркви за период 1981–2010

Aridity index values for the summer months (JJA) at meteorological stations Banatski Karlovac, Vršac and Bela Crkva are shown in Table 4.

Table 4. Aridity index values for the summer months June, July and August in Banatski Karlovac, Vršac and Bela Crkva for the period 1981 – 2010

Табела 4. Вредности индекса аридности у летњим месецима јуну, јулу и августу у Банатском Карловцу, Вршцу и Белој Цркви за период 1981 – 2010

	B. Karlovac	Vršac	Bela Crkva
AI (VI)± Sd	0,7±0,34	0,73±0,42	0,70±0,39
AI (VII)± Sd	0,4±0,43	0,52±0,40	0,50±0,38
AI (VIII)± Sd	0,4±0,32	0,5±0,40	0,47±0,38

In relation to the number of years in which the aridity index lower than 0.5 (arid and semiarid) appeared, the situation is as follows: in June this value appeared for 13 years (Banatski Karlovac), 11 years (Vršac) and 9 years (Bela Crkva) in July - 21 years in (Banatski Karlovac), 20 years (Vršac) and 19 years (Bela Crkva), in the month of August - 19 years (Banatski Karlovac), 19 years (Vršac) and 21 years (Bela Crkva) .

4. DISCUSSION

Precipitation is the most important climate factor in determining the areas which run the risk of soil degradation and potential desertification. Precipitation has the main role in the growth and spread of plant cover, but changeable and extreme precipitation can cause soil erosion and other adverse effects. It is observed in the area of Deliblato Sands that precipitation varies, both in monthly and annual intervals. The monthly and annual extremes could have significant negative influence on soil degradation in Deliblato Sands. The properties of precipitation disposition in Bela Crkva are almost completely consistent to the ones in Vršac.

The analysis of the number of days with extensive precipitation (more than 20 mm) showed that the area of south Banat, which includes Deliblato Sands, has somewhat more probability compared to central and north areas of Banat (Figure 2). However, the frequency of precipitation above 20 mm is considerably increased going from these lowlands towards west and south-west of Serbia. On the basis of the data on maximal precipitation, the largest number of days with abundant precipitation is in the months of the vegetative period.

Apart from damages that could be caused by short term rainfalls of strong intensity (Kadović *et al.*, 2013), **wind impact** is also an important factor of soil degradation in the sands. The effects of wind erosion and associated deposition include damage to soils through the loss of chemical fertility, the loss of soil depth, damage to crops and pastures through sandblasting and burial, damage to infrastructure by drift sand and dispersion of weeds and diseases Faghini and Afzali (2013). According to the results of storm wind, it is a certain extent sufficient for Deliblato Sands because the less frequent storm wind in this part of Košava area the less unfavourable consequences caused by wind erosion.

The temperature of air and soil, apart from precipitation, is the main factor determining the climate in all world regions as well as the distribution of plant cover on various soil types (WMO, 2005). Seasonal and daily changes in temperature and precipitation can influence soil humidity, biological activity, the speed of chemical reactions, the type of vegetation, and other. Soil degradation is increased in longer periods with insufficient precipitation, high temperatures, and strong winds because they contribute to drying of the surface soil layer and the loss of its structure (Zhenghu *et al.*, 2004, Jia *et al.*, 2011). With all of the above, reviewing direct influence of temperature and precipitation to the process of degradation should be completed with the frequency of droughts of various durations (Li *et al.* 2009).

The increase in annual temperatures and precipitation in Deliblato Sands and wider, caused many stressful climate changes which had a negative influence on the process of soil degradation. Those increases primarily manifest in longer drought periods which lead to vegetative destruction and loss of biological and economic productivity in the region, and wind and water erosions (extreme drought periods are usually followed by excessive and strong precipitation which cause strong soil erosion).

In order to determine the degree of aridity of Deliblato Sands climate, the balance between precipitation (as input) and evapotranspiration (as output) is particularly important. It is clear that the actual (AET) and not potential evapotranspiration (PET) is the real output, but the adoption of AET could complicate the assessment of drought enormously (Tsakiris G. and Vangelis H., 2005). Therefore PET can be selected as the key parameter representing the intensity of the atmosphere to absorb water from various ground surfaces, and PET is the basis of most actual evaporation estimations (Milly, 1992; Wang and Dickinson, 2012). Consequently, the changes in PET due to climate change are likely to produce an effect on actual evaporation and more generally on the primary production of plants (Barella-Ortiz *et al*, 2013).

As it was mentioned in the methodology, aridity index (AI) was defined as the ratio between annual precipitation (P) and potential evapotranspiration (PET). It represents the basis for defining the areas prone to the risk of soil degradation and potential desertification. There are different methods for assessing PET. The most complex ones are based on the energy balance equation and require a large amount of climate data such as Penman-Monteith equation (Allen *et al*, 1998). Simpler methods usually require one or two meteorological elements (Thornthwaite, 1948; Priestly and Taylor, 1972.; Hargreaves and Allen, 2003).

The advantage of applying the Thornthwaite (1948) method is reflected in the fact that the potential evapotranspiration is determined only on the basis of average monthly air temperatures.

When monthly and annual sums of potential evapotranspiration are determined, the conditions are created for determining the **aridity index** (AI) which is the end product of this analysis. On the basis of the annual ratio between precipitation and potential evapotranspiration (P/PET), **humid** climate (AI>0.65) prevails in Deliblato Sands. However, when aridity index for the warm half of the year is taken into consideration, the assessment of aridity is completely changed. The results of these assessments for the April – September period were given on the right hand side of figure 7. It is obvious that the number of seasons with **semi-arid** and **dry sub-humid** characteristics is considerably increased compared to the previous case scenario. Twelve out of 30 seasons in Banatski Karlovac were in the category of **semi-arid**, 12 were **dry sub-humid**, and 8 were **humid**; in Vrsac 11, 7, and 12; and in Bela Crkva 8, 12, and 10, respectively.

Summer months (Jun, July August) at studied meteorological stations appeared to be the predominant season with arid and semiarid characteristics.

5. CONCLUSION

The vulnerability of the special nature reserve Deliblato Sands to hydro-meteorological disasters (excessive precipitation, floods, wind storms, droughts ...) was analysed on the basis of climate factors which have the unfavourable influence to soil degradation

processes and potential desertification. Aridity level of the climate in Sands was determined by applying the available aridity index (AI) which is the ratio between annual (season) precipitation (P) and potential evapotranspiration (PET).

The results of researches performed for the last 30-year period (1981 – 2010), show an increase in annual air temperatures (T) and annual precipitation sum (P). The increases in annual temperatures and precipitation in Deliblato Sands and wider, caused numerous stressful climate changes which had negative influence on soil degradation processes.

Aridity index (AI), which is the end product of this analysis, showed that **humid climate** ($AI > 0.65$) prevails in the area of Deliblato Sands. However, aridity changes completely when the warm part of the year (April – September) is separately analysed. In a case like that, about 2/3 of seasons showed the following aridity categories: **semi-arid** and **dry sub-humid**, whereas 1/3 were **humid**. In summer months (Jun, July August) at the studied meteorological stations predominantly appeared the season with arid and semiarid properties.

It is necessary to emphasise that the Thornthwaite method compared to the Penman-Monteith, Hargreaves, Priestly-Taylor and other methods, usually shows lower values of potential evapotranspiration. The application of the above mentioned methods will considerably reduce the ratio of annual precipitation and potential evapotranspiration (P/PET), i.e. aridity index (AI), which will show the increased aridity of Deliblato Sands climate for a larger number of years. On the other hand, as part of recently adopted Energy and Water Balance Monitoring System in Europe (Rosema, A, de Weirdt, M, Foppes, S.), on the basis of meteorological data obtained from the Metweosat satellite, PET is in accordance with the Penman-Monteith equation which was calculated as the product of net radiation (Rn) and number 0.8, i.e. $PET \approx 0.8Rn$. Applying the equation in question to available Rn data for the Banatski Karlovac and Vrsac stations, the data on potential evapotranspiration were obtained and they were quite close to the results obtained by the Thornthwaite method.

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АНАЛИЗА ИНДИКАТОРА АРИДНОСТИ НА ПОДРУЧЈУ ДЕЛИБЛАТСКЕ ПЕШЧАРЕ

Резиме

Анализа годишњих температура у другој половини 20. века показала је, да је у већем делу Србије регистрован пораст температуре, који је био нарочито изражен у последње две деценије прошлог века (Spasov *et al.*, 2002). С друге стране, током поменутог 50-годишњег периода, евидентирано је опште смањење годишњих сума падавина широм територије Републике (изузев у високим планинским областима западне Србије). Поменуте климатске промене, које се огледају у повећању температуре и смањењу падавина, доприносе стварању повољнијих услова за деградацију земљишта у нашим крајевима.

Резултати истраживања других фактора деградације земљишта и дезертификације, поред климатских параметара, показали су да коришћење земљишта у Војводини, која има само 6% шумског покривача, ствара повољне услове за развој јаких процеса ерозије ветром (Kostadinov S., Spasov P., 2006.). Делиблатска пешчара је посебно угрожена овом појавом у једном делу године, када дувају јаки источни и југоисточни ветрови.

Екстремни услови станишта (едафски и климатски) и порекло шумских култура, условљавају нестабилност ових система. Као последица тога, слабе виталност и стабилност шумских екосистема, а штетни фактори се јављају у сукцесији и утичу на иреверзибилне токове њихове девастације и деградације.

Угроженост Специјалног резервата природе Делиблатска пешчара од хидрометеоролошких непогода (обилне падавине, поплаве, олујни ветрови, суше,...), анализирана је на бази климатских фактора који неповољно делују на процесе деградације земљишта и потенцијалне дезертификације. Степен аридности климе Пешчаре је оцењен применом познатог индекса аридности (AI), који приказује однос годишњих (сезонских) падавина (P) и потенцијалне евапотранспирације (PET).

Резултати истраживања су извршена за последњи 30 годишњи период (1981-2010. година), у коме је регистрован значајан пораст годишње температуре ваздуха (T) и годишњих сума падавина (P). Поменуто повећање годишњих температура и падавина у Делиблатској пешчари и шире, изазвале су бројне климатске стресне ситуације, које су неповољно утицале на процесе деградације земљишта.

Индекс аридности (AI), који представља финални резултат ове анализе, је показао да на подручју Делиблатске пешчаре преовлађује у глобалу **влажан климат** (AI>0.65). Међутим, услови аридности се у потпуности мењају када се посебно разматра топли део године (април – септембар). У том случају, око 2/3 сезона су попримиле категорије аридности: **полу-сушно** и **мало влажно**, а једна трећина **влажно**. У летњим месецима (јун, јул, август), индекс аридности показује да подручје Делиблатске пешчаре припада, претежно, аридној и семиаридној зони.

Потребно је нагласити да метод Thornthwaite, у односу на методе Penman-Monteith, Hargreaves, Priestly-Taylor и др., углавном даје мање вредности потенцијалне

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евапотранспирације. Примена резултата поменутих метода у приличној мери ће смањити однос годишњих падавина и потенцијалне евапотранспирације (P/PET), односно индекс аридности (AI), што ће у већем броју година указивати на повећану аридност климе Делиблатске пешчаре. С друге стране, у оквиру недавно успостављеног Система мониторинга енергетског и водног биланса у Европи (Rosema, A., de Weirdt, M., Foppes, S.), на бази метеоролошких података добијених помоћу сателита Meteosat, PET је у сагласности са једначином Penman-Monteith рачуната као производ нето зрачења (R_n) и броја 0.8, тј. $PET \approx 0.8R_n$. Применом поменуте једначине на расположивим подацима R_n за станице Банатски Карловац и Вршац добијени су подаци о потенцијалној евапотранспирацији који се у великој мери подударају са резултатима добијених методом Thornthwaite.

