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Climate Characteristics of the Illyrian Phytogeographic Area

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ABSTRACT

The first ecological research in the Illyrian phytogeographic area, located on the Balkan peninsula in south-eastern Europe, dates back to the early 20th century. Traditionally, the Illyrian phytogeographic area includes Bosnia and Herzegovina, Montenegro, Croatia and parts of Slovenia. Due to climate change, more available data and new measurement techniques, the Illyrian phytogeographic area may have shifted northwards to the southern Alps and parts of Austria. In this study we have analysed climate as an important ecological variable for delineating the Illyrian phytogeographic area using precipitation and air temperature from 75 climatological stations in Bosnia and Herzegovina, Croatia, Slovenia and Austria (Carinthia). Our statistical analysis suggests, that there are significant differences in the analysed climate parameters across the countries, suggesting that sub-sections may already exist within the extent of the Illyrian phytogeographic area.

Keywords: Dinaric alps; Mediterranean forests; site conditions; climatology; meteorological measurements; Illyrian phytogeographic area

INTRODUCTION

The first analysis of the Illyrian vegetation was done by Beck - Mannagetta (1901). Adamović (1907) then defined the Illyrian area and stated that it more or less follows the area of the central Dinaric Alps. This area covers parts of contemporary Slovenia, Croatia, Bosnia and Herzegovina, Serbia and Montenegro. Adamović (1907) divided the Illyrian zone fittingly into the following subzones: Bosnian, Herzegovinian-Montenegro and Serbian subzones.

The term "Illyrian floral element" introduced by Beck - Mannagetta (1901) represents all plant taxa that are either (1) completely limited in their distribution or (2) have their centre of distribution in the Illyrian area. Illyrian floral elements from the climatic point of view are mainly thermophilic and heliophilic taxa, even when growing in mountains, due to the strong influence of the Mediterranean Sea on the Dinaride mountains (Trinajstić 1992). Similar interpretations of the climate of the Illyrian area are found in Horvatić (1967), Horvat et al. (1974) and Stefanović et al. (1983).

Fukarek (1978) defines the so-called "core" zone of the Illyrian province, which comprises the area between the rivers Kupa, Korana, Una, Sana and Vrbas. More recent references of the Illyrian phytogeographical area also include part of the southern Alps in Carinthia, Austria (Annon. 2006, 2013). Fukarek (1978), similarly to Adamović (1907), has described the wider Illyrian area as a complex area that can be divided into: northern (Slovenia-Croatia), central (Bosnian) and southern (Herzegovina-Montenegro). Mayer (1986) shared this view and published a map of the climate on the Balkan Peninsula. This map shows that the traditional extent of the Illyrian area does not include the Alps, which are assigned to the "alpine" climate and separated from the Illyrian area.

Detailed analysis of the western part of the Illyrian area by Wraber (1960) for Slovenia and Fukarek (1980) for former Yugoslavia suggest that the western boundary of the Illyrian phytogeographical province indeed ends in Slovenia and does not extend into Austria.

Analysing the map by Wraber (1960), Fukarek (1978) states that, at that time under the name *Fagion illyricum* (Horvat 1938) and now under the name *Aremonio-Fagion* (Horvat 1950, Török et al. 1989), the area includes the following sub-regions: Dinaric, pre-Dinaric, pre-Alpine and pre-Pannonian. The Alpine sector starts at the Slovenian-Austrian border, extends into Austria (Mayer 1986), and is separated from the Illyrian Phytogeographical Province. In the classic book "*Vegetation Südosteuropas*" (Horvat et al. 1974), analysing the vegetation of Southeast Europe, the border of the Illyrian province is described in detail: "Tolmin basin in the Soča (Isonzo) valley across the mountains around Cerknog, Idrije and Škofje Loka, and the Sava basin between Kranje and Ljubljana, further along the Sava valley towards Zidan most (Kum, Veliko Kozje). The lower Savinja basin to the valleys of the river Dravinja (Konjiška gora, Boč) and the valley of the river Sotla (Macelj)".

The classic understanding is that the area of the Dinarides coincides geographically and spatially with the phytogeographical area of the Illyrian province. There is evidence for this link in the naming of the neutrophilic beech-fir forests of the Illyrian area. The original name of this forest type was *Abieti-Fagetum dinaricum* by Tregubov (1957). One year later Fukarek and Stefanović (1958) changed this name to *Abieti-Fagetum Illyricum*, suggesting a tight link between the two terms. Currently the valid name of this forest is *Omphalodo – Fagetum* (Tregubov 1957, Marinček et al. 1993).

The above cited authors (Adamović 1907, Horvat et al. 1974, Fukarek 1978, Mayer 1986) individually conclude that the Illyrian area extends to Montenegro, Bosnia and Herzegovina and Croatia, and that the western boundary of the Illyrian area is in Slovenia and the northern boundary in the pre-alpine area of Slovenia, not extending to the Alps. Recent research related to the phytogeographic division of the western part of the Illyrian province in Slovenia was covered by Dakskobler et al. (2000), Dakskobler (2002), and Surina (2002), while Dzwonko et Loster (2000), Marinšek et al. (2013), Stupar et al. (2022), Ugarković et al. (2022) wrote about the ecology, syntaxonomy and phytogeographical differentiation of the southwestern Balkan peninsula.

More recently, Vukelić et al. (2010), Collalti et al. (2014) and Lévesque et al. (2014) highlighted the impacts of climate change (e.g. increase in average temperatures, changes in precipitation amount and seasonal distribution) on forest area, forest productivity or sensitivity to changes in habitat conditions. Climate change may require long-term changes in forest management that will require a reliable understanding of the origin of tree provenances (Lindner et al. 2014), in order to evaluate the future adaptability and adaptability of tree species under various climate change scenarios (Geßler et al. 2006, Taeger et al. 2013). The available literature underpins the necessity of reliable knowledge on the climatic characteristics of phytogeographical areas.

GENERAL CLIMATE CHARACTERISTICS OF THE ILLYRIAN AREA

Historically and for practical reasons, defining the Illyrian area was done almost exclusively based on flora. However, the Illyrian phytogeographic area has some other peculiarities that are often "neglected", such as vegetation syndynamics and vegetation zoning. Both of these characteristics are a consequence of the ecological characteristics of this area and may help in understanding of the Illyrian phytogeographical area. Climate is an important ecological factor and should be considered in attempts defining the Illyrian phytogeographic area.

General descriptions of the climate of the Illyrian area were given by Horvat et al. (1974), who stated that the

Figure 1. Phytogeographical division of South Eastern Europe (Mayer 1986).

climate of the Illyrian province is different from the climate of other vegetation zones of the Balkan Peninsula, such as the Moesian regions, the Carpathians or the European Alps. In the Illyrian area, there is enough precipitation during the summer and no summer drought, while the Mediterranean climate influence is still present. The seasonal precipitation shows a decrease in the summer months (June-September) for the Illyrian area, while in the Alps in contrast the amount of precipitation increases during summer compared to winter. In the Illyrian area, a usually persistent snow cover lasting from late autumn to March, April or even May protects the soil from frost with an insulating layer from several decimetres up to one meter thick.

The climate in the mountains of the Illyrian area is usually mild, rainy, with a maritime influence. Annual rainfall is usually around 1200-1300 mm, although it can range up to 2000 mm. The middle and upper elevations are often influenced by persistent cloud cover or cloud fog, contributing to the maritime climate character of this area (Horvat et al. 1974). The influence of climate on vegetation is expected to vary along an altitudinal gradient, which is evident from the distinct altitudinal vegetation zoning. As the altitude rises, temperatures drop, late and early frosts shorten the vegetation period, precipitation and the number of foggy days increase and the snow cover is larger and more persistent. More detailed descriptions of climate parameters in the Dinaric Mountains can be found at: https://www.dinarskogorje.com/klima.html.

The objectives of this study are: (1) to analyse regional variations in the Illyrian phytogeographic area using climate station data from Bosnia and Herzegovina, Croatia, Slovenia and Austria (Carinthia), and (2). to check which climatic parameters (air temperature, precipitation) are suitable factors in determining the extent of the Illyrian phytogeographic area.

MATERIAL AND METHODS

All available climate data were collected from Bosnia and Herzegovina (BiH), Croatia, Slovenia, Austria (Carinthia) (mean annual temperature by month, annual average temperature, mean amount of precipitation by month, annual average precipitation sum) for the period 1961-2010 and taken from the Chamber of Agriculture and Forestry in Carinthia (AUSTRIA). In total, data from 75 weather stations were analysed, of which:

- 42 from Slovenia (42 had precipitation data): Illirska Bistrica. Bohinjska Cesnjica, Rateče, Babno Polje, Bovec, Celje, Čepovan, Gornja Radgona, Gornji Lenart, Jareninski vrh, Javorje, Klenik, Kočevje, Kredarica, Krn, Krvavec, Kum, Lesce, Lisca, Ljubljana Bežigrad, Ljubljana JP Airport, Mali Lipoglav, Maribor ER Airport, Maribor Tabor, Miklavški hrib, Mozirje, Murska Sobota, Nanos, Abram, Nova vas, Novo mesto, Planina pri Sevnica, Planina pod Golico, Planina (under Mirno goro), Postojna, Rogaška Slatina, Sevno, Slovenske Konjice, Šmartno near Slovenj Gradac, Topol near Medvodah, Vedrijan, Velenje, Šalovci, Tomaj, Vojsko, Vrhnika, Zgornja Ščavnica;
- 4 from Croatia: Gospić, Knin, Ogulin, Zavižan;
- 13 from Bosnia and Herzegovina: Bihać, Bjelašnica, Bugojno, Butmir, Goražde, Ivan Sedlo, Jajce, Livno, Mostar, Sanski Most, Sarajevo, Tuzla, Zenica;
- 12 from Austria (Carinthia): Bad Bleiberg, Dellach, Bad Eisenkappel, Ferlach, Klagenfurt, Kornat, Reisach, Fresach, Höhenbergen-Tainach, Kanzelhöhe, Loibl-Tunnel, St. Michael ob Bleiburg.

Statistical analysis was conducted using one-factor analysis of variance ANOVA with the StatGraphycs Centurion XVI software. The least significant difference test (LSD test) was used to determine the statistical significance of the average differences for the analysed climate parameters by month between individual countries.

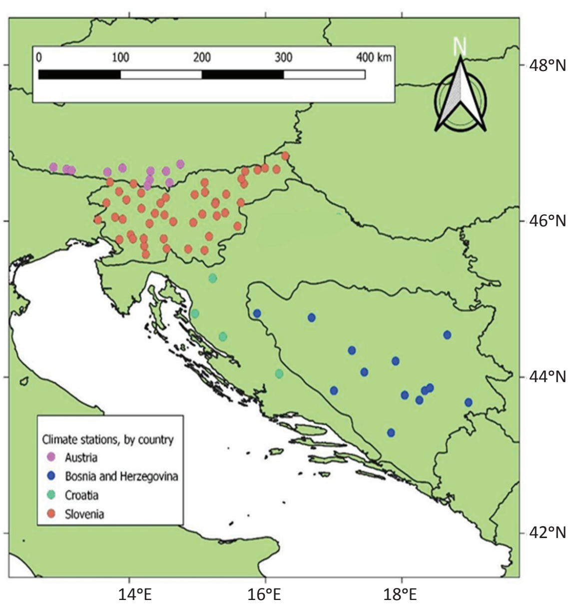


Figure 2. Locations of the used weather stations.

RESULTS

Statistical analyses were conducted for the amount of precipitation and air temperature using data from all weather stations (Table 1).

Table 1 shows that statistically significant differences ($p < 0.05$) occur between October and February for temperature and during the entire year for precipitation except in March, April and November. The climatic elements with significant differences grouped by countries are shown in the following subsections.

Analysis of the Influence of Locality on Precipitation

The results of the conducted one-factor analyses are presented in the graphical (Figure 3-7) and tabular (Table 2-6) form.

Table 1. Presentation of determined values of One-Way ANOVA for the level of significance (p) and the ratio of variances (F) by month, and the average by year for the amount of precipitation (mm) and temperature (°C). Marked (*) are statistically significant differences at p<0.05.

Month	Factor: Temperature (°C)		Factor: Amount of precipitation (mm)	
	Ratio (F)	level of significance (p)	Ratio (F)	level of significance (p)
I	7.18*	<0.001*	5.22*	0.0027*
II	*	0.0215*	7.20*	0.0003*
III	1.39	0.2536	2.02	0.1190
IV	1.22	0.31	1.85	0.1470
V	0.74	0.5325	3.40*	0.0226*
VI	0.59	0.6231	14.98*	<0.001*
VII	0.73	0.5368	17.70*	<0.001*
VIII	0.98	0.4052	23.52*	<0.001*
IX	1.92	0.1349	11.42*	<0.001*
X	2.88*	0.0421*	4.25*	0.0083*
XI	6.08*	<0.001*	1.65	0.1866
XII	7.52*	<0.001*	2.87*	0.0431*
Average (I-XII)	2.03	0.1175	3.31*	0.0252*

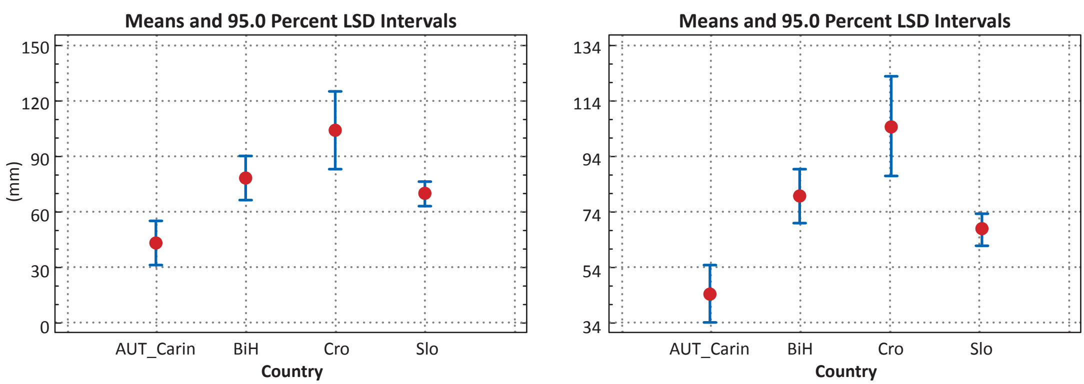


Figure 3. Average values with 95% LSD confidence interval for precipitation (mm) in January **(left)** and in February **(right)** for four different countries.

Table 2. Presentation of the formed homogeneous groups with regard to precipitation (mm) in January **(left)** and in February **(right)**, depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	43.50	X
Slo	42	70.12	X
BiH	13	78.89	XX
Cro	4	104.48	X

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	44.82	X
Slo	42	67.45	XX
BiH	13	79.17	XX
Cro	4	104.20	X

Our results show that for the amount of precipitation in January and February two homogeneous groups were distinguished, namely Austria, as the first group, and the other three countries, as the second group (Figures 1 and 2, Table 1). This means that in these two months the amount of precipitation in Austria is significantly lower compared to Slovenia, Croatia and Bosnia and Herzegovina.

On the other hand, during the vegetation period, i.e. from June to September, two homogeneous groups were evident, the first group including Austria and Slovenia, where on average during these four months there was significantly more precipitation compared to Croatia and BiH, as the second group (Figures 3, 4, 5, 6, and Tables 2, 3).

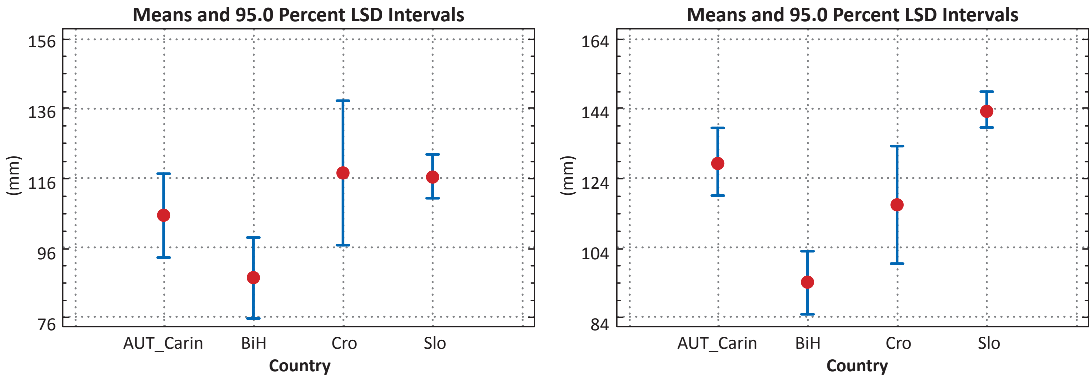


Figure 4. Average values with 95% LSD confidence interval for precipitation (mm) in May **(left)** and in June **(right)** for four different countries.

Table 3. Presentation of the formed homogeneous groups with regard to the average amount of precipitation (mm) in May **(left)** and in June **(right)**, depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
BiH	13	87.53	X
AUT_Carin	12	105.46	XX
Slo	42	116.52	X
Cro	4	117.73	XX

Country	Count	Mean	Homogeneous Groups
BiH	13	94.22	X
Cro	4	116.65	XX
AUT_Carin	12	128.82	XX
Slo	42	143.52	X

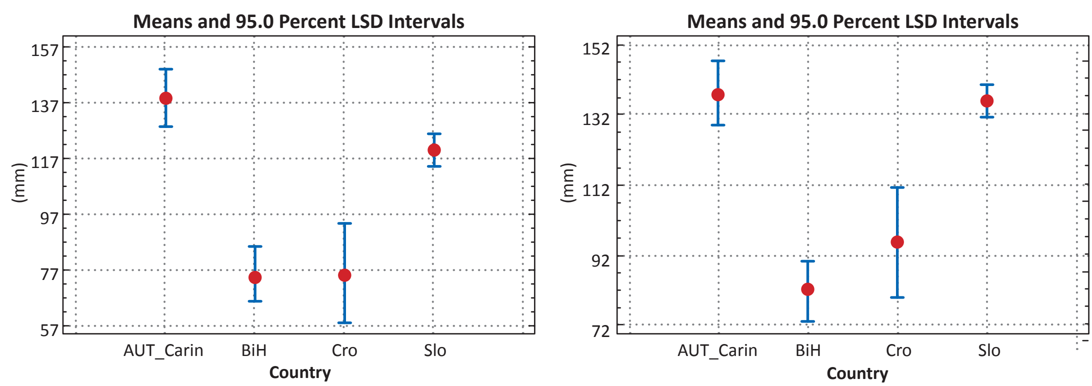


Figure 5. Average values with 95% LSD confidence interval for precipitation (mm) in July **(left)** and in August **(right)** for four different countries.

Table 4. Presentation of the formed homogeneous groups with regard to precipitation (mm) in July **(left)** and in August **(right)** depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
BiH	13	75.45	X
Cro	4	75,58	X
Slo	42	119.91	X
AUT_Carin	12	138.67	X

Country	Count	Mean	Homogeneous Groups
BiH	13	81.33	X
Cro	4	95.50	X
Slo	42	135.76	X
AUT_Carin	12	138.02	X

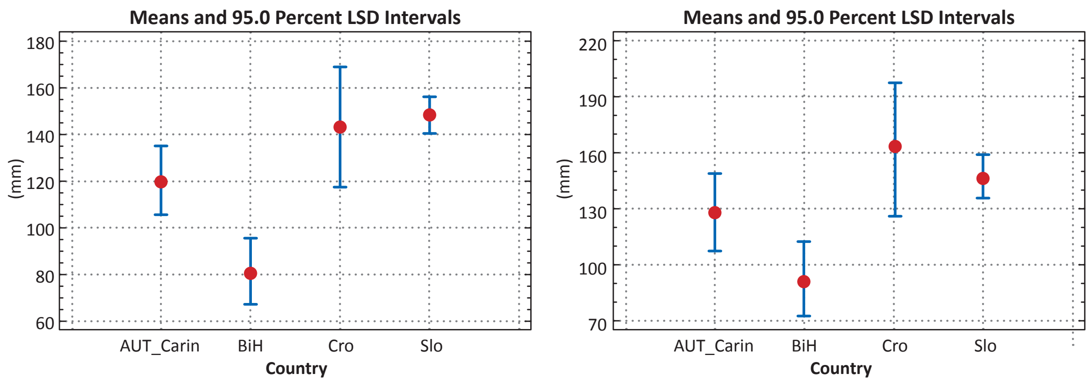


Figure 6. Average values with 95% LSD confidence interval for precipitation (mm) in September **(left)** and in October **(right)** for four different countries.

Table 5. Presentation of the formed homogeneous groups with regard to precipitation (mm) in September **(left)** and in October **(right)** depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
BiH	13	81.49	X
AUT_Carin	12	120.36	X
Cro	4	143.00	XX
Slo	42	148.31	X

Country	Count	Mean	Homogeneous Groups
BiH	13	92.46	X
AUT_Carin	12	128.62	XX
Slo	42	147.21	X
Cro	4	161.58	X

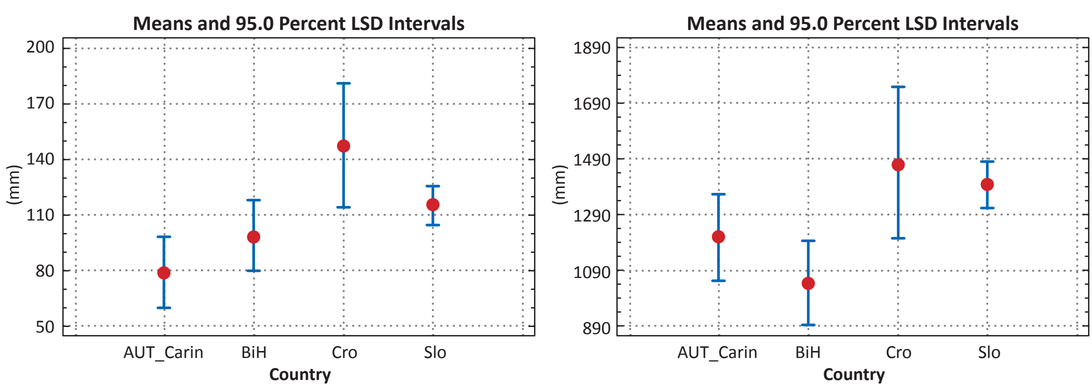
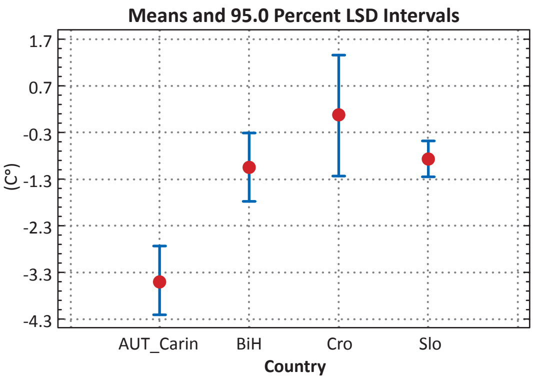


Figure 7. Average values with 95% LSD confidence interval for precipitation (mm) in December **(left)** and for annual precipitation sum **(right)** for four different countries.

Table 6. Presentation of the formed homogeneous groups with regard to precipitation (mm) in November **(left)** and the annual precipitation sum **(right)** depending on the analysed countries

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	79.31	X
BiH	12	99.01	XX
Slo	42	115.31	X
Cro	4	147.60	X

Country	Count	Mean	Homogeneous Groups
BiH	13	1045.35	X
AUT_Carin	12	1208.01	XX
Slo	42	1397.24	X
Cro	4	1475.08	XX



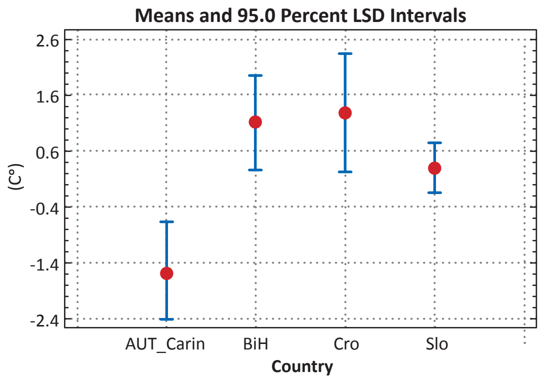
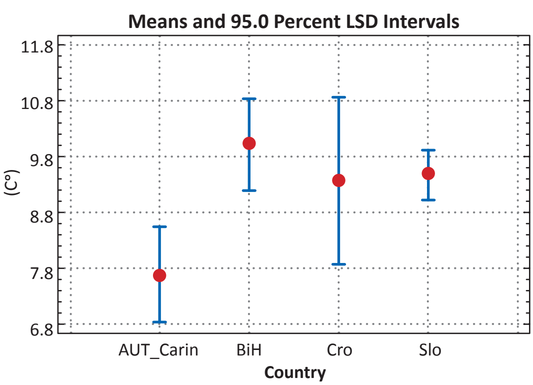


Figure 8. Average values with 95% LSD confidence interval for air temperature (°C) in January **(left)** and in February **(right)** for four different countries.

Table 7. Presentation of the formed homogeneous groups with regard to average air temperatures (°C) in January **(left)** and in February **(right)**, depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	-3.48	X
BiH	13	-1.05	X
Slo	46	-0.86	X
Cro	4	0.05	X

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	-1.53	X
Slo	46	0.30	X
Cro	4	0.78	XX
BiH	13	1.12	X



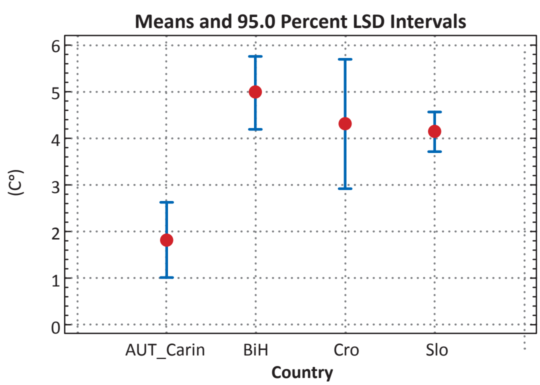
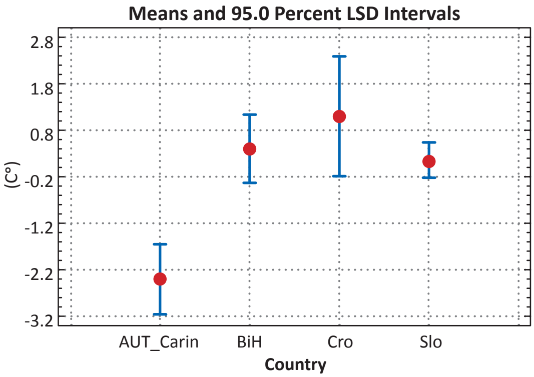


Figure 9. Average values with 95% LSD confidence interval for air temperature (°C) in October **(left)** and in November **(right)** for four different countries.

Table 8. Presentation of the formed homogeneous groups with regard to average air temperatures (°C) in October **(left)** and in November **(right)**, depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	7.71	X
Cro	4	9.38	XX
Slo	46	9.47	X
BiH	13	10.02	X

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	1.80	X
Slo	46	4.12	X
Cro	4	4.30	X
BiH	13	4.9	X



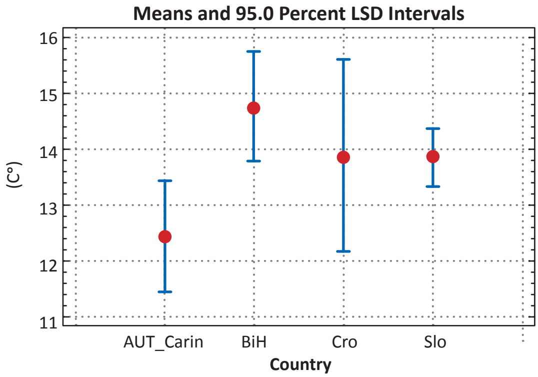


Figure 10. Average values with 95% LSD confidence interval for air temperature (°C) in December **(left)** and during the year **(right)** for four different countries.

Table 9. Presentation of formed homogeneous groups with regard to average air temperatures (°C) in December **(left)** and the average annual temperature **(right)** depending on the analysed countries.

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	-2.40	X
Slo	46	0.02	X
BiH	13	0.40	X
Cro	4	1.08	X

Country	Count	Mean	Homogeneous Groups
AUT_Carin	12	7.16	X
Cro	4	8.83	XX
Slo	46	8.88	X
BiH	13	9.24	X

This suggests a pronounced summer and winter maritime influence of the Mediterranean climate of the Adriatic Sea on the Dinaride mountains (BiH and Croatia) where the climate is drier, while the Alps (part of Slovenia and Austria) are outside of that influence and are more influenced by the Atlantic climate. It can be concluded that the more humid climate during the summer, i.e. with less precipitation during the winter, distinguishes the Alps from the Dinarides with regards to precipitation.

Analysis of the Influence of Locality on Air Temperature

In a similar way, the monthly results of the ANOVA for temperatures are presented. Statistically significant differences appeared for the following months: January, February, October, November and December (Table 1).

DISCUSSION

Already Horvatić (1967) noted that the entire Illyrian area differs in comparison with the neighbouring eastern Moesian province receiving a higher amount of precipitation. Compared to the southern Mediterranean area with a different precipitation pattern, the summers in the Illyrian area are warm, but have a sufficient amount of precipitation during the summer months. Horvatić (1967) further states that the Mediterranean influence on precipitation prevails in most of the Dinaric mountains, with large amounts of snow in winter creating a thick and long-lasting snow cover, while the continental pluviometric regime is characterized by abundant and frequent rain in summer in comparison to precipitation in winter.

The above implies that in the Illyrian area at the interface of the two climate regimes there are two precipitation peaks: one in autumn-winter and one in spring. This is significantly different compared to seasonal distribution of precipitation in the Alps, where one precipitation maximum during the summer is typical. Our analysis confirms this based on the examples of Bjelašnica (BiH) and Kanzelhöhe (Austria - Carinthia) in Figure 11.

Our results are line with Horvat et al. (1974) and the amount of summer precipitation in Austria (Carinthia) is sufficient without drought, but the Mediterranean influence is visible in summer months (June to September) in the southern parts of the Illyrian area. The distribution of precipitation shows a decrease in the amount of precipitation in these months in the Illyrian area, while in the Alps, on the contrary, the amount of precipitation increases during the summer months.

Similarly, Stefanović et al. (1983) in the ecological-vegetational zoning of BiH indicate that there are significant penetrations of the Mediterranean climate into the continental part of BiH during the summer, describing the area of the inner Dinarides from the mountains of Plješevica in the northwest to the mountains of Maglić and Volujak in the southeast as following: "The entire area is under the influence effects of the mutual conflict between moderate continental and modified Mediterranean climate". Fukarek (1970) decribes the area of the Dinaric mountains of Prenj, Orijen and Čvrsnica as having a climate varying from Mediterranean to continental conditions. This is also supported by Trinjstić (1992), who stated that the climate in the mountains of the Dinarides is strongly influenced by the Mediterranean climate.

Beus (1984) has a somewhat different position on the interface of Mediterranean and temperate continental climates and proposes a division of the Dinarides of Bosnia and Herzegovina into two parts: the outer Dinarides - with a stronger Mediterranean and Pannonian climate influence with prevalence of beech and fir forests without spruce, and the inner Dinarides - without these influences, which is reflected in the appearance of beech and fir forests with spruce. Fukarek (1970) states that the appearance of European and West Asian *Abies* species in the global understanding represents a set of species adapted to the transitional Mediterranean climate, and that *Picea* species (except for *Picea omorika*) show a relation to the boreal, high-elevation climate. The occurrence of larch (*Larix decidua*) is confined to the coldest parts of Slovenia (Bončina et al. 2021).

Elaborating on the association of beech forests and beech-fir forests (*Aremonio – Fagion* Horvat 1950, Török et al. 1989) in the context of understanding the Illyrian area, Vukelić (2010) states that both climate and geological-pedological background play an important role in understanding the extent of this area. In this context, Sukachev (1972) also asks the question: "Is plant cover really a reliable sign for determining the forest type and other habitat conditions do not have to be investigated"?

In a broader context, Vojniković (2015) brings the connection between the occurrence of European larch (*Larix decidua*) in the Alps and Scots pine (*Pinus sylvestris*) in the Dinarides in the context of different directions of succession, which are related to mesophilic habitats. He proposes that the Alps are more mesophilic than the Dinarides and therefore more suitable for the appearance of European larch and the reverse is evident for Scots pine. The occurrence of Scots pine on the dolomite slopes of the alpine area in Slovenia in the plant community *Rodothamno – Pinetum sylvestris* (Rozman et al. 2020) was confirmed by Bončina et al. (2021), who explicitly stated that this type does not include the pioneer succession of Scots pine stands on potential beech sites in the Alps, but rather represents a permanent stage of vegetation, confirming Vojniković's point of view. However, even in the context of construction, Vojniković (2015) understands European larch as a pioneer and gives it a greater importance of belonging to the Alpine area, than the appearance of Illyrian species, which can also be found in the Alpine area.

However, the mentioned border should not be understood "sensu stricto", that is, it should be understood as a diffuse border. Individual Illyrian species, due to their wide ecological amplitude can also enter the alpine sector, but when moving away from the border of the Illyrian province they gradually disappear. The above means that only and exclusively in smaller border areas within the Alpine sector, forms of extra zonal vegetation and fragments of Illyrian forests can appear, which are conditioned by orographic, edaphic and microclimatic factors.

Our analysis provides fresh evidence on a climatic discrepancy in the Illyrian area, which is sometimes considered a homogenous climate region. While BiH and Croatia undoubtedly have a predominantly Illyrian climate, Slovenia and Austria (Carinthia) deviate from the typical

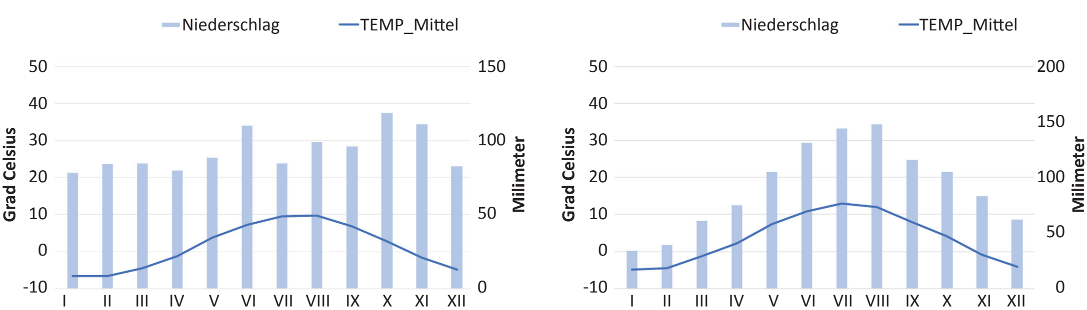


Figure 11. Climate diagrams for: **(a)** Bjelašnica (BiH) and **(b)** Kanzelhöhe (AUT – Carinthia).

Illyrian climate. The Alpine area of Slovenia with regards to temperature and precipitation in winter is similar to BiH and Croatia and with regards to summer precipitation similar to Austria (Carinthia). Austria (Carinthia) deviates clearly from the climatic characteristics of BiH and Croatia in all analysed parameters. The aforementioned climate studies indicate that the Alpine part of Slovenia represents a transitional Illyrian-Alpine area, while Austria (Carinthia) belongs to the Alpine phytogeographical area. This statement does not exclude the fact that Illyrian flora or Illyrian plant communities may occur extra-zonally within the Alpine area. when defining a specific phytogeographical area. The appearance of "typical floral elements", in this case Illyrian, can also be related to environmental factors, through compensation and replacement of habitat factors. There is uncertainty in using flora to define the Illyrian area and other parameters may be helpful, including climate, geology, syndynamics and vegetation zoning. Utilizing all available evidence (ecological, edaphic, floristic and vegetation) may lead to a better understanding of the phytogeographic nature of an area.

CONCLUSIONS

Based on the analysis of individual climate parameters by month and annual average/mean (precipitation and temperature), the Alpine area of Slovenia and Austria (Carinthia) differs from the typical Dinaric-Illyrian area (Bosnia and Herzegovina (BiH) and Croatia) in terms of climate. The climate of the typical Illyrian area is mild and rainy in winter and has a distinctly maritime character, especially during the summer, compared to the alpine area, which is influenced by the Atlantic climate during the summer. During the winter months, the amount of precipitation is lower in Austria (Carinthia) and Slovenia, as well as the temperature, while the temperature and amount of precipitation are higher in BiH and Croatia.

Our results suggest that climatic characteristics must be considered as a part of the environmental-habitat factors

Author Contributions

SV, BB, conceived and designed the research; SV prepared the data and wrote the primary test; BB performed the statistical analyses; BB, ĆV and MN reviewed the research and text; MN prepared map with GIS; SV, BB, ĆV and MN prepared the original draft of the manuscript.

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