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TEMPORAL DYNAMICS OF THE VEGETATION PERIOD IN THE MYZEQE PLAIN (ALBANIA) BASED ON TEMPERATURE THRESHOLDS (1961–2020)

[1*]Gazmir Çela, [2]Sonila Papathimiu and [2]Sabri Laçi

[1]Department of Meteorology, Institute of Geosciences, Polytechnic University of Tirana, Albania.

[2,3]Department of Geography, Faculty of History and Philology, Uiversity of Tirana, Albania.

*Corresponding author

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ABSTRACT

This agrometeorological field study analyses the growing season as a key indicator for assessing the impact of climate change on agricultural ecosystems. The objective is to determine the start, end and duration of the growing season in the Myzeqe field during the period 1961-2020, corresponding to two climate norms. The analysis is based on daily mean temperature data from six meteorological stations covering the entire study area. The temperature data combine observed meteorological data with ERA5 reanalysis data, which were aligned with the observed series to fill in time gaps. The start of the growing season was defined as the first day in a sequence of six consecutive days with mean daily temperatures above +10.0°C. The end was defined as the day before the first sequence of six days with temperatures below +10.0°C occurring after 1 July. The results show an average extension of the vegetation period by over 4 days, as a long-term climate trend and compared to the reference period 1961-1990. These changes imply, on the one hand, a greater potential for plant production, and on the other hand, increased sensitivity to heat stress during the summer months.

Keywords: Vegetation period, Minimum temperature, Agroclimatic conditions, Growing season

1. INTRODUCTION

The assessment of climate from an agricultural point of view is the basic element on which the activity of the science of agrometeorology is based. One of the most sensitive and widely used indicators to measure these changes is the vegetation period, which represents the time interval

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between the beginning and end of the biological activity of plants, closely linked to air temperature.(Chmielewski & Rötzer, 2001).

In recent decades, a trend towards earlier onset and extension of the vegetation period has been documented in various parts of Europe, significantly affecting the agricultural calendar, ripening cycles and agricultural yields.(Penuelas, Rutishauser, & Filella, 2009).

Such studies for Albania are not lacking, but they are rare and are carried out only in scientific institutions in the field of climate. These studies began in the 1960s and continue to this day. However, with reference to vegetation periods, long-term studies of database analysis are lacking. The aim of this study is not only to present the long-term progress for the Myzeqe Plain, but also to identify trends by comparing 2 standard periods of climate norms, 1961-1990 and 1991-2020.

Through this approach, a detailed assessment of phenological trends in one of the most important agricultural areas of the country is provided, contributing to the understanding of climate impacts on local agricultural systems.

2. DATABASE AND METHODOLOGY

The database for this study spans a 60-year period, and the analysis includes six meteorological observation stations, as shown in Figure No. 1. The observed data belong to Albania's National Meteorological Monitoring System. To fill data gaps, the reanalyzed dataset from Copernicus ERA5 has been utilized.((C3S), 2023). Based on all scientific techniques for processing meteorological data, such as temperature and precipitation, the correlation between these two data sources is high. The most challenging element in correlating these datasets is precipitation, where this indicator reaches a value of 0.81.(Çela, 2024).

To define the beginning and end of the vegetation period, a standardized climatological approach was followed, widely used in international studies in the field of agrometeorology. (SHMI, 2024). The basic limit of average daily temperatures to calculate the vegetation periods is taken as a base temperature of 10.0°C. In the meteorological practice of Albania, the sum of daily temperatures equal to or greater than 10.0°C has been applied because at the average daily temperature above this threshold, most agricultural crops of this geographical latitude begin the process of active vegetation.(Mandili, 1975).

Specifically, the beginning of the growing season was defined as the first day in a six-day series with average daily temperatures equal to or higher than +10.0°C. This temperature threshold is considered the biological limit of growth activity for many agricultural crops and natural species in moderate climates. On the other hand, the end of the period was defined as the day before the beginning of the first six-day series after July 1, where temperatures fall below this growth threshold. If such a series did not occur, the end was taken as December 31.

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For each calendar year and meteorological measurement site, the start date of the growing season, the end date, as well as the length of days for each period were calculated. These indicators were analyzed at a multi-year level using the two 30-year standard climatic periods 1961-1990 and 1991-2020 as time references.

Regarding the technical side of data processing, they were analyzed through Python and Excel. The "Origin" software statistical program was used to obtain better resolution of the graphs. To express the geospatial distribution of the analyzed scientific indicators, maps were constructed through ArcGIS.

To increase the practical value of the analysis of vegetation periods, a table with the respective thermal needs of some of the main agricultural crops is presented, referring to the duration and the corresponding biological minimum.

This classification is evidenced because some of the agricultural crops have a different biological minimum from 10.0℃, specifically the cotton plant has 14-15℃ (Mici-K.Plaku, 1963). As a result, the results on the start and end dates of the vegetation periods above the threshold of 15 and 20℃ are presented in a separate table.

This methodological approach combines the continuity of climatic analysis with the practical importance of agrometeorological indicators, aiming to provide a valid scientific basis for agricultural planning and for assessing the potential impacts of climate change in the low Mediterranean regions.

3. RESULTS

The Vegetation Period Assessment is a scientific analysis based on the values of average daily temperatures. As presented above and in more detail in the methodology, the basis on which this scientific analysis is built is the series of daily temperature data for 60 years at 6 meteorological measurement sites of the Myzeqe Plain.

Air temperature is one of the main elements of the climate. With its average regime, with its annual and daily progress as well as with its extreme values, it affects the life and activity of humans and plants (IHM, 1985). Referring to the daily air database and the relevant calculations, the multi-year average annual air temperature is 16.3 ℃ referring to the 60-year time period 1961÷2020. Referring to Figure No. 1 where the annual distribution of average air temperatures is presented, their linear increasing trend is evidenced. From the results of the linear trend calculations, the annual increase for these 60 years is 0.02 ℃ per year.

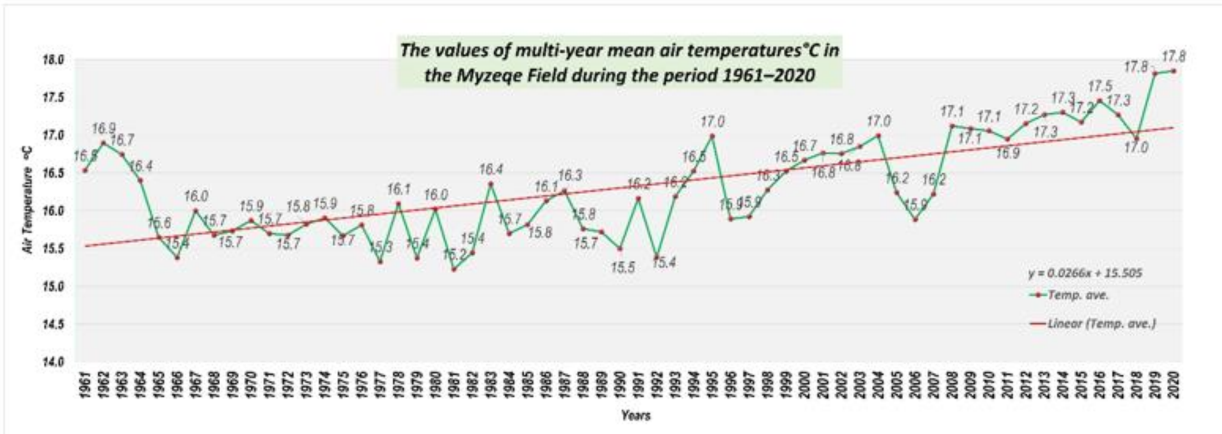

Fig. 1: Average annual air temperatures (°C) in the Myzeqe Plain during the time period 1961-2020

In the continuation of the analysis of multi-year monthly average temperatures, a crucial aspect is the comparison between the two climatic norms. Figure No. 2 presents the graph illustrating the monthly distribution of temperatures during the first and second climatic norm periods, along with the corresponding anomaly values (Çela, 2025). An increase in temperatures is the most evident phenomenon across all months of the year. The winter season shows the smallest positive anomalies, with an increase of +0.2°C. Regarding the summer season, while July was the hottest month during the first climatic norm period, with an average temperature of 23.9°C, in the second climatic norm period, August has become the hottest month, with an average multi-year temperature of 26.1°C, whereas July now records 25.6°C(Çela, 2025). For the transitional seasons, spring and autumn, anomalies are relatively similar, averaging between 0.7°C and 1.0°C(Çela, 2025).

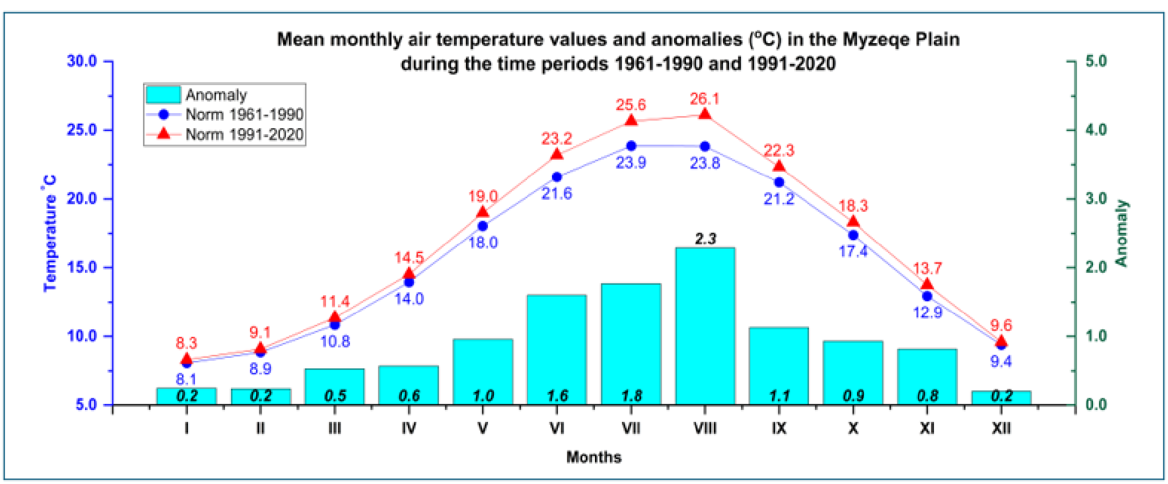

Fig. 2: Average monthly air temperatures in the Myzeqe Plain during the time periods 1961-1990 and 1991-2020 and the corresponding anomalies

An important part of the analysis of agro-meteorological conditions of a given geographical area is the calculation of vegetation periods. The vegetation period, known as the plant growing season, is the period when weather conditions are favorable for the growth and development of plants. It is known as the period when plants actively grow and develop their phenological processes. Vegetation periods consist of the average date of the stable passage of temperature above a certain threshold, specifically above the threshold of 10.0 ℃ which is the usual temperature threshold for the agro-climatic needs of the Mediterranean region. Also, this temperature threshold is useful for the evaluation of plants cultivated with an annual cycle.

From the database, the vegetation periods have been calculated for each station and for each year throughout the 6-year period. The temperature of the beginning of vegetation (biological minimum temperature). Each agricultural crop begins its activity within a certain temperature range, which for all crops is from 0 to 20.0 ℃ (Rye 0 ℃, corn 10-12 ℃, palm 18-19 ℃, etc.) without reaching this biological minimum, the plants do not germinate.(Mici-K.Plaku, 1963). By identifying time periods with a stable passage of temperatures above the 10.0℃ threshold, for at least 5 days. To avoid chaotic results from the data calculation, the month of July has been separated, which will make the separation between the search for a start date before this month and the end date in the second half of the year.

Figure No. 3 shows the average annual graph of the beginning, end and length of the vegetation period in the Myzeqe Plain with reference to 60 years. The left Y axis shows the reference dates from January 1 to December 31.

The green square dots represent the values of the average date of the beginning of vegetation and in brown are the values of the average date of the end of the vegetation period, together with the corresponding linear trend line. On the right Y axis, the length of the PV is presented in days, expressed through a black line. The graph shows a progressive shift in the date of the beginning of the vegetation period towards the earlier months of the year. In the first decades of the analysis (1960–1980), this date started on average around mid-February, while in recent decades it has been moving towards the beginning of February (on average on 06/02). This shows that temperatures above 10°C are being recorded earlier in the year, which is consistent with trends observed in other Southern European countries. (Intergovernmental Panel on Climate, 2023).

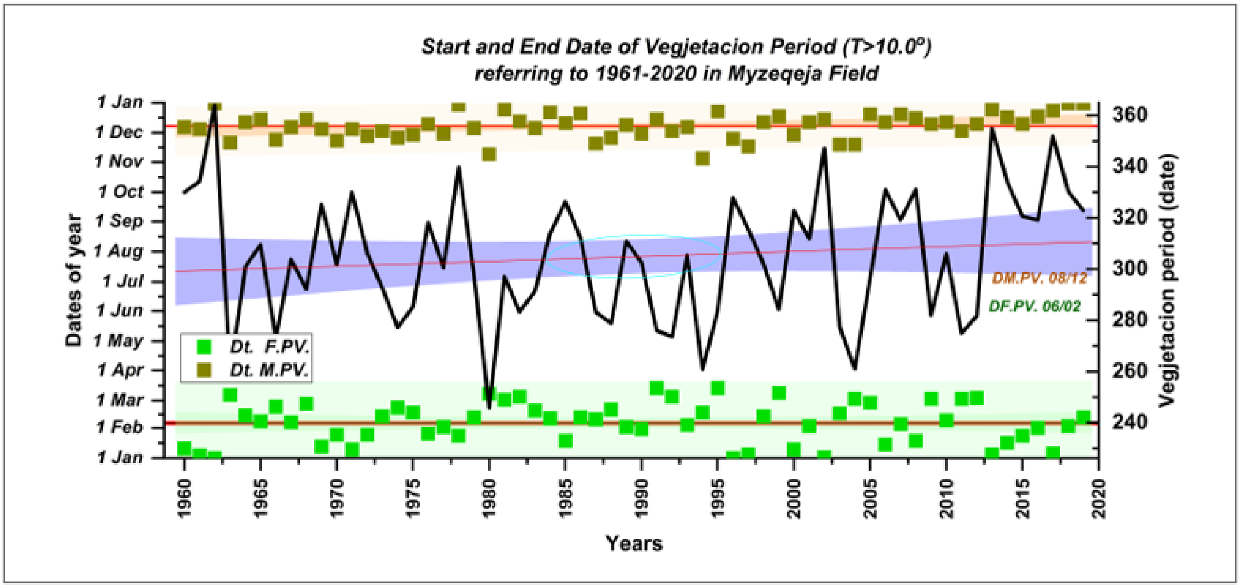

Fig. 3: Vegetation Period Timing and Duration (10.0 °C) – Myzeqe Plain, 1961–2020

On the other hand, the end date of the vegetation period has shifted towards the end of December, with an average of around 08/12. This indicates that temperatures above 10°C are continuing even at the end of the year, especially during autumn and early winter, postponing the end of the active vegetation season. This phenomenon implies a warming of the autumn-winter period, which, although it can be seen as an opportunity for crops with delayed development, can bring negative consequences such as postponing the vegetative rest cycle and disrupting natural phenology.

The black line in the graph shows that the annual length of the growing season has increased significantly from an average of 270–290 days in the 1960s–1980s to more than 330 days in the last years of the analysis. This represents an extension of the active growing season by over 40–60 days, which is a strong indicator of the impact of climate on the region's agricultural ecosystems.

The extension of the growing season is one of the most consistent indicators of the impact of climate change, and has been documented in detail both at the regional level(Chmielewski & Rötzer, 2001).

Further analysis of the vegetation periods is presented in more detail in Figure No.4 where the trend of daily temperatures throughout the year for the Myzeqe Plain in two climatic norms. The graph shows the temperatures in the first climatic norm in green and the average daily temperatures in the period 1991-2020 in red. It is clearly evident that almost every day of the year the temperature values are higher during the second climatic norm. The corresponding dates of the beginning and end of the vegetation period for both norms are marked with straight vertical lines.

An interesting fact is that the average date of the beginning of the vegetation period does not change throughout the 60 years, corresponding to February 6th.

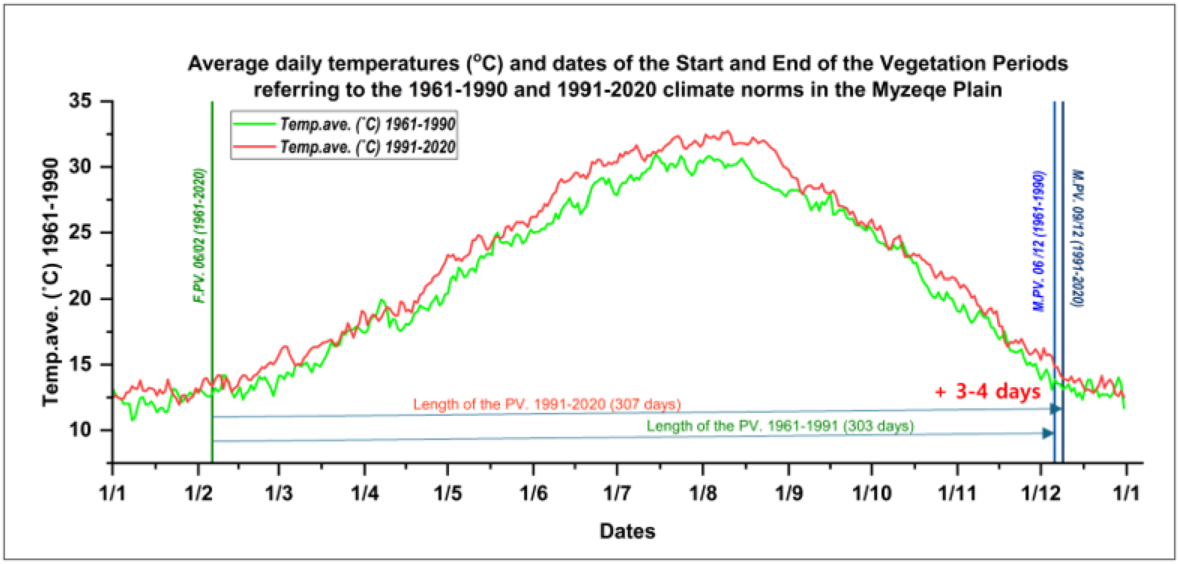

Fig. 4: Average Daily Temperatures (°C) and Start and End Dates of the Vegetation Periods in the Myzeqe Plain According to the 1961–1990 and 1991–2020 Climate Norms

As for the last date of the vegetation period, in this case changes are evident. From December 6th, the vegetation period in the Myzeqe Plain ends on December 9th with an anomaly of 3-4 days.

The change in the absolute value of the end of the vegetation period cannot be given in whole days since there are years where the anomalies are more or less than these values. This conclusion is confirmed and is evident in the results of this graph where the corresponding lengths for each climatic norm of the vegetation periods are horizontally presented with arrows, where from 303 days which is the first climatic norm to the second 30-year period the duration is 307 days. If we refer to the values of duration in days, the anomalies come out 4 days longer than the first norm.

The results obtained from the analysis of climate models for determining the duration of vegetation periods are of particular importance when examining the meteorological measurement sites of the Myzeqe Field in particular. As a result, Figure No. 5 shows the respective dates for each meteorological measurement site for both norms. The X axis of the graph shows the dates of the vegetation periods, while the Y axis shows the meteorological measurement sites. On the left side of the graph, the dates of the beginning of the PV are displayed in horizontal columns, while on the right, the values of the end of the PV are displayed.

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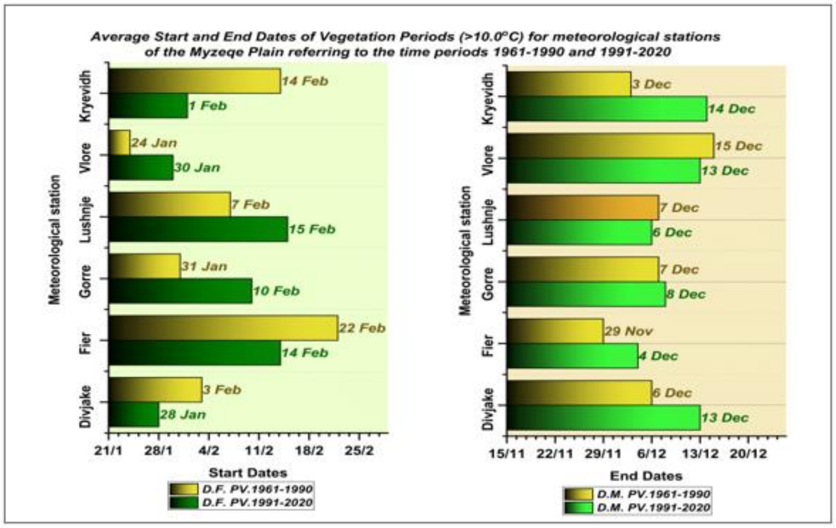

Fig. 5: Average Onset and End Dates of Vegetation Periods (>10 °C) – Myzeqe Plain, 1961–1990 vs. 1991–2020

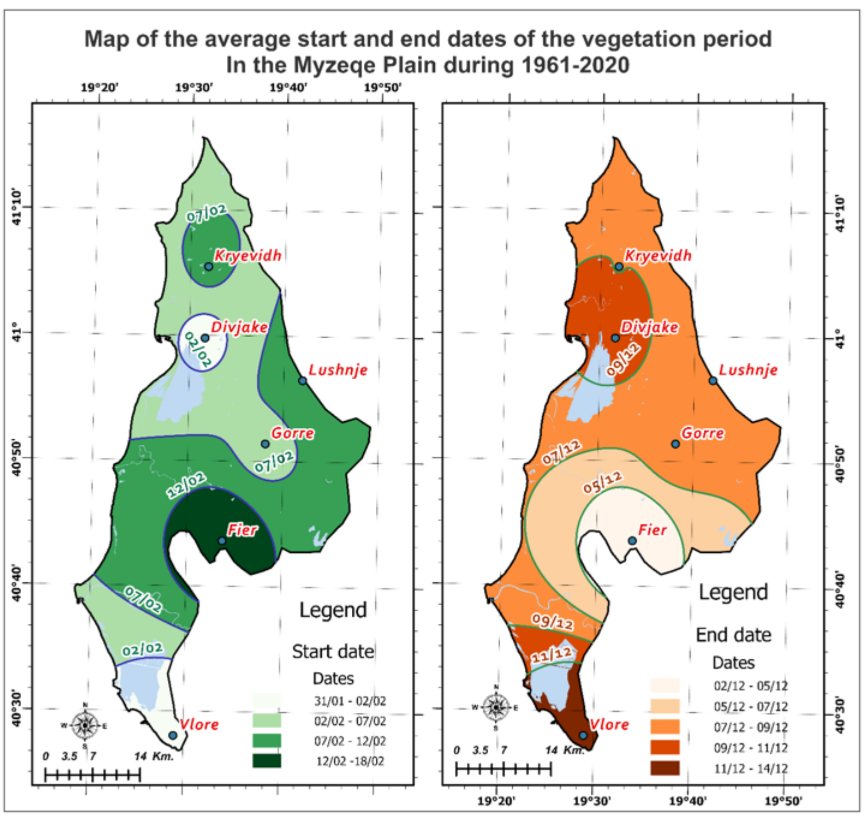

Fig. 6: Map of the average start and end dates of the vegetation period in the Myzeqe Plain referring to the time period 1961-2020

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This graph is limited in its attempt to present the results for the entire Myzeqe Field, being satisfied only with the presentation of the values of certain monitoring points. To fill this gap, the use of Geographic Information Systems (GIS) is required. To achieve this goal, Figure No. 6 presents a map of the average start and end dates of the PV in the Myzeqe Plain, referring to the entire period 1961-2020.

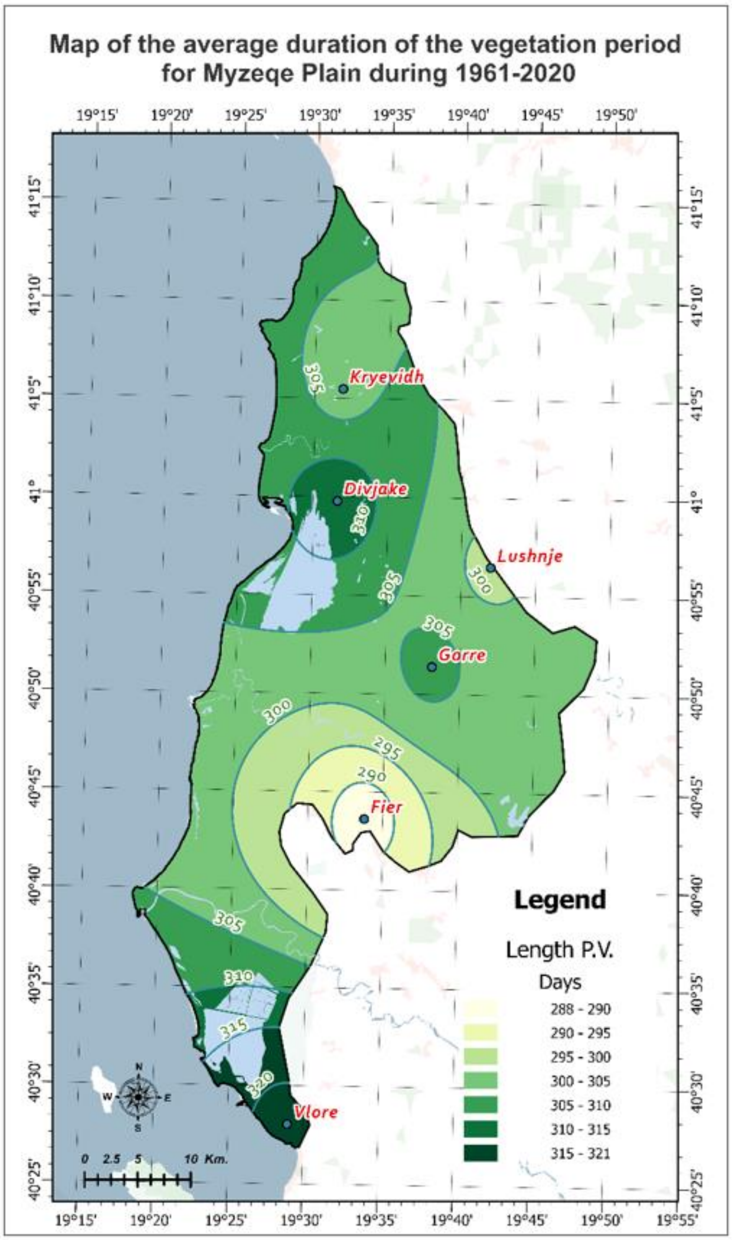

Fig. 7: Map of the Duration of the Vegetation Period Referring to the Time Period 1961-2020 in the Myzeqe Plain

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Based on the methodology for determining the start and end dates of the vegetation period for the entire 60-year period, the start date is between January 31st in the area of Divjaka and Vlora. The rest of the territory has a time deviation of several days back to the geographical area around the meteorological station of Fier where February 18 marks the latest date of the start of the vegetation period. This spatial distribution occurs as a result of the geographical positioning where the western part of the Myzeqe Plain is under the most present mitigating effect of the water mass of the Adriatic Sea, while further inland near the city of Fier is affected by the proximity to the hilly terrain. In the same situation of the influence of local factors of climate formation, the results of the last date of the vegetation periods are also presented, shown in the map on the right of figure no. 6. In the Fier area, the vegetation period ends on average in the first week of December. The western part around the Divjaka and Vlora areas extends until mid-December. These values represent an average distribution that shows clear features of a favorable climate with high potential for agricultural development. It should be noted that depending on the climate of one year or another, the dates of the beginning and end of the vegetation period shift in time, presenting situations different from the average climate for specific years. In addition to the scientific analysis of th e agroclimatic potential of the Myzeqe Plain, it is important to analyze the period between the 2 average dates for each period.

For this purpose, Figure No. 7 presents the geographical distribution of the average values of the length in days of the vegetation period in the geographical area of the Myzeqe Plain, referring to the time period 1961-2020. For this element, local climate formation factors again dictate the geographical distribution. The western area from Vlora to Divjaka presents a longer period of up to about 320 days with temperatures above the 10.0°C threshold, while the eastern part has values from 290 to 300 days of vegetation period. The maps were produced through Geographic Information Systems using IDW interpolation tools.(Sluiter, 2009) interpolation tools and the distribution of values is exact at the interpolated reference points by creating the corresponding raster according to this methodology.

Following this analysis, the practical aspect directly related to the biological needs of plants regarding the biological minimization of each of them on the one hand and the minimum biological needs for the duration of the day on the other hand is of particular importance. Based on table no. 1, the requirements of agricultural crops against the temperature regime are presented.(Mici-K.Plaku, 1963).

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Table 1: Specific requirements of different plant species for the duration of the vegetation period and the biological minimum temperature

Crop	*Length of the vegetation period*	*Biological minimum temperature (°C)*
Citrus	***190-240***	***10.0***
Olive	***210-260***	***10.0***
Grape	***120-200***	***5.0***
Cotton	***120-180***	***14.0 ÷15.0***
Corn	***120-180***	***10.0 ÷ 12.0***
Wheat	***134-272***	***1.0 ÷ 2.0***

Based on the indicators presented in the table and all the results presented in the graphs and maps above, the Myzeqe Plain meets all the biological agroclimatic needs necessary for the growth of these plants. Given the fact that various agricultural crops such as cotton or corn present needs with a biological minimum with a threshold higher than 10.0°C, Table No. 2 presents the results of the Average Start and End Date of the Vegetation Period at different temperature thresholds at the meteorological measurement sites of the Myzeqe Plain during the time period 1961-2020. As presented above, the vegetation period above the 10.0°C threshold begins on average between January and February and ends in December, for the 15.0°C threshold, it begins on average on April 21st and ends on average on November 5th.

Table 2: Average Start and End Date of the Vegetation Period at Different Temperature Thresholds at Meteorological Measurement Sites of the Myzeqe Plain during the Time Period 1961-2020

Mean onset and termination dates of the vegetation period under various temperature thresholds, based on meteorological station data from the Myzeqe Plain (1961–2020)

Threshold T.ave. (°C)	*10.0 °C*		*15.0 °C*		*20.0 °C*	
Station	Start	End	Start	End	Start	End
Divjake	31-01	10-12	21-04	08-11	27-05	05-10
Fier	18-02	02-12	26-04	01-11	30-05	24-09
Gorre	05-02	08-12	20-04	05-11	26-05	02-10
Lushnje	11-02	07-12	21-04	06-11	24-05	04-10
Vlore	27-01	14-12	20-04	10-11	27-05	05-10
Kryevidh	08-02	09-12	22-04	06-11	28-05	02-10

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The results presented for all meteorological measurement sites of the Myzeqe plain in this table also show the average dates of the beginning and end of the vegetation period above the 20.0℃ threshold. This threshold is important for various agricultural crops, such as cotton of different varieties, where on average on May 27th the vegetation period with a biological minimum above the 20℃ threshold begins and ends on average on October 2nd. This indicates a time extension of 128 days, vegetation period, indicating that the Myzeqe plain has high potential for agricultural temperature.

4. CONCLUSION

This study highlights multi-year trends in the evolution of vegetation period characteristics in the Myzeqe Plain, Albania. Initially, monthly and annual average temperatures were analyzed for the period 1961–2020. A comparison between the two climatic normals (1961–1990 and 1991–2020) reveals positive monthly anomalies, with August in the 1991–2020 period emerging as the hottest month of the year.

Regarding periods with average temperatures exceeding the 10.0°C threshold, the start date of the vegetation period remains unchanged across both climatic normals, corresponding to February 6th. However, the end date shifts from December 6th (in the first normal) to December 9th (in the second), indicating an extension of 3 to 4 days.

The corresponding maps illustrate the spatial distribution of the start, end, and duration of the vegetation periods. This distribution shows a decreasing trend from west to east, influenced by temperature gradients, with longer vegetation periods observed in hilly inland areas due to higher temperatures.

Considering that some crops require minimum biological temperatures above 10°C, additional analyses were performed using 15°C and 20°C thresholds. The results show that even for these specific crops, the Myzeqe Plain demonstrates high climatic potential.

The extension of the vegetation period represents an opportunity for agricultural development, yet it also brings new challenges related to water management, work cycles, and increased vulnerability to extreme weather events. Consequently, the implementation of local adaptation strategies and the application of real-time phenological monitoring are essential tools for sustainable agricultural planning.

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