Disaster Risk Management (DRM) Plan for Climate Change in Devoll

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Introduction

The Disaster Risk Management (DRM) plan for Devoll Municipality addresses the growing impacts of climate change on agriculture and rural communities of this municipality. This structured plan aims to identify, assess, and mitigate risks associated with climate-induced hazards. Its objectives include enhancing climate resilience, protecting vulnerable communities, and ensuring sustainable agricultural practices. Following ToR but considering the limitation in terms of time and budget, after consultation with ADAD Malore, the 'disasters' are related to drought, hot weather, frost, intensive sun, excessive water, floods, and hails. Other natural hazards that cause disasters like landslides, avalanches, and forest fires are not considered. Furthermore, considering the share of fruit trees in the crop structure of Devolli municipalities, the level of investment and the impact of climate changes on these groups of crops, the discussion is centered around fruit trees.

1. Identification of climate change adaptation champions (farmers)

2.1 Workshop with relevant local stakeholders

A workshop was organized in December to identify farmers in Devoll municipality who are already applying adaptation measures to climate changes. After a presentation on the various impacts of climate changes in the Devoll region, farmers discussed their experiences. The list of participants can be found as an appendix to this report.

Farmers from Devoll municipality have already identified several climate stressors of concern, including temperature stress, water quality, drainage, and extreme weather events. Frequently farmers autonomously have adapted their practices to the weather variability and they have experienced how to react to changing weather. However, besides reporting such practices during the workshop or survey (see below), there are no consistent records of such autonomous adaptation practices. For instance, during heat waves, hot, dry winds lasting as little as two to three days can be a major risk, and affect both the quality and quantity of production. One farmer explained that he tries to cover his vegetables in hay to reduce sun and heat damage. Droughts are also a primary concern. Because the irrigation and drainage infrastructure are often non-functional, farmers have very limited capacity to adapt to droughts. Farmers are trying to substitute groundwater sources with water coming from reservoirs or springs.

Another tool used to collect relevant information on practices used by the farmers to protect their crops from damages caused by weather variability (hot weather, drought, excessive water, hail, intensive sun etc.) was collected using a Google form survey with a number of specialized farmers, besides those present in the workshop (see § 3).

Table 1. Best practices in applied by farmers of Devolli municipality

Indicator	Best adaptation practice in place	Farms affected or acceptance (small large all)	Indigenious practices	Tested
Heat stress	Overhead irrigation	small	to some extent	to some extent
	Shading	small	to some extent	low
	Mulching	small	High	high
Drought	Drip irrigation	large	to some extent	high
	Tolerant varieties	small	Low	low
Insolation	Shading	Small	n/a	to some extent
Changes in season and growth stages	Change the ripening period of varieties	large	to some extent	to some extent
Hail	Hail nets	large	n/a	high

Source: results from the Workshop

All this information, both from the workshop and the survey, was a valuable resource for preparing the DRM Plan. Moreover, information on climate change adaptation measures and practices already tested/promoted in Devoll region shall be integrated with information on the measures from the national agricultural policy, and from national systems for support of agriculture that can be related to climate change adaptation.

2. Risk Assessment and Hazard Identification

2.1 Identify Climate-Related Hazards

Climate-related hazards in the Devoll region include floods, droughts, wildfires, hailstorms, and frosts. To carry out a risk assessment and hazard identification, the meteorological data for Devolli municipality is essential. The meteorological network in Albania is owned by the Institute of Geosciences (IGEO), a national scientific research center in regional and applied geology, seismology, meteorology, hydrology, and the environment. The Institute monitors and evaluates natural hazards such as earthquakes, storms, avalanches, floods, droughts, fires, active tectonics, massive mass movements, soil erosion, etc., with the aim of risk reduction.

2.1.1 Availability of meteorological data for climate change analysis in Devoll municipality

IGEO owns and uses the national data archive of meteorology, both analogs and digital formats, to accomplish operational and strategical support towards civil protection structures and support scientific research and academic activities. The Institute is responsible for generating, updating, modernizing, and securing the national data archive. In this regard, it should play a key role in providing data for climate change studies.

IGEO publishes a monthly climatic bulletin which aims to provide information on the meteorological situation of each month as well as in the climatic context, to provide estimates on climate change and the tendency of in Albania. The Bulletin contains: (a) a synoptic assessment and some key features from the meteorological point of view that characterize the analysed month; (b) meteorological data which, after being checked, digitized, verified and processed according to the scientific technical standards of WMO mainly for air temperature, atmospheric precipitation, etc.; is reflected in the form of charts, maps, etc., in order to give an estimate and clear idea of the time and space distribution for the territory of our country; (c) comparison with the rate values referring to the period 1961-1990 or other periods of time to enable the conclusion to be made of how the various climatic elements are moving in the perspective of climate change for Albania (surface air temperature anomaly; mean air temperatures and their anomalies; (d) based on the information and scientific climate assessment products from the world's most recognized scientific professional centres, provides estimates for the medium- and long-term forecast of the expected situations for the coming months following the date of each bulletin broadcast; (e) two short sections on agrometeorology and climate changes; (f) the last columns of this bulletin relate to the coverage of various information related to scientific achievements in the field of meteorology or the climate in particular, not only in Albania, special events such as "International Meteorological Day", results of scientific research work or different subjects realized by students under the scientific leadership of the department.

2.1.2 Accessibility of meteorological data for climate change analysis in Devolli municipality

Although IGEO is a research institute under the Polytechnic University of Tirana (PUT), meteorological datasets covering historical and current periods are not available even for research purposes, let alone farmers. A short section about agrometeorology has been included in the Climate Monthly Bulletin were they report indices like NDVI for the vegetation, Standardized Precipitation Index (SPI) for drought, the sum of active temperature above 10°C threshold and evaporation, beginning and end of the growing season (vegetation period). However, the presentation is rather illustrative, for one region, is not presented in every bulletin and there are no tables or annexes with raw data to be used by researchers. More importantly, these are not related to main crops. As a result, farmers rely solely on privately funded or neighboring country sources for meteorological information.

The lack of access to meteorological data for Devolli Municipality is has impacted and hindered the preparation of DRM Plan for Devolli Municipality. IGEO provides datasets on payment thus the expert has used published or unpublished meteorological data from WorldClim, IGEO or other sources. Other indices like growing degree days or chilling units for main crops, etc. could not reported. Several graphs showing climate change at the country's level were used from publication of IGEO personnel (Zobra, P.) including the study on chilling units for the area of Korça, important for the production of apples.

2.1.3 Analyses of the most common agrometeorological indices for Devoll municipality

According to the climatic division of Albania, conducted on the basis of climatic criteria determined in the monograph "Albania's Climate" edition 1972, the territory of Devolli municipality falls mostly under the Mediterranean pre-mountainous climate and southern pre-mountainous climate with only the most eastern part under the Mediterranean southeastern mountainous climate. The reference meteorological stations were those of

Bilishti and Miras. Table 2 gives some climatological variables for the multiannual period of reference.

Table 2. Climatological variables for the multiannual period of reference (1961 – 1990) for the Municipality of Devoll

Month	Avg. Temp. (°C)	Avg. Rainf. (mm)	Avg. no. Days with Rainf. ≧ 0.1 mm	Avg. Water Vapor Pressure (mb.)	Avg. Air Humid. (%) at 14:00	Avg. Cloud. (hours)	Durat. of Insolat. (%)
January	–4	80	14	7.7	72.5		40
February	0	80	12				
March	4	60	12				
April	8	60	14	10.°°5	50		
May	12	60	12				
June	16	40	10				
July	18	30	6	18.5	40	2.5	80
August	18	30	6				
September	16	60	8				
October	12	100	10	11.5	52.5		
November	8	150	12				
December	4	100	14			7.5	
Annual	**10**	**850**	**130**			**6**	**60**

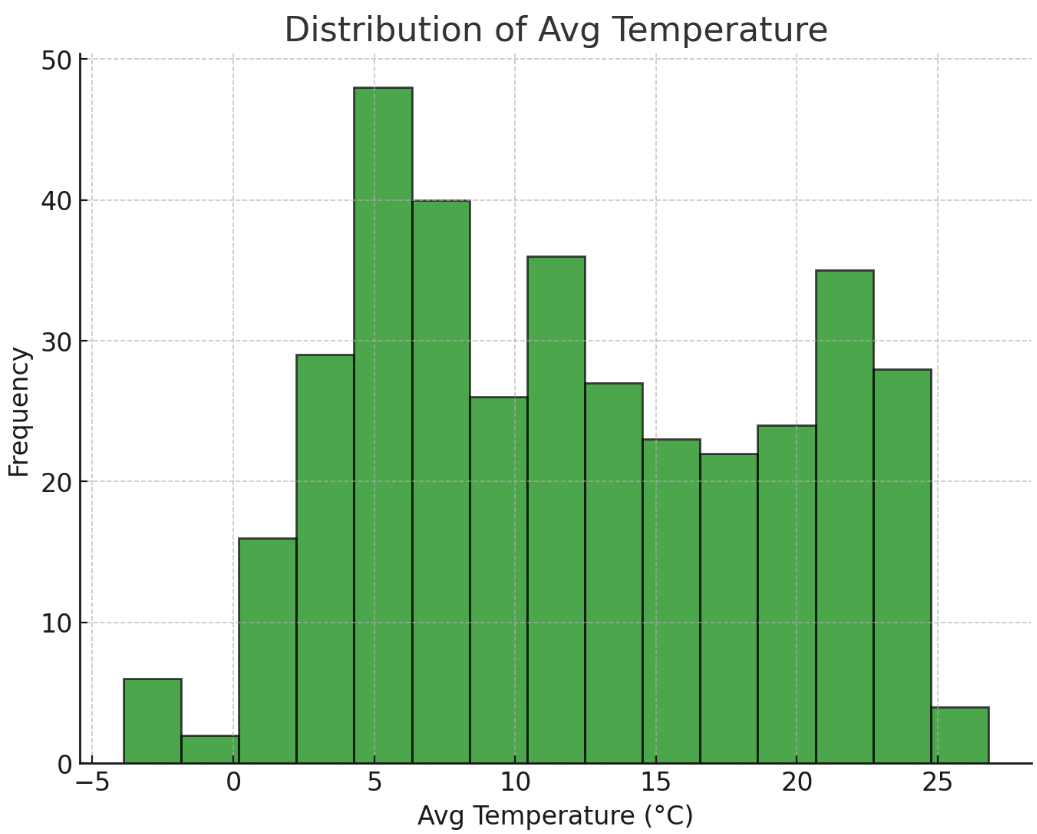
Source: various publications of the Hydrometeorological Institute

The multiannual (1961-1990) average minimum temperature reduced to the sea level according to the mean gradient for January was 6°C while the average maximum temperature was 25°C and the average for the year was 16°C. The average temperature for the warm season was 14°C. These data and the following have been based on long-term (30 years) observations with isotherms drawn for every 1°C or 2°C. The final drawing of the isotherm has considered the determination of the dependence of the temperature towards the altitude of the place above sea level, using graphic and analytical methods. This has allowed us to determine the vertical gradients. Air temperatures are characterized by a change gradient of 0.6°C decrease for every 100 m of increase in altitude.

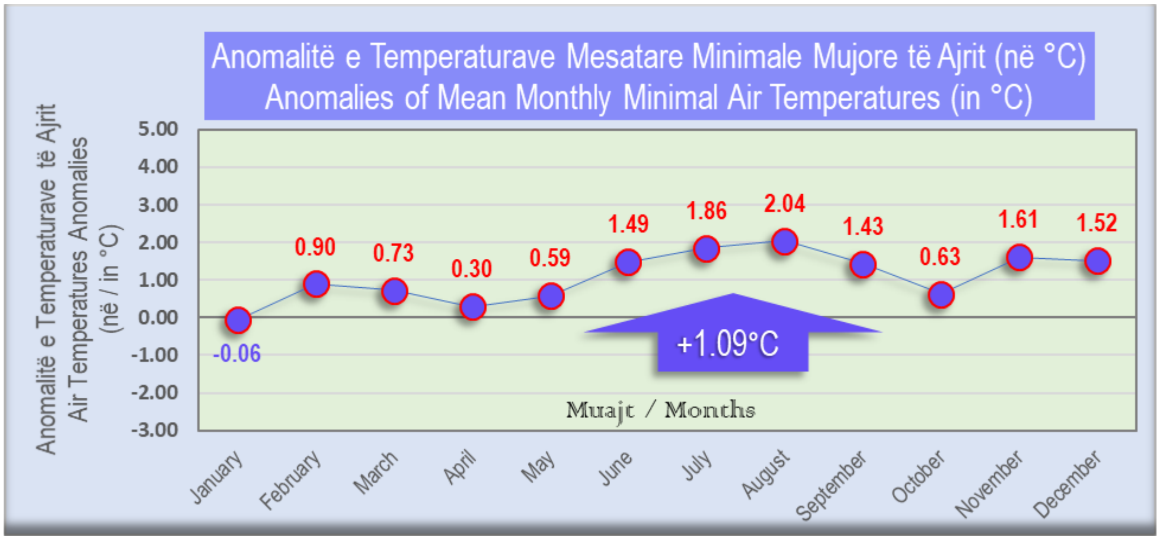
Another important index is the daily maximum temperatures for each season's middle months and the whole year. The criteria used are similar to those used for the monthly and annual mean temperatures. Based on isotherms drawn for every 2°C, the monthly average of daily maxima was 4°C (January), 10°C (April), 26°C (July), 14°C (October) with an annual maxima of 14°C. Using the same methods for daily maxima, we found that the monthly average of daily minima was–4°C (January), 4°C (April), 10°C (July), 6°C (October) with an annual maxima of 4°C.

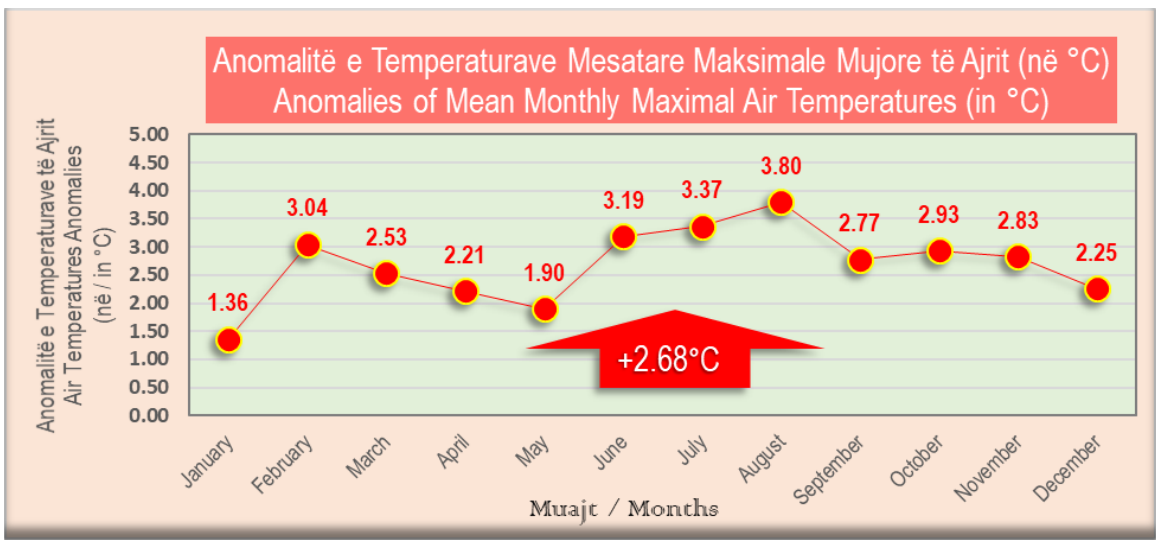
Table 3. Climatological variables for the year 2020 for the Municipality of Devoll

Month	Avg. Temperature (°C)	Avg. Rainfall (mm)	Days with Rainfall ≥ 0.1 mm
January	5.12	32.4	10
February	6.18	28.7	8
March	10.5	41.2	12
April	15.3	47.5	15
May	20.1	56	13
June	25.2	48.1	9
July	28.7	36.4	6
August	28.1	29.8	7
September	23.9	32.1	8
October	17.6	40.3	10
November	11.4	39.7	11
December	6.8	35.9	9
Yearly Avg.	**16.9**	**39.3**	**9.9**



In order evaluate the impact of climate changes, the figures below compares the air temperature indices for te reference period with the current period (2017 – 2023). The first figure below demonstrates that there are significant anomalies for the mean monthly minimal air temperatures especially in the warm period of the year with an yearly average of 1.09°C. In the case of mean monthly maximal air temperatures, the anomalies are much higher, with an yearly average of 2.68°C.



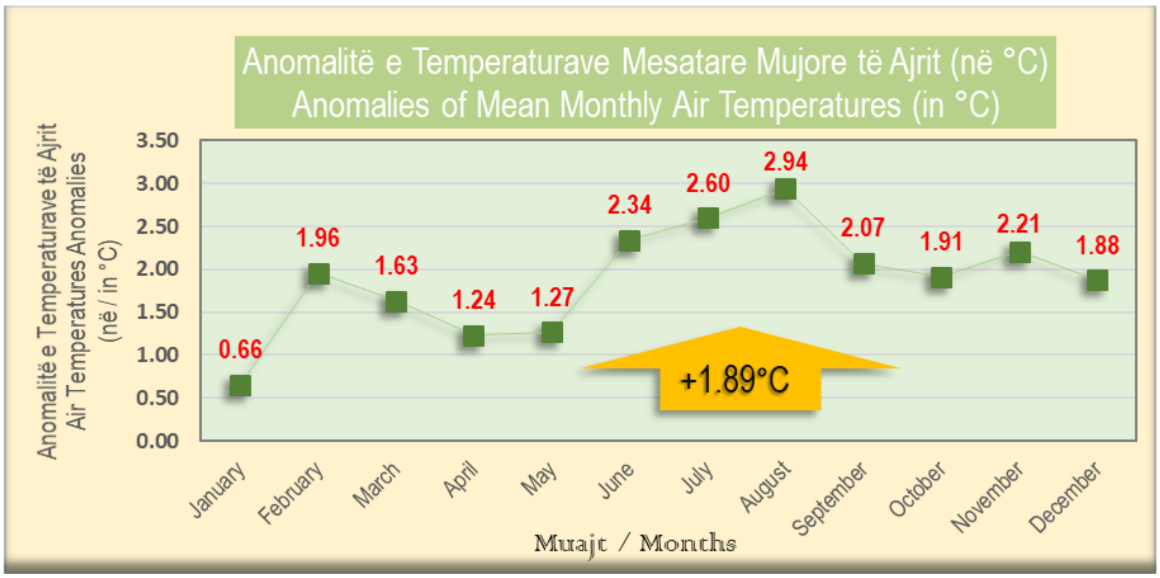


The annual average of daily minima for Devoll was 4°C. Using longer-term observations (since 1931), we found that the absolute minimum temperature for the reference period was –24.8°C, recorded in 1967, and the maximum 35ºC, recorded in 1958. Using the first and last day of every frost considering the date when the minimum temperature was lower or equal to 0°, it was found that the average first day with frost in Devoll was November 1st, and the last day was April 11th.

Table 3. Average air temperatures for Devolli municipality for the period 2017 – 2023

Air temperature by month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Abs. Max. Temp.	16.1	21.8	22.2	26.6	31.6	34.3	36.2	34.0	31.1	27.6	22.2	15.2	36.2
Abs. Avg. Max. T.	12.1	13.7	17.9	21.5	25.9	30.4	32.8	31.4	28.0	24.1	17.2	12.8	33.5
Max. Avg. Temp.	4.7	6.1	9.7	14.0	19.6	23.8	26.3	25.9	23.1	16.4	10.7	6.3	15.5
Average Temp.	0.7	2.0	4.9	8.8	13.9	17.6	19.7	19.4	16.3	11.0	6.1	2.1	9.8
Min. Avg. Temp.	-2.5	-1.0	0.6	3.8	8.1	11.3	13.1	13.0	10.2	6.1	2.1	-1.3	5.2
Abs. Min. Avg. T.	-10.4	-7.9	-6.2	-0.8	2.8	7.0	8.7	8.9	5.1	-0.7	-4.4	-7.9	-8.9
Abs. Min. Temp.	-20.9	-13.8	-16.5	-2.5	0.0	5.4	4.9	6.6	-0.5	-7.4	-10.2	-15.0	-17.5

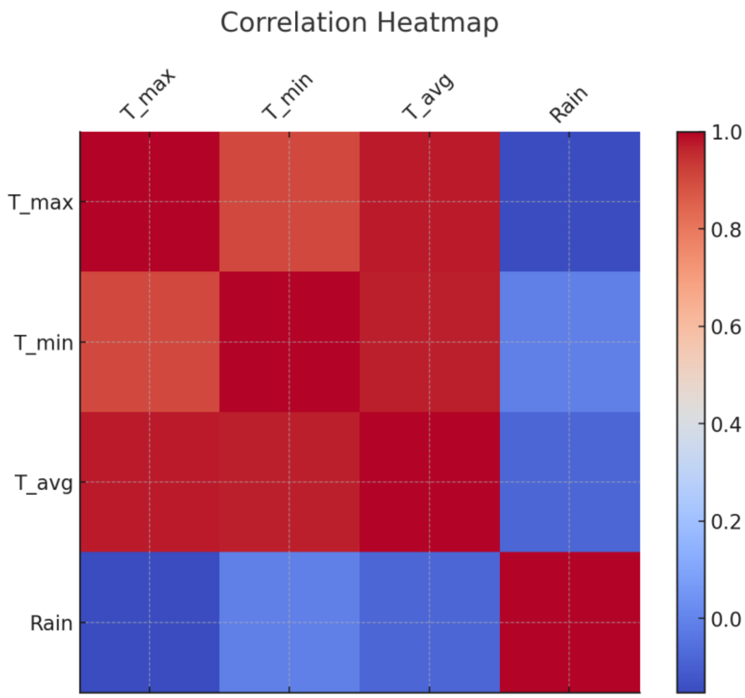
Source: Meteorological Service



Analyzing the anomalies of air temperature in the last seven years (2017 – 2023) in comparison to the reference period (1961 – 1990), the air temperature in Devolli municipality **has increased by +1.9°C.**

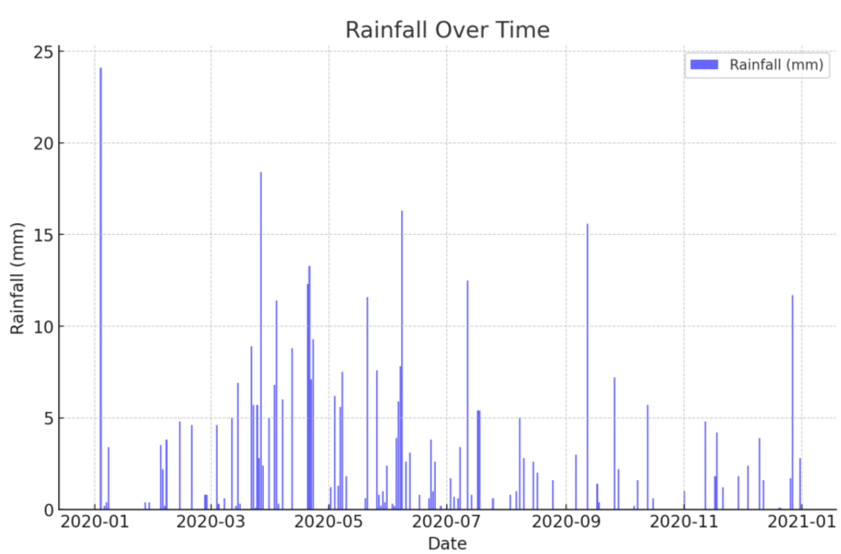
Another important set of data to assess the climate changes is the average dates of the beginning, end, and the average duration of the period with daily mean temperatures equaling or exceeding 0°, 5°, 10°, 15° and 20°C. These days, the different phenological stages of arable crops, particularly fruit trees, are important. The determination of the average dates was calculated graphically with histograms but shown in a narrative form for easier reading. Isochrones indicating the average dates are also reported. Thus, the average date for the beginning of the period with a daily average temperature ≧ of 0ºC was February 1st, while the ending of the period was January 9th. The average duration of the period with a daily average temperature ≧ 0°C for Devoll was 343 days. More important for the vegetation and agricultural production is the average date for the beginning of the period with an average daily temperature ≧ 5°C. For Devoll this was March 20th and the period with these temperatures ends on November 25th, lasting 250 days. The average date for the beginning of the period with an average daily temperature ≧ 10°C was May 21st while it ends in September 21st with a duration of 123 days. The average date for the beginning of the period with an average daily temperature ≧ 15°C was June 21st while it ends in September 16th with a duration of 87 days. The average date for the beginning of the period with an average daily temperature above 20°C for Devoll was July 23rd and the ending date was Aug. 8th, (16 days).

The correlation heatmap illustrates the relationship between the different meteorological variables: maximum temperature (T_max), minimum temperature (T_min), average temperature (T_avg), and rainfall (Rain).



High Correlation Between Temperatures (T_max, T_min, T_avg): The maximum, minimum, and average temperatures are highly correlated (correlation coefficient close to 1). This is expected since these variables are interrelated. On warmer days, both T_max and T_min tend to be higher, leading to higher T_avg. Similarly, colder days show lower values for all temperature variables.

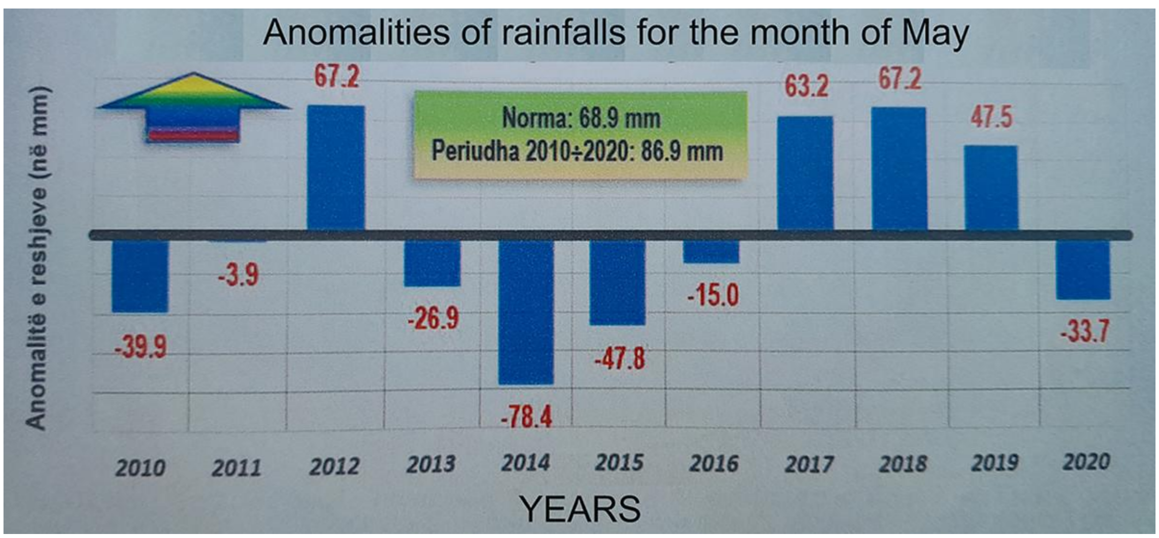
Low Correlation Between Rainfall and Temperatures: Rainfall (Rain) shows little correlation with temperature variables (correlation coefficient near 0). This suggests that rainfall events are not strongly dependent on temperature. Other factors, such as atmospheric pressure, humidity, or wind patterns, likely play a more significant role in determining rainfall.



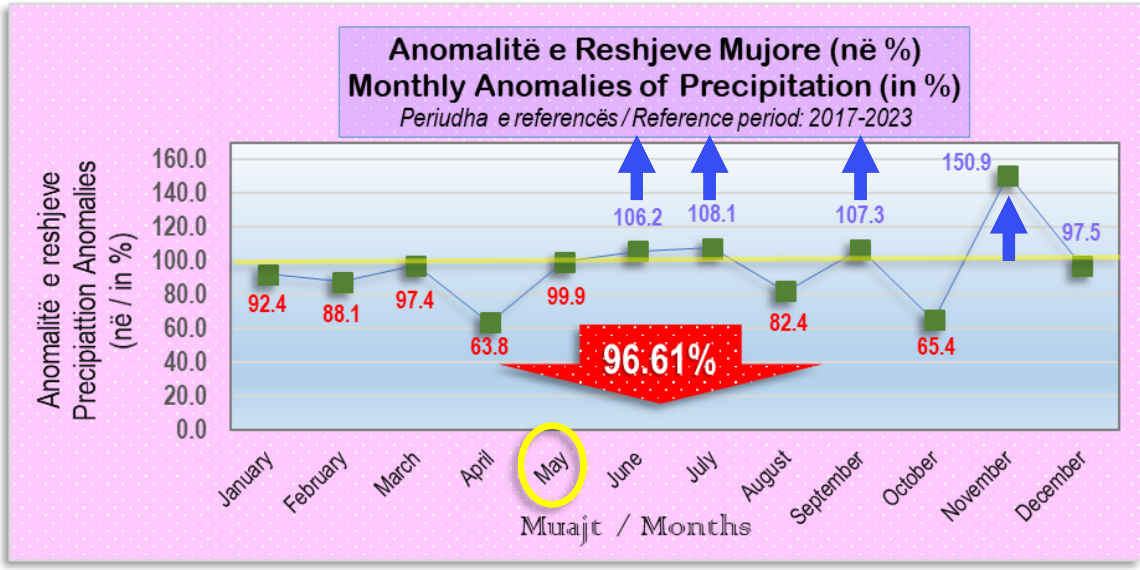
The high correlation among temperature variables makes it easier to predict one temperature metric if others are known. The low correlation between rainfall and temperatures indicates that seasonal or geographical factors may influence the region's precipitation patterns rather than purely thermal dynamics.

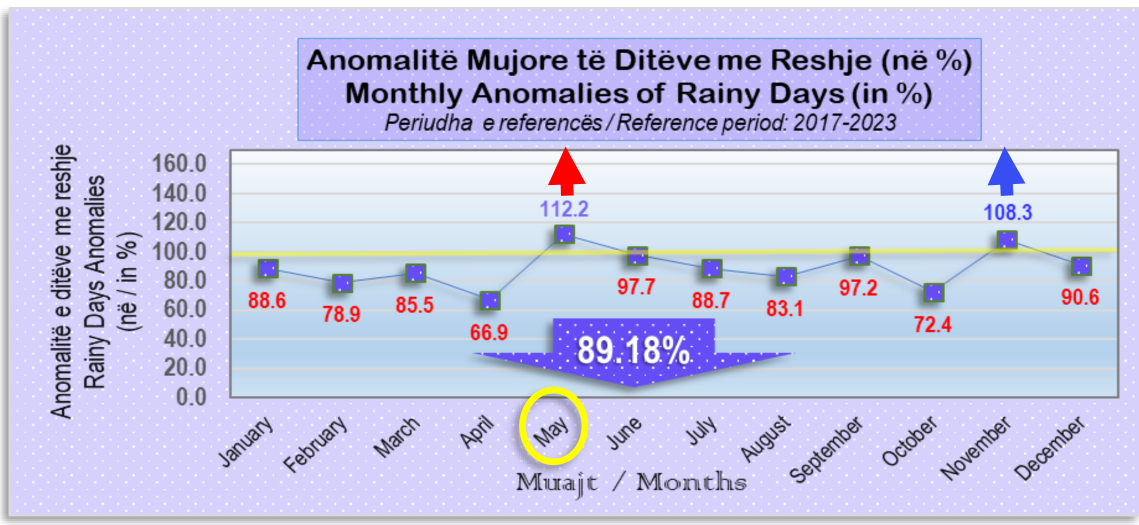
It is known that the rainfalls in Devolli municipality are among the lowest in all the country. The average rainfall for the entire year has been relatively low (~850 mm) and much lower during the vegetation period April – September (less than 300 mm) creating frequent water stress conditions, especially for horticultural crops, i.e. fruits and vegetables. Most of the rains fall during the cold period (~550 mm). Rainfalls during the vegetation period (from April 9th to November 11th) in the last 10 years have been 443 mm. If we compare the last five years (2017-2023) with the reference period (1961 – 1990), there is an increase of 15% relative to the warmest period of the year.

In addition to total precipitations, it is important to see their distribution during the warm and cold periods of the year. As shown in Table 2, the average number of days with rainfalls ≧ 0.1 mm was 130 days but with effective rainfalls (≧ 10.0 mm) was only 30. The average annual snow cover was 30 – 40 cm lasting 40 – 50 days per annum (days with snow cover are considered those days in which, at least 50% of the earth's surface around the meteorological station has been covered with snow). During the reference period, there were about 30 – 40 days with snowfall (days with snowfall are considered those days in which at least 0.1 mm of snow has remained on the ground or has immediately melted).



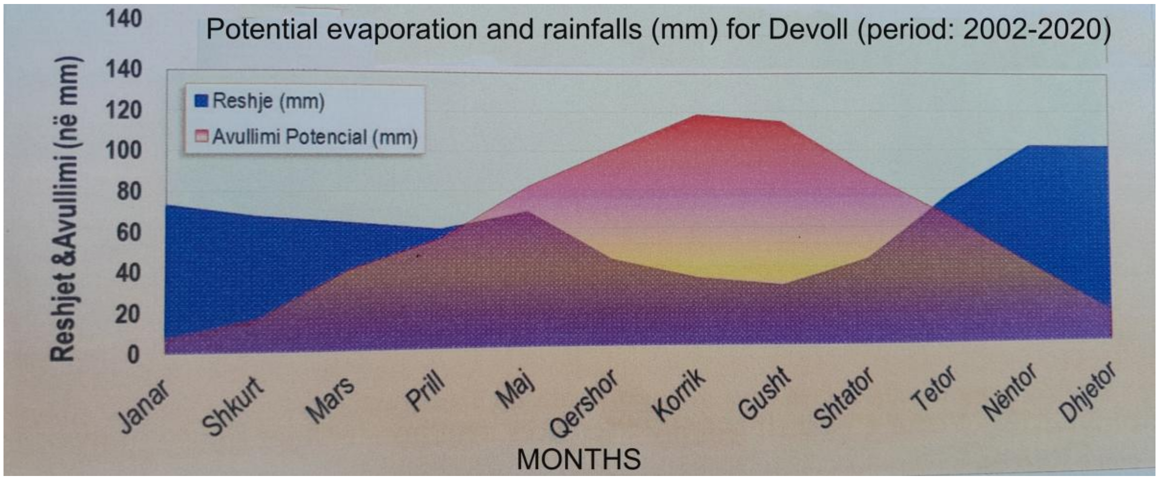
When we compare the data of the reference period with the current period, we clearly see a variability of their distribution which has important repercussions in agriculture in general, and fruit production in particular. In this context, we analyzed the anomalies in rainfalls and the water balance, especially when the needs of the crops are higher and the rainfalls are low. In about 42% of the cases, the values of rainfalls for April are under the average value of 58.8 mm or of the norm (reference period) of 60.3 mm. We can find anomalities of rainfalls even when we analyse the rainfalls for the period 2010 – 2020 for May, as in the figure above; in about 64% of the cases, the values of rainfalls are under the average value of 86.9 mm, whilst against the norm of 68.9 mm are below it in 42% of the cases.

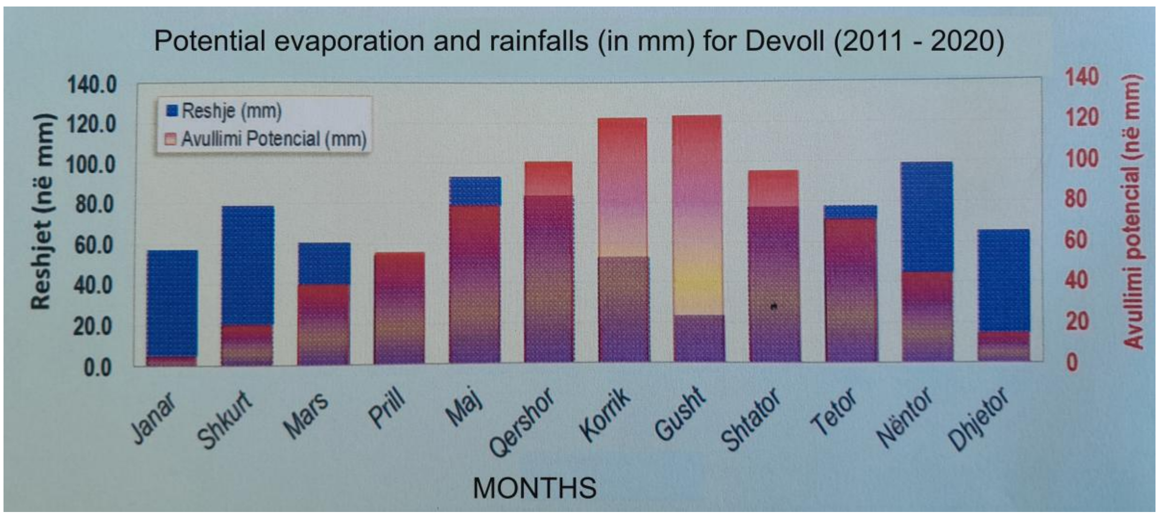




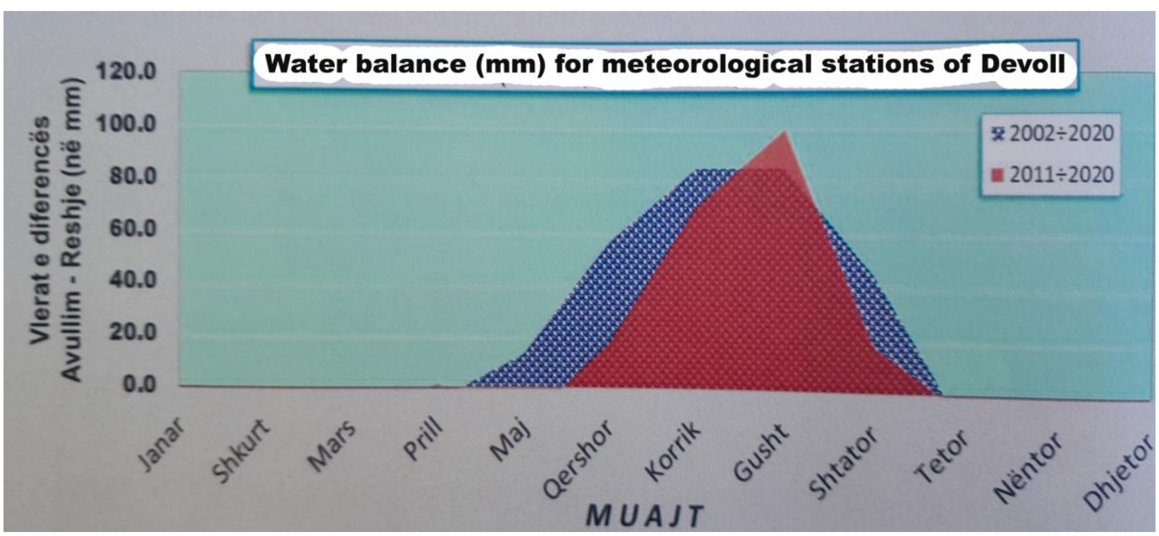
Analyzing the anomalies of rainy days in the last seven years (2017 – 2023) in comparison to the reference period (1961 – 1990), the number of rainy days in Devolli municipality has **decreased by -10.82%.**

The next two figures show a detailed analysis by month of the relationship between rainfalls and potential evaporation for the period 2002 – 2020 as well as for the period 2011 – 2020. The graphics show an improvement of the situation for April and May in the second decade (2011-2020) against the previous values, while there is a worsening for the period for August.

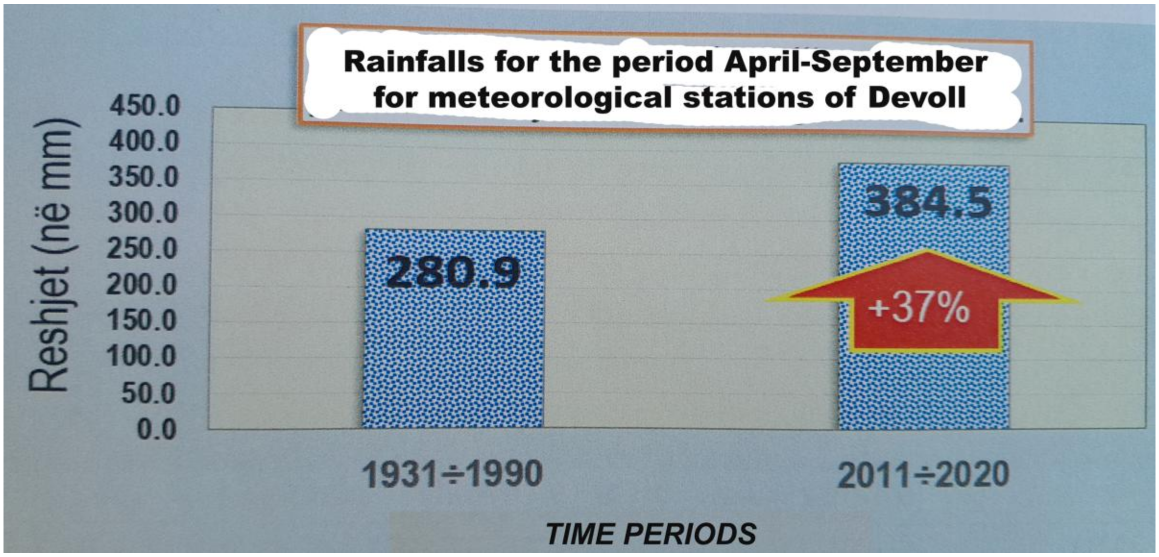




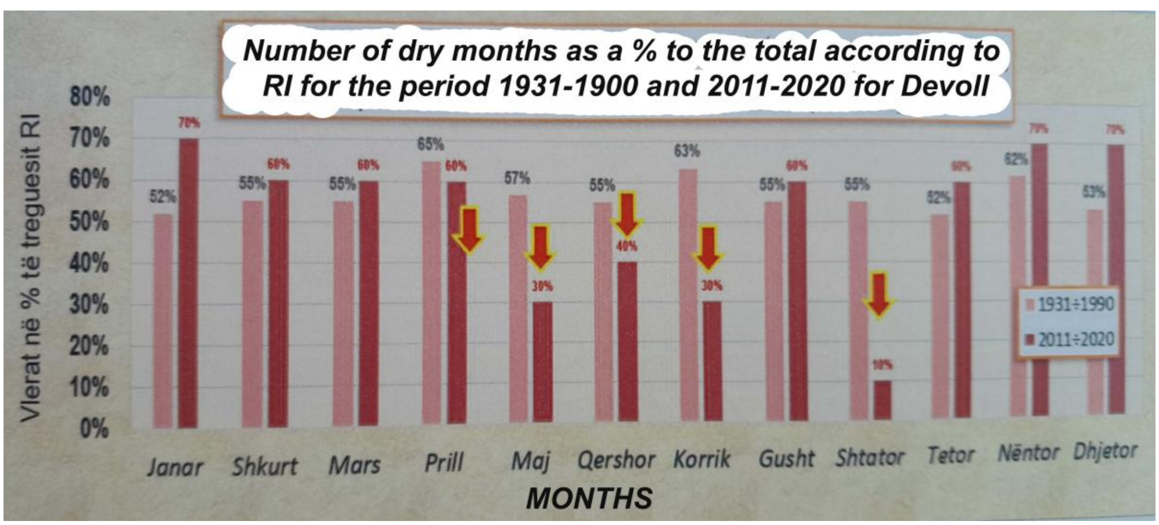
The next figure shows the water balance and the need for functional irrigation systems, especially from May to August.



The following graphic shows the rainfalls during the period April – September which is the most relevant period for vegetation growth, especially for the fruit trees. The data show a situation with rainfalls of 280 mm, referring to a longer reference period (1931 – 1990), while for the decade 2011 – 2020 demonstrates an significant increase by +37% with a value of 385 mm.

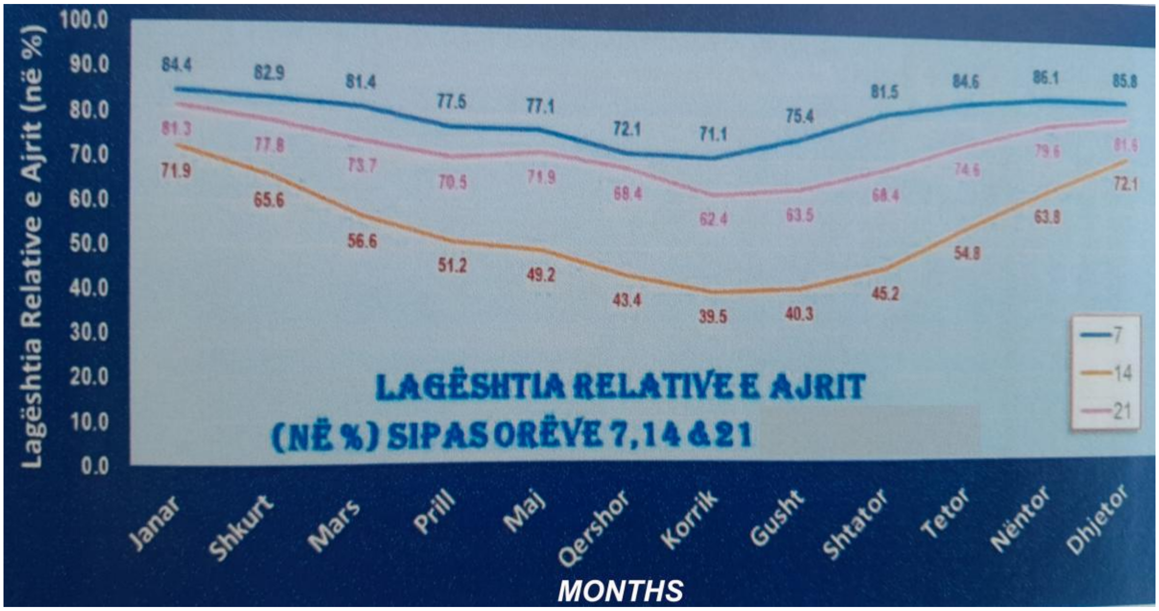


The rainfall during the warm period of the year was analyzed using a rainfall index (RI) that indicates the amount of rainfall in relation to the multiannual average for a certain location. The figure below shows a drastic reduction during the dry months (referring to rainfalls in % by RI) for five months from April to September, with the exception of August, which shows a slight increase.

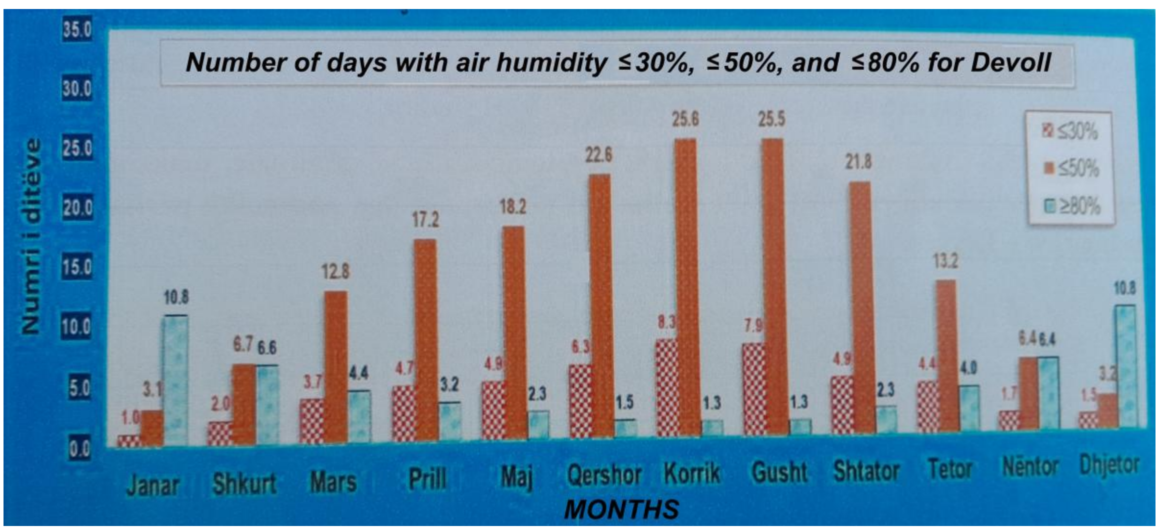


In addition to precipitation, we considered it important to refer to air humidity (%) and water vapor pressure (mb.), which are important variables affecting crop physiology, particularly the onset of fungal and other plant diseases. The average vapor tension was reduced to the sea level for the middle months of each season.

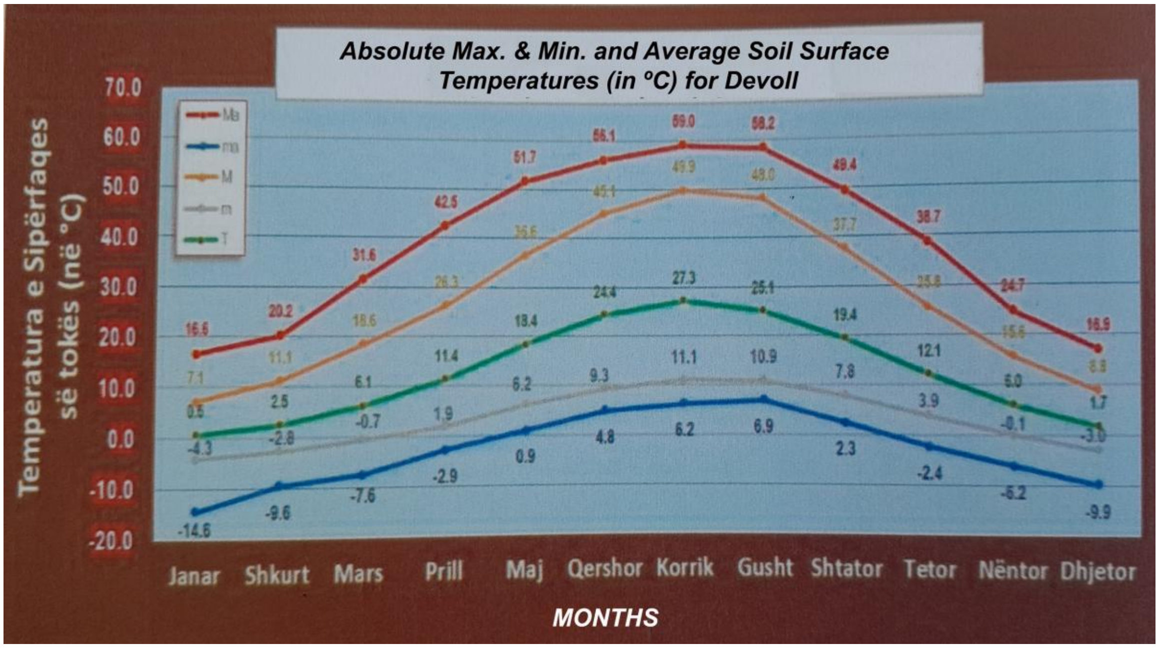
The following figures show the changes in air humidity (%) during the months and in three times of the day, at 7:00, 14:00 and 21:00.



Another valuable meteorological information is also the number of days with air relative humidity ≤ 30%, ≤ 50% and ≤ 80%. The duration of the period with low air humidity during the midday is an important information especially during the hot period of the year, where the water stress increases in the leaf surface of fruit trees.



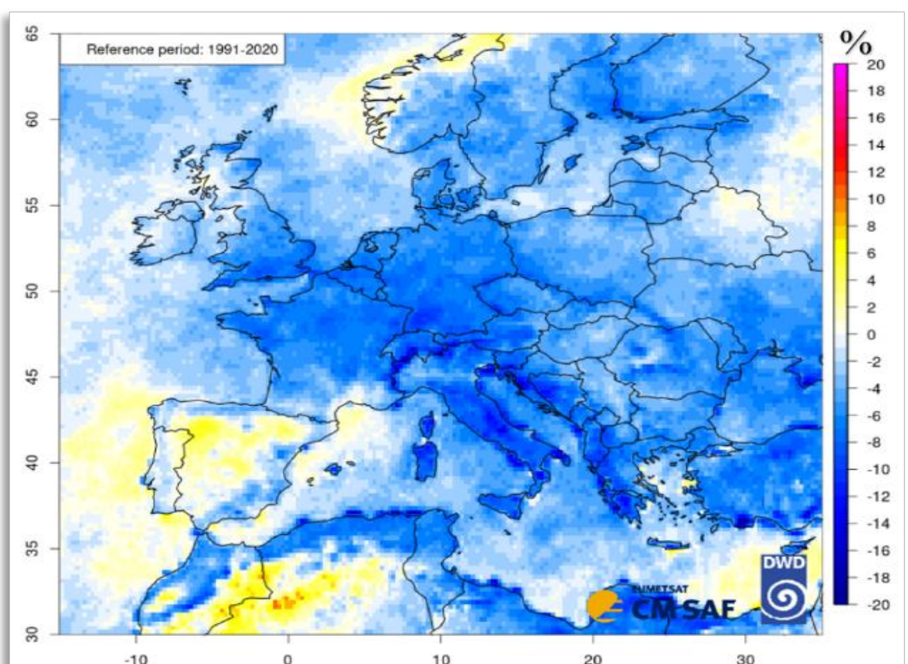
Another climatic variable is the soil surface's temperature and its vertical profile at different depths, which is as important as the air temperature for the normal growth and development of crops. Soil temperatures influence the physiology and production of fruit trees. The figure below shows Devoll's soil temperature dynamics.



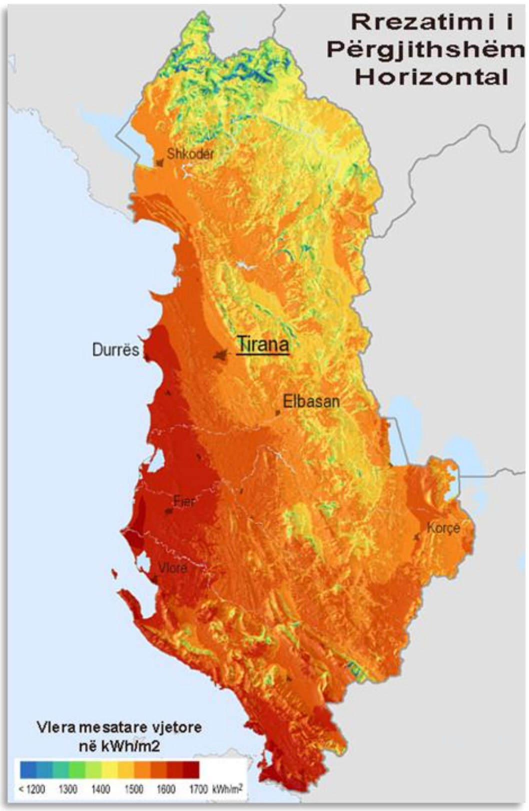
From Dec. to March, there are on average 21-27 days with a minimum soil temperature ≤ 0°C

Mean cloudiness is computed for July, as the least overcast month and December as the most overcast month. A 10-degree system has been used to observe cloudiness. Clear days were denominated those days on which the arithmetical mean of cloudiness is lower to or equal 1.7 (i.e. the daily sum is smaller than or equals 5). Overcast days were denominated those on which the arithmetical mean of cloudiness equals or exceeds 8.3 (i.e. the daily sum equals or exceeds 25). It resulted that the average number of clear days in Devoll municipality is 80 – 85 and those cloudy 100 – 120.

The figure shows the anomaly of the cloud's coverage (in %) for the European continent from 1991 to 2020, according to EUMETSAT, etc. The maps show a **reduction of –16%** for Albania.



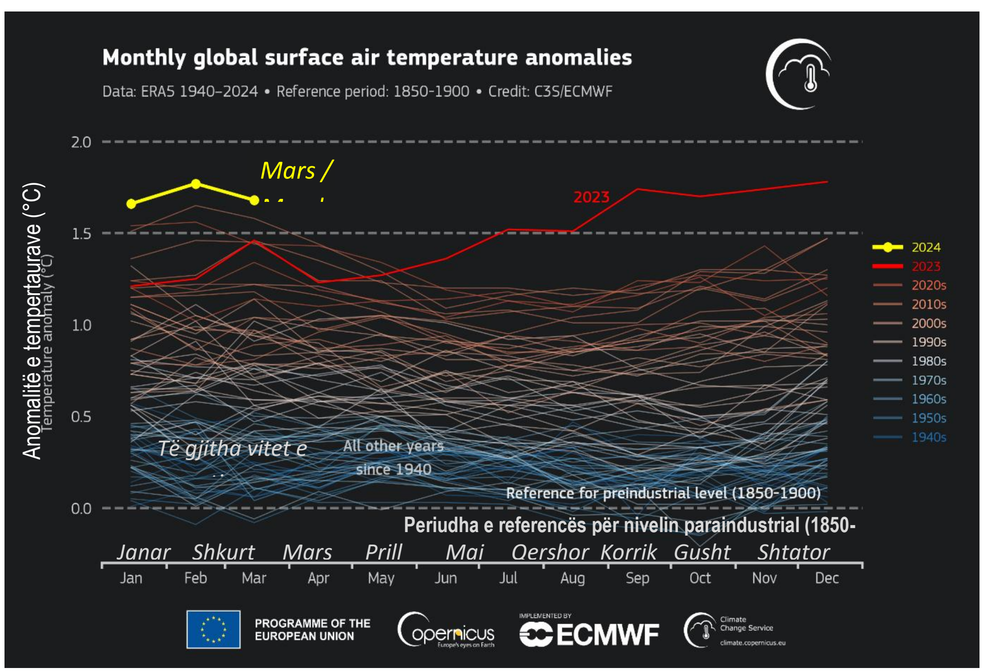
The next map shows the anomaly of the sunshine index (hours of sunshine) for the European continent for 1991-2020 according to EUMETSAT, etc. The maps show an **<u>increase of +5÷10%</u>** which is also correlated to the reduction of the cloud's coverage.



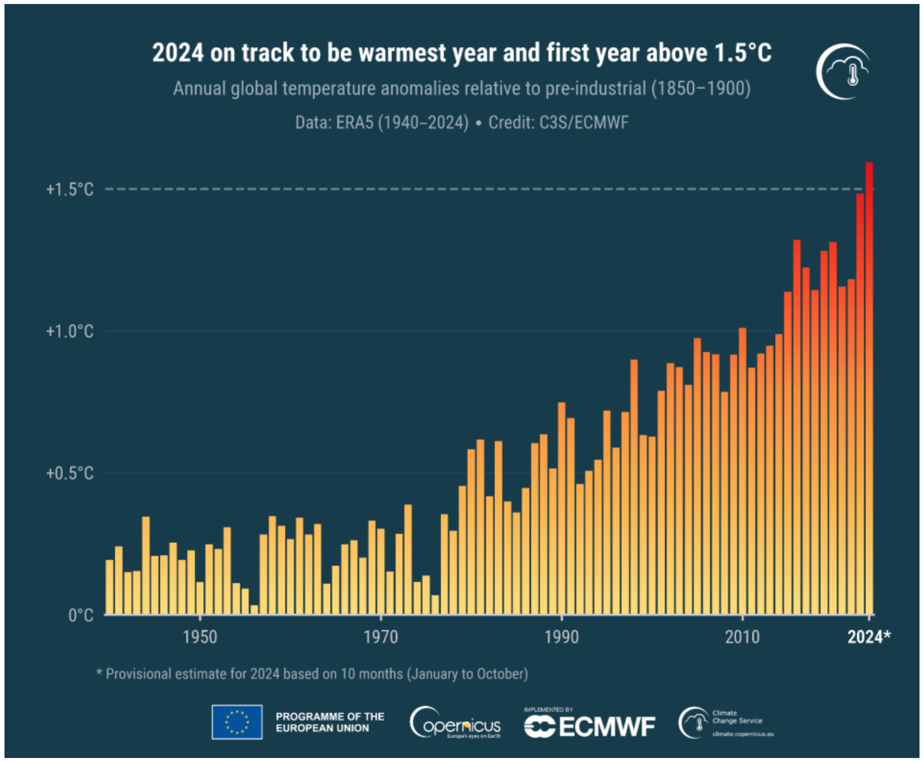
Sunshine duration is important for photosynthesis and the productivity of crops. The data sunshine duration (hours) illustrates January, as the month having in general the least insolation duration, July, as the month having the greatest insolation duration as well as the annual insolation duration. The relative durations were 40% for January, 80% for July with a 60% annual duration. The actual duration for January was 100 – 125 hours, for July 325 – 350 hours whilst the actual annual duration of insolation for Devoll was 2400 hours.

The global radiation has an important influence on crop growth. If we compare the values of the this horizontal radiation in te last years, they fluctuate between 2200 ÷ 3000 hours of sun per year. If we compare it to the norm for the period 1961 – 1990, there are +150 up to +300 hours of sun.

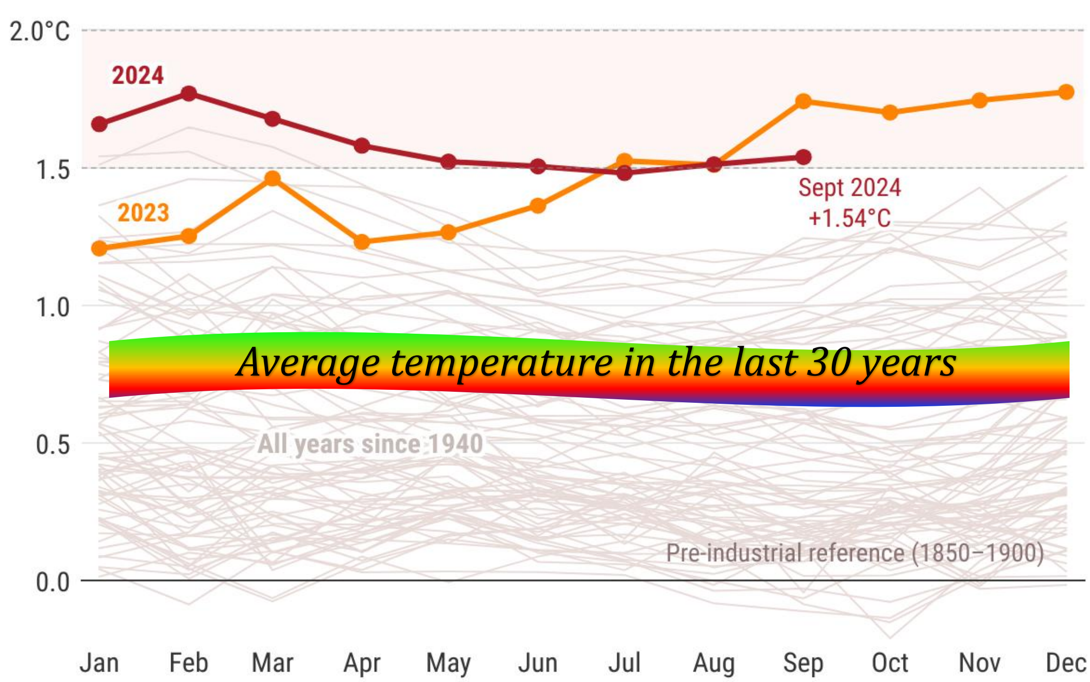
Looking at the data from year 2024, it can be really clean the trend of global warming, with record high air tempera-tures. The following graphs show data for the beginning of the year,



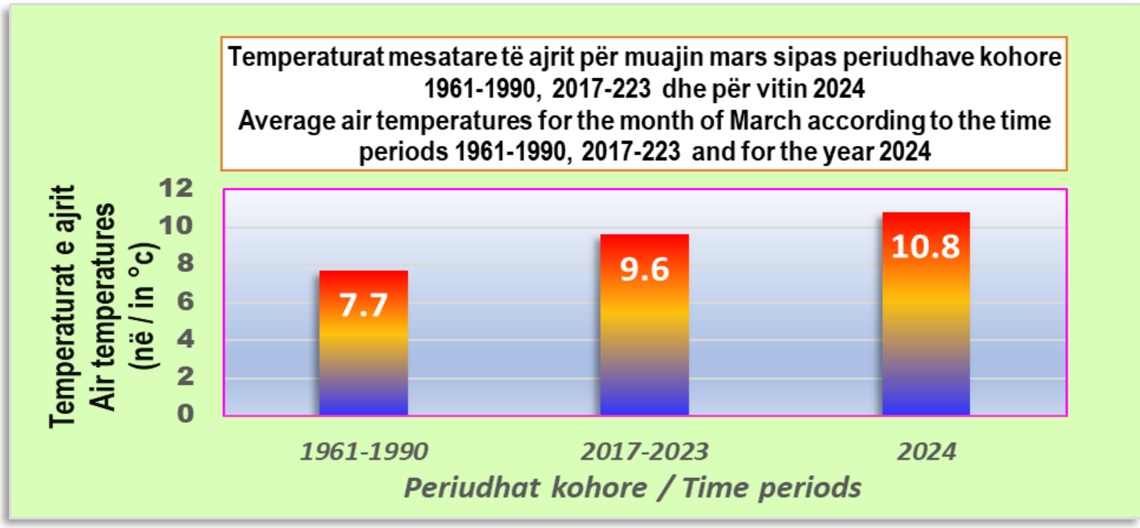
during winter, which are 1°C higher than 2023 and much higher than the previous decades' temperatures shown in light lines.



The next graphs shows the annual global temperature animalities relative to the pre-industrial period. As we can see, 2023 was very close to by 2024 exceed the 1,5°C difference to this period making 2024 the warmest year in the recorded history.



In order to compare the previous graph for European continent with the data from Albania, we have shown below the average air temperatures for the month of March according to our reference period (1961 – 1990) with the period 2017 – 2023 and for the March of 2024.

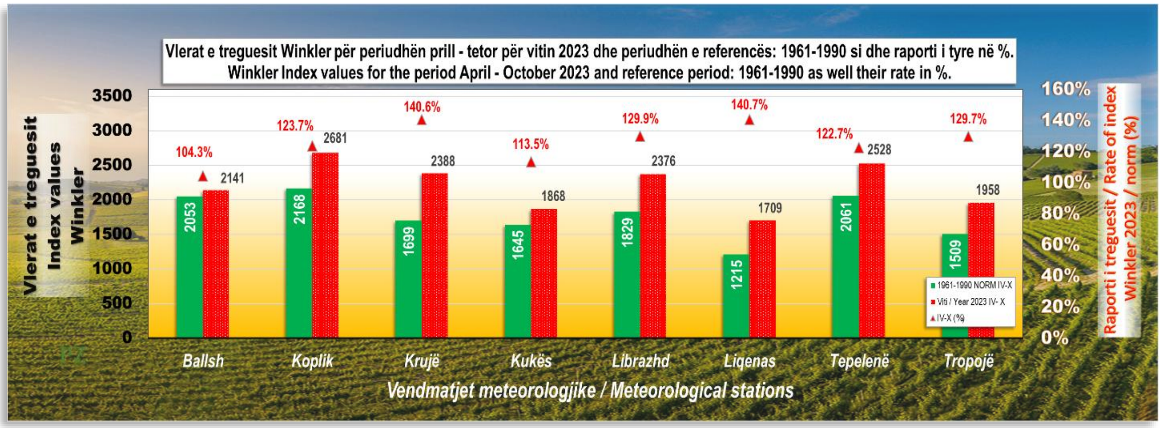


2.1.5 Analyses of the phenological monitoring

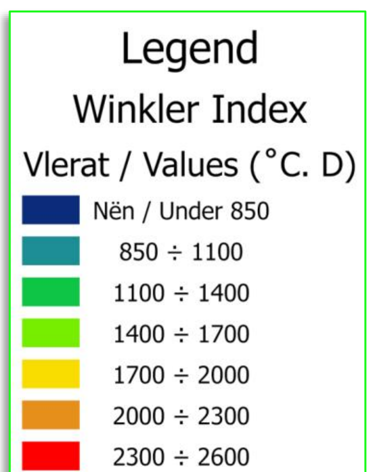
Phenological monitoring offers crucial insights into the observed alterations in crop growth patterns and the appearance and duration of various phenological stages. Elevated temperatures and accelerated temperature accumulation shown in the previous section have the potential to trigger earlier initiation of growth, premature flowering, abbreviated growth phases, and a reduced period for biomass accumulation, among other effects. Analyzing historical records provides a comprehensive view of how crops have responded to annual weather variations and aids in anticipating their future behavior. This data is invaluable for making informed decisions regarding agricultural practices in the face of changing climate conditions. By closely tracking these phenological shifts, we can better adapt and optimize our approaches to crop management and cultivation strategies.

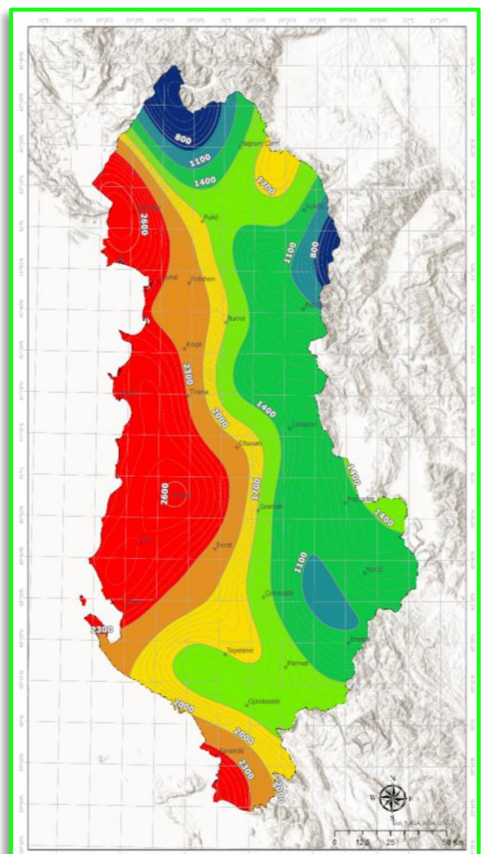
It is reported that there are 13 phenological stations but there is no official information on the indices measured. There is no systematic phenological information from other sources. The only phenological information that could be retrieved was from USDA's Foreign Agricultural Service and only for the beginning and end of the growing season of winter wheat and maize. In the absence of data from IGEO, we have shown some bioclimatic (or phenological) indices that are useful to understand the changes is the growing season, growing degree days or chilling units accumulated, etc. as they have a great impact on the biology, production and quality of crops, particularly fruit trees.

The Winkler Index, also referred to as the "Winkler Heat Zone Index," is a system used to classify agricultural regions based on their thermal suitability for specific crops. The index is calculated by summing the daily average temperatures exceeding 10°C during the growing season, typically from April to October in the Northern Hemisphere. This cumulative heat measure provides a basis for determining the climate suitability of a region for agricultural activities.

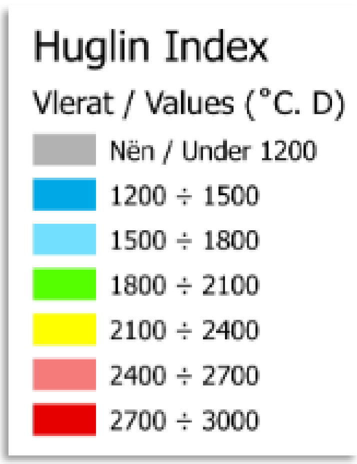


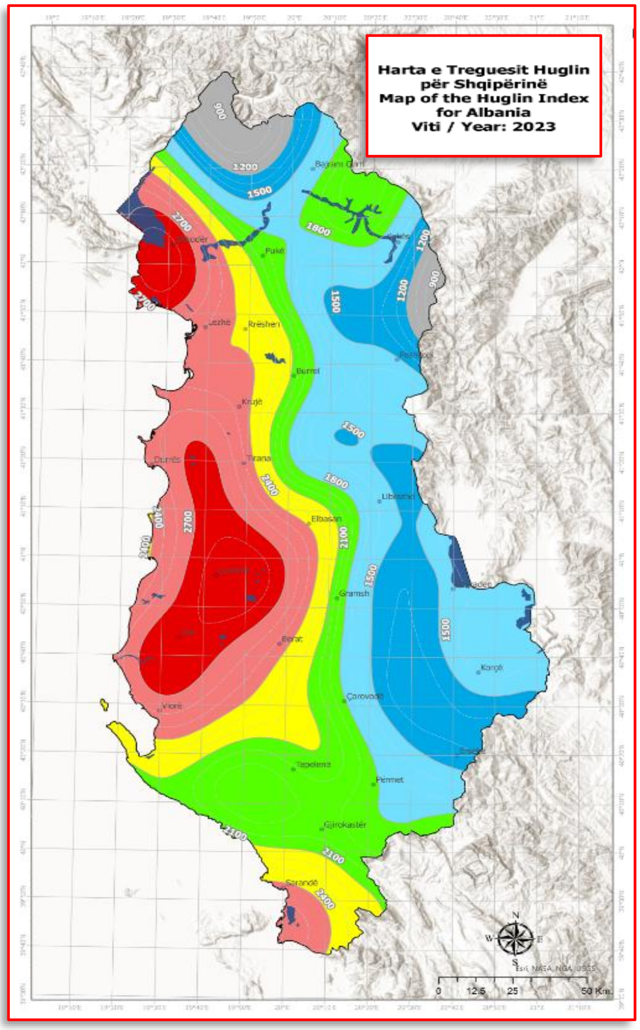
When comparing the data for 2023 with the reference period (1961 – 1990), we can see an increase by +10~40%. The map associated to the data for the entire territory of the country is given for the current period (year 2023). Albania is divided into 5 zones. There is obviously a slight shift of the delineated zones with an increase in favor of the high range values. However, as far as the Wikler indicator is concerned, it must be said that it has some limitations related to the fact that it only takes into account the air temperature and does not take into account the type of soil, precipitation, lighting period, etc. Therefore, this indicator is used together with a number of other indicators to make the evaluation more complete. It should also be noted that this indicator is designed more to make large-scale regionalization's and is not very suitable for localized assessments.





Another phenological index is the Huglin Index, which takes into consideration the duration of the lighting period as well as gives a greater weight to the values of the maximum air temperatures. It is known that the factor of solar radiation or the period with irradiance plays an important role in the photosynthetic processes as well as in the quantity and quality of the final product. Therefore, it has found a wider use than the Winkler index in European continent.





This trend of higher temperatures and very mild winter may have consequences on the non-fulfilment of chilling requirements, which is very important for the induction of flowering.

The climatic and phenological indices analyzed so far clearly indicate that **the vegetation period** for Devoll municipality has been influenced by global warming and has increased from a duration of 193 days to 216 days or about 4 weeks longer in the last years. This enables growing cultivars with a higher requirement for growing degree days above 10°C and utilization of more light for photosynthesis and production.

The start of the vegetation period is associated with a delay gradient of 5 days for every 100 m of altitude, while it is closed with an earliness gradient of 3 days for every 100 m of altitude against the field of Korça. The gradients of delay for the beginning of the vegetation period area 9 days for every 1 degree of displacement in latitude towards north and 12 days of earliness for its ending. The average temperature for the vegetation period in the last decade has been 17.2°C, a higher value than the reference period.

Chilling requirements are a critical factor in the successful cultivation of fruit trees, particularly those grown in temperate climates. These requirements refer to the number of hours a tree must be exposed to temperatures between approximately 0°C to 7°C during its dormant period to overcome bud dormancy and ensure proper flowering and fruiting in the following growing season.

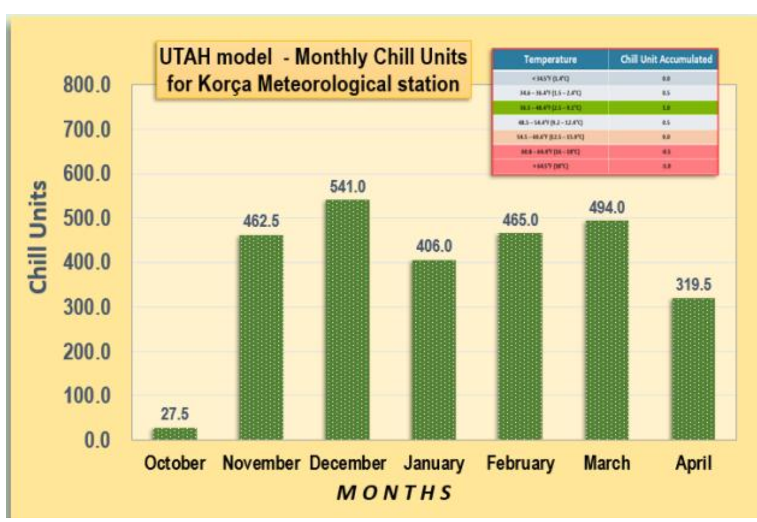
Fruit trees enter a state of dormancy in the winter as a natural response to colder temperatures, which helps them survive adverse weather conditions. During this period, the accumulation of chill hours signals the tree to prepare for growth when warmer temperatures return. Insufficient chilling can lead to uneven bud break, poor flowering, reduced fruit set, and lower yields.

Chilling requirements vary widely among species and even cultivars of fruit trees (see Table 4).

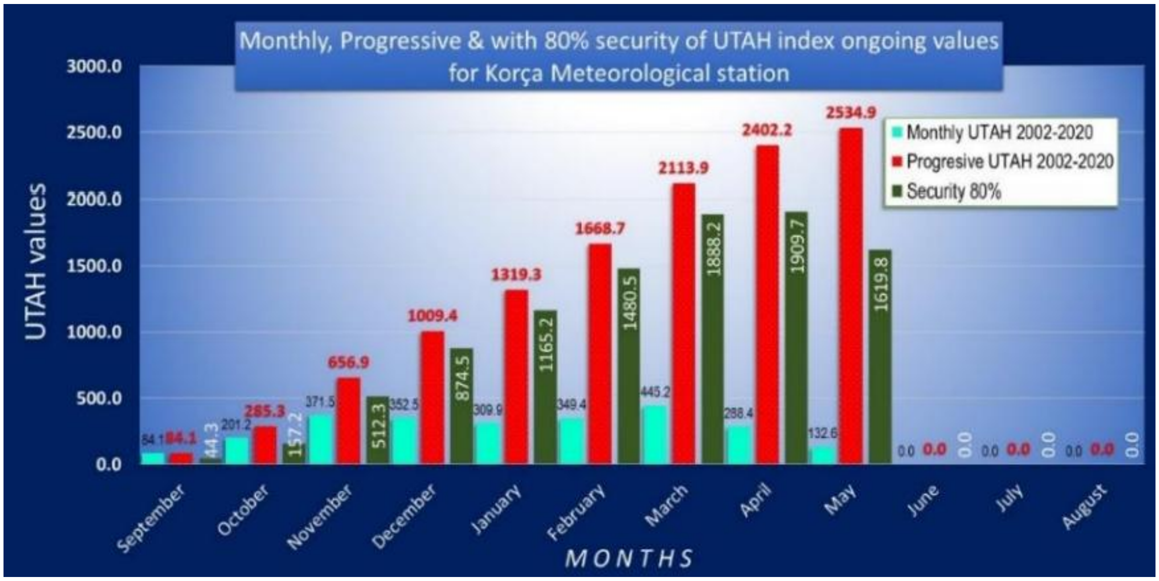
Table 4. Chilling requirements for main fruit trees

Species	Chilling Requirement (0 - 7°C)
Apple	200 – 2000
Pear	600 – 1500
Cherry	500 – 1300
Peach	200 – 1100
European Plum	700 – 1700
Japanese Plum	500 – 1500
Apricot	250 – 900

This concept is especially relevant in the context of climate change, where fluctuating winter temperatures and warmer conditions may disrupt traditional chilling hour patterns. Growers must adapt by choosing suitable cultivars, implementing orchard management strategies, or exploring innovative technologies to mitigate these challenges.

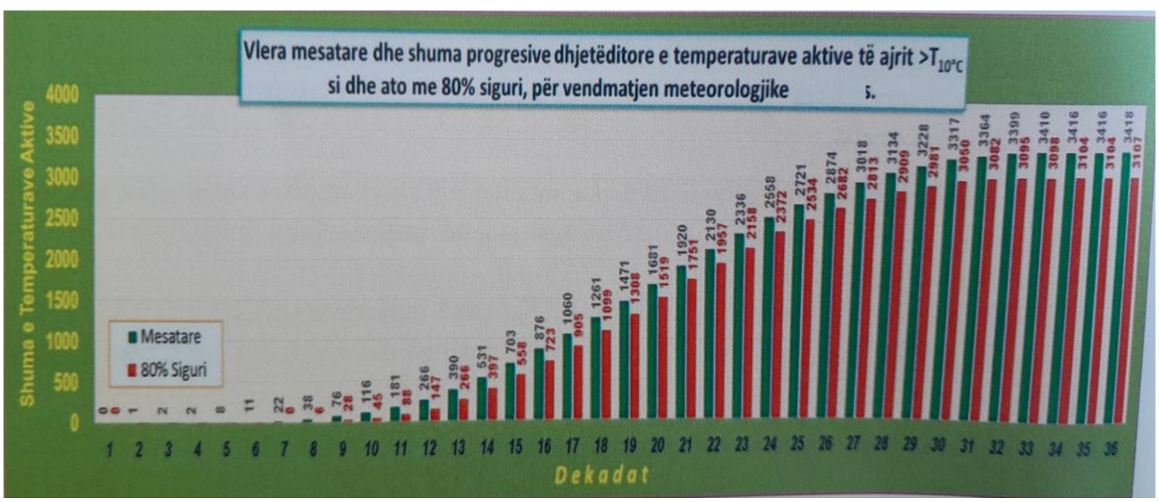


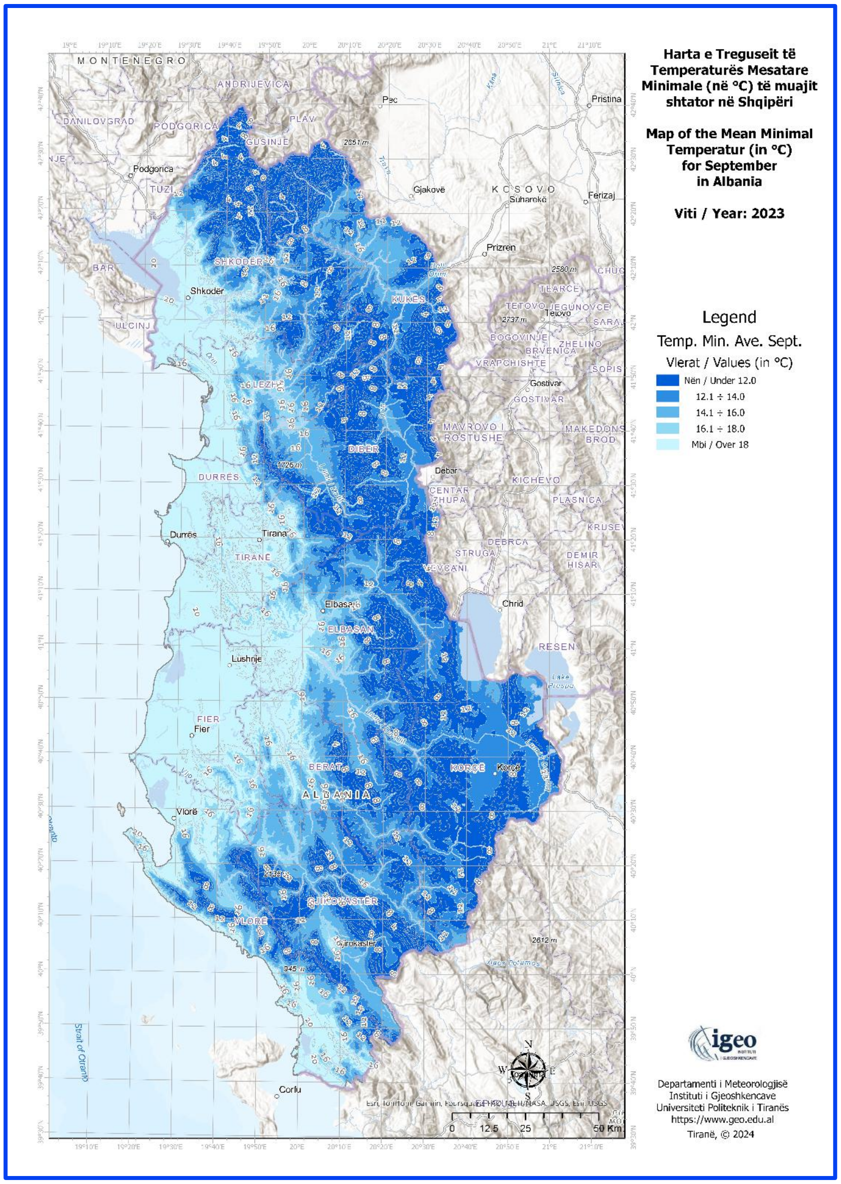
In a study carried out by a group of authors, led by Prof. Zorba from IGEO, using the UTAH model, it was concluded that the chilling units accumulated were still sufficient for the induction of flowering for most of fruit trees. As one can see, the progressive units for the period 2002 – 2020 show the accumulation of more than 2500 units. The general warning effects causes more days to have chilling temperatures than freezing temperatures (which are not counted).



Notwithstanding, the trend of increased temperatures will inevitably lead to physiological issues related to the non-fulfilment of chilling requirements, namely significant dud drop, delayed leaf emergence, prolonged, irregular, staggered flowering and insufficient fruit set.

In the recent years, the growing degree days > $T_{10°C}$ has increased remarkably for Devolli region. With the increase in altitude, the values decrease with a gradient of 200°C for every 100 m. The figure shows the average 10-day and progressive values with 80% certainty of the total active temperatures > $T_{10°C}$. This important analysis concludes that the average values of these indices (the norm), nowadays represent values with 80% certainty.





For the Night Cooling Index (CI), data on the minimum average air temperature for the last month of the growing season were analyzed. CI is a variable for night cooling that takes into account the average minimum nighttime temperatures during the month when ripening typically occurs. The purpose of this index is to improve the assessment of qualitative potentials, especially in relation to fruit aromas. The importance of this climatic factor is related to color and aromas.

In general, there is no damage during the dormant season. Due to climate changes, the minimum temperatures in Devolli region during winter hardly exceed minima of -18°C which do not cause damage to dormant perennial crops. However, late frosts have caused significant damage in the last years. Frosts during the beginning of the vegetation growth or even during the early flowering stages have resulted in heavy yield reduction. Fruit growers are not prepared to protect their trees from these frosts. In similar regions, fruit growers used overhead sprinklers to spray the flowers in order to protect them from dying out. Spraying fruit trees to protect them from frost involves using water to create a protective layer of ice on the trees and their blossoms. This method leverages the physical principle of latent heat of fusion, which is released when water transitions from a liquid to a solid state (freezes). When water sprayed onto the tree freezes, it releases latent heat, which helps maintain the

temperature of the tree tissues and blossoms at or just above freezing (0°C). This prevents the tissues from reaching damaging lower temperatures.

Water must be continuously sprayed as long as freezing conditions persist. If water is not reapplied, the ice layer can become a heat sink and further cool the plant, potentially causing damage.

The ice layer formed on the plant acts as an insulating barrier, slowing down the rate of heat loss from the plant tissues to the colder environment.

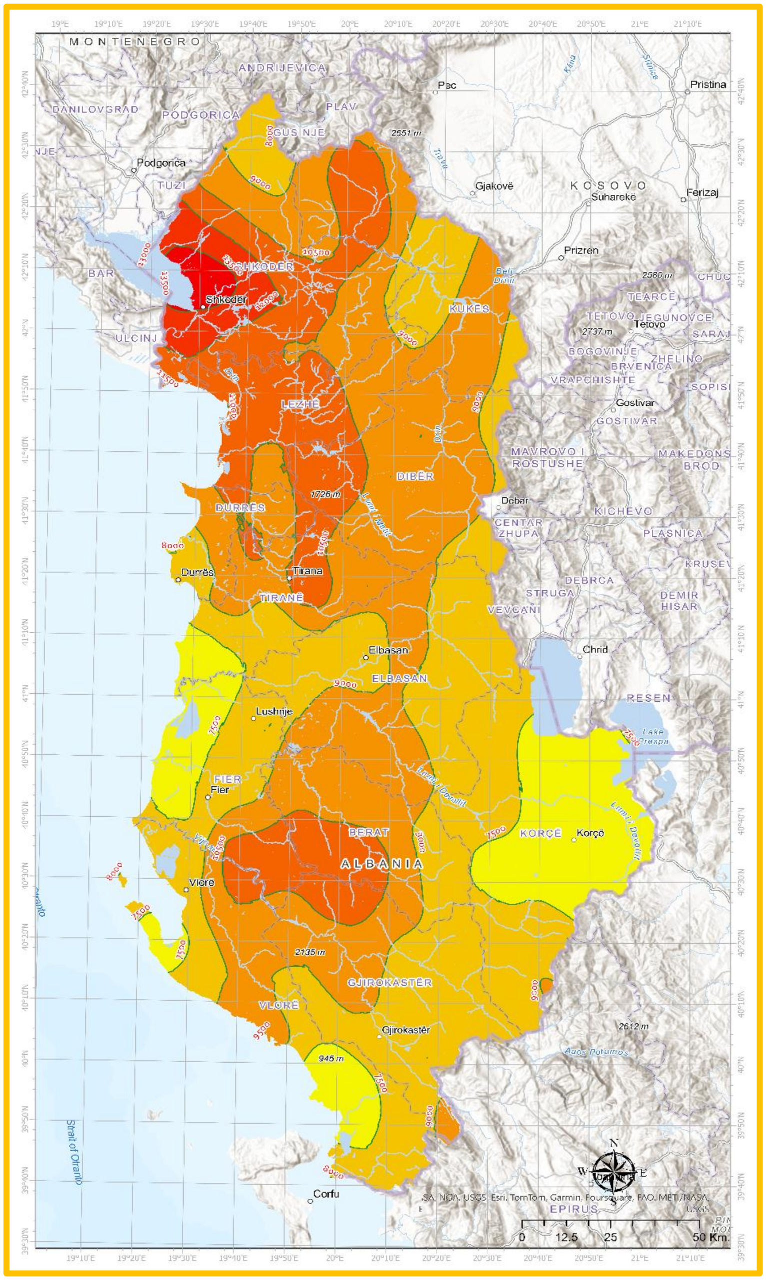
This method is most effective in conditions where temperatures are slightly below freezing (e.g., -2°C to -5°C) and frost events are short-lived. It is commonly used in orchards with access to sufficient water and frost-sensitive crops like apples, cherries, and stone fruits.

This technique is widely used because it is cost-effective and provides immediate protection, but it requires careful management to avoid unintended damage. The same sprayers are used for irrigation. In Albania, most fruit growers have installed drip irrigation being the most efficient irrigation method but it is not helpful for frost protection.

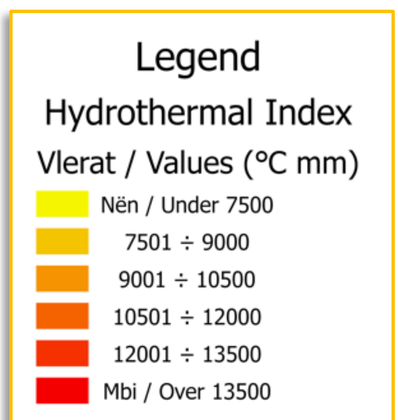
Continuing the discussion of phenological indices, the next one is te hydrothermal index. The Hydrothermal Index (HI) is a bioclimatic indicator that integrates the combined effects of temperature and precipitation on plant growth and development. It is commonly used to evaluate the suitability of a specific region for crop cultivation, particularly for perennial crops like fruit trees, vineyards, and others sensitive to climatic conditions.

The HI formula is based on the relationship between temperature and precipita-tion over a specific period, typically the growing season for crops. It is calculated by dividing the average temperature (T) during the period by the total precipitation (P) over the same timeframe.

Essentially, the formula quantifies how much heat is available relative to the water supply. A higher HI value indicates a greater dominance of heat relative to water, often signaling conditions of heat stress or drought. Conversely, a lower HI value suggests an abundance of water compared to heat, which could lead to waterlogged conditions or insufficient thermal energy for optimal crop growth. This ratio helps researchers and farmers assess the suitability of climatic conditions for specific crops, plan irrigation, and anticipate challenges posed by heat or water stress. As it can be seen, Devolli municipality is classified under 7500 (°C mm) which means that there is an abundance of water but with possible conditions of insufficient thermal energy for optimal crop growth.

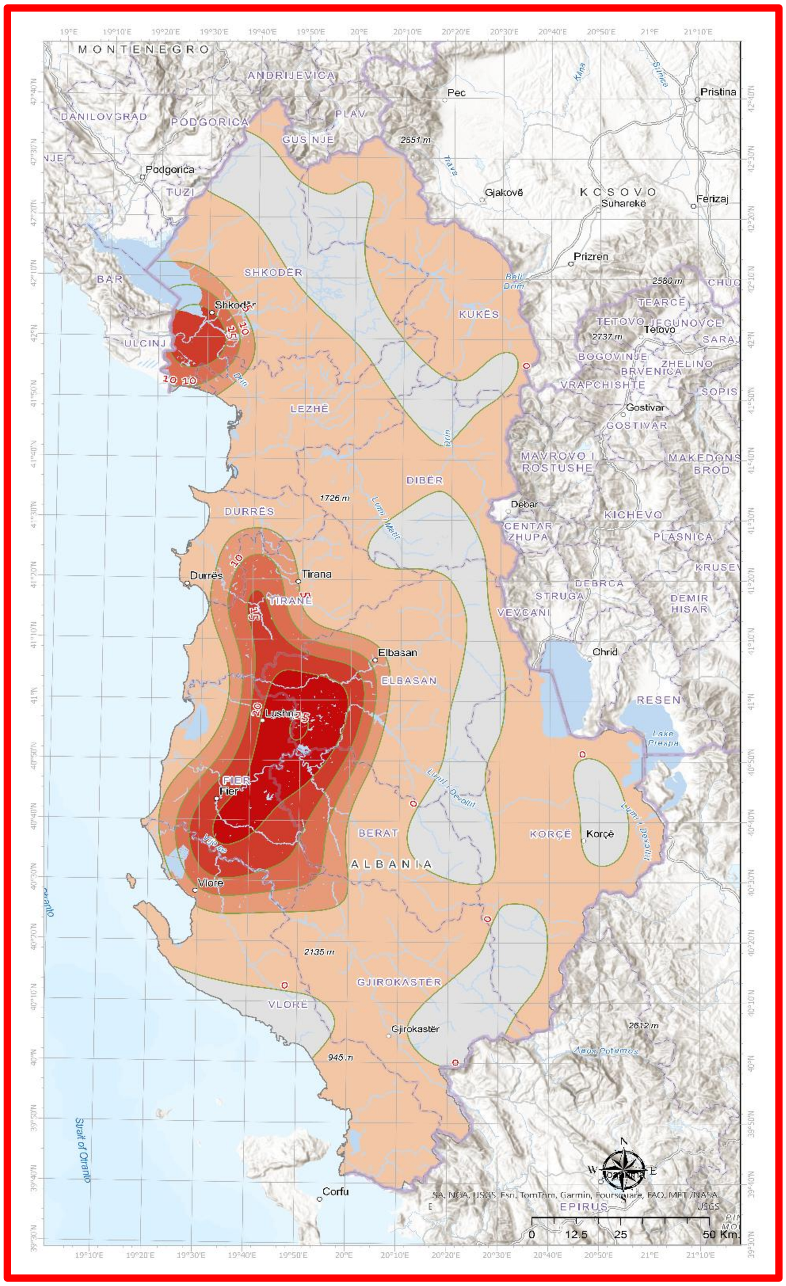


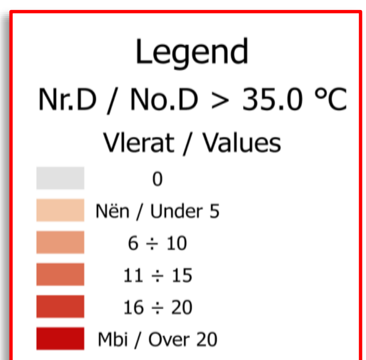
Another climatic indicator which has received importance due to global warming is TASMAXs35. This is a shorthand for the maximum air temperature recorded during a 24-hour period. s35 indicates the threshold temperature of 35°C. The "s" denotes "surpassing" or exceeding this value, TASMAXs35 refers to a climatic indicator used to measure extreme heat events.



Specifically, it represents the number of days in a year when the maximum daily air temperature (TASMAX) exceeds 35°C.

The TASMAXs35 indicator is commonly used in agricultural and environmental studies to evaluate heat stress on crops, as prolonged exposure to temperatures above 35°C can negatively affect plant physiology, flowering, fruit set, and yield. This index assesses climate risks for specific regions like Devoll, as an increase in the frequency of days exceeding this threshold may indicate a trend of warming and its potential impacts on ecosystems, water resources, and human activities. This map can guide adaptation strategies, such as identifying heat-tolerant crop varieties, improving irrigation management, or adjusting planting schedules. For instance, regions with a high TASMAXs35 value may require measures to mitigate heat stress impacts on plants, livestock, and infrastructure.





Light is important for fruit trees: it warms the soil, it is important for assimilation (sugar content in fruits, wood ripening), the accumulation of yellow pigments in the fruit, breakdown of chlorophyll; the formation of red surface color in fruits (anthocyanins) and development of strong flower buds. However, the values of radiation reported above, can damage fruit trees and this has led to light-exclusion netting.

Exclusion netting influences the microclimate only in terms of light and wind intensity, inside an entirely enclosed orchard. Lower light levels are known to decrease crop coefficient and, as a consequence, plant water requirements. Thus, nets in general have demonstrated to be beneficial for saving water purposes. Since there is a growing commercial interest in the use of full canopy netting, knowledge on the microclimate effects, plus the influence on tree physiology and water status, with repercussions on final yield, over multiple years, is required. Covering the block with a cloth or shade net that excludes a portion of the radiative energy. If available, this purpose can also be served by a hail protection net. In many cases, the degree of shading is different: a classical anti-hail net has 20% shading whilst an exclusion net has 40% shading. The higher shading properties create a more favourable microclimate for the trees, allowing them to improve marketable fruit weight, compared to hail net. A remarkable commercial impact gained by exclusion netting is lowered water requirements with sustained fruit productivity.

The installation of dynamic photovoltaic panels over orchards or other crops in Devolli municipality could meet the challenges of protecting orchards from climate change and drive the energetic transition. Studies aimed to evaluate the impact of fluctuating shading (photovoltaic panel orientation to maximise panel light interception) on water relations, leaf morphophysiological characteristics and yield determinants have found positive results. With a mean shading rate of 50–55%, air temperature was reduced by 3.8 °C, while relative humidity was increased by 14% under shading conditions. Depending on the season, the

lower radiation and stressful microclimate decreased the irrigation between 6% and 31%. Fluctuating shading reduces the photosynthetic capacity of leaves, lower carbohydrate assimilation, lower flower intensity at the shoot scale means that the agrivoltaics technology should still improve. Although agrivoltaic systems may reduce alternate bearing behaviour hin apple trees, it did not maintain sufficient yields.

Another method to reduce the heat stress is spraying over trees. Spraying over trees is an effective practice to reduce excess heat and protect fruit quality during periods of extreme temperatures. The method relies on the evaporative cooling effect, where water sprayed onto the tree canopy absorbs heat as it evaporates, thereby lowering the temperature of the fruit and leaves. This practice is particularly useful in preventing heat stress, sunburn, and damage to the fruit's surface. Intermittent spraying ensures the canopy remains moist without overwatering, while low-volume sprinklers are commonly used for efficient and uniform application.

As with frost control, low-volume mixing sprinklers are the most suitable.

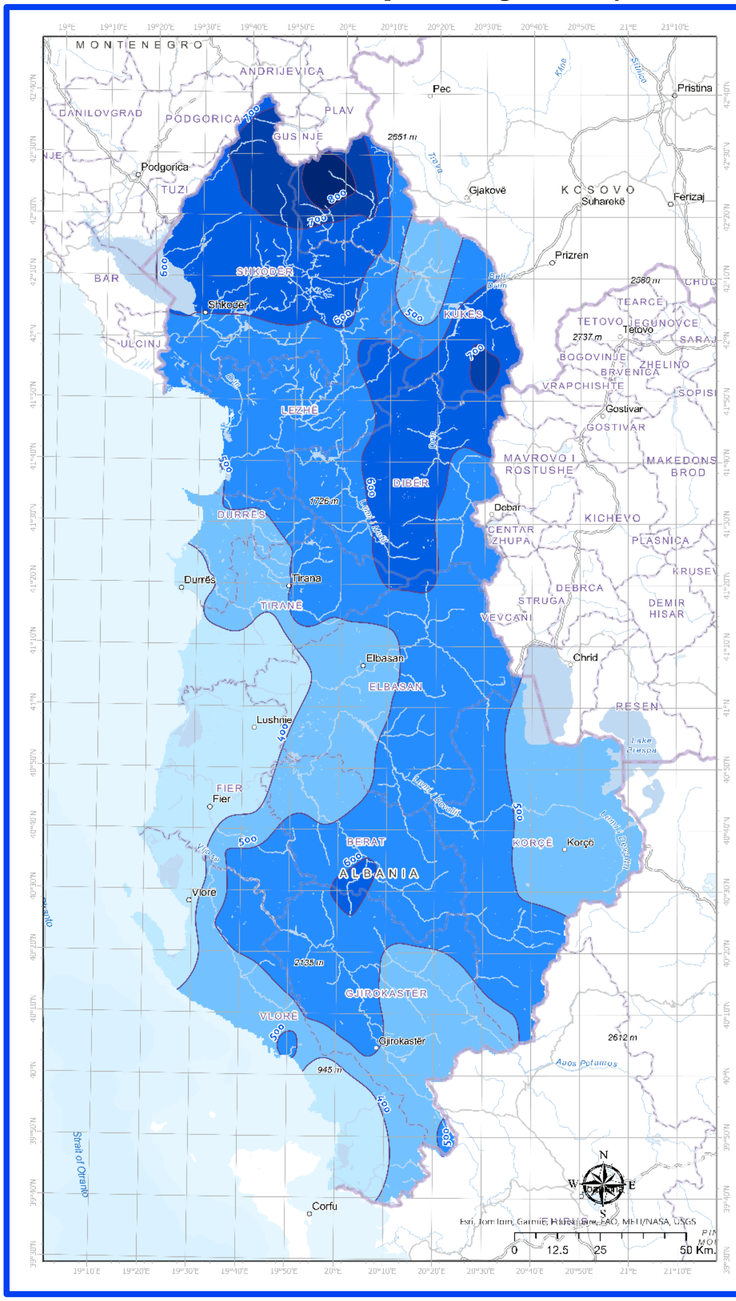
Sunburn in fruit trees is a significant issue that occurs when fruits or foliage are exposed to intense, direct sunlight, often following unexpected changes in canopy cover. This damage is more severe in trees with weak rootstocks or inadequate structural support, as such forms lack sufficient shading mechanisms. Sudden exposure of shaded fruits to full sunlight can cause cellular damage, leading to discoloration, reduced fruit quality, and even loss of market value. To mitigate sunburn, it is essential to optimize crown forms, select appropriate rootstocks, and implement protective measures such as shade nets or strategic pruning to maintain consistent light distribution.

These images are becoming very frequent for fruit growers in Devolli municipalities with an increasing share of fruits that cannot be sold for fresh consumption. Such damages from sunburn require adaptation measures to reconsider rootstocks and training systems.

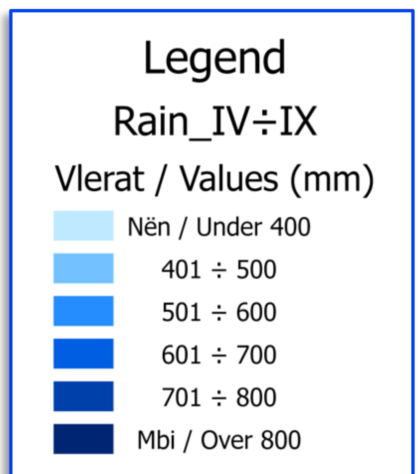
The GSPR (Growing Season Precipitation Range) is a vital climatic index used to evaluate water availability for crops, particularly during their active growing period. The cumulative rainfall during the April-September period (GSPR) is a critical metric for assessing the climatic water availability for crops, including fruit trees, during the growing season. This approach provides an estimate of how much water is available in the environment to support plant growth and development. However, it is important to note that such a simplified method overlooks the effects of rainfall frequency and intensity, as well as the demand for evaporation driven by atmospheric conditions. A more nuanced approach that accounts for these factors could offer a more comprehensive understanding of water supply potential for agricultural systems.

Additionally, essential variables such as surface wind speed and global radiation, which are critical for evaluating evaporation rates (, are often limited in representation within a small set of climatic simulation models. This limitation may reduce the accuracy of evaporation assessments. Moreover, relying solely on temperature-based evaluations for estimating evaporative demand may result in overestimations. A broader consideration of meteorological variables and their interactions is essential for accurate climate-based assessments of water availability for crops, especially for fruit trees, which have specific water requirements during their productive phases.

The cumulative rainfall (DSPR) from April to July, along with the number of days with precipitation exceeding 1 mm (DSPRs1) during the same period, serves as a critical climatic metric for assessing environmental conditions impacting crops. This timeframe aligns with a sensitive growth phase for many crops and plants, during which they are particularly vulnerable to environmental stresses, including diseases. The combination of total rainfall and the frequency of rainy days during this period has been identified as a robust predictor for the spread of fungal diseases. Furthermore, these climatic indicators have proven to be valuable for estimating the required number of treatments and predicting the early onset.

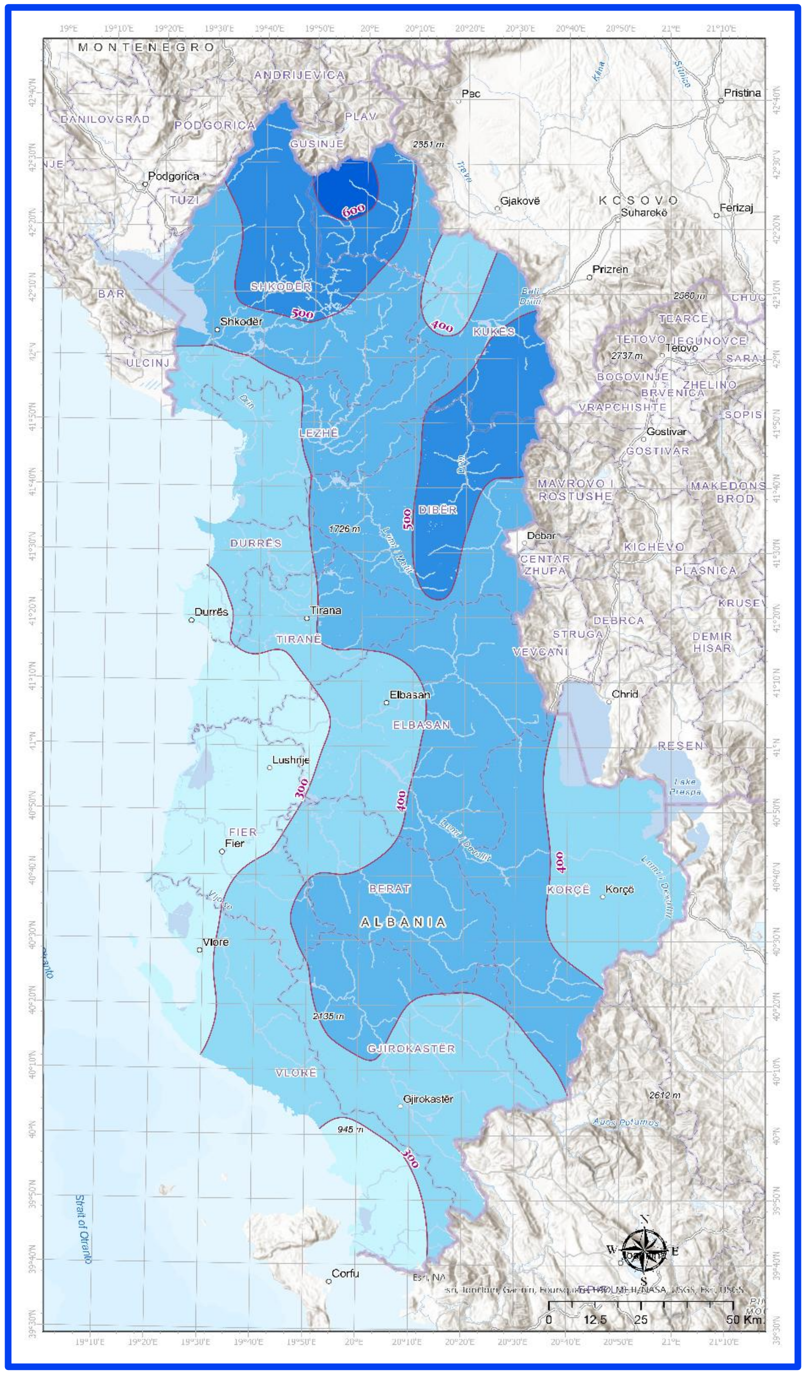


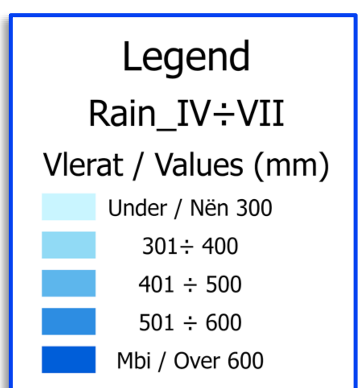
These metrics can also be applied to other crops sensitive to prolonged wet conditions, where excessive rainfall and frequent rainy days create an ideal environment for fungal and bacterial diseases. For instance, crops like wheat, potatoes, and tomatoes are also susceptible to diseases triggered by similar climatic conditions. Incorporating such rainfall indicators into agricultural management strategies allows for improved disease forecasting, optimization of treatment schedules, and mitigation of



crop losses across various agricultural systems. By integrating rainfall patterns with other environmental variables, such as temperature, humidity, and wind speed, models can provide more comprehensive insights into disease dynamics, helping to enhance sustainable agricultural practices.

In the context of climate change, incorporating additional climatic variables such as humidity, temperature, and wind patterns into rainfall-based assessments becomes increasingly critical for accurate disease prediction and crop management strategies. As climate change intensifies weather variability and alters long-term patterns, a multi-variable approach provides a more comprehensive understanding of how shifting climatic conditions influence pathogen development and crop vulnerability. By leveraging advanced simulation models and localized data that account for these evolving dynamics, agricultural stakeholders can develop adaptive interventions tailored to changing conditions. This approach supports sustainable farming practices that not only reduce reliance on chemical inputs but also enhance resilience to the

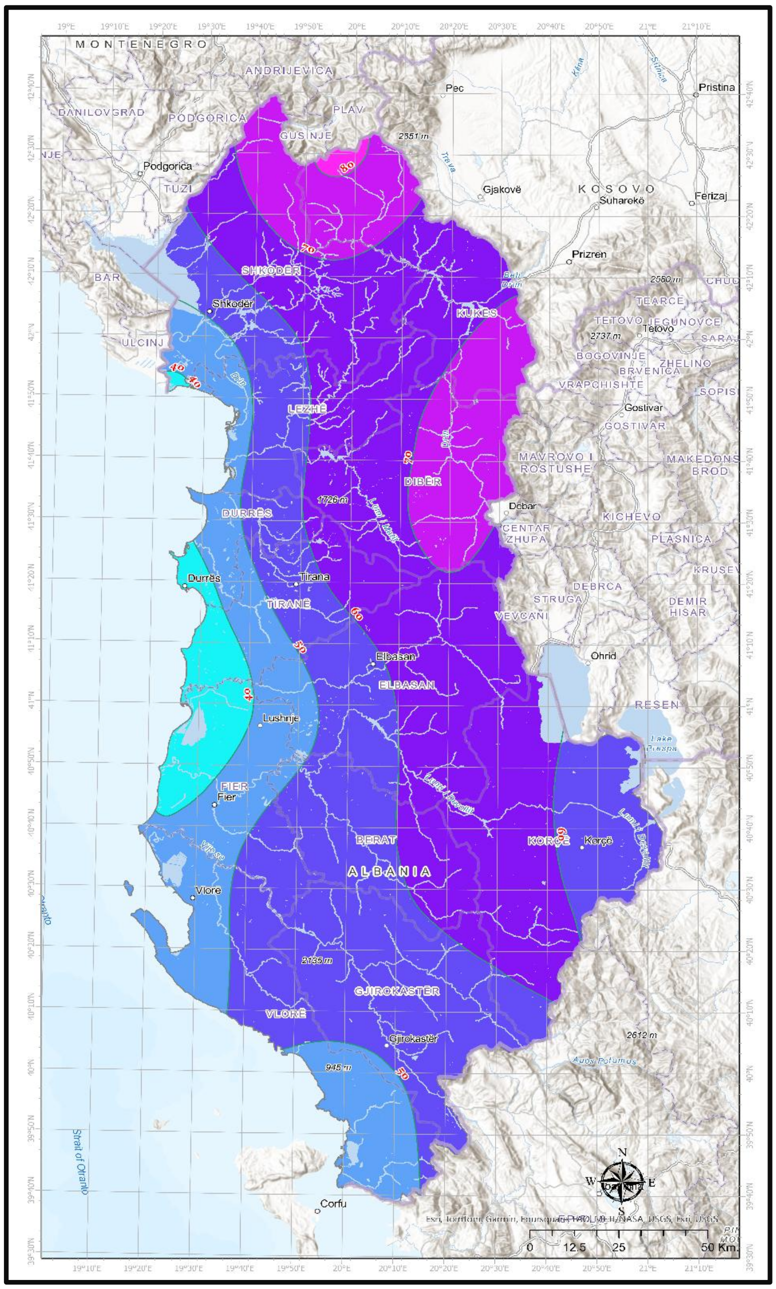


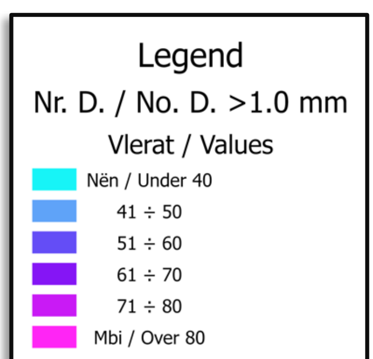


unpredictable impacts of climate change, safeguarding both productivity and quality in the face of mounting environmental challenges.

In the context of climate change, the number of rainy days during critical agricultural periods provides essential information about the feasibility of conducting mechanical work and applying phytosanitary treatments. As changing precipitation patterns result in more unpredictable and intense rainfall, ensuring dry weather conditions for these practices becomes increasingly challenging. Such variability poses significant obstacles to agricultural operations, particularly in systems relying on frequent interventions to manage pests and diseases.

Furthermore, the effectiveness of contact-based phytosanitary products—commonly used in organic farming and designed to remain on the surface of plant tissues without penetrating them—is especially compromised by rainfall. These products are quickly washed away during rainy periods, reducing their efficacy and necessitating more frequent reapplications (Pérez-Rodríguez et al., 2016). This highlights the need for adaptive strategies, including the development of more resilient treatments and better-integrated pest management approaches, to





mitigate the impacts of shifting rainfall patterns exacerbated by climate change.

Hail damage is a particularly disruptive natural phenomenon, posing significant challenges for agricultural systems due to its unpredictability and severe impacts. The frequency of hailstorms plays a critical role, especially in orchards, as repeated events can exacerbate losses over time. The intensity of hailstorms further compounds the problem, not only jeopardizing the yield of the current growing season but also causing lasting damage that can negatively affect production in subsequent years.

As climate change contributes to shifts in weather patterns, the increasing occurrence and intensity of hailstorms represent a growing threat to sustainable agriculture. Mitigation measures such as the adoption of protective netting, improved forecasting systems, and resilient farming techniques will be essential to minimize the damage caused by this challenging natural event and ensure the long-term viability of agricultural production.

Devolli is one of the regions most severely affected by hailstorms, making it particularly vulnerable to this unpredictable and destructive natural phenomenon. The frequency and intensity of hail in this area not only cause immediate damage to crops but also have long-term repercussions for agricultural productivity. Orchards and other high-value crops in Devolli are especially at risk, with hailstorms often leading to significant losses in yield and quality.

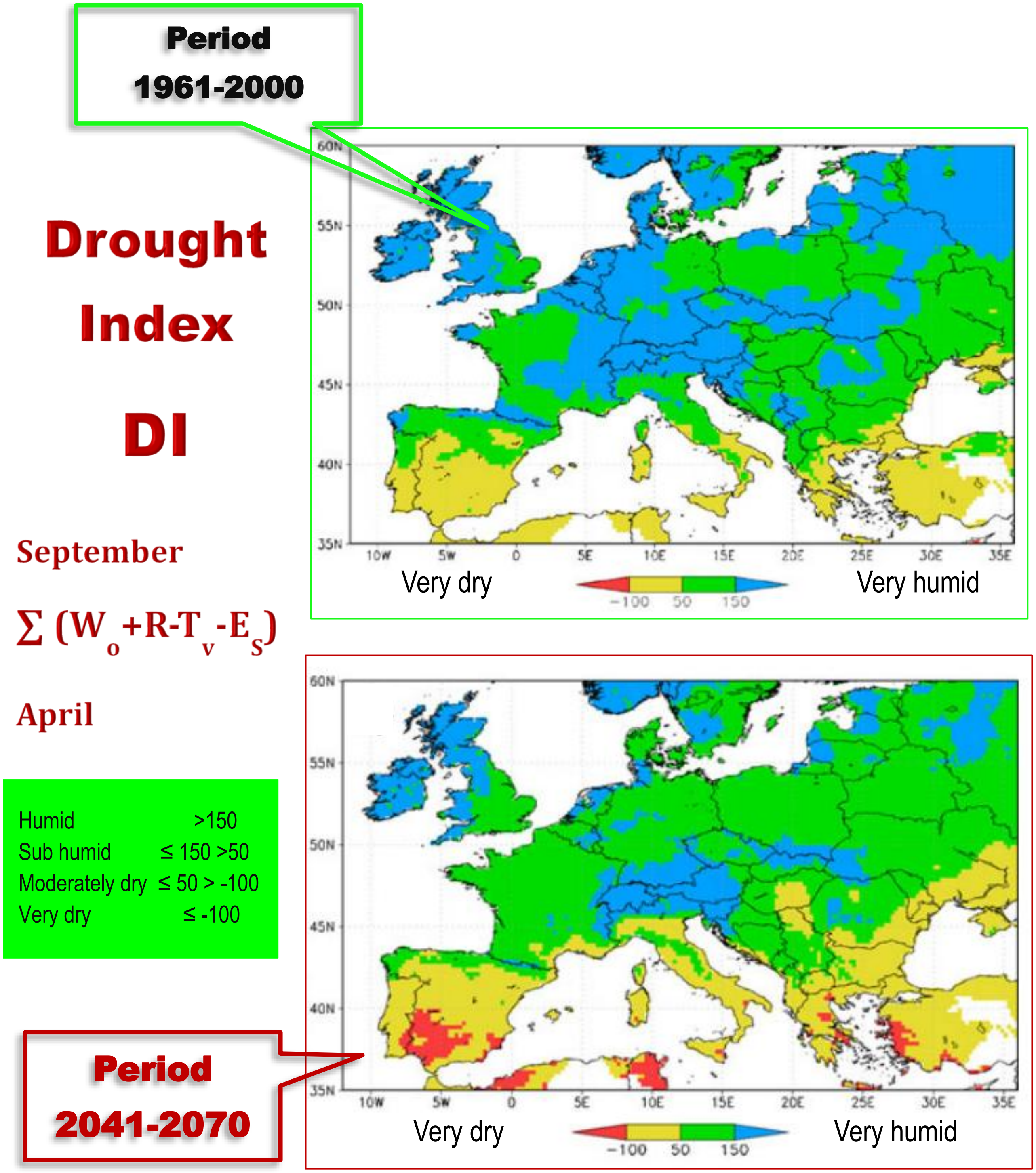
Table 5. Number of days with hails in Devoll

MONTHS												SHUMA VJETORE
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
0.1	0.1	0.3	0.8	1.2	0.6	0.1	0.2	0.1	-	0.1	-	3.6

Given its susceptibility, the region requires targeted strategies to mitigate the impact of hail. Solutions could include implementing protective measures such as anti-hail nets, enhancing weather monitoring and early warning systems, and exploring crop insurance schemes to support farmers in coping with economic losses. Addressing the challenges posed by hailstorms in Devolli is essential to safeguarding the livelihoods of its agricultural communities and ensuring the sustainability of its farming practices in the face of increasingly volatile weather patterns.

In the context of climate change, the drought index (DI) for the upcoming period indicates a significant increase in drought conditions across most of southern Europe. This projection aligns with the anticipated changes in climatic models, which predict a notable intensification of arid conditions in the region. Areas such as the southern Iberian Peninsula, Greece, and Turkey are expected to experience severe drought (DI < −100 mm), highlighting the growing vulnerability of these regions to prolonged water scarcity.

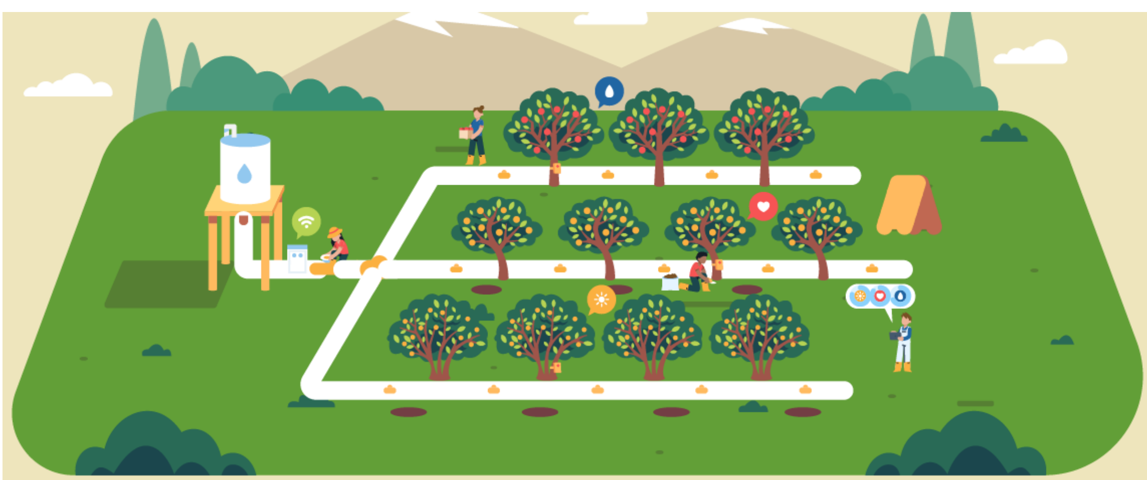
As climate change exacerbates the frequency and intensity of droughts, these trends underscore the urgent need for adaptive water management strategies, improved agricultural practices, and policies aimed at mitigating the impacts of reduced water availability. Efforts such as promoting drought-resistant crop varieties, enhancing water storage infrastructure, and implementing sustainable land-use practices will be critical to address the challenges posed by these projected climatic shifts.



Irrigation based on soil moisture measurement, coupled with decision support systems (DSS), plays a pivotal role in addressing the challenges posed by climate change. Soil-based irrigation methods rely on precise monitoring of soil moisture levels to determine when and how much water to apply. This approach minimizes water wastage, enhances crop water-use efficiency, and ensures that plants receive the right amount of water at the right time, which is increasingly critical as water resources become scarcer due to erratic weather patterns. Advanced tools like soil moisture sensors and tensiometers provide real-time data, enabling farmers to make informed decisions that optimize irrigation practices and reduce the risk of over- or under-watering.

Decision support systems (DSS) further amplify the effectiveness of soil-based irrigation by integrating data from multiple sources, such as soil moisture levels, weather forecasts, and crop-specific water needs. These systems use algorithms and predictive models to provide actionable insights, helping farmers adapt to the growing unpredictability of climate conditions. For instance, during prolonged droughts or unexpected rainfall, DSS can guide adjustments in irrigation schedules to maintain crop health while conserving water. In regions where water availability is constrained, these systems can be instrumental in ensuring sustainable water management, improving yields, and supporting food security.

In the context of climate change, the adoption of these technologies is not just beneficial but necessary. Increasingly frequent and severe droughts, shifts in precipitation patterns, and rising temperatures exacerbate the demand for water-efficient farming solutions. Soil-based irrigation and DSS not only help mitigate these challenges but also contribute to resilience by reducing dependency on guesswork and improving the capacity to adapt to climate

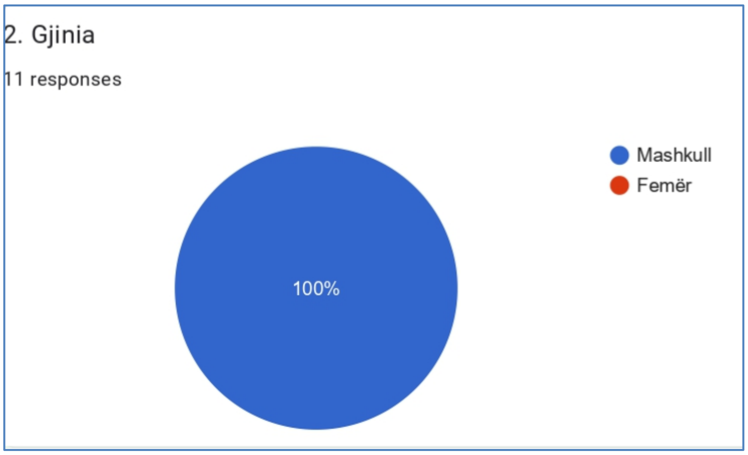


variability. By promoting sustainable water use and maximizing agricultural productivity, these approaches are key to building a more climate-resilient agricultural sector.

3. Survey with specialized farmers from Devoll on the adaptation to climate changes

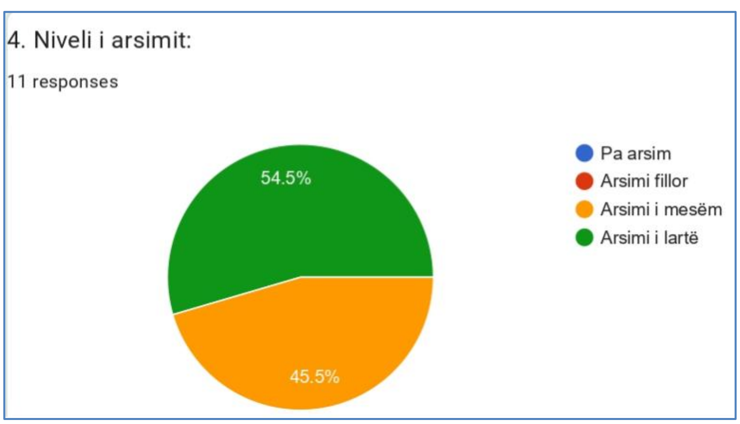
An important methodological instrument to collect relevant information on practices used by the farmers to protect their crops from damages caused by weather variability (hot weather, drought, excessive water, hail, intensive sun etc.) was collected using a survey with several specialzied farmers, besides those present in the workshop.

The first two questions revealed insights into the demographics and education levels of specialized farmers.



All respondents were male, indicating a lack of representation from women, which might limit the diversity of insights. This highlights the underrepresentation of women in climate adaptation discussions and farming initiatives. It is therefore necessary to introduce targeted programs to involve women and younger farmers in climate adaptation initiatives and establish youth-focused agricultural training programs to incorporate innovative practices.

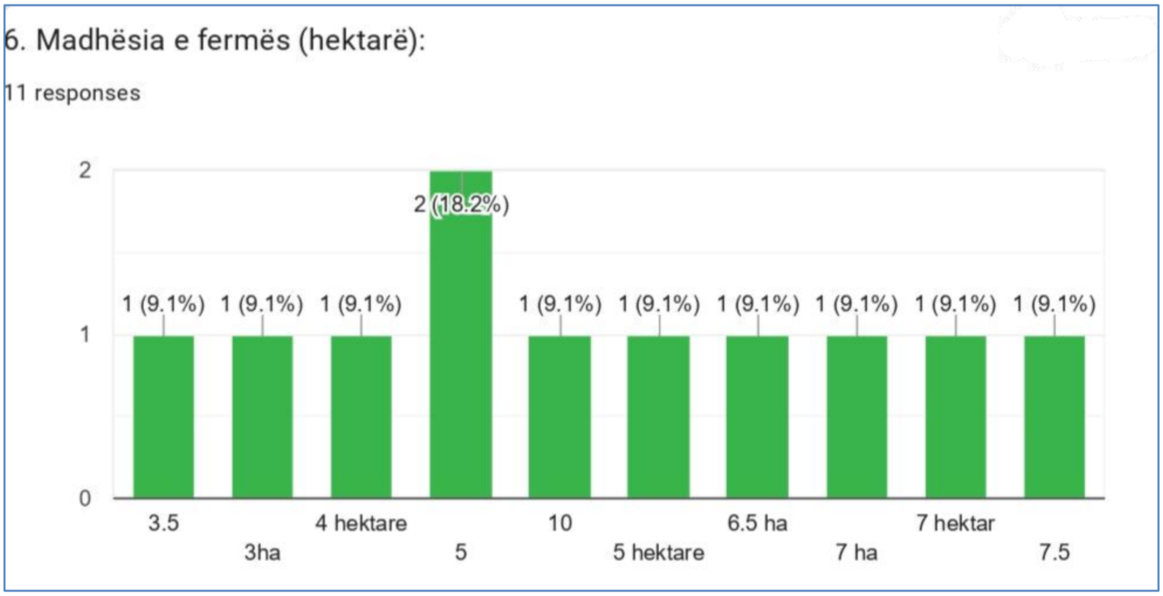
Respondents ranged from their 30s to 50s, suggesting experienced farmers but with potential gaps in involving younger generations.



About 54.5% had secondary education, and 45.5% had higher education. This implies a relatively educated group that could be more open to adopting new agricultural techniques.

The survey indicates significant variability in farm sizes, with values ranging from 3 hectares to 7.5 hectares. The median farm size appears to be around 5–6 hectares, which is relatively small compared to industrial-scale farms but consistent with family or smallholder farming in the region. Smaller farms may lack the economies of scale to invest in climate adaptation measures like irrigation systems, improved storage, or protective infrastructure (e.g., hail nets). Limited land may constrain the diversification of crops, leaving farmers more vulnerable to specific climate-related risks.

The survey highlights that the majority of participants are engaged in fruticulture (fruit farming) as their main agricultural activity. This is evident from responses emphasizing fruit cultivation, including apples and other crops.



The dominance of fruticulture suggests that the region's agricultural economy heavily relies on tree crops. This focus can provide high-value products but also comes with specific vulnerabilities to climate change, such as: (i) Increased sensitivity to temperature changes and frost; (ii) Greater susceptibility to pest outbreaks and diseases influenced by changing weather patterns; (iii) Erratic rainfall and frequent droughts can severely impact tree crops, especially during flowering and fruiting periods; (iv) Hailstorms, which were frequently mentioned, pose a significant risk, as they can damage crops and reduce yields drastically.

To adapt to challenges, fruit farming requires longer-term planning and investments compared to annual crops, making it harder to adapt quickly to sudden climate shifts. Farmers may need access to improved irrigation systems, resilient tree varieties, and protective infrastructure (e.g., anti-hail nets) to mitigate risks.

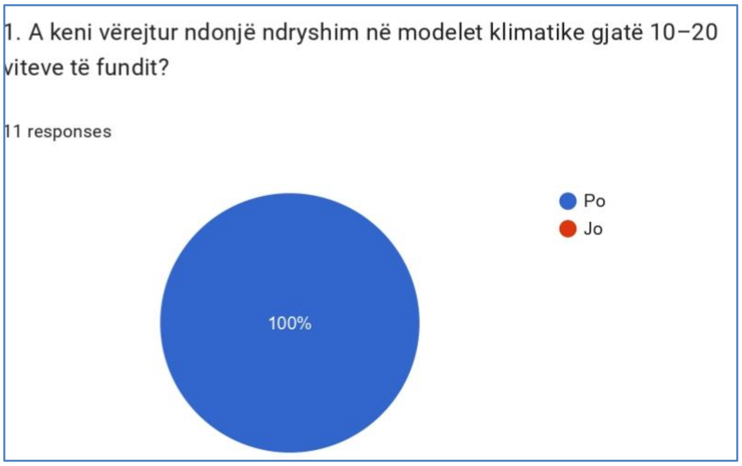
In terms of diversification potential, while fruticulture is a key focus, encouraging diversification into other agricultural activities like vegetable production, grains, or livestock could reduce risk and provide alternative income sources during poor fruit harvests.

Targeted support for fruit farmers, including subsidies for resilient cultivars, advanced training in pest and disease management, and financial aid for infrastructure, would strengthen their resilience to climate change.

Promoting cooperative efforts for shared infrastructure like storage facilities or processing units could improve value addition and reduce post-harvest losses.

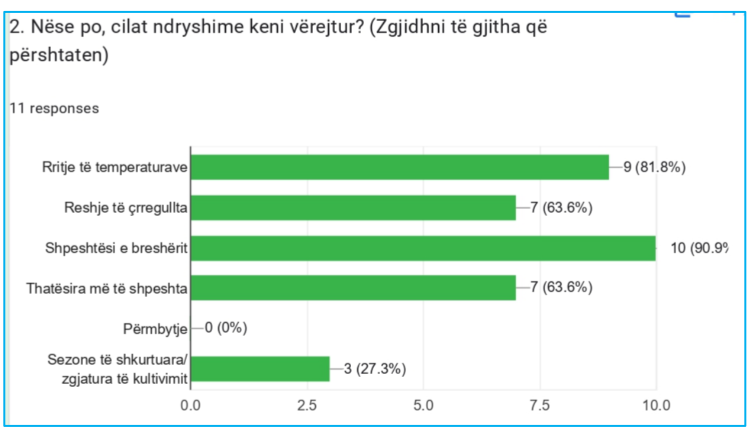
In terms of opportunities, farmers with medium-sized holdings (5–7 hectares) might have enough resources to implement basic adaptation strategies, especially if supported by subsidies or training. Smaller farms might benefit from community-based or cooperative adaptation strategies (e.g., shared irrigation systems or collective purchasing of resilient seeds).

Policies should be tailored to support smaller farms through grants or low-interest loans, enabling them to invest in infrastructure like water-saving technologies or climate-resilient crops. Programs encouraging farm cooperatives could help smallholders achieve economies of scale and improve access to markets and climate-smart inputs.



All respondents noted changes in climate patterns, emphasizing increased temperatures, erratic rainfall, and more frequent droughts and hailstorms. These observations align with global trends in climate impacts.

The next question highlights the depth of awareness among farmers about climate changes and their direct impact on agricultural practices. The observed climate-related changes, as highlighted by the farmers, include:



(a) *Temperature Increases*: 81.8% of respondents reported an increase in temperatures. This aligns with global trends, where rising temperatures affect crop growth, water availability, and overall agricultural productivity. Rising temperatures correlate with faster crop maturation but increased water demand.

(b) *Irregular Rainfall*: 63.6% of respondents noted irregular rainfall patterns. This unpredictability disrupts farming schedules, affects soil moisture levels, and increases the risk of crop failure. This trend will lead to challenges in irrigation scheduling and crop planning.

(c) *Hailstorms*: 90.9% of respondents observed an increase in the frequency of hailstorms. Hail is a significant risk factor for crops, particularly in fruticulture, where it can cause extensive damage. In this municipality, highly affected by hails, it is necessary to expand the use of hail nets and develop financial support for hail-damaged farms.

(d) *Frequent Droughts*: 63.6% of respondents observed more frequent droughts. This issue severely impacts water resources, soil fertility, and crop yields, creating challenges for sustainable agriculture. Adapting to droughts requires the implementation of advanced irrigation techniques and promote drought-resistant crop varieties.

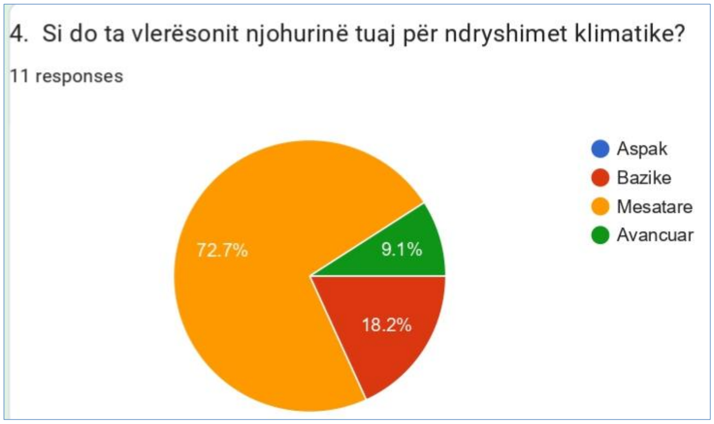
(e) *Flooding*: 0% of respondents mentioned flooding as an observed change, suggesting it is not a primary concern in this region.

(f) *Extended or Shortened Growing Seasons*: 27.3% of respondents observed changes in the duration of growing seasons. These shifts can disrupt traditional planting and harvesting cycles, requiring farmers to adapt their practices.

All participants agreed that these changes are affecting their farming activities, demonstrating a strong awareness of the climate's impact.

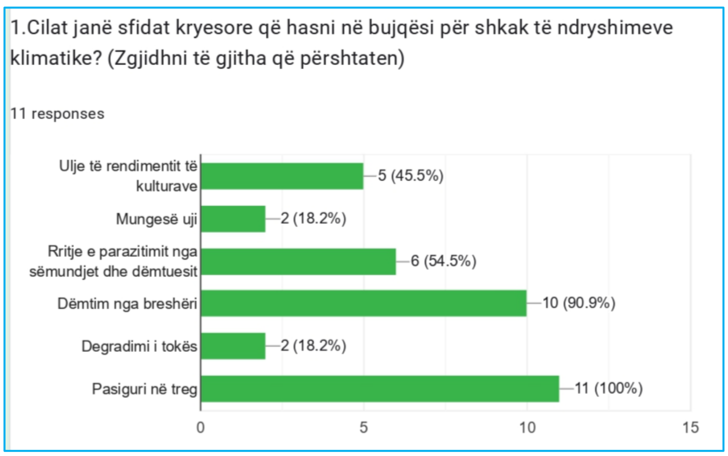
The responses suggest that temperature increases, hailstorms, and irregular rainfall are the most pressing climate-related changes in the Devoll region. These changes are likely affecting crop health, water resources, and income stability for farmers. The potential effects on agriculture are (a) *rising temperatures* which may accelerate crop maturation but could also increase water demand and stress on crops; (b) *irregular rainfall* making it difficult to plan irrigation schedules, often resulting in overwatering or under-irrigation; (c) *hailstorms* which pose a direct threat to crop yields and quality, particularly for fruit crops; (d) *droughts* that reduce soil moisture and water availability, leading to lower productivity and increased costs for irrigation.

Farmers will need tools and strategies to deal with these changes, such as drought-resistant crops, protective measures (e.g., anti-hail nets, and efficient irrigation systems.

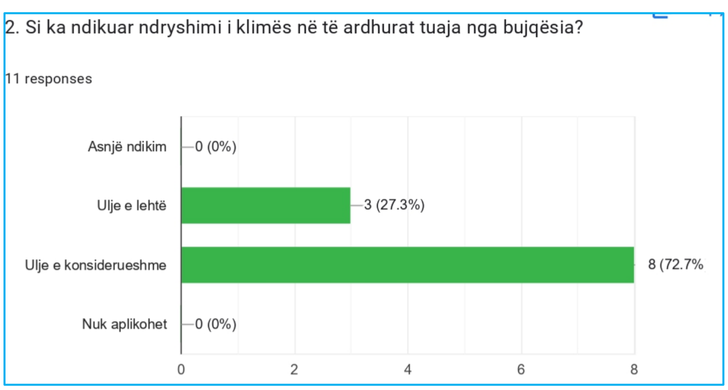


Most respondents rated their knowledge of climate change as "basic" or "intermediate," suggesting a need for targeted educational initiatives to enhance their understanding.

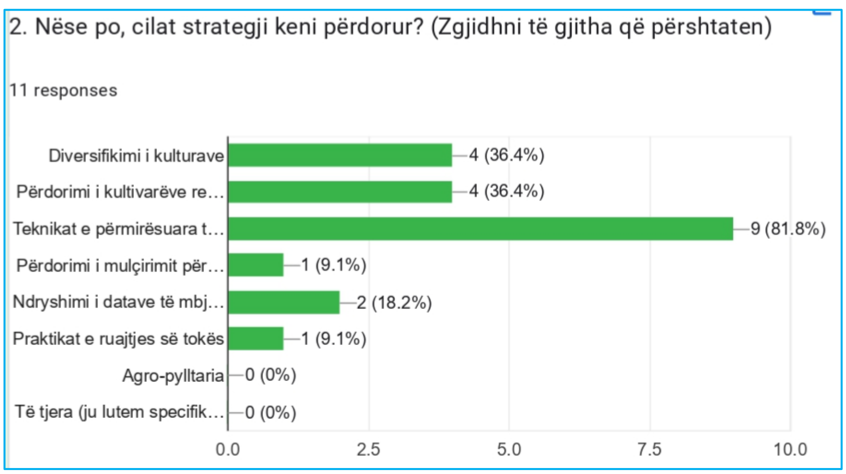
In the following graph, the responders rate the challenges they face. The primary challenges included crop yield reduction (90.9%), pest and disease proliferation (54.5%), and hail damage (45.5%). These highlight the multifaceted impacts of climate change on agriculture.



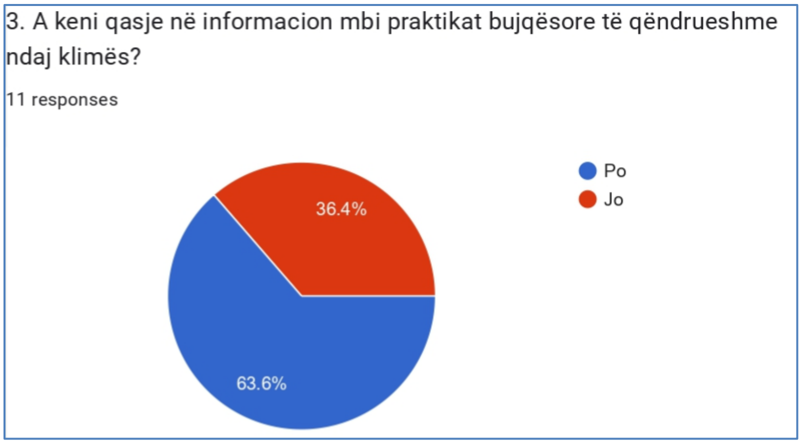
As shown below, a significant 72.7% reported considerable income reductions due to climate-related factors, underscoring the financial vulnerability of farmers.



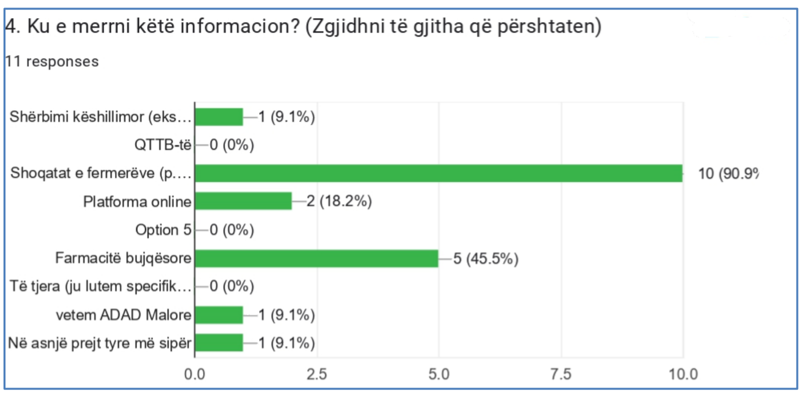
When asked if they have implemented changes to adapt only 36.4% had adopted strategies to adapt to climate change, indicating a large proportion may lack resources or knowledge for adaptation.



Farmers were asked about which strategies they have adopted. Popular measures included improved techniques (81.8%) and cultivar use (36.4%). Minimal usage of mulch (9.1%) suggests room for promoting cost-effective soil moisture retention methods.



Most respondents lacked access to information on sustainable practices, showing a significant area for improvement.



The responses indicate the sources from which farmers in the Devoll region access information on sustainable farming practices and climate adaptation:

(a) *Agricultural Advisory Services*: 9.1% of respondents rely on advisory services. This low percentage suggests a limited role of formal agricultural extension systems in disseminating information. There is an urgent need to strengthen agricultural extension services to disseminate practical, locally adapted solutions.

(b) *Farmers' Associations*: 90.9% of respondents reported farmers' associations as their main source of information. This highlights the significant influence of local networks in spreading knowledge and best practices. Actions should promote community-based cooperative efforts for shared infrastructure and knowledge exchange.

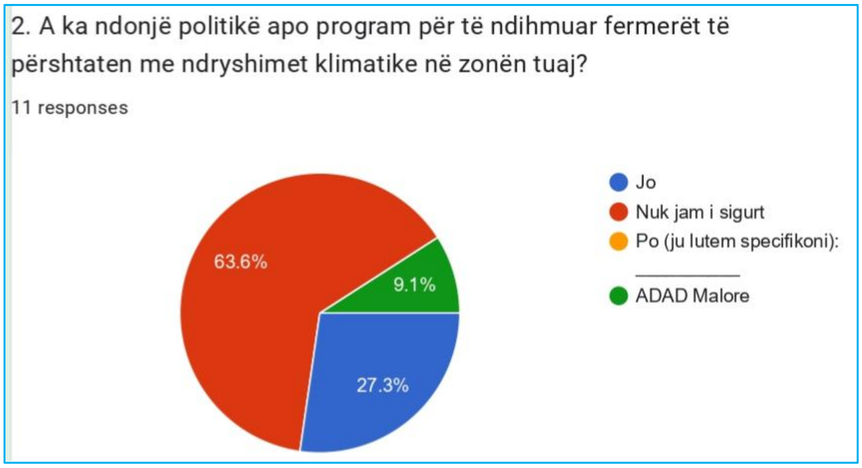
(c) *Online Platforms*: 18.2% of respondents utilize online platforms. While this percentage is relatively small, it reflects growing digital engagement among farmers.

(d) *Agricultural Pharmacies*: 45.5% of respondents rely on agricultural input suppliers for information. These businesses are key intermediaries but may focus more on selling products than providing comprehensive advice.

(e) *Other Sources*: 9.1% of respondents mentioned "ADAD Malore" (likely a specific organization) or "None of the above." This suggests limited engagement with alternative or official resources.

Analyzing the above data, we see that about 9% of respondents rely on advisory services which indicates gaps in the availability or accessibility of formal agricultural extension systems. This is an area where targeted interventions could greatly enhance farmers' knowledge and resilience. This low percentage suggests a limited role of formal agricultural extension systems in disseminating information. 91% of respondents reported farmers' associations as their main source of information. This highlights the significant influence of local networks in spreading knowledge and best practices. ADAD Malore is a farmer association that has played a key role in this regard. The overwhelming reliance on farmers' associations (90.9%) underscores the importance of community-based knowledge-sharing mechanisms. These networks are trusted sources of practical advice tailored to local conditions. About 18.2% of respondents utilize online platforms which shows some farmers are embracing digital tools, but broader access to reliable online resources and training on their use is needed to improve uptake. While this percentage is relatively small, it reflects growing digital engagement among farmers. A large percentage (46%) of respondents rely on agricultural input suppliers for information. These businesses are key intermediaries but may focus more on selling products than providing comprehensive advice. This suggests that many farmers obtain technical advice while purchasing inputs. However, advice from these sources may sometimes prioritize product sales over long-term sustainability.

In terms of support needed, farmers emphasized the need for subsidized inputs (72.7%), financial aid (63.6%), and infrastructure improvements like irrigation systems (63.6%). These responses highlight practical areas for intervention. Public and private investments in resilient agricultural infrastructure, such as modernized irrigation and weather-resistant storage should be prioritized. Policy-makers should develop tailored subsidies for climate-resilient technologies and practices. In particular, they could launch micro-insurance schemes to safeguard against financial losses from extreme weather. They should also facilitate access to real-time meteorological data to optimize water and crop management.



Only a minority were aware of policies or programs supporting climate adaptation, reflecting a disconnect between policy implementation and farmer awareness. Some responded declared that they were informed from ADAD Malore about new programs or policies.

The next question raised was: "*Do you think crop insurance would help protect against financial losses due to climate-related failures?*"

All participants expressed a positive sentiment toward crop insurance as a valuable tool for mitigating climate-induced risks. Farmers clearly recognize the potential of insurance as a financial safety net, particularly in light of recurring climate-related disasters like hail, droughts, and erratic rainfall. Some show cautious optimism about its effectiveness. They have heard that production insurance works in other countries which reflects awareness of international practices and a desire to see them implemented locally. The mention of successful insurance schemes in other countries reflects farmers' awareness of potential solutions and a desire for similar mechanisms to be introduced locally.
While farmers acknowledge the value of crop insurance, the lack of existing programs or accessibility in the Devoll region creates a gap that needs to be addressed. Responses such as ("I think yes") and indirect mentions of crop insurance suggest that while farmers are open to the idea, they may lack firsthand experience with such schemes, leading to cautious optimism.

The other question was "*What do you think is the most important change needed to ensure sustainable agriculture in the face of climate change?*"

The responses from farmers emphasize the following key themes:

(a) *Financial Support and Subsidies:* Many respondents highlighted the need for state support through subsidies to sustain farming and avoid financial ruin. Suggestions include subsidies for production units, disaster mitigation systems (e.g., anti-hail nets, frost protection), and insurance schemes to reduce financial losses caused by extreme weather.

(b) *Infrastructure Improvements*: Farmers emphasized the importance of irrigation systems and infrastructure upgrades to cope with erratic rainfall and prolonged droughts. Other suggestions included anti-hail nets to protect crops from increasingly frequent hailstorms.

(c) *Market Security*: Responses pointed out the necessity of market assurance, such as guaranteed purchase agreements for produce, to provide stability and reduce the economic impact of climate-related disruptions.

(d) *Technical and Knowledge Support*: Several farmers mentioned the need for technical assistance from agricultural associations to guide them in adopting sustainable practices. Recommendations included training and guidance on climate-resilient farming techniques and the adoption of modern technologies.

(e) *Insurance Mechanisms:* Farmers advocated for the introduction of crop insurance as a crucial safety net to compensate for yield losses caused by climatic events. Specific

(f) *Investments:* Some respondents proposed investments in renewable energy systems (e.g., solar-powered irrigation) and mechanization to enhance efficiency and reduce costs.

To address the challenges posed by climate change in agriculture, several key implications and recommendations emerge. Governments and stakeholders must prioritize financial aid and develop insurance schemes tailored to the needs of smallholder farmers. Such initiatives would help mitigate the risks associated with extreme weather events and ensure the long-term sustainability of farming livelihoods.

Building capacity among farmers is another critical area. Training programs that focus on water conservation, climate-resilient crop varieties, and modern farming techniques can significantly enhance farmers' ability to adapt to changing conditions. Empowering them with practical knowledge and skills will not only improve productivity but also strengthen their resilience to climate impacts.

Collaboration among farmers through cooperatives offers another promising solution. By pooling resources, cooperatives can invest in shared infrastructure such as advanced irrigation systems or protective measures like anti-hail nets. This collective approach can make it easier to implement costly but essential adaptations.

Finally, supportive market policies are essential to address the economic uncertainties farmers face due to fluctuating yields. Governments and stakeholders should establish policies that guarantee stable pricing and secure markets for agricultural products, providing farmers with much-needed financial stability and confidence in their investments.

By integrating these strategies, the agricultural sector can better prepare for and adapt to the challenges of climate change.

Most participants were optimistic about their ability to adapt in the next 5–10 years, showcasing resilience and willingness to embrace change.

In terms of training preferences, the respondents suggested techniques for water conservation, sustainable farming practices, and climate-resilient crop management were the top training priorities.

3.2 Infrastructural support for farmers

Investments in resilient agricultural infrastructure are essential to adapt to climate-induced risks. Considering the specific features of agricultural systems in Devolli municipalities, priorities include:

- Installing hail nets to protect fruit orchards from frequent hails
- Modernizing irrigation systems to manage water during droughts or heavy rainfall.
- Installing weather forecasting tools and early warning systems.
- Rehabilitating drainage infrastructure to reduce flood impacts.

4. Climate-Resilient Policies and Financial Support

4.1 Climate change adaptation measures and practices in national documents related to climate change and agriculture

The main reference for adaptation measures to climate change is the joint study between World Bank and government of Albania "*Reducing the Vulnerability of Albania's Agricultural Systems to Climate Change – Impact Assessment and Adaptation Options*". The study identifies and prioritizes options for climate change adaptation in the agricultural sector, both at the national and agroecological zone level. At the national level, which can be applied also for Devolli municipality, the most important measure is to increase the access of farmers to technology and information, both generally and for adapting to climate change. Achieving this goal will necessitate engaging in capacity-building initiatives to enhance both research and extension services. These efforts will be crucial in promoting superior agronomic practices directly on farms. This entails the wider adoption of demonstration plots and ensuring farmers have access to comprehensive information regarding the availability and optimal management of high-yielding crop varieties. Additionally, it is imperative to implement strategies aimed at sustaining yields in the face of more frequent instances of extreme water stress, a trend anticipated with ongoing climate change. It is worth emphasizing that allocating resources towards extension services yields a notably high benefit-to-cost ratio.

The next adaptation measure is to improve the dissemination of hydrometeorological information to farmers. It is imperative to allocate sufficient funding and direct the efforts of IGEO towards effectively communicating climatological information to farmers. In the short run, there is a pressing need for heightened capacities and a more farmer-centric institutional approach to facilitate improved decision-making at the farm level. Looking ahead to the medium term, these enhancements will also play a pivotal role in informing sound policy decisions in Albania.

Another adaptation measure is to improve information collection and dissemination on soil types, drainage potential, and crop suitability. The Agriculture Technology Transfer Centres (ATTC) in Fushe-Kruje, operating across Albania, should strengthen their evaluation of soil data. This data should be more closely aligned with both national policy endeavours and localized farmer education initiatives. Notably, ATTC is on the verge of releasing assessments regarding the suitability of crops, which will serve to inform national policies and directly benefit farmers. This step will synergize with others aimed at enhancing drainage infrastructure. Additionally, employing crop modelling in conjunction with detailed soil information on a spatial scale has the potential to be a potent tool for effectively directing investments in infrastructure.

An additional adaptation measure is to encourage private sector involvement to most efficiently adapt to climate change. The economic analysis underscores a compelling incentive within the private sector, as the gains from implementing measures to enhance the climate resilience of Albanian agriculture far outweigh the associated costs. Therefore, it is imperative for the national government to concentrate on establishing policies that facilitate effective private sector involvement in adaptation efforts. This could involve activities like evaluating seed and livestock varieties for their suitability to Albania's climate, terrain, and soil conditions, and subsequently offering recommendations for the most suitable options. However, the actual provision of these varieties could be left to the private sector.

4.2 Measures from the national agricultural policy, and from national systems for support of agriculture that can be related to climate change adaptation

Climate change is referred in the vision of the Strategy for Agriculture, Rural Development and Fisheries (SARDF) 2021 – 2027 "Enable an efficient, innovative and viable agri-food and fisheries sector in Albania that in a position to better withstand national and international market pressures and respond to challenges of climate change and sustainable natural resource management, while improving the quality of life of rural residents and increasing the attractiveness of rural areas." One of the four general objectives is strengthening sustainable management of natural resources and climate actions. The specific objective is contributing to climate change mitigation and adaptation, as well as renewable energy. The SARDF's objectives with their specific interventions contribute to the achievement of the SDG 13 of the UN Agenda 2030. Another major international commitment to which the SARDF is directly linked under its objectives is UNFCCC.

The National Plan for Mitigation of Climatic Changes promotes the conserve and increase the content of carbon in arable lands, encourages sustainable agricultural practices, introduction and protection of agroforestry practices and green infrastructures in agricultural areas and encourages the use of agricultural waste. All the practices of increasing of organic matter in the soil would increase the resilience to climate changes. This includes the use of biochar which helps to achieve the mitigation goals and in the same time provides adaptation benefits.

The Monitoring of the Action Plan 2019 - 2021 and National Strategy on Climate Change, 2020-2030 envisages a specific program to support new agricultural technologies, or seed variety adaptation to climate change and drafting of water basin management plans.

The Fourth National Communication of Albania on Climate Change (2022) foresees to improve energy efficiency in agriculture (tractors, irrigation, biomass), improve manure management systems and implement agro-forestry practices in agricultural lands.

The revised Nationally Determined Contribution 2021 urges the increase of the area of greenhouses, tunnels and hail protection systems, promoting plant breeding programs, which are focused on the development of new cultivars adapted to climate change (drought and cold resistant), application of crop rotation practices, in the plain areas of the country, as well as the planting of perennial crops, in hilly and mountainous areas.

The Albania's First Biennial Update Report 2021 sets targets related to the increase in the number of certified organic farms and farmers benefitting from irrigation infrastructure.

4.2.1 Specific measures benefiting farmers in Devoll municipality

National Climate Adaptation Measures

The study identified key measures outlined in national policies that are directly applicable to the Devoll region:

(1) *Enhanced Research and Extension Services*: Increase farmer access to technology and capacity-building initiatives to promote best practices.
(2) *Improved Data Accessibility*: Strengthen the dissemination of meteorological and soil data to facilitate informed decision-making.
(3) *Private Sector Engagement*: Encourage private investment in adaptive agricultural solutions, such as resilient crop varieties and efficient irrigation systems.

<u>Recommendations</u>:

- Establish localized weather monitoring stations and improve access to regional climate forecasts.
- Expand partnerships with private sector entities for innovation in climate-smart technologies.

Agricultural Policy Integration Measures

The Strategy for Agriculture, Rural Development, and Fisheries (SARDF) 2021-2027 includes ambitious climate goals, such as:

(1) Promoting renewable energy and sustainable practices.
(2) Supporting agroforestry and conservation agriculture.
(3) Enhancing soil health through the use of biochar and organic farming practices.

Recommendations:

- Provide grants and training to encourage adoption of agroforestry and conservation agriculture.
- Integrate biochar initiatives into regional farming practices.

Infrastructure and System Improvements

The current infrastructure in Devoll municipality has critical gaps:

(1) Drainage Systems: Aging drainage canals require rehabilitation to mitigate flood risks.
(2) Early Warning Systems: There is a lack of comprehensive frost and hail early-warning mechanisms.
(3) Agricultural Extension Services: Current services are inadequately equipped to address climate risks.

Recommendations:

- Modernize drainage and flood management infrastructure.
- Implement regional early warning systems for frost, hail, and drought.
- Strengthen the capacity of Agricultural Technology Transfer Centers (ATTCs) to address climate adaptation challenges.

Financial Mechanisms for Resilience

Farmers consistently emphasized the need for financial tools:

(1) *Crop Insurance*: All participants supported introducing insurance to mitigate financial risks from hail, drought, and other climate impacts.
(2) Subsidies and Grants: Prioritize funding for:
    (a) Renewable energy systems (e.g., solar-powered irrigation).
    (b) Hail protection infrastructure (e.g., nets, shade covers).

Recommendations:

- Develop a robust crop insurance program tailored to the needs of smallholder farmers.
- Offer financial incentives for adopting climate-smart technologies and practices.

Public Awareness and Capacity Building

(1) Inadequate farmer awareness of available programs and policies remains a barrier to climate adaptation.

Recommendations:

- Conduct targeted awareness campaigns highlighting government initiatives and financial support programs.
- Establish training modules focused on:
    - Water conservation techniques.
    - Sustainable farming practices.
    - Climate-resilient crop management.

4.4 Brief analysis of the current infrastructure and systems for preventing and mitigation the negative effects of weather extremes on crop production

Hail events have also intensified and with increased frequency in the last decade. In the past, this phenomenon was quite rare and would not justify the investment in hail nets for apple and cherry orchards (the most important fruit trees). Currently, an increasing number of fruit growers are installing hail nets. Until such investments will cover the areas under risk, crop insurance could be considered.

Frosts are also a frequent phenomenon but there are no early-warning systems, or systems for regular monitoring and forecasting at regional or national level, with exception of a couple of private service providers which apply crop scouting in very small zones.

The current agricultural extension service is not oriented toward ameliorating risks from climate. Although the service aims at covering the entire country, it has little or no capacity to advise on adapting agricultural systems to the climate risks. Agricultural research capabilities are expanding but have few connections to extension. The Agriculture Technology Transfer Centres, or ATTCs, conduct research and demonstrations on farm with a division of responsibilities by crop. However, these centres have yet to focus on climate change as a major risk to agricultural production, and are not as effectively coordinated with the extension service or Agricultural University of Tirana as they could be.

A good part of the lands in Devolli municipality are located in areas prone to floods. As it has been reported, Devolli municipality was affected by the floods of 2015. Before 1990, there have been high investment in drainage systems. Changes in land ownership, lack of maintenance and cleaning of drainage canals has resulted in increased damages from floods. However, after the flood of 2015, there have been no other events and from the survey it is not perceived as a risk.

Many farms are small (average size of 1.3 hectares) and have limited resources for adaptation investments. Agricultural markets are limited too.

Table 5. Best adaptation practices in place

	Best adaptation practice in place	Farms affected	Tested
Heat stress	Overhead irrigation	small	To some extent
Heat stress	Shading	small	Low
Heat stress	Mulching	small	High
Drought	Drip irrigation	large	High
Drought	Tolerant varieties	small	Low
Insolation	Shading	small	To some extent
Changes in season and growth stages	Change ripening period of varieties	large	To some extent
Hail	Hail nets	large	High
Training programs	various donors and public institutions delivering trainings on climate change adaptation	small	To some extent

5. Conclusions and Recommendations

Albania appears among the most sensitive European countries to climate change. Since agriculture accounts for about 20% of the GDP and almost half of total employment of both women and men (the highest in Europe), climate changes effect on agriculture sector might impact also the wellbeing of rural communities that depend on this sector. Global climate change will impact mostly "smallholder" farmers (more than 80% of farms in Albania can be considered small farms or smallholders). Their vulnerability to climate change comes from various socioeconomic, demographic, and policy trends limiting their capacity to adapt to change.

Analysis of climatic data by various independent studies for the last 20 years demonstrate higher temperatures, decreased and more variable precipitation, reduced river runoff, increased frequency and severity of extreme events, etc. Climate scenarios for the next decades predict an exacerbation of these phenomena therefore adaptation is the only way out. The Strategy for Agriculture, Rural Development and Fisheries (SARDF) 2021 – 2027 is more environmentally ambitious. As a result, environment, climate and biodiversity-related support measures shall be eligible to receive higher aid intensity. The logframe with indicators and targets in SARDF has planned introducing good agricultural and environmental conditions to a number of farms with conditionalities related to climate change mitigation and adaptation. The target for 2024 is 7000 farms and for 2027 is 10,000 farms.

Modern climate change adaptation measures including best practices for sustainable farming are currently almost non-existent in Albania and should be part of extension services and the agriculture knowledge and innovation system (AKIS). After a careful review of all the documents cited in this report, some key recommendations have been put forward for all stakeholders and grouped into broad categories.

Public awareness, knowledge and skills

- Strengthening public awareness, knowledge and skills of the agricultural administration, advisory structures and farmers on EU standards related to climate change mitigation and adaptation.
- Increase the availability and accessibility of trained agricultural advisors in the region to provide tailored, science-based recommendations.
- Knowledge transfer networks for good environmental practices are extremely important. The production of training materials for climate change mitigation and adaptation, with the involvement of research institutes, universities, environmental NGOs and other civil society organisations, while the delivery of training involving farmer organisations in practical demonstration is ideal for the sustainability of the networks.
- Empower associations with better resources, training, and partnerships to become effective hubs for climate-smart agriculture knowledge.
- Train farmers to use online platforms effectively, ensuring they access reliable and up-to-date information.
- Support programmes to address knowledge limitation of farmers on climate change.
- Encourage agricultural pharmacies to offer unbiased, educational advice alongside product sales by training their staff on sustainable practices.

Demonstration of climate resilient agricultural systems

- On a pilot basis, adequate voluntary environment and climate-related measures, that go beyond the legal requirements and best practices, can be tested and scientifically verified in close coordination with the academia, advisory services and international community.
- Pilot eco-schemes aiming at the maintenance and improvement of the environment and climate change mitigation and adaption should be prepared and implemented, thus increasing the institutional capacity and raising the awareness. All construction/ rehabilitation and modernisation costs, the costs for machinery, equipment and training should be covered by the projects.
- Introduction of climate-resilient crop varieties and farmer training programs to help adapt to changing growing seasons.
- Standards that aim to contribute to the mitigation and adaptation to climate change, to tackle water challenges, the protection and quality of soil and the protection and quality of biodiversity through good practices only.
- Promotion of best practices, such as use of cover crops, no tillage or minimum tillage, crop diversification and rotation etc. Support farmers applying conservation or regenerative agriculture.

- Optimize agronomic practices and inputs: fertilizer application and soil moisture conservation; improve soil, water, and crop management; improve appropriate land use, and develop resource management strategies.

Investment in assets to mitigate the impact of climate change

- Address the lack of timely meteorological information needed to respond effectively and improve farmer access to hydrometeorological data
- Setting up local weather monitoring systems to predict and prepare for erratic rainfall or hailstorms.
- Focus regional cooperation programs on implementing reliable early warning system and long–range weather forecast system and provide efficient information dissemination;
- Improve irrigation water infrastructure and application efficiency; rehabilitate irrigation infrastructure, including water storage infrastructure; broad-scale water regime planning
- Support for water-saving technologies and protective infrastructure to mitigate the effects of hail and droughts.
- Improve drainage infrastructure; implement floodplain management measures; increase understanding of water resource threats and groundwater risks to improve water use efficiency in agriculture and for urban zones
- Install hail nets in fruits trees or shadowing nets in vineyards in areas were harvesting is being anticipated by climate change effects
- Improve crop varieties for resilience to climate changes
- Risk management through insurance schemes

Support programs

- Providing crop insurance to reduce financial risks from climate events.
- Offering subsidies for renewable energy and water conservation technologies.
- Grants for climate adaptation grant scheme (see ANNEX 2)

6. Collaboration and Local Partnerships

6.1 Multi-Stakeholder Engagement

Collaboration among local universities, research institutions, government agencies, and farmers is critical for implementing a successful DRM plan.

Proposed Initiatives:

- Partner with the Agricultural University of Tirana and local NGOs for research on climate-resilient practices.
- Establish farmer-led committees to ensure ground-level feedback and participation in decision-making.
- Foster regional cooperation with neighboring municipalities to share resources and strategies.

6.2 Public-Private Partnerships (PPPs)

Encourage private sector investment in agricultural technologies and climate adaptation infrastructure.

Proposed Initiatives:

- Develop incentives for private companies to invest in renewable energy solutions for agriculture.
- Promote agribusiness collaborations for shared value chain improvements.

7. Monitoring and Evaluation

7.1 Establishing Metrics for Success

A robust monitoring and evaluation (M&E) framework is essential to assess the effectiveness of the DRM plan.

Key Indicators:

- Adoption rates of climate-smart practices (e.g., irrigation systems, hail nets).
- Reduction in crop losses due to extreme weather events.
- Increased farmer participation in training programs and cooperatives.
- Improved access to and use of meteorological data by farmers.

7.2 Periodic Assessments

- Conduct regular evaluations to identify gaps and opportunities for improvement.
- Proposed Schedule:
- Annual progress reviews involving all stakeholders.
- Mid-term assessments to refine strategies and reallocate resources if necessary.

7.3 Reporting and Feedback Mechanisms

- Establish transparent reporting channels to ensure accountability and continuous improvement.
- Recommendations:
- Develop a centralized online platform for reporting progress and sharing resources.
- Facilitate farmer feedback through surveys and community meetings to refine interventions.

ANNEX 1. Impact of climate change on main crops of Devolli municipality

Maize

Changes in average temperature during the growing season of maize (April to October) reveal an increase of about 1°C to 2°C from 1992 to 2020. Maize yields and climatic mean and weather extreme variables are strongly correlated. Higher values of all temperature variables were associated with higher yields.

Changes in precipitation for the same period have been mainly negative (- 100 to 300 mm) during the growing season and particularly in the most productive region.

Some coastal regions of the country have had more days with excessive heat above 35°C in the last 20 years but much more night heat events (nights with minimum temperatures above 20°C). The latest can result in faster heat unit (growing degree days, GDD) accumulation that can lead to earlier corn maturation. However, maize plants are sensitive to heat stress (>30 °C) and there is a strong decline in grain yield as plants face heat stress above this threshold for a prolonged duration.

Maize yields have increased remarkably in the last 20 years (1992 – 2020) which can be related to technology but also climatic changes (increased heat accumulation, less frost events during the growing season, etc.). However, studies on adaptation to climate changes in agriculture foresee that the effects on maize yields will vary by region, with increases in the southern highlands and decreases in other regions, probably because current temperature is most moderate in the mountainous southern highlands and so increases can enhance yields. Effects of climate change on maize yields may also be linked to effects on livestock due to the effects of climate change on forage crops like rainfed alfalfa and grassland yields.

Winter Wheat

Changes in average temperature for wheat's growing period (October to July) have been slightly less pronounced than those for the growing period of maize, but some important production areas in southeast have had hotspots of temperature increases. In general, wheat yield is positively correlated with minimum, average, and maximum temperatures. Minimum temperature is positively related to the yields of winter wheat.

Changes in total precipitation show similar spatial patterns for the growing period of winter wheat as for maize but lower in absolute values (–150 mm). Again, the largest decreases occurred in the northern Albania. Considering the phenological stage of wheat, this reduction in precipitation does not have a major impact on yield. Notwithstanding, there are more events of heavy precipitation during the growing period of winter wheat causing frequent damages. Wheat production enjoys a significant comparative advantage because of the widespread accessibility of irrigation capacity in Albania.

Night heat events increased during the period when winter wheat is grown. Night heat positively influences wheat yields in Albania. The significant global loss of crop yield is primarily due to heat-related damage during the reproductive phase. Terminal heat stress causes morphophysiological alterations, biochemical disruptions, and reduction of genetic potential.

The number of frost events also decreased during the growing period of winter wheat in the last 20 years. However, some areas in the southeast have received more frost with a negative effect on wheat yields and sometimes very late frosts just before harvesting.

Climate change is projected to have the potential to improve yields of winter wheat (if pest damage does not increase). Yield increases can result as climate change will likely result in an extended growing season, more moderate fall and winter temperatures, and greater precipitation and water availability during the wheat growing season. Some experts noted, however, that the recent decline in wheat yields might be attributable to increased incidence of pest damage to this crop. In the highland areas, winter wheat is cultivated at temperatures below the optimal temperature, and so climate change can enhance yields and extend the growing season.

Alfalfa

Climate change is projected to have the potential to improve yields of irrigated alfalfa in most regions. Such potential is high under all scenarios, due to beneficial effects of higher temperatures and a longer growing season.

Apple

Apples have been damaged almost every season by late frosts or hail requiring the installation of hail nets. The cost of hail nets is very high, especially if orchards do not have a supporting system, but is becoming an obligatory cost to avoid complete loss of production.

Expected increase in temperature will affect the phenology of apples, altering their patterns for sprouting, flowering, giving and ripening the fruit. The changing climate make fruit trees susceptible to common and new pests, fungal diseases, and more.

ANNEX 2. A proposal for climate adaptation grant for Devolli municipality

1. Background

Since a decade Albania has been urged to support the implementation of both the United Nation Framework Convention on Climate Change (UNFCCC) in enacting the Paris Agreement. The agriculture sector is one of the domains where Albania aims to best achieve the ambitious targets lying at this Convention, addressing climate change challenges and also to raise the competitiveness of the sector. The efforts made to achieve these targets requires the active participation of all social groups at national level, which develop innovative products, processes, and services to gain adaptation knowledge and methods. In order to support the farmers and other stakeholders in enabling adaptation capacities, a competitive grant is provided. The topics covered in this call for grants are based on the Law for Agriculture and Rural Development, the principles of the Strategy for Agriculture, Rural Development and Forestry (SARDF) 2022-2028 and the main components of the Green Deal. In the SARDF 2021-2027 the EU Green Deal is reflected on the identification of possible actions relevant to contrast the climate changes, the supply of clean, affordable and secure energy, the promotion of the circular economy in the concerned industrial sectors, improving the energy and resource efficiency in building and renovating, accelerating the shift to sustainable and smart mobility, the design of a fair, healthy and environmentally-friendly "Farm to Fork", preserve and restore ecosystems and biodiversity, and a zero-pollution ambition for a toxic-free environment.

The selection process and the disbursement of funds is handled by Agriculture and Rural Development Strategy (ARDA) and in accordance with Agriculture and Rural Development Program Fund (ARDPF) procedures.

In order to enable an environment for absorbing adaptation measures for the climate change, the European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is followed. The interactive innovation approach under the European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI) fosters the development of demand-driven innovation through projects, turning creative new ideas into practical applications thanks to interactions between partners, the sharing of knowledge and effective intermediation and dissemination. Main beneficiaries will be eligible if organised in a similar structure to EU EIP AGRI individual farmers or small groups of farmers. In European Union, the individual farmers or small groups of farmers are farmers and small farmer groups, set up to work on finding an practical solution for their farms to a shared problem or issue.

2. Main project priorities

3.1. Purpose

This call for grants aims at demand-driven innovation because research projects' objectives and planning are targeted to the needs/problems and opportunities of end-users. They should result in practical knowledge which are easily understandable and accessible.

The objective of the call is to support the development and diffusion of innovative adaptation practices, tools, and technologies. The small grants can be used to address adaptation challenges in various thematic areas. The projects under this call must aim for the the following goals:

- Support the implementation or increase the ambition of nationally determined contributions (NDCs)
- Support action on the ground to contribute to the SAFRD 2022-2027
- Address the risks, challenges and opportunities of global megatrends (e.g. increasing demand for natural resources, rapid urbanization, digitalisation) in the context of climate change and biodiversity loss
- Strengthen networks, knowledge sharing and cooperation of organisations working on climate change and biodiversity related issues
- Develop and promote the use of climate smart technologies
- Contribute to awareness building and education regarding climate change and biodiversity
- Engage in cross-sectoral and multi-stakeholder cooperation and / or involve the local population.
- Investments should support transition from conventional to organic production regime (foreseen in Measure 4) and improving agronomic practices through advisory (Measure 10).

Given the cross-cutting nature of climate change, this can include a wide range of topics with which climate change interacts and intersects, but the relationship to climate change should be made explicit. Advice funded under this call should be linked to at least one SARDF 2022-2028 4th priority subcomponents for rural development and shall cover at a minimum one of the following:

- Climate change mitigation action and energy efficiency cross-compliance obligations (and Natura 2000 obligations applying to foresters);
- Support for farm modernization, competitiveness-building, sectoral integration, innovation and market orientation, as well as the promotion of entrepreneurship;
- Soil management, water management, most of the RDPs Water use efficiency, water quality protection, integrated pest management or reduced use of pesticides.
- Production techniques, with the adoption of integrate production and organic production; introduction of precision-agriculture systems and machinery and technical means that reduce the environmental impact; use of resistant plants and seeds and organic seeds and seedlings; eco-friendly soil management.
- Green management of the cultivation fields' areas, by grassing of the cultivation/orchard inter-rows, development of green buffer-zones, hedges, tree-lined areas, nests and shelters for birds and wild fauna.
- Integrated pest management namely biological control.
- PPP management, with construction of collective plants for the preparation / distribution of mixtures of pesticides and fertilisers, construction of units to wash the PPP spraying machine, investments in management systems of the related wastewater, establishment of systems of collection and disposal of PPP empty/used containers.

- Traceability, implementing systems for data recording on the use of chemicals and withholding periods as well as transferring the records to the buyers.
- The introduction and improvement of systems for the reduction of gaseous emissions and dust contamination
- Efficient use of water resources (e.g., drip irrigation systems, restoring water reservoirs)
- Biodiversity measures, namely the conservation of same rare cultivars or cultivations and seedlings production of plants included in the Red List
- Waste management namely plastic and package waste as well as organic waste
- Examples of circular economy installation renewable energies production equipment (photovoltaic, biomass) for self-consumption, implementation of traceability systems and improved control of residues, investments (equipment and installations) for self-production of energy from wind, solar (thermal and photovoltaic) and biomass (MAPs waste and exhausted MAPs), (equipment and installations) for production of compost

3.2. The type of projects to be implemented

Different categories of projects can be submitted namely best-practice, demonstration, pilot initiatives to provide a remedy for climate change effects in agriculture. This might range from projects that target the development of new products, practices, processes and technologies to testing and adapting of existing technologies and processes in novel geographical and environmental contexts with main focus on climate change adaptation. Each project is required to have an information, awareness and dissemination part in order to guarantee the diffusion of knowledge.

Proposals should focus on practical measures farmers can implement to adapt to climate change. This can be addressed in the form of deployments planned as part of the project itself, or via a concrete plan for disseminating the work among relevant sectors or organizations.

4.Main expected outcomes

The types of project that applicant can develop and implement are either: a new project from a new individual farmers or small groups, or a new project from an existing individual farmers or small groups.

Several expected results have to be achieved:

- New innovations are encouraged and accelerated. Development of innovative adaptation practices, tools and technologies are encouraged and accelerated;
- Evidence base are generated. Evidence of effective, efficient adaptation practices, products and technologies generated as a basis for implementing entities and other funds to assess scaling up.
- Investing in infrastructure, equipment, pilot product lines, and advanced manufacturing necessary for applied research and innovation activities, including technologies that create capabilities for further innovation in a range of other sectors.

- Facilitating cooperation, networking activities and partnerships among different innovation actors working in the same field – universities, research and technological centres, SMEs and large firms – to achieve synergies and technology transfers.
- Creating potential Operational groups. The project focuses on small regional, national, and local organizations in selected working groups which are supported to encourage active engagement of the experts, farmers and service providers in order to implement effective locally adapted approaches to the impacts of climate change and biodiversity loss. The indirect objective of the grant is to strengthen small implementing organisations/semiformal groups in further developing their capacities and in strengthening their professional networks and foster them as agents of change for climate and biodiversity action on the ground.

5. Beneficiaries

The call for proposals aims to support people who are directly engaged in developing practical solution for their farmss and in the economic exploitation of new ideas through: advisory and support services, direct investments, and financial instruments that help access private sources of funding.

The beneficiaries are farmers and small farmer groups, set up to work on finding an practical solution for their farms to a shared problem or issue. Size and composition of the Group (EIP AGRI Initiatives like) depend on the project itself. The approach requires that end-users and multipliers of research results, such as farmers, farmers' groups or advisors are closely involved throughout the whole project period. This should lead to practical solution for their farmss that are more likely to be applied in the field, because those who need the solutions will be involved right from the start and will bring in complementary practical knowledge: from defining the questions, to planning, to implementing research work, to experiment and right up until possible demonstration and dissemination. The formation of any Group should take place on the initiative of the actors involved. The Operational Group is recognized ("labelled") by the selection of its project. No specific conditions are laid down regarding the composition or minimum size of TG (apart from the fact that a minimum of three partners must be involved).

An Operational Group is meant to be 'operational' and tackle a certain practical problem or opportunity, a 'need from practice', that may lead to an practical solution for their farms. Therefore, OG have to draw up a plan that describes their specific project and the expected results. The OG have to disseminate the results of their project, in particular through the ATTC network.

The exact activities in a project plan depend on the actors that are involved and the problem or opportunity that will be tackled. However, the OG must cooperate in a project which will contribute to the aims of the SARDF 2022-2028, to the NPEI priorities, and to the linked national/regional strategy. OG should be composed of those key actors that are in the best position to realise the project's goals, to share experiences and to disseminate the outcomes broadly.

Potential actors to be included in the operational group

- Farmers (especially large farmers), agribusiness and associations
- Suppliers of agricultural inputs and machinery (wholesale and retail).
- Private advisory services operating in the field.
- Members of associations and other groups namely Albanian Agribusiness Council (KASH), National Federation of Forest and Pasture users Association, Albanian Rural Network, existing Local Action Groups (LAGs) and other NPO and NGOs operating in the sphere of agriculture and rural development and environment
- Experts from MARD depended institutions, namely Agricultural National Extension Service (ANES) in transfers information from Agricultural Technology Transfer Centres (ATTCs), Food Security and Veterinary Institute (FSVI) and National Food Authority,
- Academic staff members and students from Agricultural University of Tirana and Faculty of Agriculture of University Fan Noli in Korça.
- Staff members and students of Agricultural vocational schools

The applicant must have dedicated reporting staff and have that ensure proper reporting of activities.

6. Targeted clusters

The application for grants are welcomed from all farmers from Devolli region, as the most effected by climate changes. regions of Albania.

7. Budget

The call for Small Grants on climate change adaptation (CCA) selects project proposals with a total funding volume between EUR 5,000 and EUR 10,000. Proposals with financial requests over or under the above amounts will not be considered. The duration of the projects shall cover a period of twelve months.

8. Procedure

After the call for proposals is closed, the submitted proposals will undergo a selection process and the applicant organisations will be informed in due time. The decision whether to fund a project will be based on the review of the proposal and the assessment of the organisation. The Small Grants Board secretariat will review the application and make a recommendation to the ARDA. Please note that a review phase including close exchange between the applicant and the Committee of experts will follow the final selection for funding. Final adjustments to the proposal and budget may still be necessary to meet all existing standards and requirements of the CCA Small Grants.

9. Criteria on support applicants

- Project personnel need to demonstrate appropriate competency, in the form of formal staff qualifications, appropriate experience and regular training. Beneficiaries should demonstrate experience and reliability with respect to the fields in which they advise (e.g. the field of environment and climate mitigation)
- Eligible costs under this call are the costs of organizing and delivering the knowledge transfer or information action. In the case of demonstration projects, support may also cover relevant investment costs (setting up farm management, farm relief and farm advisory services, as well as forestry advisory services, including the obligatory Farm Advisory Service, and costs of training of advisors. Costs of training of advisors are also covered.
- Eligibility Criteria concerning the project:
    - Project proposals must clearly address one of the funding areas:
    - Adapting to the impacts of climate change
    - Preparing innovative interventions for plant protection and animal health protection
    - Conserving biological diversity
- Applicant organizations have to be groups formed by farmers, input providers, exporters, academics or staff of Agriculture Technology Transfer Centers which are represented together based on a year agreement and signed by a notary. Other entities should be Agriculture Cooperatives, not-for-profit organizations, Agriculture Technology Transfer Centers and Local Action Groups.
- The applicant must have dedicated reporting staff and have that ensure proper reporting of activities.
- The duration of the proposed projects should cover a period of twelve months. Longer durations may be acceptable if justified appropriately.
- Projects must be implemented on a local, national, or regional level. Projects with a global focus cannot be funded.
- Projects must be implemented by the applicant organization itself. Forwarding of funds to other implementing partners or beneficiaries is not permitted.
- The requested financing should be disbursed within a period of 12 months.
- The application includes all mandatory documents.
- Projects must have an initial draft of a capacity development concept.
- The submitted documents are filled out completely (that includes all spreadsheets of Excel documents such as Budget and other sections).
- The templates are provided as separate attachments (refrain from reformatting or modifying to avoid unintended mistakes).