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PEDO-CLIMATIC RISKS OVER FĂlLTICENI CITY RELATED ORCHARDS

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Key words: climate risk, pedological risk, Chrono-spatial evolution, orchards

Abstract: Through this study, "Pedo-climatic risks over Fălticeni city related orchards", we intend to conduct a study that highlights the way that a number of parameters such as climate and soil, through their evolution, may be considered a risk factor for orchards nearby Fălticeni city.
The analysis of potential risk factors was conducted in direct relation with the of dominant species from studied area, which are apple (*Malus domestica*) and plum (*Prunus domestica*).
From a climatic perspective, there were taken into account two parameters, temperature and rainfall, to see if they can induce a risk status in the studied orchards and as soil factors that were taken as parameters in our analysis are: soil reaction, carbonates of calcium and the ground water level, which are, at the same time, indicators that impose the most common restrictions over the studied plantations.

Introduction

Most often, the risk is understood as the product of the probability of a phenomenon and the negative consequences it may have, thereby associating two distinct elements: on one hand the hazard, on the other element receptor of destructive effects, which the often human society. (Stanga, 2012). Stanga (2012) said about exposure that should not be forcibly attached to hazard, nore to vulnerability. Spatial distribution principle is the basic principle of geography and, from this point of view, any natural or man-made phenomenon or process, must be reviewed from a chrono-spatial perspective in a well-defined

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territory. The studied unit is part of what is called the Suceava Plateau, situated exactly in its southern section, Falticeni Plateau. The last one mentioned is located between Moldova and Siret valleys and it is crossed from west to east by Somuzul Mare and Somuzul mic. (Bacauanu, 1980).

1. METHODOLOGY

Temperatures and rainfall-related data used in this paper were extracted from ROCADA and the data interpretation was performed in Microsoft Excel 2010, and Rstudio where, after sorting the data by decades was considered the realization of different types of graphics to highlight the evolution of the parameters analyzed and therefore the risks induced by it. (Dumitrescu, 2015)

Pedological indicators analysis was made based on the data obtained from OSPA Suceava who provided a large scale cartographic material (1:10k) with the distribution of types and subtypes of soil in the territory related to Fălticeni and the soil unit sheets that included analytical data of each representative profile.

For quantitative data modeling, but also to create a database there was used as a software Microsoft Excel 2010 in which there were introduced pedological indicators for each soil unit, specific to each horizon of each soil profile, modeled below.

In the first stage, digitization of soil units and profile location was required in order to obtain the spatial database which was further used to create maps. This action was done in QGIS, an open source, licensed under the General Public being an official project of the Open Geospatial Sources Foundation (OSGeo).

The pH and carbonate distribution was represented on the profile, modeling the data in Rstudio, where it was highlighted the variation of the two indicators from the bottom quartile to the top one, the median being also pointed out. This type of representation was made for every soil type encountered in the orchards from the studied teritory.

Groundwater level was represented through a cartogram in QGIS software.

2. RESULTS AND DISCUSSIONS

The results achieved after applying the used methodology, were reported to the specific species of trees found in the studied area and how they operate phenophases in the growing season, thus, highlighting the risks induced by analyzed pedo-climatic parameters.

The vegetation period was determined for the species apple and plum so that the first day of vegetation was considered to be the first day of the year in which the average maximum temperatures exceeded the absolute minimum temperature of the species, and the last day of the vegetation was considered to be the first day of the second semester where the minimum temperature falls below 0^0C. We note that the absolute apple species minimum temperature is 8^0C and 6^0C for plum. (****Zonarea speciilor pomicole în funcție de condițiile pedoclimatice și socio-economice ale României*- Institutul de cerccetare-dezvoltare pentru pomicultura Pitești-Mărăcineni, 2014).

Regarding the interval between the first day and the last day of the vegetation cycle, in literature, is evoked for apple and plum a period that's framed between 170 and 210 days, respectively 160-210 days.

Being closely related to temperature, there was an increase of the growing season with ten days in the last ten years. The vegetation cycle is taken up to 250 days, as a result of an increasing trend of temperature which, in the studied area, between 1961-2013 increased around $1,5^0$C. (fig. 1).

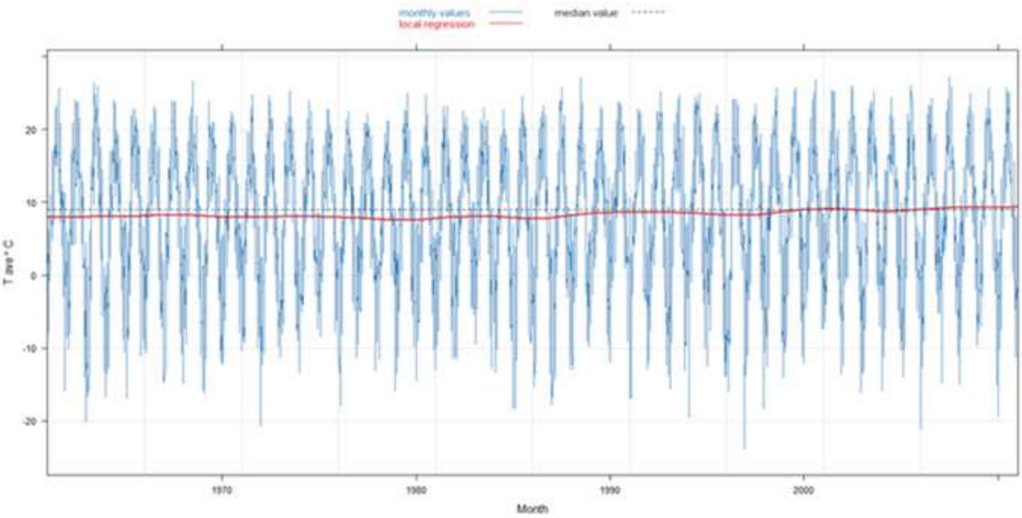


Fig.14. Monthly average temperatures (1961-2013, after Rocada)

From the data string (1961-2013) that we analyzed it can be seen an obvious increase of the growing period, but the thing that needs to be pointed out is that February and March suffered an increase of tempearture with $0,28^0$C, inducing in this way an earlier start for the vegetation cycle, but also exposing the tree plantations to a potential frost. (fig. 2).

Following the climate changes, we deduce that the growing season start is occurring earlier, thus inducing the same time, changes in the occurrence of phrenological phases. For example, if the plum fruit buds used to start swelling occur in early April, now, in most years occurs in mid-March.

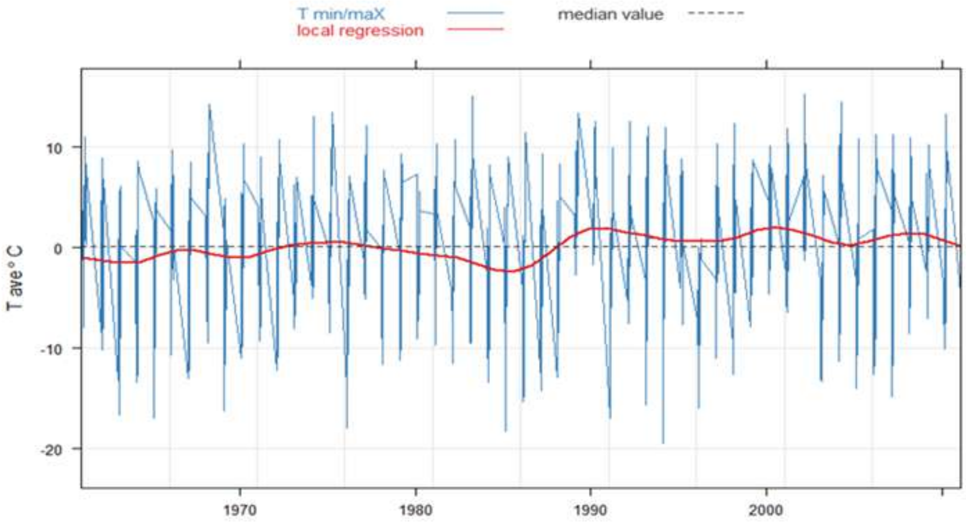


Fig.15. Multiannual average temperature for February and March
(1961-2013, after Rocada)

This early flowering increases the vulnerability and expose to a high risk of damaging the orchards from a late spring frost, a good example being the one in 1998 when the vegetation period began around February 13th. The first 25 days with an average of 6^0C heat, the average maximum temperature was $12,36^0$C, followed by a succession of 19 days where the average temperature was $-2,24^0$C and minimum temperature $-4,47^0$C followed by $4,37^0$C day previous as shown below.

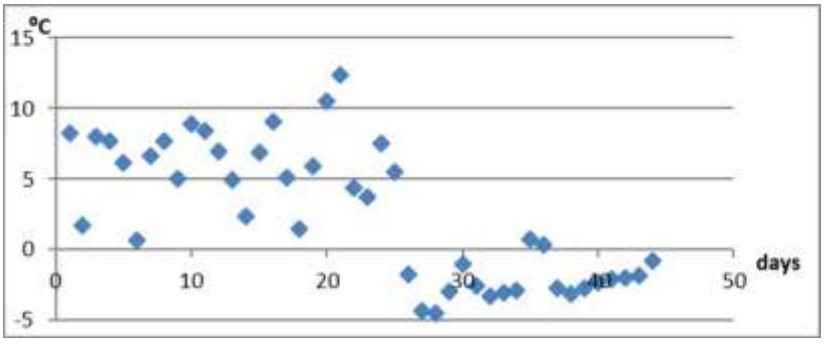


Fig.16. Daily average temperatures for the first 44 days of the vegetation period
for 1998 (after Rocada)

Plum flowers are sensitive to cold rains, persistent fog and frosts, during bud phase, they resist to -3.3 to 5.5 ° C, when open they freeze from -2.2 ° C to-5.0 ° C, flowers destruction is occurring in large proportions (90%), and for the apple species, the buds can withstand temperatures of up to -5 ° C, when open, they resist up from -1.6 to -2 ° C, and the newly formed fruit only to -1.1 ° C. So, in 1998,the fruit production was affected in Fălticeni city in very large proportions, resulting a total of 3142 tonnes of fruits, 4.5 times less than the previous year, 1997, when the total fruit production was 14224tonnes. Rainfall, seem to be defined by a cyclical character in the studied area,but generally keeps a steady trend the average being 611 mm.

Plum requirements for water are relatively high, being satisfied in hilly areas with more than 600 mm rainfall annually, of which 300-350 mm in May and July, and the apple has higher requirements with a minimum of 700 mm, the upper limit of two species were 1500 mm, both developing sensitivity water in excess. (****Zonarea speciilor pomicole în funcție de condițiile pedoclimatice și socio-economice ale României*- Institutul de cerccetare-dezvoltare pentru pomicultura Pitești-Mărăcineni, 2014).

A large amount of precipitation is needed in the first half of the growin season where the main stages from this period occur and requirements are lower in the second half of the growing season, which highlights the importance of distribution of rainfall during the growing season. Lack of water can lead to growth inhibition of fruit, decreasing production and quality.

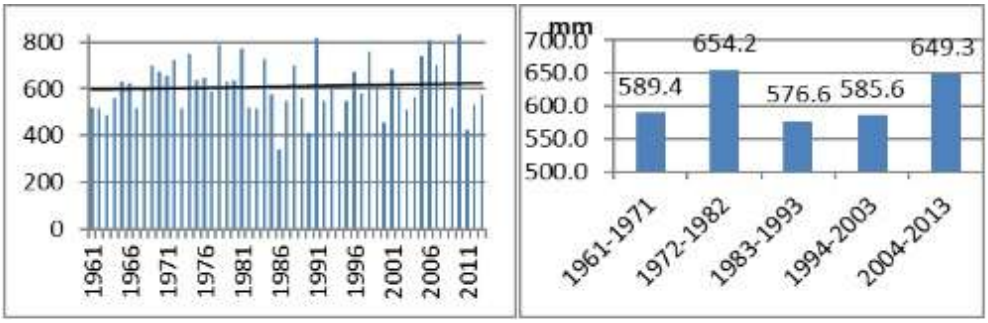


Fig.17. Multiannual average precipitations on decades (1961-2013, after Rocada)

In 2003, the fruit production in the studied territory was 4037 tones, given the fact that the amount of rainfall in the growing season did not exceed 390 mm, identifying 79 days with 0 mm of 190 (vegetation period) (fig. 5) and in 1991, in a favorable context, fruit production was 14286 tones, registering a rainfall of 747mm (in the growing season), precipitation uniformly distributed over those 226 days (Fig. 6).

Benefiting from the climatic parameters "temperature" and "precipitation", we could correct them according to the MESP, and for this we taken into account the slope, aspect and permeability in order to highlight the changes in terms of orchards distributions in other favorability classes, smaller or larger, producing a comparison

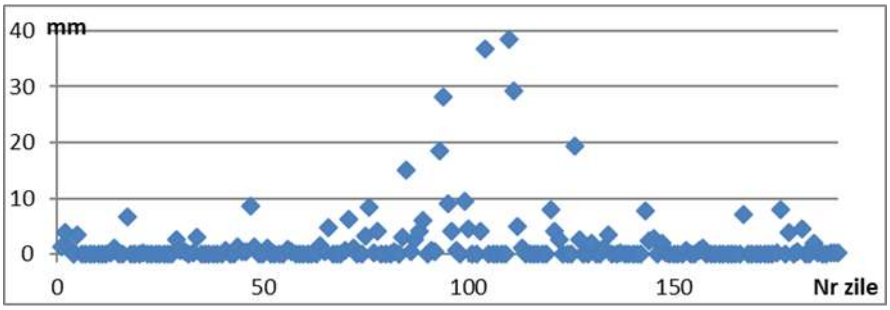


Fig.18. Distribution of days with rainfall during the vegetation period for 2003 (after Rocada)

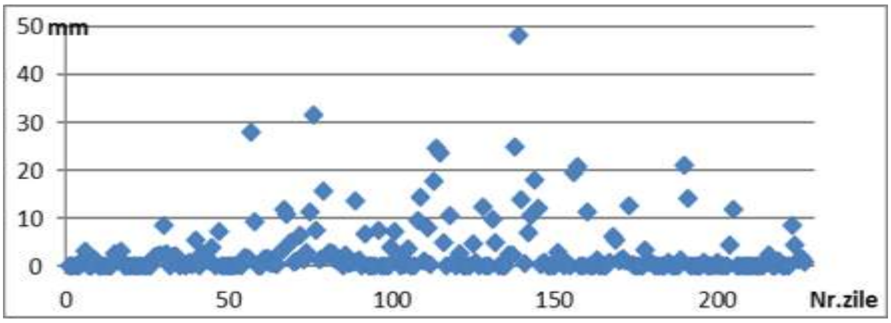


Fig.19. Distribution of days with rainfall during the vegetation period for anul 1991(after Rocada)

with the situation from the soil studies made by OSPA after the formula:

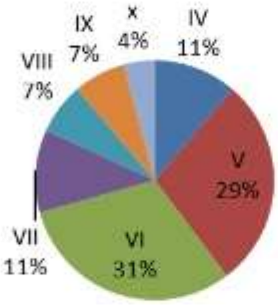
$$NBm \frac{Tm * Pm * NBn}{Tn * Pn}$$

Where: NBm = modified bonitation note; Tm = modified temperature; Pm = modified precipitation value; NBn = originat bonitation note; Tn = measured temperature value; Pn = measured precipitation value.

Bonitation note is given in absolute terms from 1 to 100, and favorability classes are from "I" to "X" so, for a land that has the quality index between 91 and

100 points, framing it will be class I of favorability, crop on that land is very suitable with very high favorability and evaluation notes that the values are between 1 and 10, the land will be assigned to class X favorability (the crop is unfit).

For a hypothetical apple orchards, following a change in the values of temperature and precipitation, an area of 74 hectares of 476.74 hectares went up in an upper class and an area of 5, 25 hectares memberships before and after changing parameters mentioned above. Thus, the apple orchards, favorability classes V and VI predominate, but, unlike the first marker in the second class III appears favorable on an area of 0.65 hectares. (fig.7).



Cl. Fav.	Supr/ha	%
IV	53,68	11,26
V	135,55	28,43
VI	147,61	30,96
VII	53,31	11,18
VIII	32,84	6,89
IX	33,78	7,09
X	19,97	4,19

Cl Fav.	Supr/ha	%
III	0,65	0,136343
IV	53,03	11,12346
V	135,84	28,49352
VI	143,68	30,13802
VII	77	16,15136
VIII	12,79	2,682804
IX	43,56	9,137056
X	10,13	2,137433

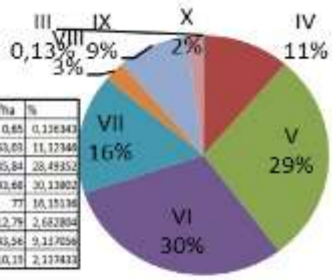
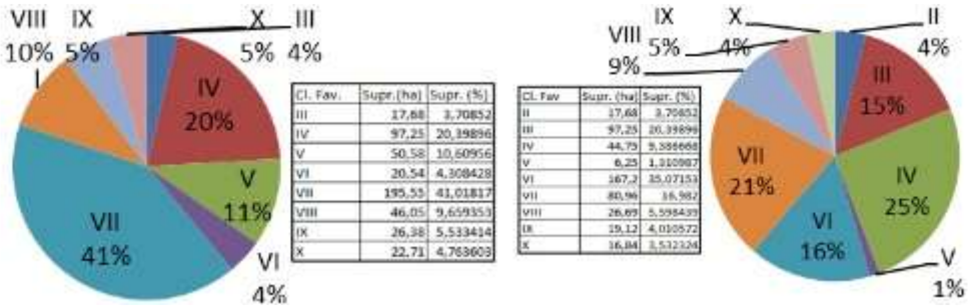


Fig.20. Framing in apple tree suitability classes after changing the temperatures and precipitations extracted from ROCADA

Towards plum suitability, after the changes that's been made, an area of 366 hectares have suffered a move to a higher favorability class and an area of 5.24 hectares underwent the same downward motion as if the apple crop. This change is a significant one and is due to the fact that plum tree is more demanding than the

apple tree towards heat, and is behaving better in plains and small hills. Thus, the new classification in favorability classes, identify the emergence of a new class, II, on an area of 17.68 hectares, the predominant remaining classes III and IV to the extent of about 40% of the study area. (fig. 8).



Cl. Fav.	Supr.(ha)	Supr. (%)
III	17,68	3,70852
IV	97,25	20,39896
V	50,58	10,60956
VI	20,54	4,308428
VII	195,55	41,01817
VIII	46,05	9,659353
IX	26,38	5,533414
X	22,71	4,763603

Cl. Fav	Supr. (ha)	Supr. (%)
II	17,68	3,70852
III	97,25	20,39896
IV	44,75	9,386668
V	6,25	1,310987
VI	167,2	35,07153
VII	80,96	16,982
VIII	26,69	5,598439
IX	19,12	4,010572
X	16,84	3,532324

Fig.21. Framing in plum tree suitability classes after changing the temperatures and precipitations extracted from ROCADA

The trees, being polycarpic plants, come to bear fruit several times over decades of life, the result is an overlap in the same year several biological processes (vegetative growth, fertilization, fruit tying, etc.). Those biological particularities cause periods of maximum consumption of nutrients, Differential dynamic, both quantitatively and qualitatively, which points out a close connection between the particularities of soil and plant, requiring soil knowledge, and how it evolves in conditions of intense exploitation, being brought into question the restrictive factors and how these problems can be ameliorated. (MESP, 1987).

In the present study, there were taken in consideration three pedological parameters, which in the study area, impose the largest restrictions, and they are: The level of groundwater, soil reaction and carbonates. To demonstrate whether the pedological indicators puts pressures on the tree species found in our area. Apple trees can support active limestone until 10-12%, however it becomes a growth inhibitor above 10% when it's below 50 cm depth. Requires a moderate to slightly acid reaction (pH 5.0-7.0). Groundwater level must be below 2.5 m depth and under any circumstances for vegetative rootstock, during rainfall does not rise to over 1,2 - 1,5m the ground surface.

Plum trees are among the species with the lowest requirements for soil, good or satisfactory capitalizing on almost all types of soil in our country. The most favorable areas are those with a slightly acid to neutral reaction (pH 5.8-7.4). Does not support salty soils or the excess of calcium (over 9-10% CaCO active). CaCO from the soil is an inhibitor of the growth of more than 12% at 50 cm depth in the soil, or more than 15% at a depth of less than 70cm. (****Zonarea speciilor pomicole în funcție de condițiile pedoclimatice și socio-economice ale României*-Institutul de cerccetare-dezvoltare pentru pomicultura Pitești-Mărăcineni, 2014)

As can be seen in fig. 9, ground water level is not at risk for developing orchards, whereas, the maximum level that can identify a water source on an area occupied by the orchard is about 3 m and in special cases, on very restricted territories may be about 1.8m.

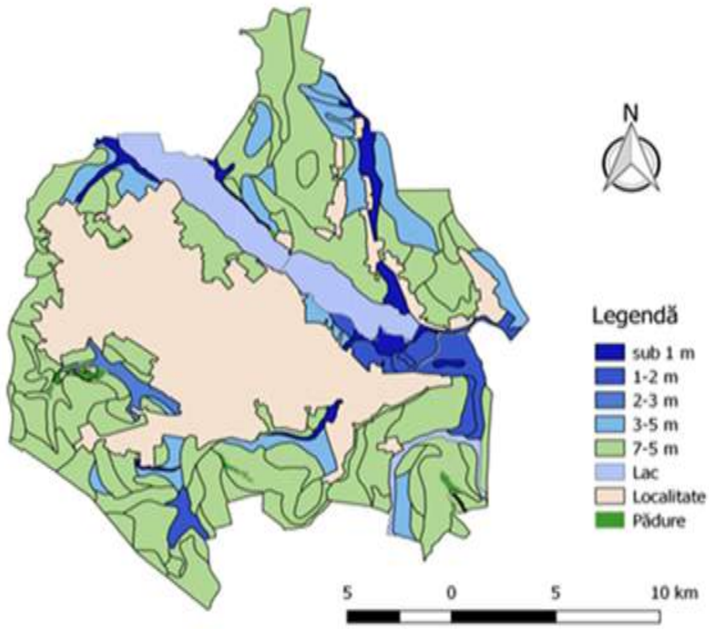


Fig.22. Ground water level

Knowing the soil reaction is necessary both for rational land use and to establish methods to improve soil fertility. Depending on soil pH, can determine the most favorable culture plans these conditions. Depending on soil pH, can determine the most favorable culture plans for these conditions. Also, knowing the soil reaction is important in determining the form in which fertilizer should be administered. PH variation for territories occupied with orchards has been illustrated on soil types, therefore, further we will emphasize the specific character of the soil reaction depending on its type, comparing them to the particularities of the species in the study.

In fig. 10 we have illustrated variation of pH profiles of soil accomplished on phaeozems occupied by orchards, can be noticed a variation in pH optimal parameters, both for apple and for plum, values below 5 (of the pH) being found at depths greater than one meter, a major importance being given to soil reaction in the first 50-60 centimeters. For preluvosol (fig. 11) is noticed a situation roughly opposite in which the pH optimal parameters of the two species are at the basis level of soil profiles, and in the top 50 cm of soil reaction ranges from strongly acidic and moderately acidic, imposing through these issues a number of restrictions from which mention reducing the intensity of nitrification and ammonification resulting in decreased nitrogen content, reducing mineralization of humus content that lowers the nutrient content of reducing photosynthesis etc.

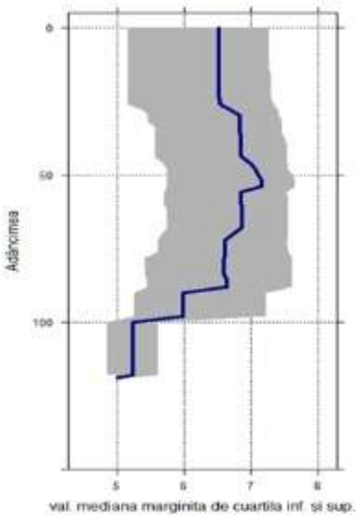


Fig. 10. pH variation for phaeozems

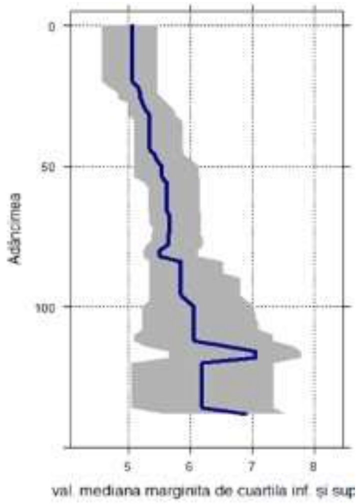


Fig. 11. pH variation for preluvosol

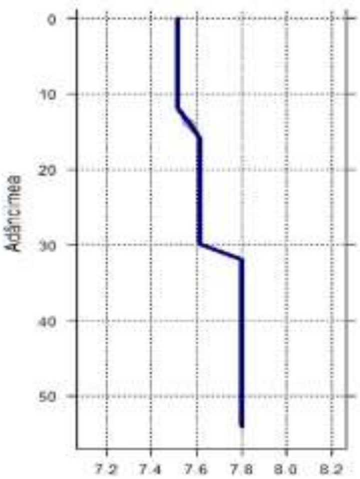


Fig. 12. pH variation for erodic anthrosol

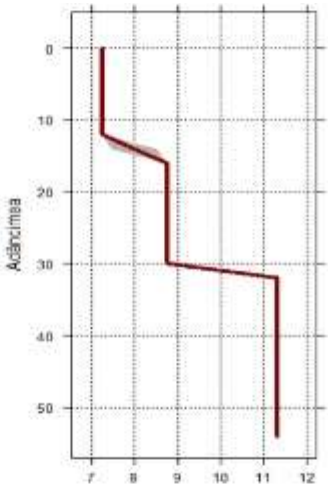


Fig. 13. $CaCO_3$ vatiation for erodic anthrosol

For erodic anthrosol, the pH value ranges between 7,5 and 7,8, being related to a weak alkaline reaction. The erodic anthrosol reaction has exceeded the upper limit for the species apple and plum entirely.

For this study, the distribution of CaCO3 was performed on all types of soil, being found only on erodosoil and phaeozems.

Conclusions

Temperature and precipitation ,through the specific characters, and through their manifestation in years with extreme events which tend to induce a state of extreme risk to the orchards, being remembered cases when low temperatures at the beginning of the growing season represented a risk factor, but also events where temperatures excessively high in the conditions of insufficient rainfall periods led to the installation of a period of drought, events that had an impact on orchards in the studied area.

In addition to the aforementioned specific events, it must be pointed out and the manner in which the two parameters have evolved over time, and trends that they have in the future and their effects on orchards. Thus, precipitation seem to maintain a constant throughout the period considered, while the temperature undergoes changes, standing out a warming of about one degree from 1961 to 2013 and 0.27 degrees in February-March, which leads to the early start of the growing season and thus the exposure of a late spring frost, which overlap phenophases of great importance (burgeoning, pollination etc.).

From the point of view of the pedological indicators analyzed and through the natural conditions of the territory, they impose some restrictions to the orchards. Ground water level is not a danger to apple and plum, in this case, except for small areas where the groundwater can be caught at depths of nearly 2 meters.

Soil reaction is optimum for phaeozems, however, in the case of preluvosoil appear limitations, whereas in the first 50 cm, pH values range from 4.5, standing out strongly acidic reaction, values below the lower limit of the species of trees in the study, otherwise erodic anthrosoils soils, where pH values exceed the upper limit of the same species, the reaction is slightly alkaline.

For erodic anthrosoils, calcium carbonates exceed the limit of 10% in the top 30 centimeters of the soil, thus becoming, growth inhibitors, but for phaeozems the limits of these tree species were not exceeded even in the top 120 centimeters, not being able to speak about restrictions.

About the pedological indicators we cannot say that it is an actual risk for Falticeni related orchards, whereas, their characteristics cannot vary considerably in a relatively short period, but we can consider the concept of risk if we connect these indicators to the climatic conditions and not only. For example, if after a period of excess rainfall, in which the groundwater level may rise, follows a period of high temperature, evapotranspiration is a very pronounced, thus resulting in an increase in the amount of salts in the upper layers.

I conclude by mentioning that through the information provided above, it could be highlighted a risk status on orchards, occurred after analyzing climatic indicators and a range of restrictions that result from characteristics of pedological parameters consider, but more than that, it was briefed also the risks that may occur as a result of the evolution and interaction of the indicators studied in this paper.

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