Opportunities for growing lavender in areas facing natural constraints exemplified by the Borika village, Bulgaria.

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Abstract:

Areas facing natural constraints represent a serious obstacle for Bulgarian farmers and to a great extent limit their development. In this regard, it is necessary to look for alternative options for optimal use of these areas so that they are as efficient as possible despite the limitations they have.

The paper presents the basic requirements of lavender in terms of climatic and soil conditions. There is also a soil and climate characterization of a village located in area of high altitude - the land of the village of Borika, Sofia in order to be able to indicate which soil types in the Borika land are best suited for lavender growing.

Key words: field ratings, soil, soil characteristics, lavender

Introduction

The land of the village of Borika is located in the Southwest region of Bulgaria, Ihtiman municipality, Sofia district. It falls in a mountainous area with an altitude of 700 - 990 m. The total area of Borika is 294,75 ha.

The soil resources in the area were studied in the large-scale soil mapping with scale 1:10 000, conducted by scientists of Nikola Pushkarov Institute of soil science, agrotechnologies and plant protection. In the land of the village there are 11 soil types, for each are presented detailed soil characteristics, which are related to the cultivation of lavender: soil texture (contains soil texture of the plowed horizon with < 0,01 mm particle size in %, the soil texture of the soil under the plowed horizon < 0,01 mm particle size in % (Kachinskiy, 1958), humus horizon depth (cm), soil profile depth (cm), soil reaction in H_2O (pH in water extraction – measured potentiometrically (WTW 720 pH meter)), texture coefficient (which is the % clay content in the B horizon divided by the % clay content in the A horizon with particles < 0.001 mm (Kachinskiy, 1958), humus content was estimated by the Turin method (Donov et al., 1974).

According to the European Union Regulation currently (2018) in force (Regulation (EU) No 1305/2013) Annex III the biophysical criteria for the delimitation of areas facing natural constraints Borika village falls into an area facing natural constraints.

Borika village is a mountainous region that has soil types with unfavorable texture (low content of particles <0,01 mm) and stoniness, shallow rooting depth (depth≤30 cm) and poor chemical properties (acidity≤5).

Lavender

Lavender (*Lavandula vera L*), belongs to the *Lamiaceae* family, which is major oil crop for the temperate climate zone and for Bulgaria. The Mediterranean countries, France, Spain, Italy and the Balkans are where the lavender originated (Reed, 2000). Lavender is a good honey-bearing and soil-strengthening plant. It is a perennial shrub, evergreen tuft.

Lavendula angustifolia grows 60-80 cm and has fragrant violet flower spikes of 3-7 cm (Reed, 2000). Spike lavender or *L. latifolia* (syn. L. spica) is also native to the western Mediterranean region and Portugal. It is later flowering and shorter than Lavendula angustifolia and the oil has a distinct camphoraceous odor (Reed, 2000). Important species are *Lavendula dentata* and *Lavendula stoechas* (Ernst, 2017). The root reaches a depth of 2-3 m (Koedzhikov et. al., 1971). It requires warm weather, strong solar radiation and lack of strong air currents. These requirements are largely satisfied on southern mountain slopes, protected from winds and over 800-1000 m height above the sea level (Koedzhikov et. al., 1971). During flowering changing and cloudy weather, as well as frequent precipitation, have the effect of lowering essential oil yields and deteriorating quality (Koedzhikov et. al., 1971).

Lavender tolerates low temperatures at an early stage of development of - 8^0, - 10^0C (Koedzhikov et. al., 1971). Adult plants with sufficient snow cover can withstand up to - 25^0, - 30^0C (Koedzhikov et. al., 1971). High summer temperatures adversely affect oil quality (Reed, 2000).

Lavender is very demanding in terms of light. When there is strong shading the oil in the flower decreases by 50% (Koedzhikov et. al., 1971). Requirement for moisture is not so demanding, it is drought-resistant, and excessive moisture gives negative results (Koedzhikov et. al., 1971). High summer temperatures adversely affect oil quality (Reid, 2000).

The crop is not demanding with respect to soils. It develops optimally on loose, air-permeable, easily absorbing heat and rich in humus and lime soils (Koedzhikov et. al., 1971). Of particular importance to the high productivity of lavender is the soil reaction. Soils of neutral (7) pH are preferred but successful crops have been produced over the range 5.8 to 8.3 pH (Reed, 2000). Lavender is best established on sandy loamy soils (Ernst, 2017). The crop is most successful when grown on well-drained soils (Ernst, 2017). Inappropriate are heavy, waterlogged and acidic soils with a high level of groundwater, as well as soils with high clay content (Koedzhikov et. al., 1971).

The main objectives of the study are:

(1) Present soil and climatic characterization of the land.

(2) Consider the lavender requirements for the main soil climatic characteristics to indicate which soil types in the land are suited for cultivation and which are impossible for cultivation.

Materials and Methods

The data, interpreted below are from the Vakarel and Sofia meteorological stations, published (officially) by NIMH-BAS and summarized for a minimum of 45 years (Climate reference book for Bulgaria, 1978, 1983, 1990).Of particular importance in agriculture is the duration of the period with average daily air temperatures above a certain limit and the temperature sums for it. "Methods for working on the agricultural land cadastre in the Republic of Bulgaria" (Petrov et al., 1988) uses these characteristics with a lower limit of 10 ^{0}C. The temperature sums for this period are called "active temperature sums" and are defined by Equation 1:

$$\Sigma\ T\ ^0C > 10^0C = (t_1 + t_2 + t_3 + ... + t_n) \quad (1)$$

Where:

$\Sigma\ T\ ^0C > 10^0$ C- the sum of effective temperatures (for the period with average daily temperature> 10^0C) in ^{0}C;

$t_1, t_2, t_3, ... t_n$ - consecutive observations of mean 24-hour temperatures of air in ^{0}C;

1, 2, ... n - index for serial number of the day through the period of measurement.

The land capability approach uses the so-called limitation method, which implies comparing land characteristics of a land unit with critical limits of each capability class. The values of land characteristics are tested first against the limits of the highest capability class and, unless all the limits are met, the land unit automatically falls to the next lower class (Van Lanen, 1991). This sieving process continues until a capability class is found at which all the limits are met. This means that if one limitation is of sufficient severity to lower the land unit to a lower class, it is allocated to that class, no matter how favorable the other land characteristics may be (law of minimum) (Van Lanen, 1991). The results are harmonized with classes from the FAO framework (FAO, 1976, 2007).

The nature of the severest limitation, e.g. erosion, excess water or climatic limitation, is specified in the capability assessment (Van Lanen, 1991). Refinements are possible by making the suitability class ratings dependent on more than one limiting land characteristic (Rosa, Diepen, 2002).

Simple limitation method compares the plant requirements with its corresponding qualitative land and climatic characteristics and the most limiting characteristics defines land suitability class (Darvishi-Foshtomi et al., 2011).

The limitation method concerns the selection of the most restricting criterion rate and considering it as the total score for a land unit (Sharififar, 2012). This method defines land classes with regard to number and intensity of limitations (Chadar et al., 2018, Sys et al., 1991).

Results and Discussion

Climatic characteristic

The land of the village of Borika falls into the Moderate Continental Climatic Sub-Area and more precisely in the climatic region of the high fields of Western Central Bulgaria. The climatic region of the highlands of Western Central Bulgaria consists of separate valleys located in the western part of Central Bulgaria and surrounded by many low and medium altitude mountains. Winter in the region is cold, but the summer is cooler. Typical of the area are late spring and early autumn frosts, due to the valley nature of the terrain.

Precipitation

Table 1. *Average monthly and average annual precipitation. (Vakarel meteorological station)*

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual sum
mm/m^2	42	37	44	55	85	82	63	44	40	49	49	47	635

Table 1. shows that the maximum rainfall is in June and the minimum is in February in the nearest Vakarel meteorological station. The average annual precipitation is 635 mm / m^2 (Climate reference book for Bulgaria, 1990).

The mountainous region of Borika has sufficient precipitation for lavender as the crop is not very demanding in terms of water needs.

Temperature characteristics

As a start date of sustained air temperature above 10^0C for the area is indicated 29 April and for the final is 9 October (Climate reference book for Bulgaria, 1983, p.173). The duration of days with sustained air temperature > 10^0C for the area is 162 days and the temperature sum is 2510^0C for this period. (Climate reference book for Bulgaria, 1983 (p.

179)) as is indicated by the nearest Vakarel meteorological station. This implies good conditions for the development of lavender during vegetation.

Characteristics of solar radiation

One of the most important condition for lavender growing is the amount of solar radiation, the hourly and daily sums of direct photosynthetic active radiation in a cloudless sky on the horizontal surface are presented.

Photosynthetic active radiation (PAR) is that part of the solar radiation with a wavelength of 0,38 to 0,71 μm, which is used during photosynthesis. The nearest meteorological station for which there is data is used and data are presented in Table 2. Due to low variation because of low distances in latitude and longitude the territory of Bulgaria does not experience big changes in the solar radiation (Climate reference book for Bulgaria, 1978). The total sum of PAR is sufficient for the vegetation cycle as it is the most important factor for growing lavender that has a direct effect on the quality of the yield.

Table 2. *Hourly and daily sum of total photosynthetic active radiation (PAR) in cloudless sky (cal./cm^2). Sofia meteorological station*

Month	Sunrise 5.30	$5.^{30}$-$6.^{30}$	$6.^{30}$-$7.^{30}$	$7.^{30}$-$8.^{30}$	$8.^{30}$-$9.^{30}$	$9.^{30}$-$10.^{30}$	$10.^{30}$-$11.^{30}$	$11.^{30}$-$12.^{30}$	$12.^{30}$-$13.^{30}$	$13.^{30}$-$14.^{30}$	$14.^{30}$-$15.^{30}$	$15.^{30}$-$16.^{30}$	$16.^{30}$-$17.^{30}$	$17.^{30}$-$18.^{30}$	$18.^{30}$-$19.^{30}$	Daily sum
I				2,6	6,4	10,1	13,4	14,8	14,0	11,5	7,3	2,0				82,1
II			0,6	5,7	10,8	16,6	20,6	23,0	22,1	18,6	13,3	7,8	1,5			140,6
III		0,3	4,6	10,5	17,0	22,1	26,2	27,5	27,0	24,8	20,1	12,8	5,9	0,6		199,4
IV		0,2	2,8	11,0	18,0	23,7	28,5	31,2	32,1	31,6	28,8	23,0	17,6	9,2	1,8	259,5
V	1,2	6,1	13,0	20,0	26,5	31,3	35,0	36,6	35,9	32,2	26,5	18,8	12,7	6,1	0,7	302,6
VI	2,0	7,5	14,4	21,3	27,5	31,7	34,7	37,2	37,7	33,5	22,4	21,5	15,3	8,0	1,8	316,5
VII	1,2	7,6	14,6	20,4	26,4	31,0	35,2	37,0	36,0	32,7	28,1	21,5	14,3	7,3	1,4	314,7
VIII	0,2	2,4	5,9	11,9	18,2	23,5	28,9	32,3	33,5	32,5	29,1	23,9	17,1	9,1	0,4	268,9
IX		1,2	4,5	9,1	15,4	21,1	25,8	28,6	29,1	27,9	23,8	17,7	10,0	0,6		214,8
X		0,2	2,1	5,6	10,9	16,4	20,4	23,2	23,7	22,0	17,1	10,5	4,6			156,7
XI			0,6	2,7	9,4	14,3	16,8	17,8	15,9	11,9	7,3	1,6				98,3
XII				1,4	6,5	10,5	13,2	14,5	12,9	9,5	4,8	0,6				73,9

Soil characteristics

On the territory of the village of Borika there are 11 soil types classified according to WRBSR 2014 update 2015 (IUSS Working Group WRB, 2015), with soil texture predominating from low to medium sandy clay according to Bulgarian soil texture classification (№ 1,2,3,4,6), followed by № 5,7,9 and low sandy-clayey № 8 and 10, as well as sandy №11. The humus horizon's depth varies depending on the soil type (10-30 cm) and all the soils are with low depth. According to the depth of the profile the soils with low depth (№ 7,8,9,10,11) and moderate depth (№4,5,6) predominate, followed by deep (№2,3) and highly deep (№1). The soils in the region have a low texture differentiation (Texture coefficient) ranging from 0.9 to 1.5, with the exception of №3 and №5, which are highly differentiated. The soil response ranges from moderately acidic to slightly acidic (pH in H_2O 4,8- 6,0). According to the humus content the soils are low to medium humus (1-3,1%), the

groundwater level is deep, over 600 cm. Affected by erosion are almost all soil types with the exception of (№1, №2, №3).

Table 3. *Matrix of soil characteristics*

№	Soil type WRBSR 2014, u 2015.	<0,01 in plowed horizon (%)	<0,01 in area under plowed horizon (%)	Humus horizon depth (cm)	Soil profile depth (cm)	Texture coefficient	pH in H_2O	Humus (%)	Suitability
1	Fluvisols	35	38	30	160	1.3	6	2.1	A
2	Phaeozems	34	39	30	150	1.3	5.3	1.2	A
3	Planosols	37	60	25	100	2.2	5.5	1.4	A
4	Luvisols	39	49	25	95	1.5	5.3	2.4	A
5	Planosols	14	51	10	70	4.7	4.8	1.2	B
6	Cambisols	40	26	20	65	1.1	5.6	1.3	A
7	Leptosols	14	14	15	20	1	5.3	1	B
8	Cambisols	28	20	20	40	1.3	5.4	1.4	B
9	Leptosols	16	12	20	40	0.9	5.1	1.7	B
10	Leptosols	25	25	15	15	1	5	3.1	B
11	Leptosols	8	8	10	20	1	5.3	1	B

Farmers need efficient practical recommendation for decision making and risk avoiding. A variant of the limitation method is proposed where a matrix of characteristics is created. This is a mountainous region with lands facing natural constraints and there are limitations for agriculture. With “A” are represented the soils that can be used for growing lavender with a lower risk, corresponding to the FAO S order(S1, S2, S3) and with “B” are represented the soils that have limiting factors of significance that make them non-suitable for growing lavender, corresponding to FAO N order (N1, N2) for Borika village (FAO, 1976, 2007).

Table 4. *Matrix of land characteristics evaluation*

№	<0,01 in plowed horizon (%) >30	<0,01 in area under plowed horizon (%) >30	Humus horizon depth (cm) >15	Soil profile depth (cm) >50	Texture coefficient <0,9 <1,5	pH in H2O >5.2	Humus (%) >1	Count Y
1	Y	Y	Y	Y	Y	Y	Y	7n
2	Y	Y	Y	Y	Y	Y	Y	7n
3	Y	Y	Y	Y	N	Y	Y	6t
4	Y	Y	Y	Y	N	Y	Y	6t
5	N	Y	N	Y	N	N	Y	3ca,ha,t,p
6	Y	N	Y	Y	Y	Y	Y	6cb
7	N	N	N	N	Y	Y	N	2ca,cb,ha,d,hb
8	N	N	Y	N	Y	Y	Y	4ca,cb,d
9	N	N	Y	N	N	N	Y	2ca,cb,d,t,p
10	N	N	N	N	Y	N	Y	2ca,cb,ha,d,p
11	N	N	N	N	Y	Y	N	2ca,cb,ha,d,hb

The small letter represents the soil limitation factors according to the legend:
n – no limitations;
ca – clay content in plowed horizon limitations (%);
cb - clay content under plowed horizon (%);
ha – humus horizon depth limitations;
d – soil profile depth limitations;

t – texture coefficient limitations;
p – pH limitations;
hb – humus content limitations.

With "Y" are represented the soils that fall under criteria for growing lavender and with "N" that do not.

As it is seen, the best soils in the region for growing lavender are 1, 2, 3, 4, and 6. As lavender tuft is not growing very deep it can tolerate slight differences in texture coefficient. The clay content in number 6 is closer to the limit and it has points close to the maximum sum of 7 (26). They all have equal to or more than 5 "Y"s. Number 5 is very acidic, with very shallow humus horizon and unfavorable soil texture, number 7, 8, 9, 10 and 11 are with very low depth and/or unfavorable soil texture and/or humus content and/or acidity.

For greater visibility in Fig. 1 and Fig. 2 maps of the studied area are also presented. The large-scale (1:10000) map of the land (digital archive of ISSAP "N. Pushkarov", digitized by EASR, MAF) includes 11 soil mapping units and is shown in Fig. 1. Note that these are images not actual maps with scale. Not all of the land is used for agriculture. Some of the land is covered with water, forests, roads, buildings.

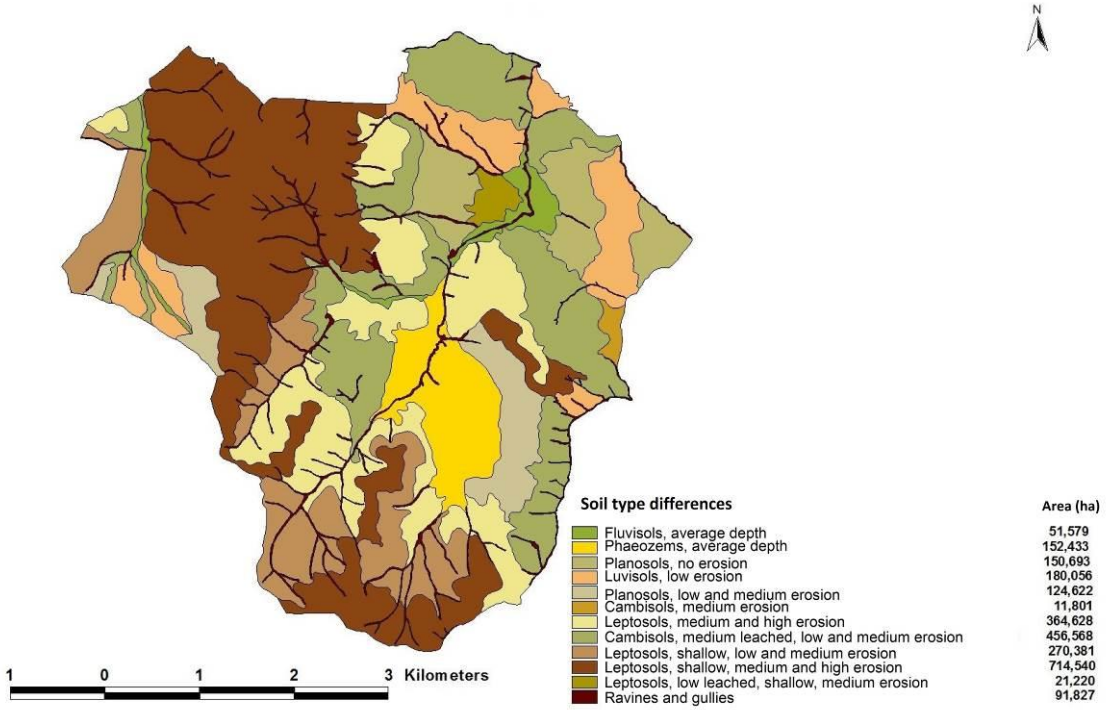

Figure 1. *Soil map of Borika village, Ihtiman district, Scale 1:10000*

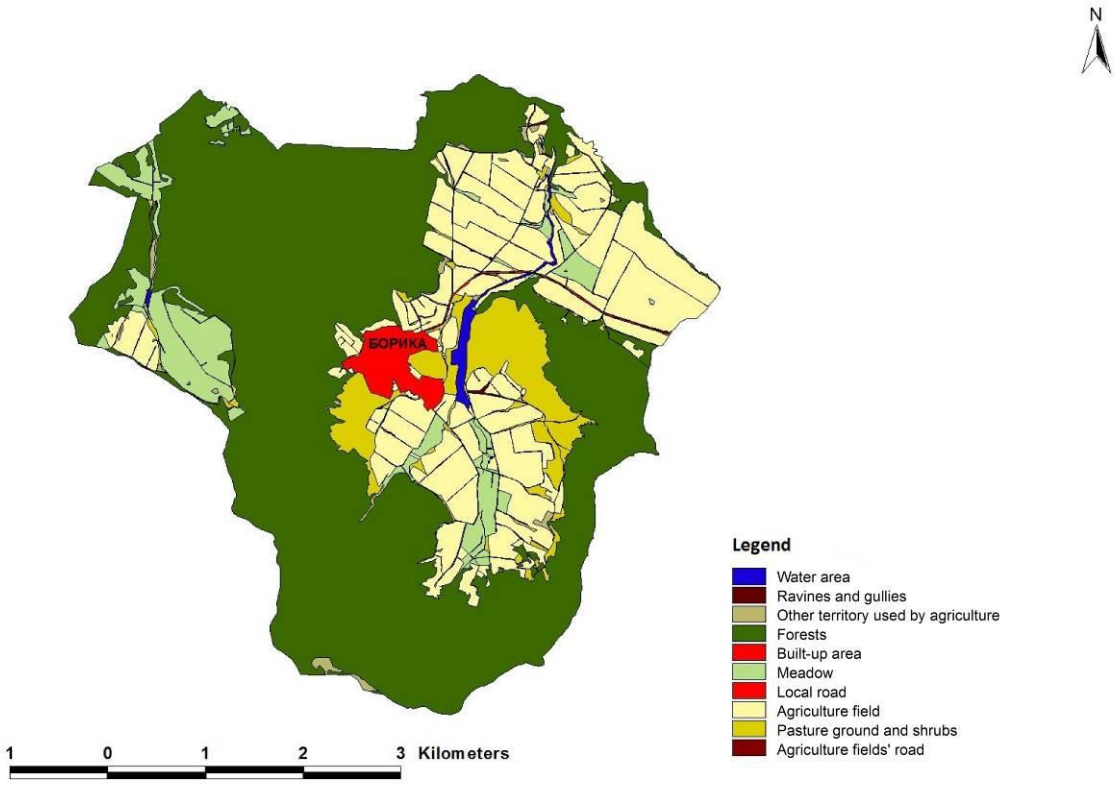

Figure 2. *Map of distribution of the land of Borika village according to methods of long-term use*

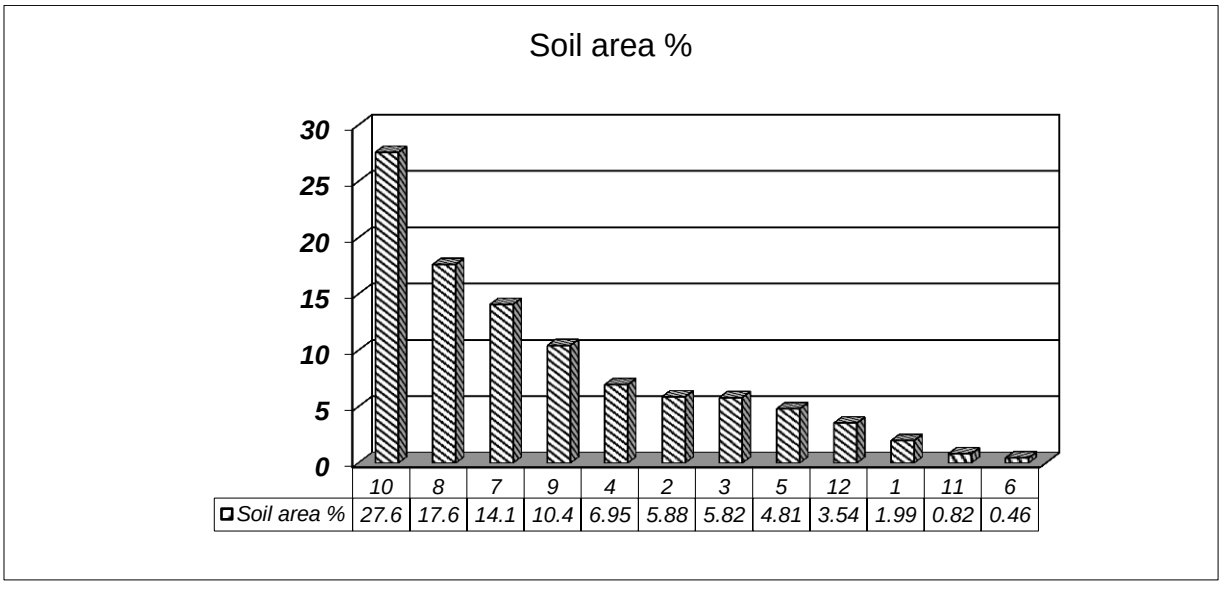

Figure 3. *Area of soil units by number*

Conclusion

It is more difficult to grow lavender in areas facing natural constraints. One of the units in the legend are not soils. These are ravines and gullies according to the Bulgarian soil map.Most of the area is covered with soil number 10, 8 and 7 (Figure 3).

The best soils for growing lavender are with number 1,2,3,4, 6 (representing Fluvisols, Phaeozems, Planosols, Luvisols and Cambisols) and they cover only 21,1% of the land. They are located near the rivers and in specific valleys with small slopes and are most suitable for growing lavender. In conditions that face natural constraints growing lavender should be cautious.

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