

ASSESSMENT OF THE LAND SUITABILITY FOR APPLES AND HAZELS GROWING

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Abstract

Agricultural land in the region of Virovitica-Podravina County (Croatia) present important natural resources for the development of this county. Of special interest are agricultural land used in growing of fruits. The main goal of this work is to estimate the value of these agricultural land for the growing of apples and hazels, pointing out at the possibilities of the further development of this branch of agriculture. Considering the characteristics of soil, climate and relief as well as the claims for the intensive growing of apples and hazels, the evaluation of the land suitability was made and it was determined that there are 51.839,2 hectares of suitable land for growing of apples and 39.728,8 hectares for hazels in the region of this county. These areas represent significant land resources, and to eliminate or reduce the already existing constraints, primarily related to physical and chemical properties of the soil, it is necessary to carry out individually or in combination the following land improvement measures when raising new plantations : vertical deep ploughing, subsoiling, organic and mineral fertilizing, calcification, the removal of stones and rocks, basic and detailed drainage, irrigation.

Keywords: *land suitability, apples, hazels, Virovitica-Podravina County, Croatia*

Introduction

Virovitica-Podravina county is located in the Republic of Croatia and covers an area of 2.021 km², of which the agricultural area of 1.168 km² (approximately 58%). Representation of orchards in the total of used agricultural land is 1.6%, which is lower than the national level of 2.1% (Statistical Year Book of Croatia, 2012). In the structure of production, the apples and hazels are the most represented. Their growing according to the development plans of the county intends to expand because of the significant interest for them. Therefore, the main aim of this paper is to establish agro-ecological features or characteristics of the soil, climate and relief of the area, and taking into account the requirements of apples and hazelnuts to make an assessment of soil suitability for their cultivation. This information may additionally be used for planning and managing agricultural policy in these areas, as well as for the financing of loans for the family farms.

Materials and methods

Soil classification is determined according to the current classification of soils (Škorić et al., 1986), and the distribution and characteristics of soils were determined according to the Basic Soil Map of Croatia measuring scale 1: 50.000 and accompanying interpreters, sections Bjelovar 2 and 4, Podravska Slatina 1, 2, 3 and 4, Donji Miholjac 2 and 4. which cover an area of Virovitica-Podravina county. Features of the relief obtained on the basis of topographic maps at the scale 1: 50.000. The conducted analysis of climatic characteristics was based on data of meteorological station Virovitica and includes precipitation and air temperature for the period 1967-2010. Assessment of the land's suitability for fruit growing in the area of Virovitica- Podravina county, respecting type and intensity limitations to their

intensive use, was made by the modified method of Food and Agriculture Organisation (FAO, 1976; Vida ek, 1976). When preparing the soil map, as well as the suitability maps for growing of apples and hazels the ESRI software package was used.

Results and discussion

Geographical position

Virovitica- Podravina County extends at the border of central and eastern continental Croatia. To the west it is bordered by low mountains Bilogora, and further south continues to Papuk and Krndija. Northern natural boundary is the river Drava and the Republic of Hungary. Geographically Virovitica- Podravina County occupies the space between 16°10' and 17°17' east longitude and 45°25' and 46°00' north latitude.

Climatic features

Generally it can be said that the climate of Virovitica- Podravina County is a temperate continental and according to value of Lang rain factor (75.8) has a semi humid characteristics. The average annual rainfall (period 1967-2010) is 810.8 mm, with a large annual variation of 552.6 mm to 1302.8 mm. During the active growing season (IV-IX month) average fall is 454.9 mm, while the outside of the growing season (X-III month) 355.9 mm. The average annual air temperature (period 1967-2010) is 10.7°C, with the annual variation of 9.3°C to 12.7°C. The average air temperature during the active growing season is 17.2°C, the coldest month is January with an average temperature of -0.1°C, while the monthly mean temperature of the warmest month - July is 21.0°C. Mean daily temperature above 10°C (effective active temperature) occurs in April and ceases during October. The average annual value of insolation in the Virovitica-Podravina County is 2119.8 hours, the highest average insolation is in July (293.6), and lowest in December (60.3).

Relief

Virovitica-Podravina County is characterized by three relief units.

1. Holocene plateau in the north part of County, which stretches along the valley of the river Drava, with altitudes ranging from 90 to 120 m.
2. Pleistocene terrace, which continues on plateau with altitude up to about 200 m.
3. Slopes and hills to Bilogora 500 m above sea level and the mountains of Papuk with altitude 500-850 m. Hence, the altitude of Virovitica-Podravina County varies between 90 and 850 meters above sea level, (Figure 1).

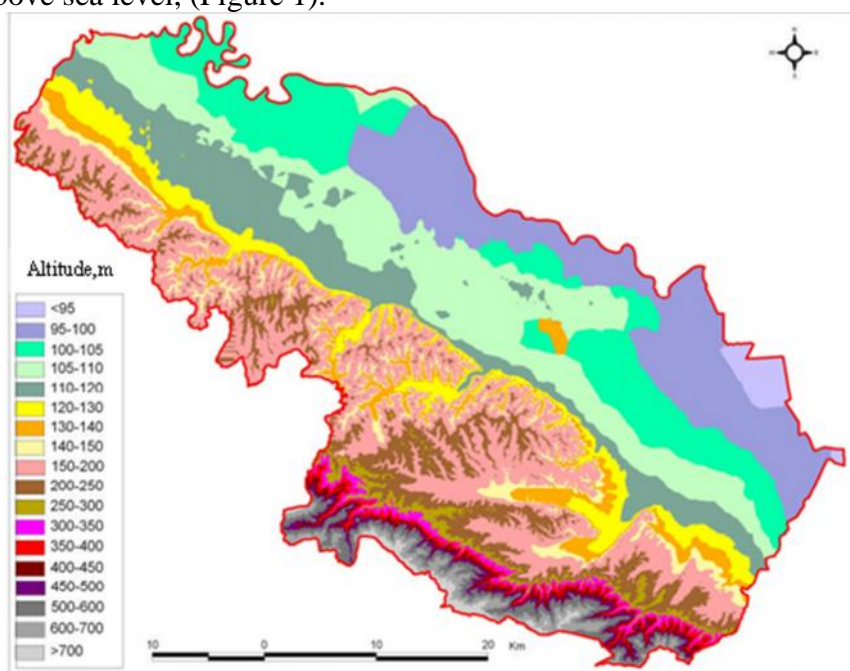


Figure 1: Altitude of the terrain in Virovitica-Podravina County
Soil

According to the Basic soil map of Croatia scale 1:50 000, in the area of Virovitica-Podravina County there are 86 soil mapping units, from the division of automorphic and hydromorphic soils, whose spatial distribution is shown on soil map scale of 1:100 000, figure 2. Ten types of soil were found, from automorphic division (rhegosol, colluvial soil, calcomelanosol, rendzina, ranker, distric cambisol, eutric cambisol, calcocambisol, luvisol and rigosol), six types of soil from hydromorphic division (fluvisol, pseudogley, pseudogley-gley, humofluvisol, eugley and histosols) and hydroameliorated soils drained with pipe drainage. Basic physical and chemical properties of certain types of soil are described according to the results of previous field and laboratory studies, and are found in expositors of Basic soil map sections Bjelovar 2 and 4, Podravska Slatina 1, 2, 3 and 4 and Donji Miholjac 2 and 4.

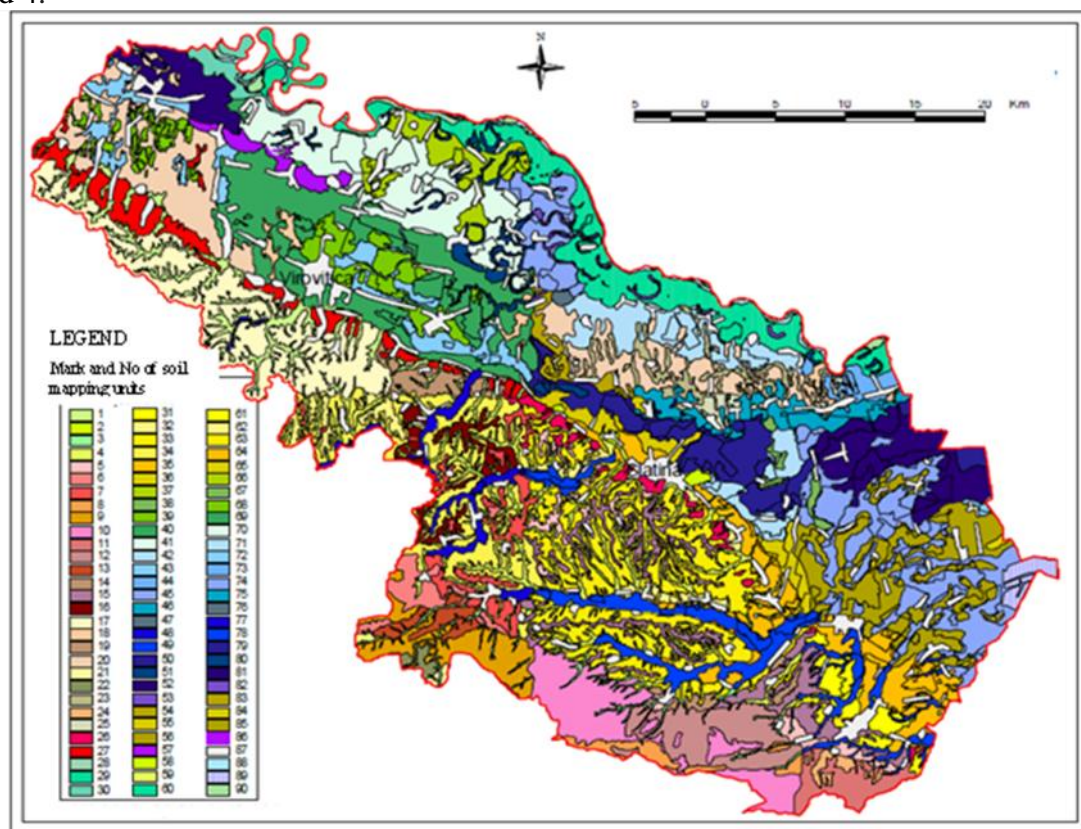


Figure 2: Soil Map of Virovitica-Podravina County, scale 1:100.000 with a legend

Evaluation of land for fruit growing

Concept and evaluation criteria

Land as an object of evaluation includes physical space - climate, relief, soil, geology, hydrosphere, vegetation, and the results of past and present human activities (drainage and irrigation, terracing, deep tillage, chemisation etc.), to the extent of their impact on benefits and features dedicated using (modified according to FAO, 1976, Vida ek, Ž., 1976).

Evaluation of land suitability Virovitica-Podravina County for apples and hazels growing is primarily qualitative and based on relevant soil properties and qualities and/or limitations of systematic soil units. Classification structure consists of orders, classes and subclasses suitabilities for fruit growing. Orders determine the suitability (P) or unsuitability (N) of soil for fruit growing; classes determine suitability degree: P-1 good or suitable soil for fruit growing without major restrictions, P-2 moderately suitable soil for fruit growing with

individual limitations and P-3 limited suitable soil for fruit growing with a number of serious limitations.

Class N-1 temporarily unsuitable soils for fruit growing that require radically arranging and class N-2 permanently unsuitable soils for fruit growing because their arrangement is not possible or not economically justified. Subclasses of soil suitability and unsuitability determine the types and intensity of limitations, which are shown in table 1.

Table 1: Types of restrictions with the intensity and the criteria used in the evaluation of land suitability for apples and hazels growing

Landforms (r) r1 = narrow stream valleys r2 = narrow river valleys r3 = closed depression r4 = plains r5 = hills r6 = mountain	Terrain inclination (n) n1 = 0-1% flat n2 = 1-3% almost flat n3 = 3-8% gentle slopes n4 = 8-16 moderate slopes n5 = 16-30% moderate steep slopes n6 > 30% steep slopes
Ecological depth of soil (du) du1 = very shallow 0-15 cm du2 = shallow 15-30 cm du3 = medium deep 30-60 cm du4 = deep 60-120 cm du5 = very deep >120 cm	Drainage (dr) dr1 = very weak dr2 = weak dr3 = incomplete dr4 = moderately good dr5 = good dr6 = slightly excessively dr7 = excessively
Climate (k) - frost, fog	
Soil acidity (a) a1 = very acid < 4,5 a2 = acid 4,6-5,5 a3 = weakly acid 5,6-6,5 a4 = neutral 6,6-7,2 a5 = basic > 7,2	Humus content (hu), % hu1 = very low < 1% hu2 = low 1-3 % hu3 = moderate 3-5 % hu4 = high 5-10% hu5 = very high > 10%
Active lime (vp), % vp1 = little < 5 vp2 = moderately 5-15 vp3 = much >15	Soil water regime mv = periodic water deficiency in the soil vv = periodic excess water in the soil v = stagnant surface waters pv = flood waters V = high level of underground water
Supply of physiologically active phosphorus, mg P₂O₅/100 g of soil (fv) fv1 = poor < 12 fv2 = moderately 13-20 fv3 = good 21-30 fv4 = very good >30	Supply of physiologically active potassium, mg K₂O/100 g of soil (kv) kv1 = poor < 20 kv2 = moderately 21-35 kv3 = good 36-50 kv4 = very good >50

Results of the assessment of land suitability

Figures 3 and 4 shows the results of evaluation of the suitability of agricultural land of Virovitica-Podravina County for apples and hazels growing, respecting the data of the soil properties, relief and climate.

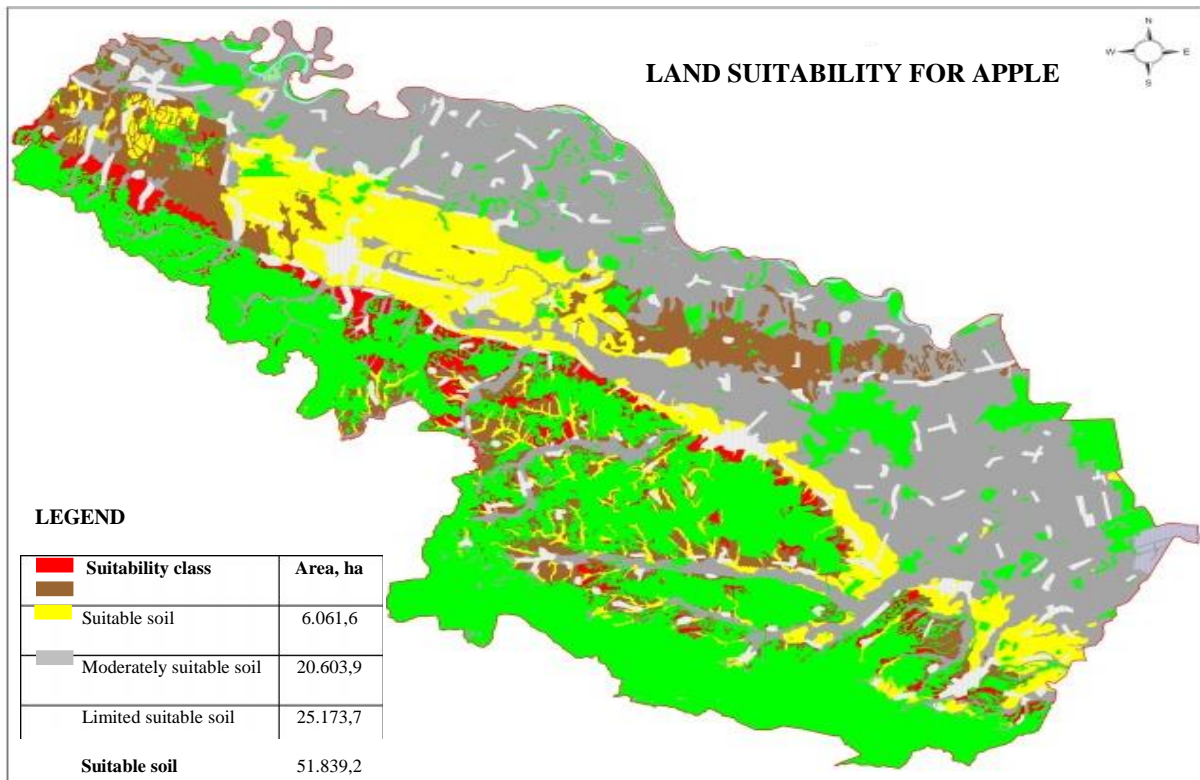


Figure 3: Suitable agricultural land for the cultivation of apples in the Virovitica-Podravina County

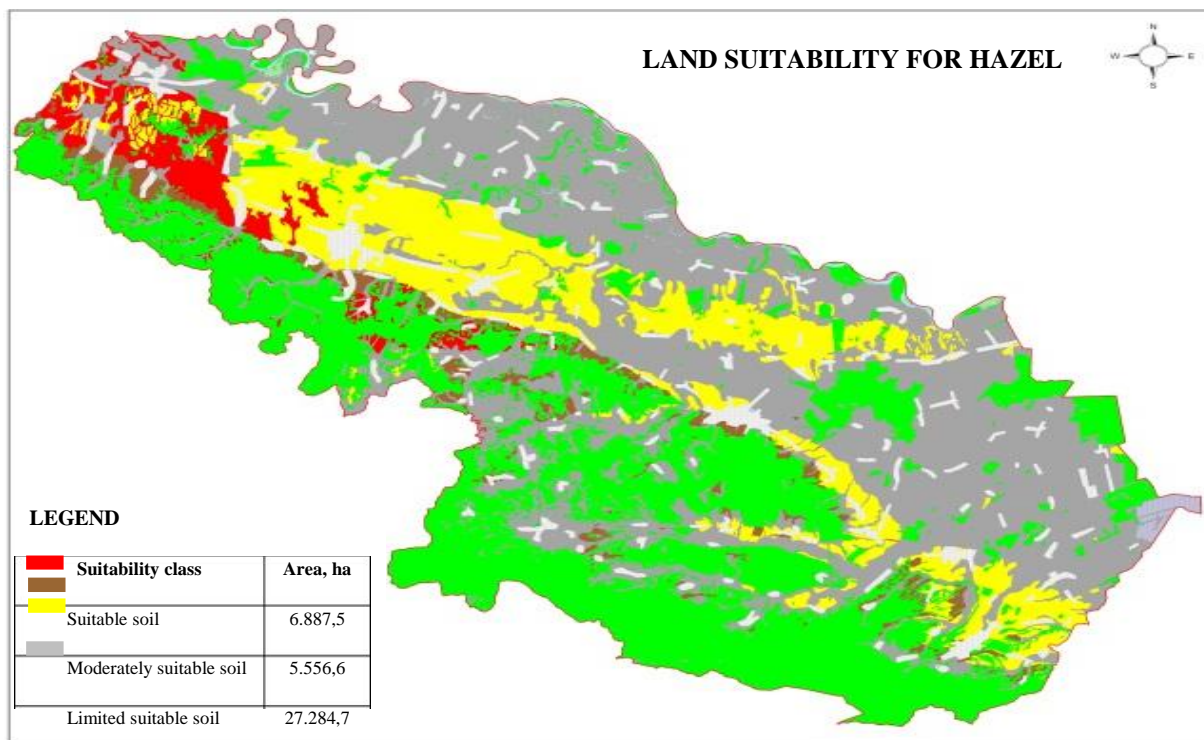


Figure 4: Suitable agricultural land for the cultivation of hazels in the Virovitica-Podravina County

In the area of Virovitica-Podravina County there are total 51.839,2 hectares of suitable land for apples' growing and 39.728,8 hectares of suitable land for hazels' growing, table 2. Good suitable soils for fruit growing (class P-1 – red colour on the map) have-6.061,6 ha for apples

growing and 6.887,5 ha for hazels growing. Moderately suitable soils for fruit growing (class P-2 - brown colour on the map) have 20.603,9 ha for apples growing and 5.556,6 ha for hazels growing. Limited suitable soils for fruit growing (class P-3 – yellow colour on the map) have 25.173,7 ha for apples growing and 27.284,7 ha for hazels growing.

Table 2: Areas of land suitability classes of Virovitica-Podravina County for apples and hazels growing

Suitability classes	Apples	Hazels
P-1	6.061,6 ha	6.887,5 ha
P-2	20.603,9 ha	5.556,6 ha
P-3	25.173,7 ha	27.284,7 ha
P	51.839,2 ha	39.728,8 ha
N-1	-	-
N-2	68.288,9 ha	80.399,3 ha
N	68.288,9 ha	80.399,3 ha

Conclusion

The main limiting factors for the apples and hazels' growing in Virovitica-Podravina County are climate (fog and frost), relief (exposure and inclination), the presence of excess water and restrictions on the physical and chemical properties of the soil (compaction, ecological depth, drainage, moisture regime, soil reaction, low humus content and supply of physiologically active nutrients). For a successful intensive apples and hazels growing is necessary to carry out the following hydro and/or agromelioration measures, individually or in combination: drainage, irrigation, deep tillage, subsoiling, calcification, humization and ameliorative fertilization. The relief can be corrected by contour tillage or terracing.

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