

AGRICULTURAL LAND OF ISLAND RAB AND HOW TO PRESERVE IT ?

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Abstract

The objective of this paper was performed evaluating the quality of agricultural land of the island of Rab in order to contribute to better use and prevent from conversion to non-agricultural purposes. Land quality is defined by the parameters of soil, climate and terrain and was determined by the standards of Croatian legislation (N.N. 53/10). Based on the results of soil research, climatological data and terrain parameters generated from the 3 D terrain model, and using the GIS system has made Map of the land quality categories of island Rab. The above mentioned analysis showed that the largest area, 239 ha of total 543 ha, occupying P2 categories (valuable arable land), the P3 (other arable land) 123 ha, complex categorie (P2/P3) 150 ha and other agricultural land only 31 ha. Agricultural land is characterized by fragmentation, depravation of property (overgrown by weeds and forestry) and lack of irrigation systems. Studies have shown that the land of the island of Rab with its quality, diversity and area is great potential for agricultural development, but in organizational and technological terms it is necessary to remove these constraints and to protect it from key risk – the conversion to non-production purposes. The project has created an expert basis for the protection of agricultural land and the results can be used to support local farmers and decision makers in managing the resources of the island of Rab.

Key words: *agriculture, land quality, Rab, GIS*

Introduction

Agricultural production of the island of Rab, like the most of the Adriatic islands, is characterized by fragmentation, split into small fractions, abandoned of holdings and lack of irrigation systems. Agricultural land defined by spatial Plan of Rab (2004) occupies 543 hectares. In addition to traditional agricultural crops: vineyards, olive groves, fruit orchards and vegetable gardens, a large proportion of the area is not being cultivated. The overall condition of the soil arrangement and agricultural production is low with the ongoing trend of the reduction of agricultural land, as well as the increasing trend of the forest and unproductive land. The project has created an expert basis for better use and protection valuable agricultural land from conversion to non-production purposes and the results can be used to support local farmers and decision makers in managing the land resources of the island of Rab.

Material and methods

Preliminary work involved the analysis of soil, geology, climate, vegetation, land use data, spatial planning documents, legislative regulation and acquisition of cartographic base. During the field research was opened and described a total of 33 soil profiles from which 78 samples were taken for laboratory analysis of the physical and chemical properties. Spatial

delineation of different soil types, was performed using Basic Croatian map 1:5000 (HOH), Digital Orthophoto Maps 1:5000 (DOF) and GPS device. On the collected soil samples were carried out standard laboratory analysis, including: pH (ISO 10390:2004), EC (ISO 11265:2004), CaCO₃ (ISO 10693:2004), CaO - Drouinou Galette method, humus content - Kotzman method, K₂O and P₂O₅ - Al method and textural wet sieving and sedimentation after disaggregation in Na-pyrophosphate (ISO 11277:2004). Soil map and Map of Land quality categories in scale 1:25.000 were prepared using the software package ArcView 3.1. and ArcGIS 10.0. All spatial data were geocoded in the national coordinate system (5 Gauss zone and - Mercator projection).

Morphometric analysis of the terrain involved the calculation of the inclination and aspect based on a digital elevation model (DEM). Digital elevation model is raster grid structure, cell size 5 meters interpolated from contour lines and height points of the topographic map 1: 5000. Assessment of the quality of the agricultural land (Q) was made, in accordance with the Croatian regulation (N.N. 53/10), by the formula: $Q = \sqrt{S \times Cl \times R}$, where:

S - soil, Cl - climate and R – relief.

Quality of the soil (S) was determined on the basis of the soil development stage, texture and geological origin (parent material) and valuated from 7 to 100 points. The basis for determination of the land quality categories is Soil map. Quality of the climate (Cl) is valuated with 1 to 10 points. According to the Regulation (N.N. 53/10) the climate of island of Rab is defined with 5-6 points. Quality of the relief (R) is defined according to the classification of the terrain slope and valuated with 1 to 10 points. Classifying of the land quality categories was made as follows:

P1 - Especially valuable arable land 80-100 points.

P2 - Valuable arable land 60-79 points

P3 - Other arable land 40-59 points.

PŠ - Other agricultural land 7-39 points.

Results and discussion

Soil classification and properties

The results of field, laboratory and cameral analysis has shown great soil diversity that is reflected in the presence of different soil types and variability of their properties. Key factors for soil properties variability are: geological, geomorphological and hydrological conditions and man impact. According to the Basic geological map of the Croatia 1:100.000 (Mamužić, P. et al. 1966) investigated area build Tertiary and Quaternary deposits, and Mesozoic limestones with dolomite occupy a very small area. In the hypsometrically lower positions and flattened Flysch sediments are covered by Quaternary sediments, mainly sands. Quaternary sediments are well developed and consist of flysch slope deposits, eolian sands and deluvial gravel deposits to weakly related breccias. In the eolian sands, transferred with the wind from the Alps in the interglacials (Riss-Wirm) dominates quartz (79-90%). The thickness of these sandy layers varies from a few decimetres to several meters. They are often mixed with the flysch slope deposits. Granulometrical Quaternary colluvial deposits are poorly sorted gravels and associated breccias sized debris up to 8 mm. CaCO₃ varies from 55 to 90%. Based on field and laboratory research, and according to actual soil classification (Škoric, A et al 1985), soils are classified as follows:

- Automorphic anthropogenic soil (Rigosols) formed on:
 - Gravel and breccias
 - Flysch sediments and eolian sand
- Hydromorphic anthropogenic soil (Rigosols) formed on:

- Pseudogley and pseudogley-gley soil on the Eolian sand and Flysch sediments
- Halomorph soil

Rigosols on the gravel and breccia

Colluvial deposits, have a high percentage (72.3) of limestone fragments - skeleton (particle size > 2 mm) and 27.7% of the soil particles (particles < 2 mm). They are classified as gravels, because the greatest portion of particles measuring 2-4 mm (average 33.9%) and 4-8 mm (average 29.5%). According to granulometric composition of the soil samples analyzed (particles < 2 mm) were classified as loamy sands, sandy loam and sandy clay loam. These soils are structureless, mealy consistency, extensive permeability, low water retention and high air capacity. The depth at which hardened gravel (breccia) occurs varies and defines their basic properties and suitability for use in agriculture. The soils on the colluvial deposits are predominantly deep, because the breccia occurs deeper than 100 cm. These soils are alkaline and strongly alkaline reaction (pH in water, ranging from 7.52 to 8.91), the variable total carbonate content ranging from 33.2 to 87.6% CaCO₃ and the low active lime (CaO) 1.78 to 4.67 %. Topsoil humus content is medium, average 3.92%. Physiologically active potassium are well stocked, with marked variations in the range from 19.6 to 145.1mg K₂O/100gr. soil. Plants accessible phosphorus ranged between 1.1 to 8.9 mg P₂O₅/100gr.

Rigosols on the Flysch sediments and Eolian sand

Basic characteristics of these soils are in close connection with the geological structure and terrain physiography. According to the mechanical composition this soils are clay loam texture and poorly developed structure. These are very alkaline and alkaline soils, with variable content of total carbonate (CaCO₃ 7.4 to 28.0%). Humus content in the soil is low. Physiologically active phosphorus ranging from poor to good amount. These soils are moderately to well stocked with physiologically active potassium.

Rigosols formed on the pseudogley and pseudogley-gley soil on the Eolian sand and Flysch sediments

These soils are characterized by Pg-Cg, P-EG-Bg-Cg or P-EG-BG-G morphogenetical soil profile structure. Signs of gleying are pronounced in soils of central, the lowest parts of the field, exposed to prolonged excessive wetting. These soils are sandy loam to silty clay loam texture and low grade structure, weakly calcareous, and slightly alkaline reaction. Humus content in the topsoil and subsoil horizons is low and very low, respectively. The supply of soil with the physiologically active phosphorus is medium and potassium good.

Halomorph soil

Halomorph soil are undeveloped, structureless, sandy clay loam soils located in the lowest terrain along the coast in the intertidal zone. Electrical conductivity (EC), measured in a suspension of soil and water in the ratio 1:5, ranging from 4.63 to 6.48 dS/m, which indicates the high salt content. These chemical properties and high sea level make them unsuitable for any agricultural production.

Spatial distribution of soil

The spatial distribution of different soils is shown on the soil map M = 1:25.000 which was allocated to the six mapping units. The largest area occupied automorphic anthropogenic soil (304 ha), which includes the Rigosols on the gravel and breccias (100 ha), and the Rigosols on the flysch slope deposits and eolian sand (204 ha). Hydromorphic anthropogenic soil on eolian sand and Flysch sediments formed on the pseudogley and pseudogley-gley soils occupy 239 hectares and is located on the lower, flattened parts - the fields and valleys. Halomorph soil occupy 15 ha and they are located in the zone of influence of the sea - the

tides. Since the mapping unit are pedosystematic homogeneous, land quality evaluation was done within mapping units using relief parameters.

Climate

According to W. Köppen climatic classification (Köppen, W. 1936) of island of Rab has a moderately warm and humid climate with hot summers (Cfa). According to the data of the meteorological station of Rab for the period 1989-2010. mean annual air temperature is 15.6 °C, and the average amount of annual rainfall is 1087.1 mm. Precipitation regime is maritime, which means that the warm part of the year is relatively arid, especially the summer months, while more precipitation falls in the winter months. Climate of the island of Rab was valuated with 6 points according to the Regulation (N.N.53/10).

Relief

Terrain analysis included the calculation and making maps of the slope and aspect. The percentage share of each category of inclination and aspect is shown in Tables 1 and 2.

Table 1: Percentage of the inclination of the analyzed area

Inclination (degrees)	0-2	2-6	6-9	9-12	12-17	17-24	24-33	>33
Percentage	35,7	30,3	16,7	8,8	6,1	2,2	0,4	0,001

Table 2: Percentage of aspect of the analyzed area

Aspect	straight	N	NE	E	SE	S	SW	W	NW
Percentage	18,5	2,5	6,8	1,4	3,2	6,8	35,3	18,8	6,6

Tables 1. and 2. shows a great variety of inclination and aspect with dominant landforms with gentle slope and warm southwestern and western aspect.

Quality categories of the agricultural land

Results of the investigation are shown in Map of the quality categories of the agricultural land (Figure 1) and Table 3.

Table 3. Quality categories of agricultural land

Quality categories	Description of the quality categories of the agricultural land	Area (ha)
P2	Valuable arable land	239
P2/P3	Valuable arable land/ Other arable land	150
P3	Other arable land	123
PŠ	Other agricultural land	31
Total area		543

P2 quality category includes deep, sandy and clay loam soils, low carbonate and soil humus content formed on Eolian sand Flysch sediments, occupying flattened terrain, incline to 6°.

P3 quality category includes medium deep soils with a slope greater than 6° and / or deep soil formed on the colluvial gravel deposits.

P2/P3 quality category was singled out as the complex due to the map scale limitations, composed of the P2 category, which occupies 68.7% and P3 which occupies 31.3% of the investigated area. P2 quality land category includes deep, sandy loam and clay loam soils in the predominantly flattened slopes, coves and wellies. Capability category P3 of land are designated terraced, medium deep and deep, loamy and clay loam Rigosols formed on the steeper terrain.

PŠ quality category occupies steeper and terraced terrains with shallow soils overgrown with the various forms and stages of forest succession, especially Aleppo pine. Halomorphic soils are unfavorable for use in agriculture and therefore not evaluated.

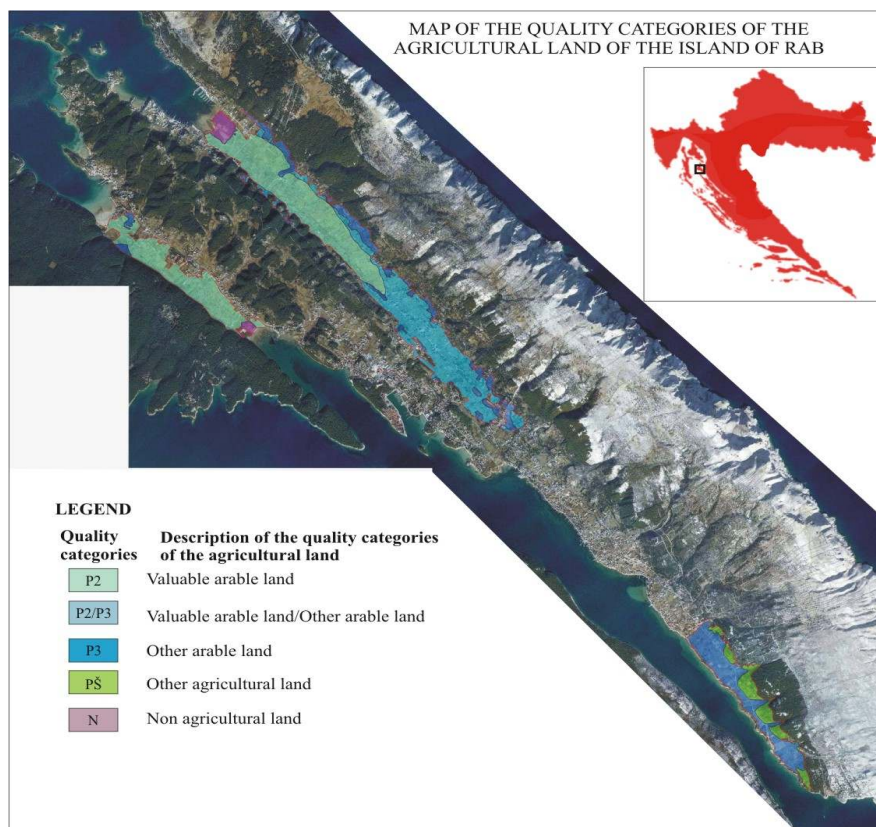


Figure 1. Map of the quality categories of the agricultural land of the island of Rab

Conclusion

Our research has shown (Table 3) that the largest area occupies quality category P2 (valuable arable land) and complex land category P2/P3 (valuable arable land in combination with other arable lands). Category P3 (other arable land) occupies 123 ha while other agricultural land (category PŠ) have the smallest share (31 ha). Above shows that the favorable natural conditions, especially the diversity and soil fertility are great potential for organizing a variety of agriculture. Since the land quality was assessed at the general level, it can only serve as a framework, while for each specific use should make a special suitability evaluation. In order to improve agricultural production, it is necessary to:

- Make regionalization of agricultural land for cultivation of the domesticated crops
- Monitor the state of the soil fertility
- Build a Soil information system
- Providing professional assistance to individual farmers
- Spatial planning to protect valuable agricultural land from conversion to non-agricultural purposes

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