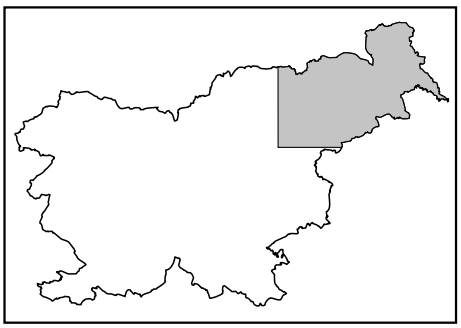
REGIONAL ECOLOGICAL UNITS OF NORTHEASTERN SLOVENIA

POKRAJINSKO EKOLOŠKE ENOTE SEVEROVZHODNE SLOVENIJE

Ana Vovk

Shallow soils in abandoned gravel pits are very sensitive to anthropogenic encroachment – Starošince na Dravskem polju (photograph A. Vovk).
Plitve prsti v opuščenih gramoznicah so zelo občutljive na antropogene posege – Starošince na Dravskem polju (fotografija A. Vovk).



Abstract UDC: 911.5(497.4-18)

Regional Ecological Units of Northeastern Slovenia

Regional ecological units are parts of the geosphere with similar lithological, relief, climate, water, and vegetation characteristics and similar soils. Differential analysis of individual regional elements enables the partition of the landscape into homogenous regional ecological units. In northeastern Slovenia, six different regional ecological units have been defined that differ according to their natural structure and the consequences of anthropogenic encroachment.

Izvleček UDC: 911.5(497.4-18)

Pokrajinsko ekološke enote severovzhodne Slovenije

Pokrajinsko ekološke enote so del geosfere s podobnimi litološkimi, reliefnimi, klimatskimi, vodnimi in vegetacijskimi značilnostmi ter podobnimi prstmi. Diferencialna analiza posameznih pokrajinskih sestavin omogoča členitev pokrajine na homogene – pokrajinsko ekološke enote. V severovzhodni Sloveniji je opredeljenih šest različnih pokrajinsko ekoloških enot, ki se razlikujejo glede na naravno sestavo in posledično antropogene posege.

Address – Naslov
dr. Ana Vovk
Faculty of Education, University of Maribor
Koroška cesta 160
2000 Maribor
Slovenia
Telefon: +386 62 225 611
Fax: +368 62 28 180
E-mail: ana.vovk@uni-mb.si

Contents – Vsebina

1. Introduction

The aim of the study entitled "Regional Ecological Units of Northeastern Slovenia" is to partition northeastern Slovenia (in test areas) into homogenous units and to determine their quantitative and qualitative features (lithological, relief, climate, aquatic, vegetation, and soil characteristics) and the harmony of land use with abiotic and biotic elements reflected in current vegetation and land use. I start with the supposition that land use is not always in harmony with the abiotic and biotic elements of a region that jointly form characteristic homogeneous units, and as a result the region is degraded in many places, a fact also reflected in the quality of the soil.
Regional ecological studies were carried out in seven test areas in northeastern Slovenia that represent the macroregions of subpannonian and subalpine northeastern Slovenia. Map 1 shows the site of the test areas in northeastern Slovenia.
The total size of the test areas is 491 km^2 (Table 1), average altitude is 400 m (the lowest absolute altitude is 175 m in the Prekmurje Plain and the highest is 978 m in the Bočko hribovje region), and the average slope is between 5° and 10°.

TABLE 1: SURFACE OF TEST AREAS.
PREGLEDNICA 1: POVRŠINA TESTNIH OBMOČIJ.

area	surface area km^2
1. Dravinjske gorice	79
2. Bočko hribovje	13
3. Dravsko polje	113
4. Southeastern Pohorje	20
5. Western Slovenske gorice	133
6. Prekmurje Plain	81
7. Southern Goričko	52
total	491

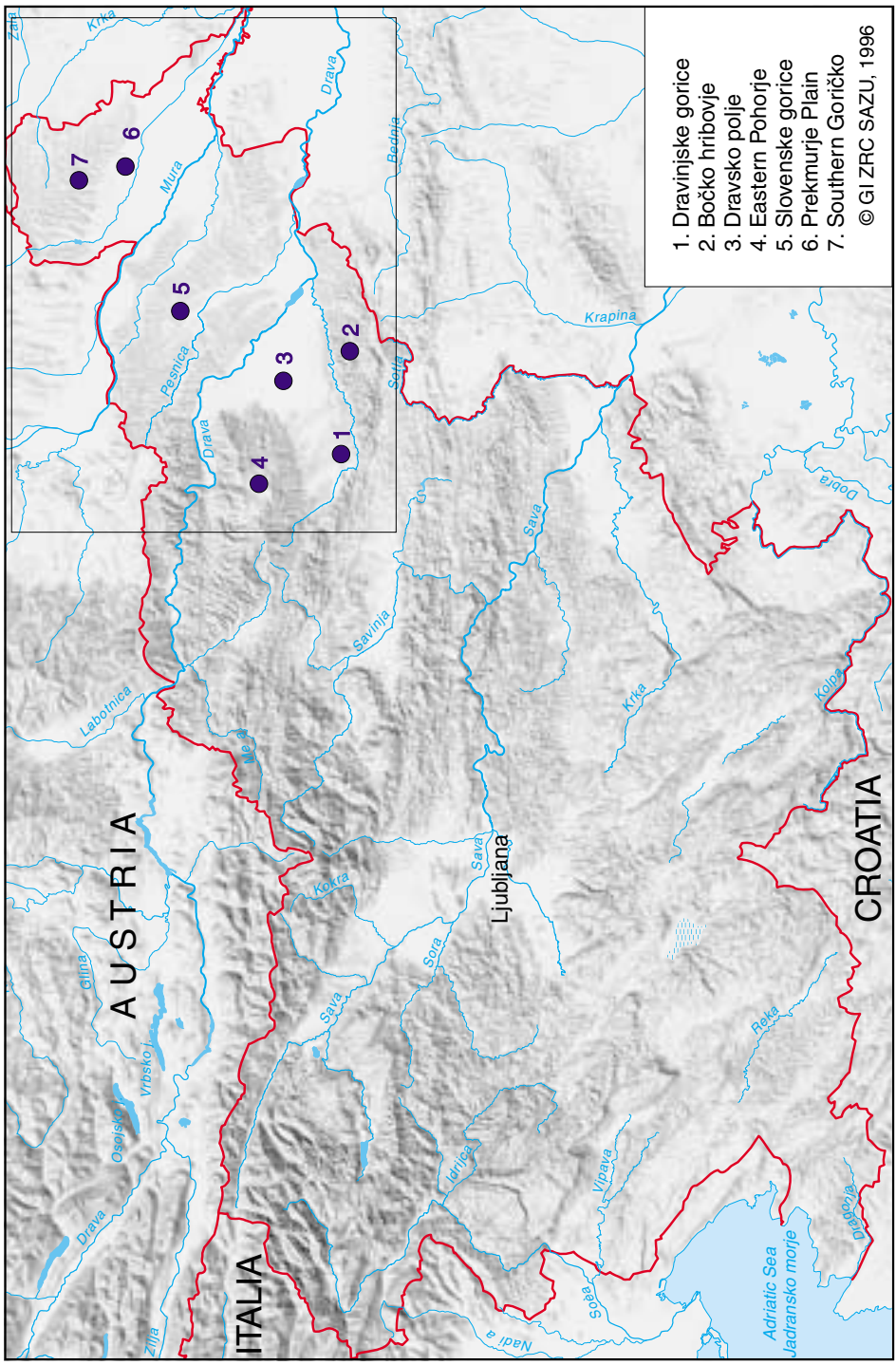
Relative to relief, the test areas include flood plains along rivers and streams, Pleistocene and Holocene terraces, hills, and mountains. The selected areas partly cover Dravinjske gorice across the Dravinja Valley and proceed to the Bočko hribovje region, Eastern Pohorje to Dravsko polje, and Southern Goričko to the Prekmurje Plain. Only Slovenske gorice is a unit as a test area.
The boundaries of the test areas do not follow recognized regional boundaries but are determined rather by the size of the 1 : 25.000 scale topographical maps.

2. Methods in Regional Ecology

Concepts of the Study

1. To gather data in particular on natural geographical parameters for regional partition according to the bibliography and in the field.
2. To analyze the gathered data in the laboratory to quantitatively establish degrees of connection (correlation) between natural regional elements and land use by means of contingency tables (Perko, 1987).
3. To link parameters overall and to establish from synthesis correlations for the represented combinations of region-forming elements (homogeneous units) and the essential characteristics and processes within them.
4. To isolate the dominant parameters in homogeneous units that define regional differentiation.
5. To present existing land use according to the characteristics of homogeneous units that determine the distribution, size, and type of land categories.

Figire 1: Locations of test areas in northeastern Slovenia.
Slika 1: Lega vzorčnih območij v severovzhodni Sloveniji.



2.1. Applied Regional Ecological Partition

By partitioning test regions into homogeneous units, we get an insight into local ecological laws. The bases for regional ecological partition are geological and pedological maps, 1 : 25,000 scale forestry maps, and 1 : 17,500 scale aerial photographs. Field and lab analysis data on samples of soil and sediments are also an important source of information. By combining data on the proportion of water, volume of pores and matter in the soil, cation exchange capacity, field water capacity, and porousness for water, we get an insight into the complicated and complex natural system.
The smallest homogeneous units are "ecotopes". Similar ecotopes combine into ecotope groups, and similar ecotope groups into regional ecological units. A regional ecological unit (REU) is therefore a part of the geosphere with similar lithological, relief, climate, water, and vegetational characteristics and similar soil characteristics. Ecotope groups have the same lithological parent material, type of soil, and similar relief conditions but differ according to land use and vegetation. The 1 : 25,000 scale ecotopes are the smallest homogeneous parts of a region characterized by the same lithological parent material, height above sea level, exposure, slope, climate and aquatic conditions, type of soil, vegetation, and use of soil.

2.2. Parameters For Applied Regional Ecological Partition

Differential analysis of individual regional elements allow the partition of a region into homogeneous units. Individual regional elements are presented in thematic maps, and according to its content, their structure is clear from descriptions in already elaborated maps and the results of field work. Complex topological synthesis serves to link all the parameters in a particular section of a particular region into a whole. The following parameters are considered:

a) Lithological Parent material

Geological maps show, with respect to their ecological value, the properties and spatial extent of individual lithological units. This defines the borders of lithological units according to water porousness, presence of carbonates, speed of weathering, and the formation of minerals important for the formation of soil. Surface and underground circulation of water is just as strongly linked to the lithological parent material.

b) Relief

Quantitative data on altitude, slope, and exposure are acquired from 1 : 25,000 scale topographical maps. Relief properties influence climate, water characteristics, soils, vegetation, and land use. Relief as a parameter for regional ecological partition divides a region according to the form of relief (origin, properties, and age), inclination of slopes (intensity of erosion), and exposure (differences in the speed of weathering between warm and cold sites).

c) Climate conditions

Climate conditions are considered for a 30-year period (1961–1990) on the basis of climate data from meteorological stations in Slovenia (Table 2). The following climate elements were considered:

TABLE 2: CONSIDERED METEOROLOGICAL STATIONS.
PREGLEDNICA 2: UPOŠEVANE METEOROLOŠKE POSTAJE.

meteorologica stations	relative altitude in m	absolute altitude in m
Murska Sobota	0	178
Mestni Vrh	62	332
Rogaška Slatina	0	235
Starše	0	241
Pragersko	0	251
Maribor	0	275
Veliki Dolenci	58	308
Slovenske Konjice	0	332
Zgornja Ščavnica	75	358

Temperatures
- average air temperature by month, year, and vegetation period
- average maximum temperature by month, year, and vegetation period
- average minimum temperature by month, year, and vegetation period
- number of days in year with minimum temperature –10 °C
- number of days in year with maximum temperature +30 °C

Precipitation
- quantity of precipitation by month, year, and vegetation period
- number of days in year with more than 20.0 mm
- number of days in year with fog

d) Evapotranspiration and water balance (classification of climate according to C. W. Thornthwaite)
It is clear from the ratio between evaporation and the amount of precipitation whether a climate is dry or humid. The amount of potential evapotranspiration is an important factor calculated using temperature and precipitation. To establish the water balance of a region, the corrected potential evapotranspiration is considered in relation to the total sum of precipitation and periods with shortages and surpluses of water are calculated.
The classification of climate according to C. W. Thornthwaite is based on a combination of letters representing values for data on the moistness of the ground, the moistness of soil according to season, a warmth index, and a warmth index for the summer months. From the curves in the diagram of water balance, the moistness condition of the soil is evident according to time duration and the amount of the surplus or shortage of water.

e) Soils (the dominant parameter in regional ecological partition)
As a basis, 1 : 25,000 scale pedological maps with pertinent keys and descriptions were used as well as publications of studies and data in any way referring to the soils of the test areas. Because the pedological (as well as other) maps are generalized, eighty-three profiles were excavated or drilled. For the interpretation of physical and chemical properties, the FAO-UNESCO classification of soils employed in Slovenia was used.
According to the Slovene classification (*Seznam pedosistematskih enot*, 1994), the following classes and types of soil occur in the framework of the division of automorphic and hydromorphic soils in the test areas:
Automorphic soils formed under the influence of precipitation water passing unobstructed through the ground profile.

Class: HUMUS ACCUMULATIVE SOIL A-C
Type: Rendzina A-AC-C
Type: Ranker A-C
Class: CAMBIC SOILS A-(B)-C
Type: Eutric soils A-(B)v-C
Type: Dystric soils A-(B)v-C
Type: Brown terra fusca soils A-(B)rz-C
Class: ANTHROPOGENIC SOILS P-C
Type of soil: Plowed soils P-C

Hydromorphic soils periodically or permanently moist due to the influence of surface, flood, or ground water.
Class: RIVERBANK SOILS A-C
Type: Riverbank soils A-C
Class: PSEUDOGLEYIC SOILS A-Eg-Bg-C
Type: Pseudogley A-Eg-Bg-C
Class: GLEYIC SOILS A-G
Types: hypogley A-Go-Gr, epigley A-Gr-Go, amfigley A-Gr
Class: ANTHROPOGENIC HYDROAMELIORATED SOILS P-G
Type: Hydroameliorated soils P-Go

f) Vegetation

• existing vegetation

In regional ecological partition, existing or current vegetation plays an important role, which is in many places replaced by the prevailing land category. Individual plants are important as indicators of ecological conditions. Vegetation is also understood as a pedogenetic factor because it influences the physical properties of the soil by increasing porousness with its root system and protects the soils from erosion. Vegetation influences chemical processes in the soil through dried debris which later develops into humus and directly forms organic material in the soil which is shown in the distinct green colour of individual horizons. Vegetation associations mitigate temperature oscillations in the soils which also effect the course of physical, chemical, and biological processes on the surface and in the ground.

Vegetation is roughly determined by climate and lithological parent material, and only areas with great variations in altitude partition into vegetation zones. In the test areas, we can only talk about zonal vegetation in Bočko hribovje, because elsewhere relief, especially microrelief, the lithological parent material, and human influence play a more significant role.

Only rare areas in northeastern Slovenia are overgrown with natural vegetation. Surfaces of anthropogenic use (cultivated fields, meadows, vineyards, and orchards) are frequent. The forested surfaces shown on the forestry maps are limited only to sites that are of no interest for cultivation or to areas that are not cultivated due to human reasons.

• prevailing land use

Categories of land use, their surface areas, and their proportion relative to total land use were taken from 1 : 17,500 scale aerial photographs. The following categories were considered: cultivated fields (ameliorated and unameliorated), meadows, forests, vineyards, built-up areas (settled, industrial, and traffic), and infertile (waters, gravel pits, quarries).

The existing use of soil has been studied for the period from 1990 to 1994, when the aerial photography of northeastern Slovenia was done.

3. Field Work

3.1. Sites of Pedological Profiles and Sampling of Soil and Sediments

The sites of pedological profiles excavated with a spade or bored with a drill are representative and complement the data from otherwise generalized pedological maps. The soil samples taken, including the parent material, were analyzed in the laboratory of the Geographical Institute in Vienna and in Physical Geographical Laboratory of the Faculty of Arts in Ljubljana. In the field, the depth of the profiles or depth of the horizons was read and data collected on land use and vegetation. Photographs of the profiles and immediate landscape provide additional information on the test areas. Samples from pedological pits were taken with a pedological bore (Dutch probe following Pürckhauer) from each horizon, including the lithological parent material, at every twenty-five centimeters. The average depth of the pedological pits was 70 cm, and 100 cm for bored profiles.

The schematic representations mark the sites of the pedological profiles and the course of the regional ecological profiles (REP). The site of an individual profile was chosen according to changes in natural and human factors. Figures 1–4 represent the orientation of regional ecological profiles (REP) and the sites of pedological profiles in the test areas.

Key:
REP – regional ecological profile, marked with /1, /2, /3
I, II, III, IV – marks of test areas:
I = Dravinjske gorice with Bočko hribovje,
II = Dravsko Polje with Eastern Pohorje,
III = Western Part of Slovenske gorice,
IV = Prekmurje Plain with Southern Goričko

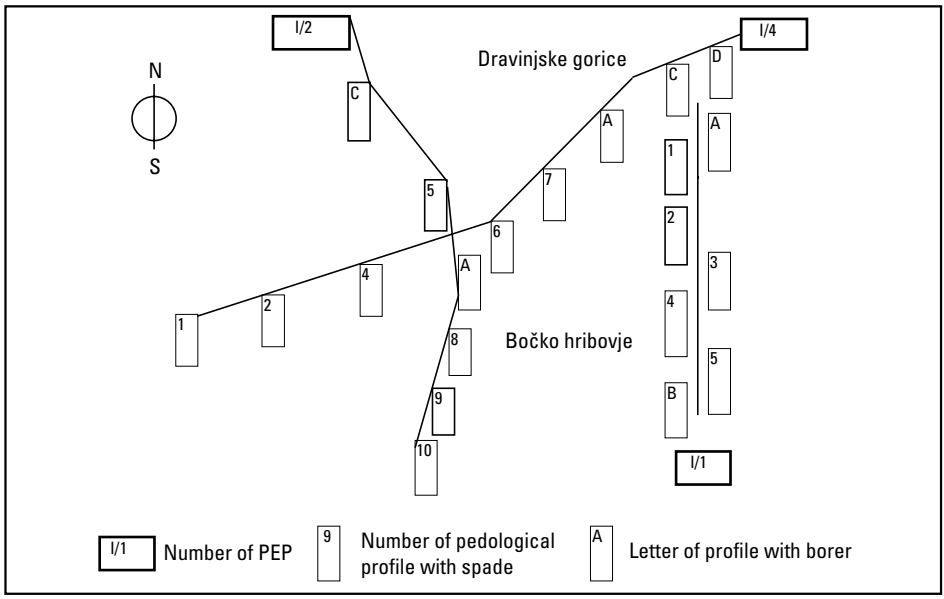


Figure 2: Site of pedological profiles and orientation of REP in Dravinjske gorice and Bočko hribovje.
Slika 2: Lega pedoloških profilov in smer PEP v Dravinjskih goricah in Bočkem hribovju.

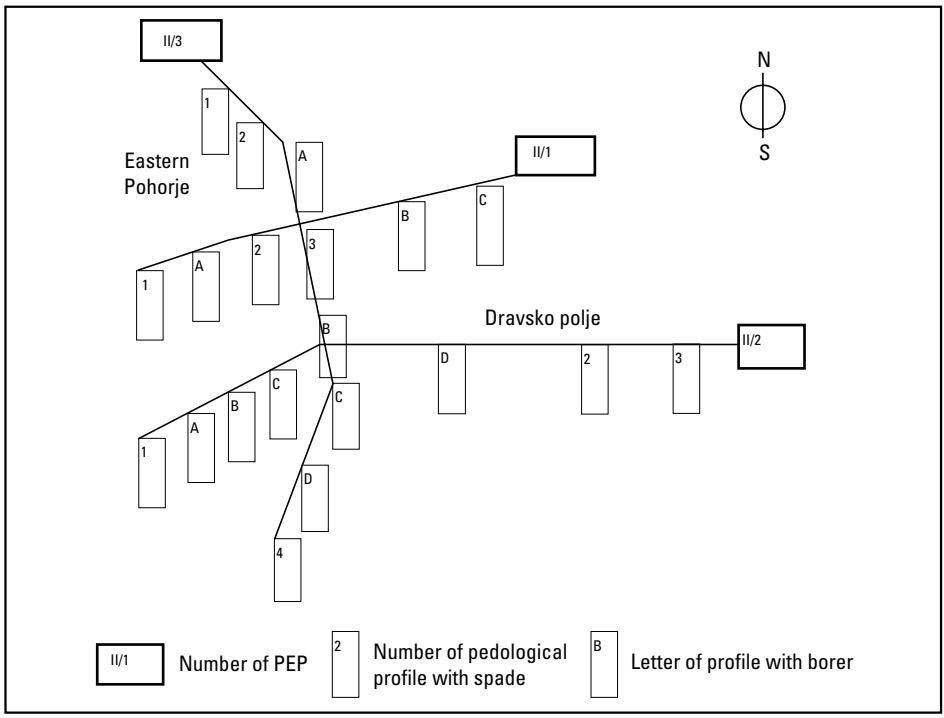


Figure 3: Site of pedological profiles and orientation of REU in Dravsko polje and Eastern Pohorje.
Slika 3: Lega pedoloških profilov in smer PEE na Dravskem polju in vzhodnem Pohorju.

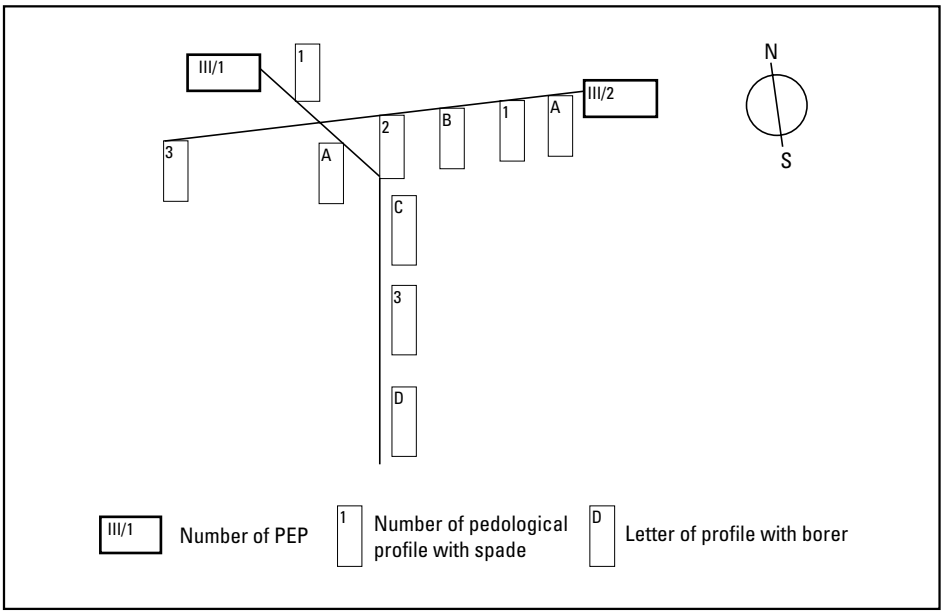


Figure 4: Site of pedological profiles and orientation of REU in the Western Part of Slovenske gorice.
Slika 4: Lega pedoloških profilov in smer PEE v zahodnem delu Slovenskih goric.

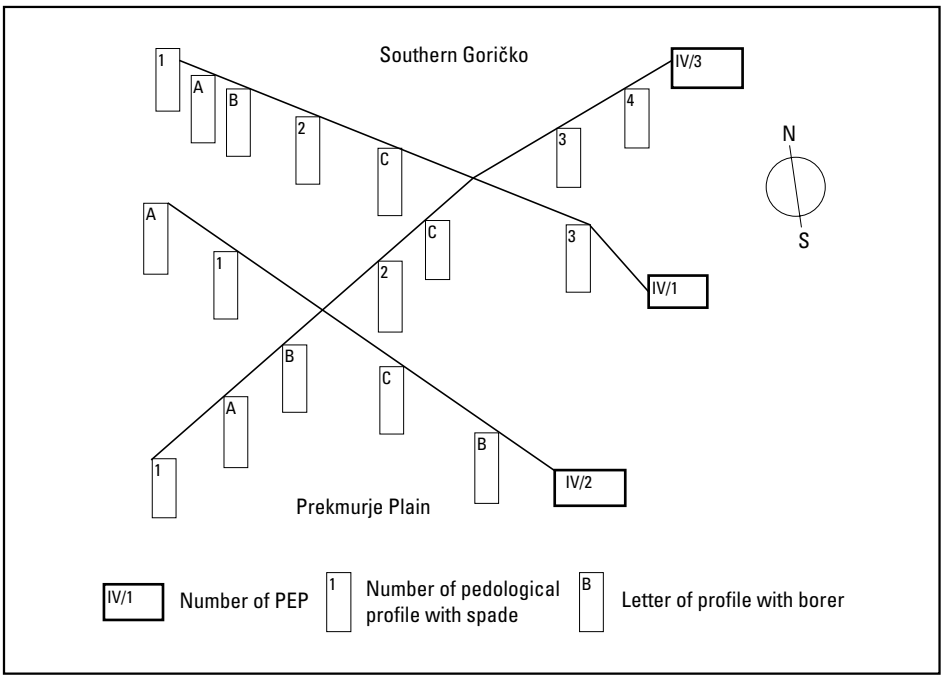


Figure 5: Site of pedological profiles and orientation of REP in the Prekmurje Plain and Southern Goričko.
Slika 5: Lega pedoloških profilov in smer PEP v Prekmurski ravnini in južnem Goričkem.

4. Laboratory Work (Physical and Chemical Properties of Soils)

The analysis of soil samples was performed according to the manuals *Laboratorijski priročnik za geografe* (Lovrenčak, 1979) and *Mehanische und Chemische Boden- und Sedimentanalyse* (Verginis, 1990). The following properties of the soils were considered:

a) Physical Analysis

- analysis of mechanical structure – texture (% of sand, % of silt, and % of clay)
- raw density and content of water Gs g/cm^3; V %, VV %
- pure density of sample Gč g/cm^3
- volume of air, water, and matter ZV, VV, SV in %
- maximum water capacity Vkmax V %, VV %
- porousness of sample for water Kf mm/sec $\cdot 10^{-3}$
- colour: Munsell Soil Color Chart at Vkmax

• ANALYSIS OF MECHANICAL STRUCTURE

Analysis of mechanical structure was done using a combined method using wet sieving and sampling according to Köhn.
Calculation of mechanical structure:
GP % = weight of remains on sieve, 0.0001g
DP % = 100 – (M + G), 0.0001 g
M % = difference between first sample and second sample, 0.0001 g
G % = second sample, 0.0001
Determination of texture: on the basis of the ascertained proportions of individual fractions, a sample is assigned to a texture class using a texture triangle according to international classification (Tommerup).

• RAW DENSITY OF SAMPLE AND WATER CONTENT IN SAMPLE – Gs, V %, VV %

Establishing the dry raw density is necessary for calculating the volume of the matter. Calculation of raw density:
Gsv = (c – b)/a
Gss = (d – b)/a
a – volume of Kopecki cylinder 100 cm^3
b – weight of empty cylinder, g
c – weight of moist field sample and cylinder, g
d – weight of sample dried at 105 °C and cylinder
Calculation of proportion and volume of water:
% V = (c – d)/(c – b) · 100
% VV = (c – d)/a · 100

• PURE DENSITY OF SAMPLE – Gč

Calculation of pure density:
Gč = (b – a)/(50 – c) in g/cm^3
a – weight of dry sample in measuring beaker in g
b – weight of empty measuring beaker in g
c – use of xylene in ml

• VOLUME OF MATTER – SV % AND PORES – PV % (AIR – ZV % AND WATER – VV %)

Calculation of volume of matter, pores, and air:
% SV = (Gss/Gč) · 100
% PV = 100 – % SV
% ZV = % PV – % VV
Gss – total density of dry sample
Gč – pure density

• MAXIMUM WATER CAPACITY – Vkmax
Calculation of maximum water capacity:
weight proportion: % V Vkmax = (a – b)/(b – c) · 100
volume proportion: % VV Vkmax = (a – b) · 100
a – weight of sample with cylinder at Vkmax
b – weight of dry sample with cylinder
c – weight of empty cylinder

Calculated Vkmax is the measure of the natural capability of soil to retain water, that is, of the field water capacity (PVK).
Calculation of PVK
Vkmax V % = weight proportion of water in water saturated sample
PVK = (V % · depth of horizon in mm) · 90%

• POROUSNESS OF SAMPLE FOR WATER – Kf
Kf – value shows the quantity of water that drains through a surface area of 1 cm^2 of porous material in one second.
$Kf = Q/(F \cdot t)$
Q – quantity of water used in ml
F – surface area of cylinder 25 cm^2
t – time taken in sec

Kf is expressed in ml of water used per sec or in cm drained per second. Sandy soils have the highest values of Kf, where water drains with a speed of 8 ml/sec · 10^{-3}, while due to their large specific surface sections that bind water, clay and silt soils have a porousness of 1 to 2 ml/sec · 10^{-3}. The most frequent porousness of samples from the test areas is in the area of 2 to 4 ml/sec · 10^{-3}.

• COLOUR OF SAMPLE
The Munsell Soil Color Chart is used to define the colours of soils.

b) Chemical Analysis
The following chemical analyses were performed:
• proportion of Calcium Carbonate – % $CaCO_3$
• proportion of organic matter – % of org. matter
• reaction – pH value
• cation exchange capacity – KIK, total of bases in absorptive part of soils – S, total of hydroxide ions – H in me/100 g, and saturation of absorptive portion of soils with bases – V %.

• PROPORTION OF CALCIUM CARBONATE – $CaCO_3$ %
Calculation of the proportion of Calcium Carbonate:
% $CaCO_3 = ((a \cdot b \cdot 2.274)/c) \cdot 100$
a – volume of loose CO_2
b – weight of 1 cm^3 of CO_2 at specific temperature and pressure. This is obtained from the table for calculating the weight of CO_2 (with the volumetric definition of $CaCO_3$) 2.274 – factor for calculation of CO_2 in $CaCO_3$
c – weight of sample

• PROPORTION OF ORGANIC MATTER – % of organic matter
Calculation of the proportion of organic matter:
% org. matter = ((b – c) / (b – a)) · 100
a – weight of empty, previously burned evaporating dish, 0.0001 g
b – weight of completely dry sample, 0.0001 g
c – weight of sample after burning at 600 °C, 0.0001 g

• REACTION OF SOIL – pH
The reaction or acidity of soil is the measure of the concentration of hydrogen ions. It is measured electrometrically by means of digital pH – meter. A solution of KCl is used because it allows the sim-

ulation of the natural conditions characteristic for agricultural soil in temperate humid areas (Grubner, 1990).

• CATION EXCHANGE CAPACITY – KIK
Analysis of KIK was performed according to the Melich method of rinsing the sample with $BaCl_2$.

Calculation of cation exchange capacity:
KIK = (0.97 · (a – b) · 10) / 116.7 me/100g
0.97 – factor for calculating $MgSO_4$
a – weight of evaporating dish and remains after 600 °C in mg
b – weight of empty evaporating dish in mg
116.7 – relative equivalent mass of $BaSO_4$
Calculation of quantity of hydroxide ions:
H = 0.2 · d · f(NaOH) · 10 me/100 g
0.2 – standard NaOH
d – titration difference between blind sample and actual sample
f – factor of dilution of NaOH

On the basis of known KIK and H, we also calculate S me/100 g and V %:
SUM OF BASES ON ABSORPTIVE PART OF SOILS:
S = KIK – H me/100 g
SATURATION OF ABSORPTIVE PART OF SOILS WITH BASES
V % = (S/KIK) · 100 V % < 50% = dystric soil V % > 50% = eutric soil

5. Water Conditions

Flowing surface waters, their characteristics and influence on the genesis of soils, as well as standing (natural and artificial) waters are presented in individual chapters according to test areas.
Above ground and underground circulation of water depends on the quantity of precipitation and the type of lithological parent material. The annual circulation of water in a certain area can be calculated as follows:
Q = Pmm – E – R
Q – total quantity of infiltrated water in m^3
Pmm – annual quantity of precipitation in a year in mm
U – annual evapotranspiration potential in mm
R – surface percolation of water in m^3
Every lithological unit has its own empirical infiltration coefficient. Carbonate stone such as limestone and dolomite (process of karstification) have the largest drainage, light sediments (sand, gravel) follow. Crystalline and metamorphic stone, flysch, sandstone, and metamorphic stone with high diagenesis (level of solidification) have the lowest infiltration values.
The results of studies show the existence of a strong connection between surface and subterranean circulation of water and morphological processes. Where R-values (surface discharge) are high (marl, gneiss), gradual, gently sloping relief forms are evident because of the processes of leaching of soil and erosion. On carbonate stone (limestone, dolomite) with small surface discharge, a strong subterranean percolation prevails and therefore various relief forms (karst) were created. This means that relief forms depend on above ground and under-ground circulation of water.
The origin of soils is closely connected with the circulation of water. Thick soils can only originate on parent material with a high R-value (little infiltration) because the processes of weathering enable the formation of horizons (B).
Vegetation and the use of soil also depend on the Q-value (infiltration) of the C-horizon and the Kf-value (porousness for water) of a specific soil. These two elements influence relief energy, exposure, altitude, type of soil, as well as anthropogenic processes related to gentle relief forms.

6. Regional Ecological Partition of Northeastern Slovenia

6.1. Definition of Regional Ecological Units

6.1.1. Dravinjske gorice

There are four REU in Dravinjske gorice that differ according to lithological parent material, relief site, and influence of underground water.

REU A is defined in flatland in the valley of the Dravinja River and along its tributaries at the altitude of 250–270 m where there are Holocene sandy loam and sandy clay alluvia originating in recent accumulation; where the influence of underground water is periodic, there are deeply gleyic and pseudogleyic soils, and riverbank soils with meadow use dominate.

For REU A as a whole, a sandy loam and sandy clay lithological parent material quite porous for water is characteristic. The altitude is 250–270 m; relief is level with a slope of 0°–2°. The average annual temperature is 9.5 °C, in the vegetation period 15.5 °C, average summer temperature is 18.1 °C, and average winter temperature is 0.4 °C. Annual precipitation is 1076 mm and surpasses annual potential evapotranspiration by 40.4%, and because a negative difference between the quantity of precipitation and the height of potential evapotranspiration does not appear in any month, an annual surplus of 406.4 mm of water occurs. Because there is no lack of water, the soil moisture index is high (63.3) and this denotes a humid climate.

Shallow riverbank soils, deeply gleyic hypogley and flatland pseudogley, differ according to the influence of underground and precipitation water. In shallow riverbank soils, water is not retained in the soil profile because of the presence in the soil of stones over 2 mm and the smaller proportion of clay fraction; therefore, the structure of the profile is A-C. In deeply gleyic hypogley, water is retained in the lower part of soil profile, usually below 50 cm, which does not directly hinder the growth of plants. The structure of the profile is A-Go. In flatland pseudogley, water is retained in the Bg horizon because of the larger proportion of clay, which as material striped from the surrounding mountains accumulates in the valleys. The structure of the pseudogley profile is A-Bg-C.

The predominant use of the soil is for meadows; cultivated fields are found in flood-safe areas along with built-up areas.

The prevailing meadow use in REU A is linked to the periodic flooding of the Dravinja River and consequentially with the shallow riverbank soils. Laboratory results showed that in the meadows the upper A horizon only reaches a depth of 20 cm (profile I/1-5) and that its texture is clay loam, non-carbonate, weakly acidic to alkaline, water porous, and poorly aired. It was determined that the riverbank soils in the Dravinja Valley covered by meadows (*Celoviti razvoj podeželja*, 1990) have their origin in texturally diverse river sediment, and are therefore silty loam and sandy loam horizons alternate in the soil profile. The relief is level but microdepressions and dead branches of the former river bed result in stagnant water. According to the findings of the cited study, riverbank soils are suitable for meadow vegetation. The physical and chemical properties of laboratory analyses of riverbank soils, as well as hypogleys and flatland pseudogleys, match previous findings from which the influence of underground water on the properties and development of the soil is evident.

Cultivated fields and built-up surface areas appear at the edge of the valley where the flatland gradually passes into the hilly world and the danger of flooding is reduced. Because the influence of underground water appears at the depth of 50 to 70 cm and the humus A horizon is 30 to 40 cm thick, the hypogleys are favourable for field use.

In silty loam colluvium at the edge of the Dravinja Valley, pseudogleys have developed that have a limited form of use because of the poor physical properties of the Bg horizon and are being overgrown by meadows and in some places by cultivated fields; trees cannot grow on pseudogleys due to the depth of their root systems. From the information on the properties of the REU A soils, we conclude that natural conditions allow the meadow use that dominates and that other land uses are poorly represented because of the dominant riverbank soils and the recent accumulation due to periodic flooding, which enables the limitation of REU A.

TABLE 3: LAND USE PROPORTIONS IN REU A.
PREGLEDNICA 3: DELEŽI RABE TAL V PEE A.

land use	proportion %
field	7
meadow	77
meadow/field	5
forest	3
built-up	8

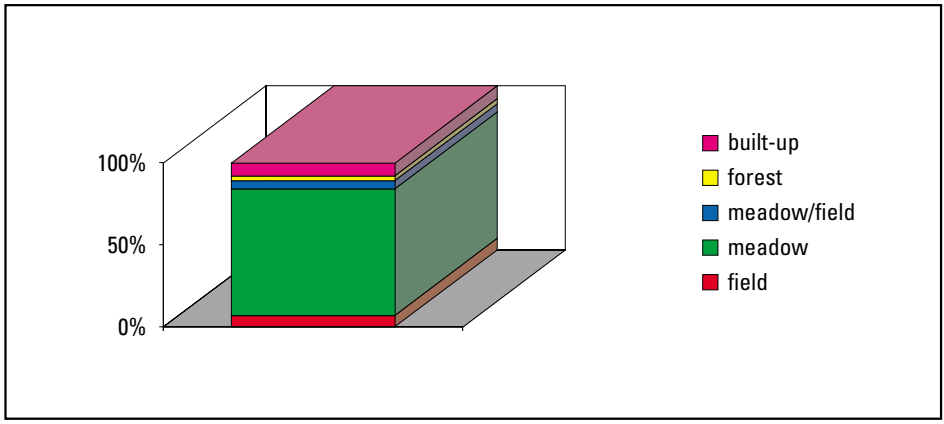


Figure 6: Land Use in REU A.
Slika 6: Raba tal v PEE A.

REU B is defined in flatland in the Ložnica Valley at the altitude of 250 m, where Pleistocene and Holocene silty loam and silty clay loam alluvia are found that result in regular standing water in the soil profile and the development of hydromorphic soils with processes of gleying.
REU B has silty clay and loam lithological parent material. Silt (fraction 0.002–0.0002 mm) has weak physical properties, cracking in drought and swelling in moist periods, and is not very porous for water. The average annual temperature is 9.4 °C, temperature in the vegetation period is 15.6 °C, average summer temperature is 18.4 °C, and average winter temperature is –0.2 °C. Because of its openness toward the east, toward Dravsko polje, subpannonian climate characteristics appear that are reflected in higher average temperatures in the summer and in the vegetation period and a lower quantity of precipitation. Annually, 1012 mm of precipitation fall, sufficient to cover the demands of evapotranspiration throughout the year. Thus, an annual surplus of 339.2 mm of water and a soil moisture index of 62.6 occur that according to Thornthwaite's climate classification signify a humid climate.
Amfigley and flatland pseudogley are under the influence of high underground water and the water retained in the soil profile. The porousness of the soil for water varies between 1.5 to 2 cm/sec · 10^{-3}, the least in comparison with the soils in other REU's. In amfigley, the reduction horizon is close to the ground surface, lessening the possibilities for cultivating the land. Therefore, the greater part of amfigleys in the Ložnica Valley were hydroameliorated, and where years ago there were swampy meadows there is a "large monoculture field" today. The structure of the soil profile is P-Go, where the depth of the plowed horizon is around 40 cm. The flatland pseudogley that covers the northeastern part of Dravinjske gorice has poor physical and chemical properties and is therefore covered with meadows; on the western edge of the Ložnica Valley is a protected *Carpinus betulus* (Lam.) forest with *Prunus padus* (L.) that passes toward the northeast into a common oak (*Quercus robur*) forest that is also protected.

TABLE 4: PROPORTIONS OF LAND USE IN REU B
PREGLEDNICA 4: DELEŽI RABE TAL V PEE B

land use	proportion %
field	20
meadow	35
forest	45

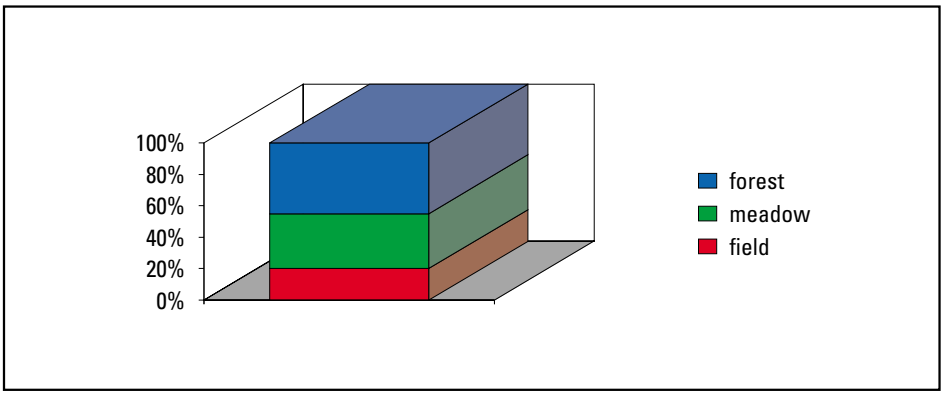


Figure 7: Land Use in REU B.
Slika 7: Raba tal v PEE B.

The prevailing forest use (an association of *Alnus glutinosa* (L.) and *Carex elongata* (L.), *Carpinus betulus* (Lam.) forest with *Prunus padus* (L.) and *Quercus robur* forest) was preserved because of the humid soils in the Ložnica watershed. Amfigley as the prevailing type of soil was partly ameliorated and devoted to field use. Laboratory results (profile I/4-C) from the ameliorated amfigley show that its physical properties have improved (particularly the ration between air and water in the pores) by drainage ditches up to 40 cm deep and that the plowed horizon is already followed by the oxidation of the Go horizon which is poorly porous, wet, and silty. Similar findings on the poor fertility of ameliorated amfigleys are found in Stepančič's commentary on the pedological map (1986). Because the prevailing type of soil is amfigley and because it has poor ecological conditions for plants to grow (and therefore for land use), swampy forests are still preserved here, giving the land with its limited REU B and the ameliorated cultivated fields a characteristic appearance. Wet meadows cover the flatland pseudogleys on the right bank of the Ložnica stream that differ from the meadows in REU A with less qualitative fodder.

Typical therefore of REU B are excessive soil moisture year round that is lithologically and climatically determined and hydroameliorated surface areas that are the result of the adaptation of man to the naturally unfavourable properties of the soil.

REU C is defined in relief dissected hills of marl at the altitude of 300 to 450 m where due to the poor porousness of marl for the underground percolation of water, strong denuding occurs. Dystric and eutric soils originating on marl are devoted to mixed field-meadow and forest use.

The properties of the region marked as REU C are determined by the marl lithological parent material of which the southernmost part of Dravinjske gorice is composed. In comparison with the rest of the hills, the relief forms are more distinct, altitudes reach from 300 to 450 m, the slope is 10° to 20°, pronounced southern and northern exposures dominate. Microclimatic conditions partly differ from the general climate situation. Southern sites receive more hours of sunlight and therefore grapevines are grown on larger surface areas, a fact also linked to the lithological parent material. In the south, Dravinjske gorice passes into Bočko hribovje where altitudes of 400 m are reached and in spite of the northwestern exposure, grapevines are grown. It is evident from the water balance for wider area of Dravinjske gorice that excessive amounts of water occur in the soil.

Along with plowed soils in larger compact surfaces, eutric and dystric brown soils are best represented. The texture is loam-clay, and field water capacity is relatively high totaling on average 142 mm. Saturation of the absorptive part of soil with bases is high in eutric soils (around 80%), while in dystric layers it never reaches 50% because of forest use or steep slopes. It is true in general that cation exchange capacity and saturation with bases increase with depth, which is on the one hand linked to the marl parent material and on the other with intensive processes of denuding on the surface soil which cause dealkalization and the leaching of basic cations (also due to the humid climate). The past and current land use is also an important factor.
Forest use is dominant followed by field-meadow use, and they alternate according to relief. acidophilic forest grows on steep and catchment area slopes, an indicator of the acidity of the habitat. Vineyards are of special importance, because they only appear in this REU on larger surface areas.

TABLE 5: PROPORTIONS OF LAND USE IN REU C.
PREGLEDNICA 5: DELEŽI RABE TAL V PEE C.

land use	proportion %
meadow/field	48
forest	50
vineyard	2

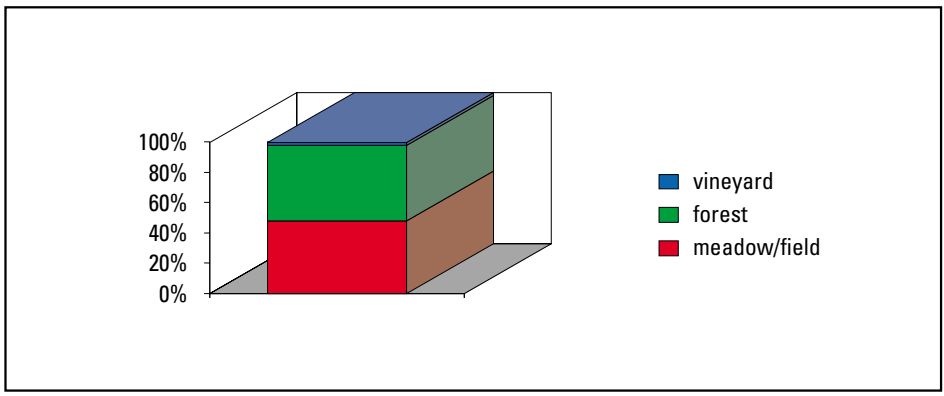


Figure 8: Land Use in REU C.
Slika 8: Raba tal v PEE C.

In spite of the dominant marl parent material which limits REU C, forest use prevails, followed by meadow-field use. Vineyards take up only 2% although the altitude exceeds 300 m of absolute height and the ridges incline toward the south. The reason is probably in the properties of the soils which according to the laboratory tests are leached out (profile I/2-9). The upper part of the profile is moderately acidic and up to 70 cm deep. Analysis of the data from the Ptuj pedological map shows that initial leaching of carbonates occurs in the dystric and eutric soils and that the A horizon is very acidic especially under the forest.

REU D is defined in gently dissected hills composed of Pleistocene loam mixed with gravel and sand. On the tops of ridges strong denuding occurs with colluvium at their feet. Because of the lack of resistance of the lithological parent material and the humid climate (periodic retained water in the soil profile), processes of pseudogleying occur in the soils.

The central part of Dravinjske gorice is designated REU D and has the most extensive surface area. The prevailing altitude is between 280 and 350 m, the relief is rounded, the slope varies from 5° to 20°, and because of the dissected ridges, all the categories of exposure are represented. The humid climate, the surplus of water in the soil, and the gentle relief forms enable periodic

pseudogleying, shown in the (B)v/g horizon in the larger proportion of clay and the poorer porousness for water.
On the tops of the ridges, gravel and sands are just beneath the surface, with a shallow A horizon that is acidic with minimum KIK and PVK.
In the transition of the hilly world into the valley, there are slope pseudogleys with a higher proportion of clay in the Bg horizon due to the accumulation of clay eroded from the tops of ridges. The intermediate Bg horizon is variously evident, and in some places an eluvial E horizon developed as well.
The prevailing land use is acidophilic and degraded beech forest with chestnut, while cultivated fields and meadows are located beside settlements on the higher sections of the slopes.

TABLE 6: PROPORTIONS OF LAND USE IN REU D.
PREGLEDNICA 6: DELEŽI RABE TAL V PEE D.

land use	proportion %
meadow/field	45
forest	55

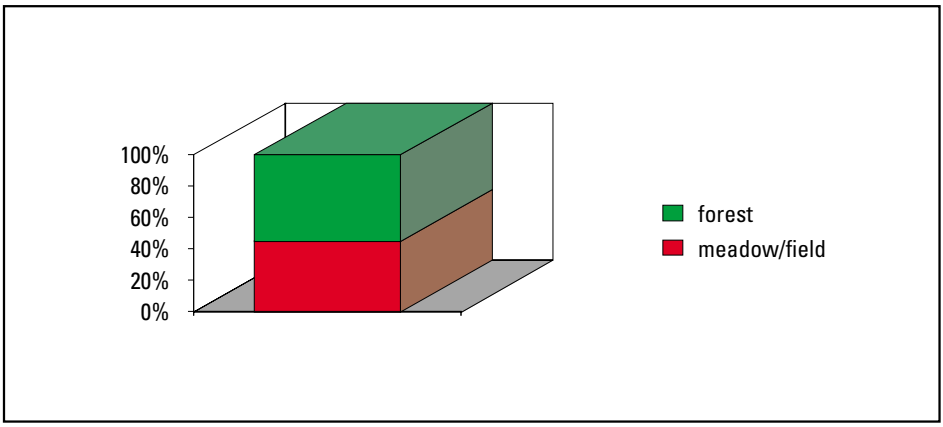


Figure 9: Land Use in REU D.
Slika 9: Raba tal v PEE D.

The prevailing land use in REU D is partly determined by the properties of the soils and partly by human factors. The laboratory results show that on the ridges of the central part of Dravinjske gorice, eutric rankers (profile I/4-7) dominate that are shallow and due to the sandy texture dry and very porous for water, which also corresponds to previous findings. Even though the above-mentioned study states that eutric rankers are agriculture ground, this is not true of Dravinjske gorice due to the dominance of forest use. The reasons for the forest use are probably not only the natural conditions but also the depopulation and remoteness from local centers that in the last five years has already changed with the economic strengthening of the central settlements.
The lower parts of Dravinjske gorice are composed of clays on which slope pseudogley developed that is devoted predominantly to field-meadow use yet is frequently overgrown by forest.
Below the determination and correlation coefficients are calculated with the aim of quantitatively (statistically) evaluating the connections between natural elements, the REU, and land use. Among the natural elements, the lithological parent material, relief forms, and the soils occurring in individual REU's are considered. For easier comparison, the four most frequent categories of land use are considered, that is, cultivated fields, meadows, mixed field and meadow use, and forest. Where vineyards, built-up areas, and larger unproductive areas appear, these are also considered.

CONNECTION OF NATURAL ELEMENTS AND REU'S WITH LAND USE IN DRAVINJSKE GORICE

TABLE 7: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 7: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	field	meadow	field/meadow	vineyard	forest
loam with sands	0.002	0.046	0.253	0.001	0.471
marl	0.004	0.006	0.042	0.64	0.004
Holocene alluvia	0.516	0.229	0.002	0	0.001
total	0.522	0.281	0.297	0.641	0.442

r^2 = 59.2% r = 0.769

TABLE 8: RELIEF FORMS AND LAND USE.
PREGLEDNICA 8: RELIEFNE OBLIKE IN RABA TAL.

relief forms	field	meadow	field/meadow	vineyard	forest
flood flatland	0	0.681	0	0	0
valleys	0.542	0.033	0	0	0.019
hills	0.013	0.003	0.29	0.322	0.233
total	0.555	0.777	0.29	0.322	0.252

r^2 = 56.8% r = 0.754

TABLE 9: SOILS AND LAND USE.
PREGLEDNICA 9: PRSTI IN RABA TAL.

type of soil	field	meadow	field/meadow	forest
eutric, dystric	0.013	0.027	0.027	0.027
brown pseudogley	0.001	0.086	0.346	0.009
pseudogley	0	0.073	0.033	0.402
riverbank	0.008	0.158	0.017	0.017
hypogley-ameliorated	0.800	0	0	0
total	0.822	0.345	0.423	0.455

r^2 = 34.8% r = 0.59

TABLE 10: REGIONAL ECOLOGICAL UNITS AND LAND USE.
PREGLEDNICA 10: POKRAJINSKO EKOLOŠKE ENOTE IN RABA TAL.

REU	field	meadow	field/meadow	vineyard	forest	built-up
A	0.035	0.542	0.001	0	0	0.001
B	0.107	0.090	0	0	0.054	0
C	0	0.030	0.184	0.067	0.181	0.060
D	0.002	0	0.058	0.003	0.465	0.013
total	0.144	0.662	0.243	0.070	0.70	0.074

r^2 = 29.8% r = 0.545

Selected examples of analyzed representative profiles inside individual ecotopes show the importance of complex topological analysis for the interpretation of a region. In the scope of individual test areas, one representative profile is presented for a characteristic ecotope of a test region.

Key for Dravinjske gorice

REU A is defined in flatland in the valley of the dravinja river and along its tributaries at the altitude of 250–270 m where there are holocene sandy loam and sandy clay alluvia originating in recent accumulation; where the influence of underground water is periodic, there are deeply gleyic and pseudogleyic soils, and riverbank soils with meadow use dominate.

EG A1: shallow riverbank soils beside running waters, non-gleyic on sandy loam alluvia
U $A1_1$ – meadows, periodically flooded on shallow riverbank soils
U $A1_2$ – cultivated fields on shallow riverbank soils
EG A2: hypogleys, deeply gleyic, at edges of valleys on sandy clay alluvia
U $A2_1$ – cultivated fields/meadows on hypogley
U $A2_2$ – meadows on hypogley
U $A2_3$ – built-up
EG A3: flatland pseudogleys on sandy clay alluvia
U $A3_1$ – cultivated fields, meadows on flatland pseudogley
U $A3_2$ – *Carpinus betulus* (Lam.) forest with Luzula luzuloides (Lam.) on flatland pseudogley
U $A3_3$ – built-up
U $A3_4$ – infertile

REU B is defined in flatland in the ložnica valley at the altitude of 250 m, where pleistocene and holocene silty loam and silty clay loam alluvia are found that result in regular standing water in the soil profile and the development of hydromorphic soils with processes of gleying.

EG B1: amfigley, on silty loam alluvia
U $B1_1$ – hydroameliorated cultivated fields on amfigley
U $B1_2$ – meadows on amfigley?
U $B1_3$ – *Alnus glutinosa* (L.) and *Carex elongata* (L.) forest on amfigley
U $B1_4$ – common oak (*Quercus robur*) forest on amfigley
EG B2: flatland pseudogley on silty clay loam alluvia
U $B2_1$ – meadows on flatland pseudogley
U $B2_2$ – *Carpinus betulus* (Lam.) forest with *Prunus padus* (L.) on flatland pseudogley

REU C is defined in relief dissected hills of marl at the altitude of 300 to 450 m where due to the poor porousness of marl for the underground percolation of water, strong denuding occurs. dystric and eutric soils originating on marl are devoted to mixed field-meadow and forest use.

EG C1 – plowed soils on steep slopes on marl
U $C1_1$ – vineyard on plowed soils
EG C2 – dystric brown soils on sandy marl, on ridges and tops of ridges
U $C2_1$ – field-meadow use and scattered settling on dystric brown soils
U $C2_2$ – *Carpinus betulus* (Lam.) forest with *Luzula luzuloides* (Lam.) on dystric brown soils
U $C2_3$ – beech forest with chestnut on dystric brown soils
EG C3 – eutric brown soils on clay marl at foot of slopes, colluvial
U $C3_1$ – field-meadow use on eutric brown soils
U $C3_2$ – beech forest with *Hacquettia epipactis* (Scop.) on eutric brown soils
U $C3_3$ – *Carpinus betulus* (Lam.) and *Luzula luzuloides* (Lam.) forest on eutric brown soils
U $C3_4$ – beech forest with chestnut on eutric brown soils
U $C3_5$ – common oak (*Quercus robur*) and *Carpinus betulus* (Lam.) forest on eutric brown soils

REU D is defined in gently dissected hills composed of pleistocene loam mixed with gravel and sand. on the tops of ridges strong denuding occurs with colluvium at their feet. because of the lack of resistance of the lithological parent material and the humid climate (periodic retained water in the soil profile), processes of pseudogleying occur in the soils.

EG D1 – eutric brown soil and ranker on clay with sand and gravel
U $D1_1$ – field-meadow use on the slopes on eutric brown soils
U $D1_2$ – acidophilic beech forest with chestnut on the tops of ridges on ranker
EG D2 – eutric brown pseudogleyic soil on gentle slopes and catchment areas
U $D2_1$ – field-meadow use and scattered settlement on eutric brown pseudogleyic soil
U $D2_2$ – acidophilic beech and chestnut forest on eutric pseudogleyic soil
EG D3 – slope pseudogley in the transition from hills to flatland, on northern exposures and silty sediments
U $D3_1$ – field-meadow use on slope pseudogley
U $D3_2$ – acidophilic beech and chestnut forest on slope pseudogley
U $D3_3$ – built-up

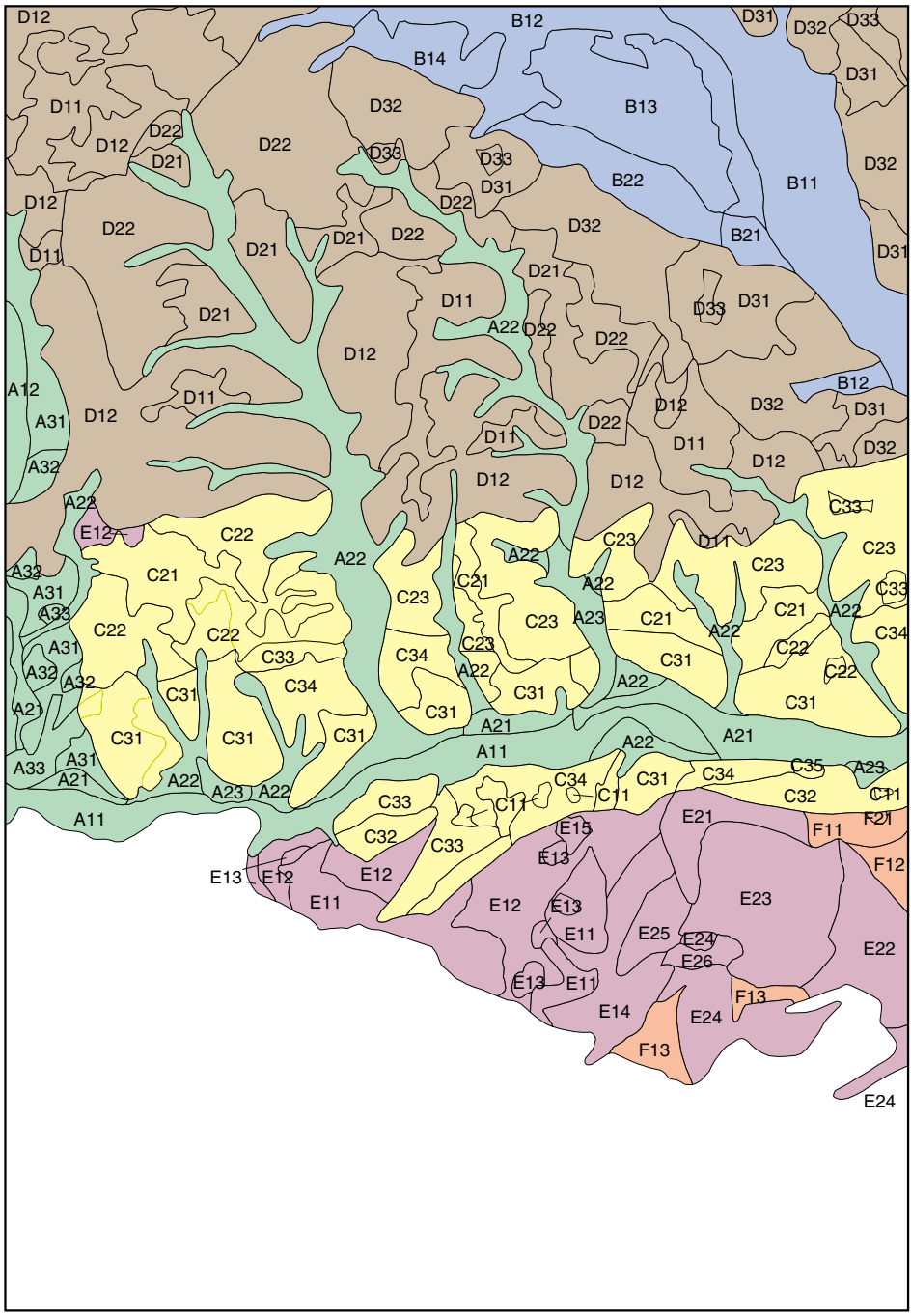


Figure 10: Map of Ecotopes in Dravinjske gorice and Bočko hribovje (map covers the area of TK-25 Poljčane).
Slika 10: Karta ekotopov v Dravinjskih goricah in Bočkem hribovju (karta obsega list TK-25 Poljčane).

Profile I/2-5
REGIONAL ECOLOGICAL UNIT: D
ECOTOPE GROUP: D1
ECOTOPE: $D1_2$
SITE: DRAVINJSKE GORICE
Altitude: 350 m
Slope: 8°
Exposure: W
Relief Form: hilly
LITHOLOGICAL PARENT MATERIAL: sand and fine gravel
WATER CONDITIONS:
Potential Evapotranspiration (corrected): 642.1 mm
Difference (Precipitation – PE corrected): 406.6 mm
Surplus of Water: 354.5 mm
Deficit of Water: 0
Soil moisture index: 63.3
Climate type: $B_3rB_1b_3$
CLIMATE:
Temperatures: Mean Annual 9.5 °C
Mean April–September: 15.5 °C
Precipitation: Annual Amount: 1076 mm
Number of Days With > 20 mm: 9.2
Mean Amount April–September: 654 mm
VEGETATION/LAND USE: Chestnut and Beech Forest (*Castaneo Fagetum sylvaticae*)
SOILS: ranker, sandy clay loam, poor in bases, PVK 103 mm

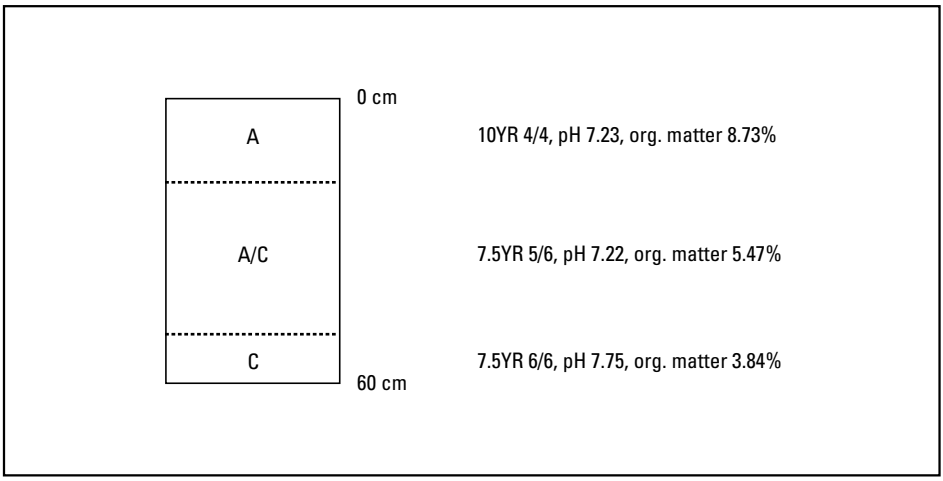
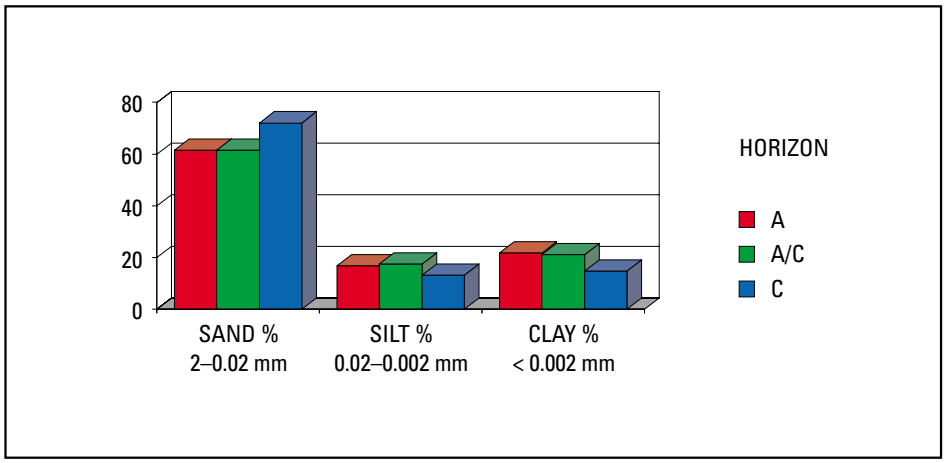


Figure 11: Description of profile I/2-5
Slika 11: Opis profila I/2-5

TABLE 11: MECHANICAL COMPOSITION BY HORIZON IN PROFILE 1/2-5.
PREGLEDNICA 11: MEHANSKA SESTAVA PO HORIZONTIH ZA PROFIL I/2-5.

horizon	sand % 2–0.02 mm	silt % 0.02–0.002 mm	clay % < 0.002 mm
A	61.5	16.7	21.8
A/C	61.5	17.4	21.1
C	72.1	13.1	14.8



Fugure 12: Mechanical Composition by Horizons for Profile I/2-5.
Slika 12: Mehanska sestava po horizontih za profil I/2-5.

TABLE 12: VOLUME OF MATTER. AIR, AND WATER IN THE SOIL FOR PROFILE I/2-5.
PREGLEDNICA 12: PROSTORNINA SUBSTANC, ZRAKA IN VODE V PRSTI ZA PROFIL I/2-5.

horizon	volume of matter %	volume of air %	volume of water %
A	40.1	50.9	9.0
A/C	42.2	54.6	3.0
C	0	0	3.0

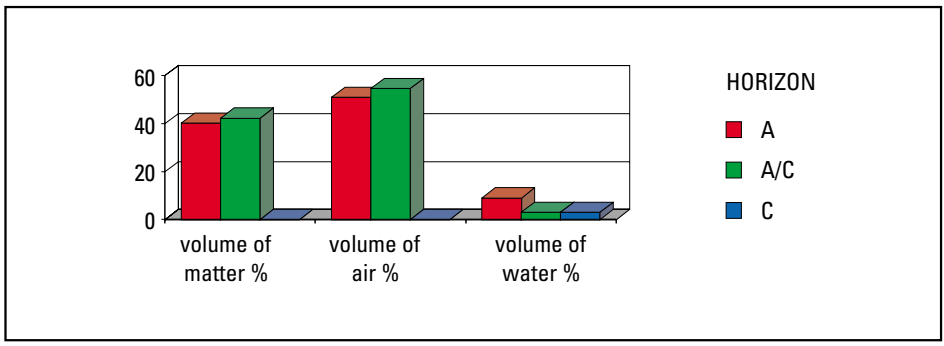


Figure 13: Volume Composition of the Soil for Profile I/2-5.
Slika 13: Prostorninska sestava prsti za profil I/2-5.

TABLE 13: OTHER QUALITIES OF THE SOIL FOR PROFILE I/2-5.
PREGLEDNICA 13: DRUGE LASTNOSTI ZA PROFIL I/2-5.

horizon	depth cm	texture	Vkmax %	Kf cm/sec · 10^{-3}	V %	absorption me/100 g KIK	S	H	V %
A	0–11	PGI	44.1	5.96	7.8	14.42	5.72	8.70	37.67
A/C	11–32	PGI	33.1	5.36	2.6	16.60	5.90	8.70	40.70
C	32–65	PGI	–	–	2.0	11.62	6.62	5.00	56.90

Explanation of the profile: Horizon A is very shallow and already at 11 cm the soil is mixed with sand and gravel. At 32 cm, the A/C horizon passes into the parent material. The size of the gravel is 0.5 to 1 cm. The colour of horizon A is yellow-brown and becomes darker with depth. Because of the PGI texture, the Kf value is very high, at 10 cm amounting to 5.96 cm/sec · 10^{-3} and at 30 cm amounting to 5.36 cm/sec · 10^{-3}. There is less than 10% of water in the soil, and the pores are predominantly filled with air. KIK is very low (below 20 me/100 g) and saturation with bases is below 50%, which denotes dystric soils.

Shallow, sandy, dry soils only support acidophilic chestnut and beech forest (Castaneo Fagetum sylvaticae).

6.1.2. Bočko hribovje

In Bočko hribovje, two REU's are defined that differ according to the origin and properties of stone which cause differences in relief, soils and vegetation and determine forest land use.

REU E is defined in hills of limestone and dolomite. On steep slopes, at the altitudes of 350 to 980 m, pseudokarstic processes dominate. On hard carbonate stone, rendzinas cover steeper slopes and terra fusca soils cover less steep sites; both are covered by forest to a large extent.

Because of changes in relief which, with altitudes of 400 to 980 m and 20° to 30° slopes, pass from hills to mountains, the climate changes. Central parts of Boč and northern exposures have an average annual temperature of 5.5 °C, temperature in the vegetation period is 11.6 °C, average summer temperature is 14.3 °C, and winter –3.8 °C. Annual precipitation is around 1202 mm, which given 532.3 mm of potential evapotranspiration means a 467.8 mm annual surplus of water. The soil moisture index is 87.9 and denotes a humid climate. On the southern slopes of Bočko hribovje and at lower altitudes, temperatures are higher: the average annual temperature is 9.0 °C, temperature in the vegetation period is 15.2 °C, average summer temperature is 17.8 °C, and winter –0.99 °C. Annual precipitation is 1060 mm which, given evapotranspiration means an annual surplus of 288.3 mm and a soil moisture index of 45.

Rendzina and terra fusca soils alternate according to relief. According to texture, they are silty loam and differ according to proportion of water, porousness for water, and PVK. There are poor growing conditions on shallow rendzinas on warm sites because they dry quickly and because of the great porousness of limestone and dolomite for the underground percolation of water, the soils retain less than 100 mm of water, denoting a dry growing place (thermophilic forest associations). On northern sites, the soils are moist, PVK is around 140 mm, and mesophytic forest associations therefore thrive on such growing places.

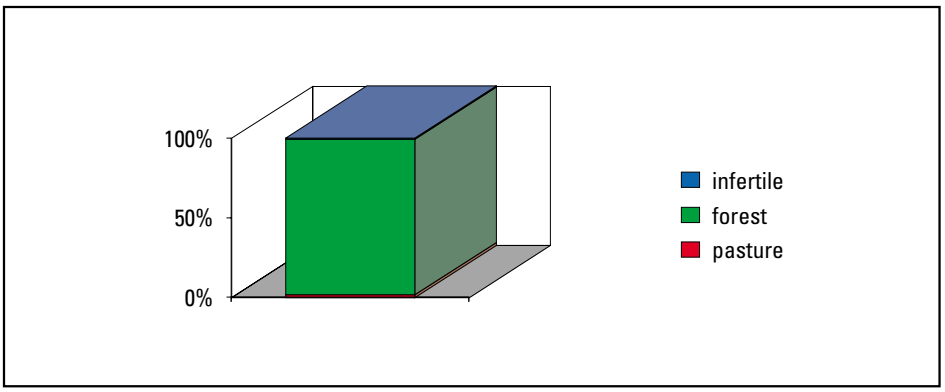


Figure 14: Land Use in PEU E.
Slika 14: Raba tal v PEE E.

TABLE 14: LAND USE PROPORTIONS IN PEU E.
PREGLEDNICA 14: DELEŽI RABE TAL V PEE E.

land use	proportion %
pasture	1.5
forest	91.0
infertile	0.5

Prevailing forest use is determined by lithological, relief, and pedological conditions. Differences between northern and southern sites are evident in the depth, moisture, and mechanical structure of the soil. Properties of soils on Boč were also studied by Kalan (Kalan, 1990), and with a comparison of his results it was possible to consolidate the network of pedological profiles. The general findings regarding the soils on Boč are that along with the rendzinas that dominate in the test area, other dystric brown, terra fusca, and pseudogleyic soils occur, the latter on marl. Because I limited Bočko hribovje according to its lithological border (limestone and dolomite), I included dystric and pseudogleyic soils in southern part of Dravinjske gorice and not in Boč as Kalan has done. Kalan's analysis of data for rendzinas on the southern slopes shows a high proportion of organic matter, high KIK and degree of saturation with bases and alkaline reaction which also appeared in my own laboratory work (profile I/2-10). Rendzinas on the northern slopes are deeper, transition A/C is developed below horizon A which Kalan had denoted (B)rz. The depth of rendzinas on northern slopes is 30–40 cm, reaction of the soil increases with depth as does the proportion of clay (profile I/1-B). The rendzinas differ according to the kind of bedrock, the form of its decay, water and air conditions, and the type of vegetation, which is also shown in the elaborated REU map (REU E falls into eleven ecotopes!)

REU F is defined on the margins of Bočko hribovje, at the altitude of 300 to 600 m where clay slate appears. Because of the poor porousness of the rock for water, strong denuding occurs. The slopes are covered by dystric soils with prevailing forest use.

REU F is found at the northern, northeastern, and southeastern foot of Bočko hribovje. Because of the poor resistance of slate to physical weathering, the surface forms are, in comparison with limestone Boč, not rocky and denuded. Because the area of REU F encompasses the smallest part of Bočko hribovje, it has no special role in appearance and function. Depending on altitude and exposure, three kinds of forest associations have developed in the REU F region that define the following ecotopes on dystric brown soils.

TABLE 15: LAND USE IN REU F.
PREGLEDNICA 15: RABA TAL V PEE F.

land use	proportion %
forest	100

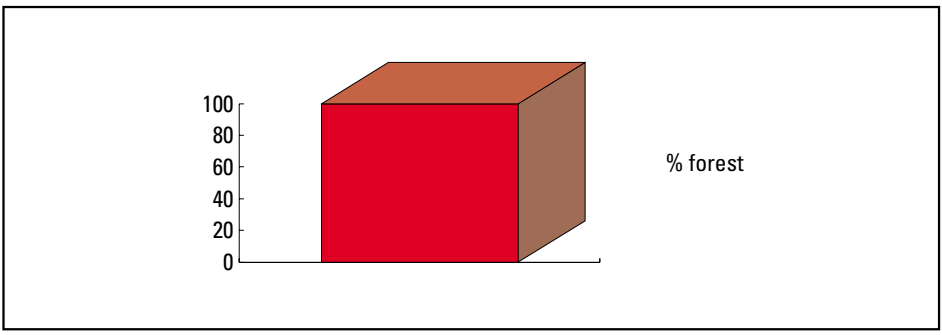


Figure 15: Land Use in REU F.
Slika 15: Raba tal v PEE F.

Absolute prevalence of forest is determined by relief and acidic, dystric soils. Reaction does not exceed 4.3 (very acidic soil), saturation with bases, and KIK are low, below horizon A, pseudogleyic (B)v/g is developed, which I link with humid climate of Bočko hribovje.
See figure 10: Map of Ecotopes in Dravinjske gorice and Bočko hribovje (map covers the area of TK-25 Poljčane).
Glej sliko 10: Ekotopi v Dravinjskih goricah in v Bočkem hribovju (karta obsega list TK-25 Poljčane).

Key for Bočko hribovje

REU E is defined in hills of limestone and dolomite. on steep slopes, at the altitudes of 350 to 980 m, pseudokarstic processes dominate. on hard carbonate stone, rendzinas cover steeper slopes and terra fusca soils cover less steep sites; both are covered by forest to a large extent.

EG E1 – dolomite hills with shallow rendzina on steep slopes and with terra fusca soil

U $E1_1$ – beech forest with *Hacquettia epipactis* (Scop.) on ridges on weathered rendzina
U $E1_2$ – beech forest with *Vicia oroboides* (Wulf) on slopes on terra fusca soil
U $E1_3$ – *Pinus silvestris* forest with *Genista januensis* (Viv.) along quarries on degraded growing places on rendzina
U $E1_4$ – *Ostrya carpinifolia* (Scop.) and *Quercus pubescens* (Willd.) forest on southern slopes on rendzina
U $E1_5$ – infertile

EG E2 – limestone hills with terra fusca soil and rendzina and forest growth

U $E2_1$ – beech forest with *Hacquettia epipactis* (Scop.) on steep northern slopes on rendzina
U $E2_2$ – beech – fir forest on eastern slopes above the altitude of 500 m on terra fusca soils
U $E2_3$ – beech forest with great dead nettle on broad, non-dissected ridges at the altitude above 500 m on terra fusca soil
U $E2_4$ – beech forest with *Carpinus betulus* (L.) on southern slopes on rendzina
U $E2_5$ – *Ostrya carpinifolia* (Scop.) and *Quercus pubescens* (Willd.) forest on southwestern slopes on rendzina
U $E2_6$ – meadow on level surface with mountain cottage on terra fusca soil

REU F is defined on the margins of Bočko hribovje, at the altitude of 300 to 600 m where clay slate appears. because of the poor porousness of the rock for water, strong denuding occurs. the slopes are covered by dystric soils with prevailing forest use.

EG F1 – dystric brown soil on clay slate

U $F1_1$ – beech forest with Hacquettia epipactis (Scop.) on dystric brown soils
U $F1_2$ – beech forest with great dead nettle on dystric brown soils
U $F1_3$ – beech forest with Ostrya carpinifolia (Scop.) on dystric brown soils

RELATIONSHIP OF NATURAL ELEMENTS AND REU WITH LAND USE IN BOČKO HRIBOVJE

TABLE 16: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 16: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	pasture	forest	infertile
limestone	0.492	0.123	0.007
dolomite	0.007	0.167	0.54
slate	0.05	0.05	0
total	0.549	0.34	0.547

r^2 = 21.8% r = 0.467

TABLE 17: REGIONAL ECOLOGICAL UNITS AND LAND USE.
PREGLEDNICA 17: POKRAJINSKO EKOLOŠKE ENOTE IN RABA TAL.

REU	pasture	forest	infertile
E	0.017	0.849	0.001
F	0	0.136	0
total	0.017	0.985	0.001

r^2 = 98.5% r = 0.992

6.1.3. Dravsko polje

In Dravsko polje, two REU's are found that differ according to lithological structure and the influence of underground water affecting the development of soils, growth conditions, and the type of land use.

REU A is defined in flatland where there are terraces of fluvioglacial gravel that is very porous for water, at the altitude of 240 to 250 m. Shallow riverbank and deeply gleyic soils and dystric ranker developed on the acidic gravel. Degraded growing places are covered by *Pinus silvestris* forest with bilberry shrub; otherwise cultivated field use prevails.

The eastern part of Dravsko polje is denoted as REU A. A common property of the ecotopes in this REU is that the surface is formed of sandy and gravel sediments that are porous for water and water is therefore not retained in the soil profile. The altitude ranges from 240 to 270 m and descends from west to east. The average annual temperature is 9.6 °C, in the vegetation period 15.9 °C; the mean temperature in summer is 18.6 °C, and in winter –0.1 °C. Annual precipitation is 984.5 mm, which does not suffice to cover the demands of evapotranspiration in the summer months. The negative difference between the amount of the precipitation and potential evapotranspiration appears from May to July, but it is minimal and does not exceed 10 mm. The annual surplus of water is 258.5 mm and the soil moisture index is 0.

The prevailing soil is dystric ranker; riverbank soils are only found immediately beside the course of the Drava River. The dystric ranker has a PGI texture, contains about 10% water, and has a low PVK which does not reach 100 mm. The rankers therefore dry quickly in dry periods, and plants on this soil suffer from drought. The structure of the profile of dystric rankers is A-C or A-AC-C. Because of the silicate gravel, the soils are very acidic and poorly saturated with bases and the cation exchange capacity is very low.

TABLE 18: PROPORTIONS OF LAND USE IN REU A.
PREGLEDNICA 18: DELEŽI RABE TAL V PEE A.

land use	proportion %
field	60
meadow	5
meadow/field	2
forest	18
built-up	12
infertile	3

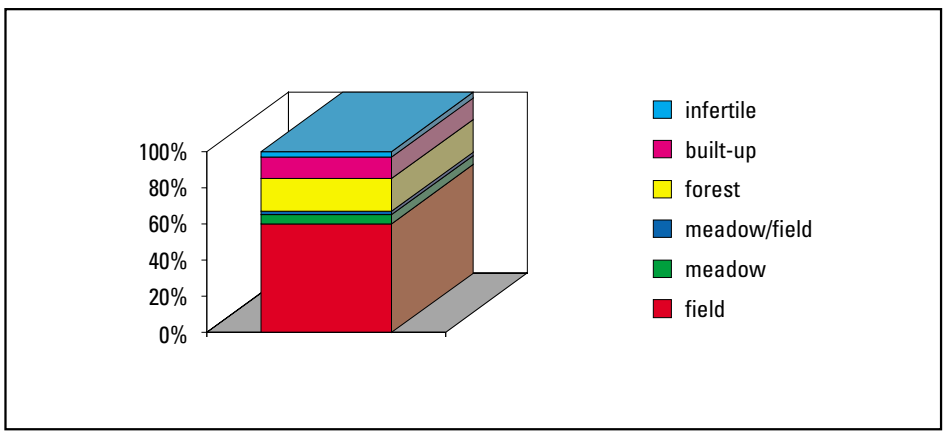


Figure 16: Land Use in REU A.
Slika 16: Raba tal v PEE A.

The dominant cultivated field use is a reflection of natural and human factors. Near Starošenjce, there is a compact complex of pine forest with bilberry shrub (*Vaccinio myrtilli – Pinetum*, Kobenza 1930). On the western margin of the Pleistocene terraces is a belt of compact settlement which toward the south becomes roadside villages. Numerous gravel pits, abandoned and working, are characteristic of REU A. The natural features (relief and, indirectly, the properties of the soils) provide the basis for the prevailing cultivated field use. The ranker on non-carbonate river gravel is defined as moderately acidic, shallow, dystric soil in the *Commentary on the Pedological Map of Ptuj*, as was also shown by laboratory data (profile II/2-2). Because water is not retained and the flat relief enables the use of mechanization, and since Dravsko polje at the same time is the second largest flatland area in Slovenia, cultivated field use is the dominant factor for ecotope partition in the area of REU A.
On extremely acidic growing places, pine forests with bilberry shrub grow, built-up areas are on the junction of river gravel with clay loam alluvia, and meadow use is rare.

REU B is defined in flatland with an altitude of 250 to 260 m; it is composed of Pleistocene and Holocene clay loam alluvia which are poorly porous for water, causing retained water in the soil profile and the processes of pseudogleying and gleying.

The western part of Dravsko polje is denoted as REU B and given the influence of underground water which causes various development of soils is very heterogeneous.
Clay and silty alluvia from the Pleistocene and Holocene are very poorly porous for water; the soils on these alluvia are therefore gleyic. REU B is drained land and swamp that is no longer as marshy as it was due to hydroamelioration. Because of its site below the foot of Pohorje, the climate is humid. The average annual temperature is 9.4 °C, in the vegetation period 15.6 °C; mean summer temperature is 18.4 °C and in winter –0.2 °C. Lower temperatures are observed in comparison with the eastern part of Dravsko polje. The amount of precipitation is higher and totals 1012 mm, which given the height of potential evapotranspiration is enough to cover the demands of transpiration. A negative difference between the amount of precipitation and the height of potential evapotranspiration does not occur in any month, and therefore the annual surplus of water is 339.2 mm and the soil moisture index is 62.6.

TABLE 19: PROPORTIONS OF LAND USE IN REU B.
TEBELA 19: DELEŽI RABE TAL V PEEB.

land use	proportion %
field	28
meadow	15
meadow/field	18
forest	21
built-up	16
infertile	2

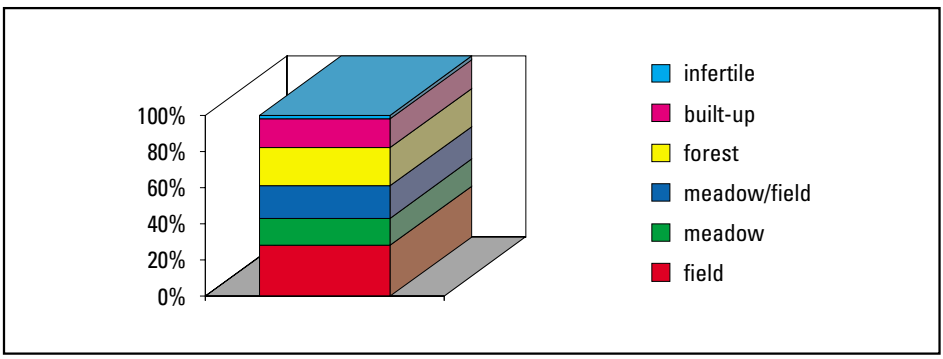


Figure 17: Land Use in REU B.
Slika 17: Raba tal v PEE B.

The soils differ according to their degree of gleying. In the northern part of the REU B area, the soils are non-gleyic with the soil profile A-(B)v-C, which represents an advantage from the point of view of settling; therefore, the area is densely built-up. In the central area, there are flatland pseudogleys A-Bg-C that are not really suitable for agricultural cultivation because of their poor physical and chemical properties. On them is mixed meadow-field use and hornbeam forest with *Luzula luzuloides* (Lam.) (*Luzulo albidae Carpinetum*, Wraber 1969). Hypogleys and amfigleys (A-Go and A-Gr) are physically unsuitable for agricultural cultivation and have therefore been ameliorated. In the surroundings of Pragersko and Sp. Gaj there are larger, compact field surface areas.
Although ecological conditions for successful plant growing and land use in the REU B area are quite different than conditions in the area REU A, cultivated fields are the most represented category of land use. The reason is not the natural conditions but the amelioration and regulation done on gleyic soils. The results of analysis showed that beneath the plowed horizon P there already exists a gleyic Go horizon, indicating the high level of underground water (profile II/3-4). Similar results are shown in descriptions of profiles in the *Commentary on the Pedological Map of Ptuj*, as well as for the gleyic soils beneath the meadows and forests. Current land use in the REU B area is heterogeneous; naturally, swampy meadows and forests would prevail.

CONNECTION OF NATURAL ELEMENTS AND REU'S WITH LAND USE IN DRAVSKO POLJE

TABLE 20: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 20: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	field	meadow	field/meadow	forest	settled
gravel	0.156	0.039	0.027	0.109	0.184
clay alluvia	0.059	0.181	0.208	0.093	0.045
total	0.215	0.208	0.235	0.202	0.229

r^2 = 10.1% r = 0.317

TABLE 21: SOILS AND LAND USE.
PREGLEDNICA 21: PRSTI IN RAVA TAL.

type of soil	field	meadow	field/meadow	forest	built-up
ranker	0.133	0.002	0.009	0.152	0.009
eutric brown	0.032	0	0.089	0	0.128
dystric brown	0.064	0	0.007	0	0.064
pseudogley	0	0.097	0.068	0.068	0.011
riverbank	0	0.045	0.020	0.020	0.005
gleyic	0	0.250	0.023	0.063	0.001
ameliorated gleyic	0.129	0	0.057	0	0.057
total	0.358	0.394	0.362	0.303	0.284

r^2 = 17.5% r = 0.419

TABLE 22: REGIONAL ECOLOGICAL UNITS AND LAND USE.
PREGLEDNICA 22: POKRAJINSKO EKOLOŠKE ENOTE IN RABA TAL.

REU	field	ameliorated field	field/meadow	meadow	forest/meadow	forest	built-up	infertile
A	0.632	0.019	0	0.017	0	0.044	0.035	0.039
B	0.016	0.151	0.069	0.038	0.120	0.060	0.056	0.006
total	0.639	0.171	0.069	0.055	0.120	0.104	0.091	0.045

r^2 = 38.5% r = 0.620

Key for Dravsko polje

REU A is defined in flatland where there are terraces of fluvioglacial gravel that is very porous for water, at the altitude of 240 to 250 m. Shallow riverbank and deeply gleyic soils and dystric ranker developed on the acidic gravel. Degraded growing places are covered by *Pinus silvestris* forest with bilberry shrub; otherwise cultivated field use prevails.

EG A1 – riverbank, shallow soil on Holocene terraces along the river bed
U $A1_1$ – willow forest directly along the river bed on shallow riverbank soil
U $A1_2$ – meadow on shallow riverbank soil

EG A2 – riverbank, deeply gleyic soils on the right bank of the Drava
U $A2_1$ – poplar forest on riverbank, deeply gleyic soils
U $A2_2$ – cultivated fields and meadows on riverbank, deeply gleyic soils

EG A3 – fluvioglacial river terraces with dystric ranker
U $A3_1$ – pine forest with bilberry shrubs on dystric ranker
U $A3_2$ – cultivated fields with small properties scattered on dystric ranker
U $A3_3$ – meadows on dystric ranker
U $A3_4$ – built-up
U $A3_5$ – infertile

REU B is defined in flatland with an altitude of 250 to 260 m; it is composed of pleistocene and holocene clay loam alluvia which are poorly porous for water, causing retained water in the soil profile and the processes of pseudogleying and gleying.

EG B1 – eutric brown soil along prolonged regulated river beds on clay loam alluvia
U $B1_1$ – built-up
U $B1_2$ – cultivated fields on eutric brown soil
U $B1_3$ – meadows on eutric brown soil

EG B2 – eutric pseudogleyic soil at the foot of Pohorje on silty clay alluvia
U $B2_1$ – cultivated fields and meadows on eutric brown, pseudogleyic soil
U $B2_2$ – built-up
U $B2_3$ – infertile
U $B2_4$ – *Quercus robur* forest with *Pseudostellaria europaea* (Schaeflein) on eutric, pseudogleyic soil

EG B3 – flatland pseudogley on silty clay alluvia
U $B3_1$ – meadows and cultivated fields on flatland pseudogley
U $B3_2$ – *Carpinus betulus* (Lam.) forest with *Luzula luzuloides* (Lam.) on flatland pseudogley
U $B3_3$ – built-up

EG B4 – hypogley, ameliorated on silty clay alluvia
U $B4_1$ – ameliorated cultivated fields on hypogley
U $B4_2$ – meadows and cultivated fields on hypogley
U $B4_3$ – *Alnus glutinosa* (L.) forest with *Carex elongata* (L.) on hypogley
U $B4_4$ – infertile

EG B5 – amfigley with swamps on silty clay alluvia
U $B5_1$ – ameliorated cultivated fields on amfigley
U $B5_2$ – cultivated fields and meadows on amfigley
U $B5_3$ – fir forest on moor sediments on amfigley
U $B5_4$ – built-up
U $B5_5$ – infertile

EG B6 – riverbank soils on clay alluvia
U $B6_1$ – meadows on riverbank soils

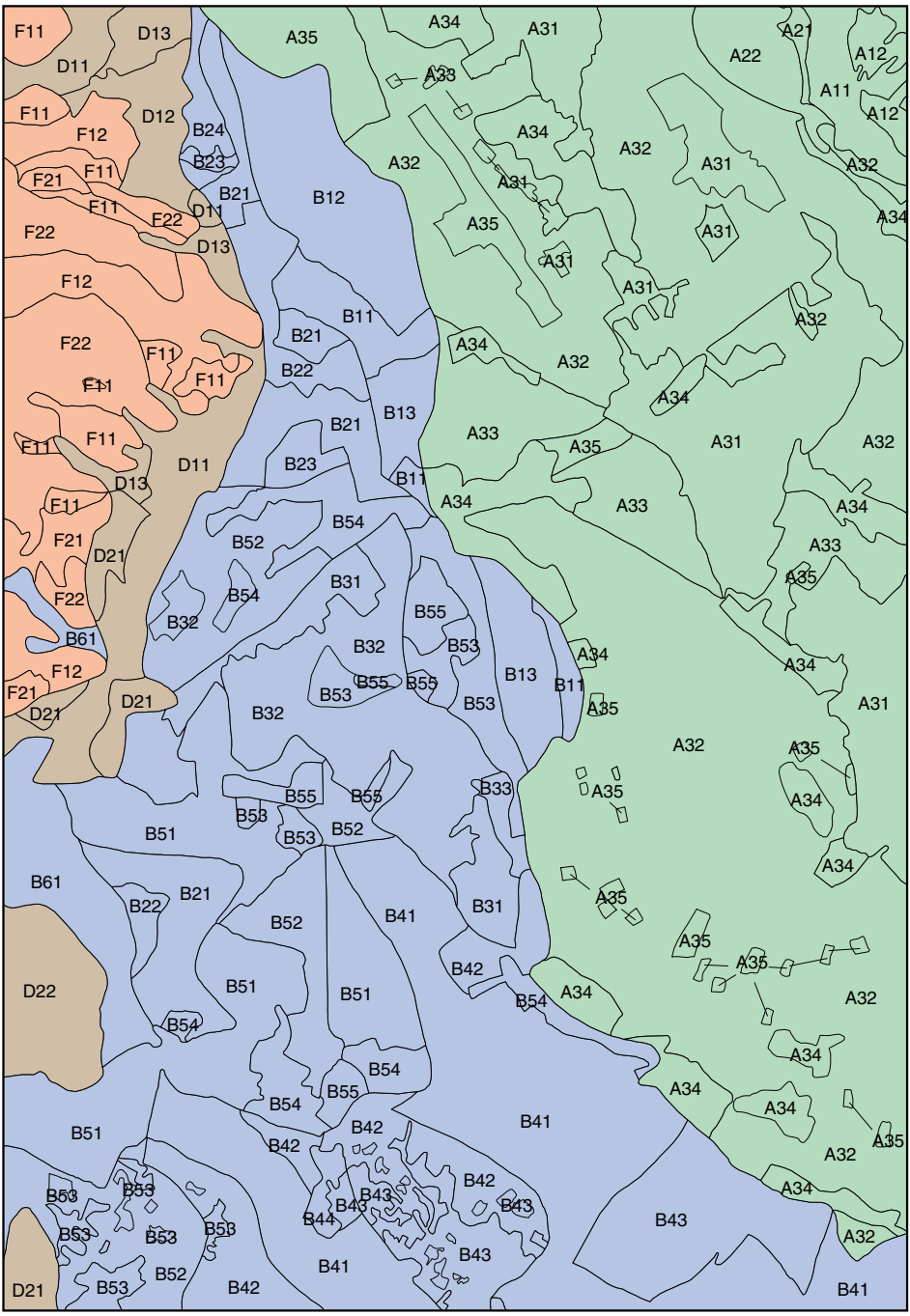


Figure 18: Map of Ecotopes on Dravsko Polje and in Eastern Pohorje (map covers the area of TK-25 Pragersko).
Slika 18: Ekotopi na Dravskem polju in Vzhodnem Pohorju (karta obsega list TK-25 Pragersko).

Representative profile for Dravsko polje:
Profile II/2-2
Regional Ecological Unit: A
Ecotope Group: A3
Ecotope: $A3_2$
Site: Dravsko polje
Altitude: 250 m
Slope: –
Exposure: –
Relief Form: flatland
LITHOLOGICAL PARENT MATERIAL: Fluvioglacial Gravel
WATER CONDITIONS:
Potential evapotranspiration (corrected) annual: 655.4 mm
Difference (Precipitation – PE corrected) annual: 329 mm
Surplus of water: 258.5 mm
Deficit of water: 0
Soil moisture index: 39.5
Climate Type: $B_1rB_1b_3$
CLIMATE:
Temperatures: Mean Annual: 9.6 °C
Mean April–September: 15.9 °C
Precipitation: Annual Amount: 985 mm
Number of Days with > 20 mm: 9.2
Mean Amount April–September 579.3 mm
VEGETATION/LAND USE: meadow
SOILS: sandy loam ranker, poor in bases, with PVK 98 mm

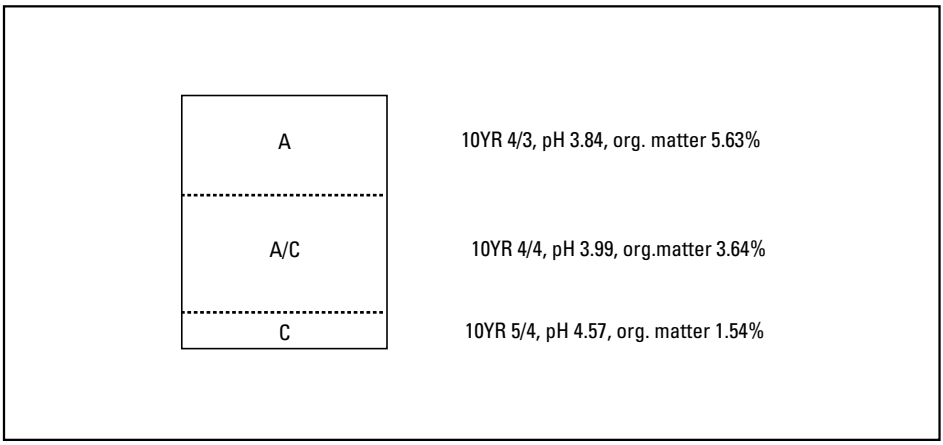


Figure 19: Description of profile II/2-2.
Slika 19: Opis profila II/2-2.

TABLE 23: MECHANICAL STRUCTURE OF PROFILE II/2-2.
PREGLEDNICA 23: MEHANSKA SESTAVA PROFILA II/2-2.

horizon	sand % 2–0.02 mm	silt % 0.02–0.002 mm	clay % < 0.002 mm
A	41.9	31.4	26.7
A/C	72.6	7.1	20.3
C	84.0	4.0	12.0

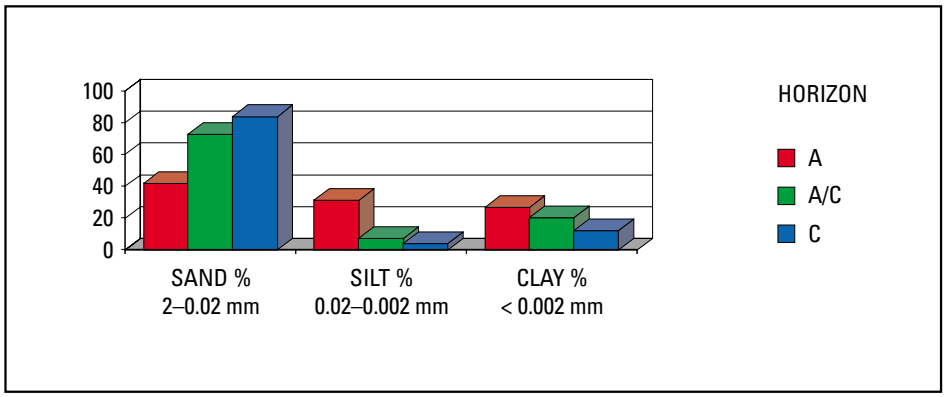


Figure 20: Mechanical structure of profile II/2-2.
Slika 20: Mehanska sestava profila II/2-2.

TABLE 24: VOLUME OF MATTER, AIR, AND WATER IN PROFILE II/2-2.
PREGLEDNICA 24: PROSTORNINA SUBSTANCE, ZRAKA IN VODE V PROFILU II/2-2.

horizon	volume of matter %	volume of air %	volume of water %
A	52.0	22.0	26.0
A/C	57.8	27.2	15.0
C	62.7	28.3	9.0

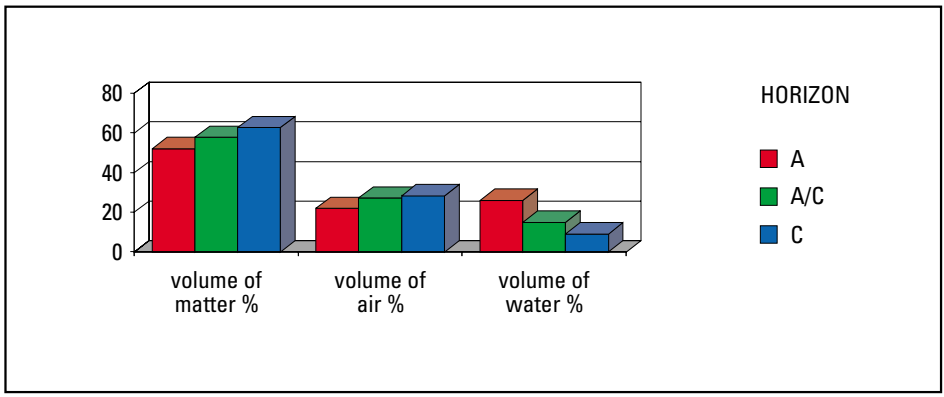


Figure 21: Volume composition of profile II/2-2.
Slika 21: Prostorninska sestava profila II/2-2.

TABLE 25: OTHER PROPERTIES OF SOILS FOR PROFILE II/2-2.
PREGLEDNICA 25: DRUGE LASTNOSTI PRSTI.

horizon	depth cm	texture	Vkmax %	Kf cm/sec · 10^{-3}	V %	absorption me/100 g KIK	S	H	V %
A	0–20	IG	40.9	3.10	20.0	9.57	2.57	7.0	26.8
A/C	20–70	PGI	31.3	7.94	0.2	5.54	1.71	3.8	30.8
C	70–110	PI	30.3	4.94	5.1	1.97	0.27	1.7	15.2

Explanation of the profile: ranker developed on gravel subsoil is a characteristic type of soil for the eastern and central parts of Dravsko polje. There are many abandoned gravel pits here. Horizon A is brown and rich with organic matter because of the nearby cultivated fields. According to its reaction, the soil is very acidic and poorly saturated with bases. Below horizon A lies transition A/C, PGI in texture and very porous for water. The volume of the matter is large because of the high proportion of stone larger than 2 mm in the soil.
Naturally, the shallow, strongly porous, acidic, and dystric soils are suitable for forest use. Meadow use and nearby cultivated fields show that soils with anthropogenic improvements are suitable for agriculture in spite of their naturally unfavourable properties. However, with the uncontrolled use of fertilizers and biochemical substances, natural disasters can easily occur.

6.1.4. Eastern Pohorje

Eastern Pohorje is defined as REU F and on its southeastern margin borders an REU D area that, according to its properties, is similar to the REU D area in Dravinjske gorice, However, because of its site at the foot of Pohorje, it is treated in this place.
REU D is defined on the hilly margins of Pohorje at the altitude of 280 to 290 m; lithologically this area is composed of Pleistocene loam with sands and gravels, on which eutric brown and pseudogleyic soils have developed. Because of its location at the juncture of two natural units, this area is quite densely built-up.
Characteristic features of REU D area are its site at the foot of Pohorje and the transition of flatland into the hilly world. The transition site is reflected in the relief, climate, properties of the soil, and the plant growth. The altitude is 280 m, the surface is almost flat with a slope of 2° to 5° and faces east. The average annual temperature is 9.7 °C, in the vegetation period 16 °C, in summer 18.7 °C, and in winter 0.0 °C. Temperatures are slightly higher because of its location above the valley bottom; the amount of precipitation is also higher, totaling 1046 mm, which suffices for evapotranspiration. The annual surplus of water in the soil is 330.8 mm, and the soil moisture index is 49.89.

TABLE 26: PROPORTIONS OF LAND USE IN REU D.
PREGLEDNICA 26: DELEŽI RABE TAL V PEE D.

land use	proportion %
meadow	50
meadow/field	10
forest	18
built-up	22

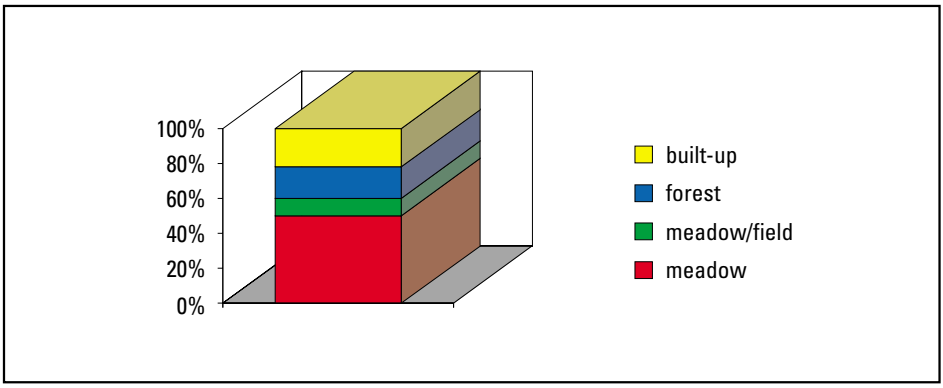


Figure 22: Land Use in REU D.
Slika 22: Raba tal v PEE D.

The soils are pseudogleyic due to colluvial processes and the humid climate. On eutric pseudogleyic soil, pine forest flourishes with the local chestnut (*Vaccinio myrtilli – Pinetum*, Kobenza 1930, var. geogr. *Castanea sativa*, Tomažič 1940), while on slopes of pseudogley degraded beech forest grows with chestnut (*Castaneo – Fagetum Sylvaticae*, Marinček and Zupančič 1979, 1994).
The prevailing meadow use depends heavily on the natural conditions that are not very suitable for field use because of the loamy sand parent material and hilly relief. Saturation of the soil with bases is low (profile II/2-1), reaction is acidic and increases with depth, water periodically is retained below horizon A and causes pseudogleying. The junction of mountainous Pohorje with the Dravsko polje flatland plays an important role in land use. Along with traffic links in the REU D area, settlement is also dense, and given this feature the REU D area of Eastern Pohorje differs from REU D area in Dravinjske gorice in spite of their similar lithological and relief conditions.
REU F is defined in hills of metamorphic stone, at the altitude of 350 to 500 m. On acidic lithological parent material and ravine-ridge relief, ranker and dystric brown soil are developed. The poor porousness of metamorphic stone for water and the humid climate encourage strong denuding, because of which forest use dominates and vineyards are found only on southern slopes.
In the REU F area, climate conditions are similar to those in the REU D area, the altitude ranges from 350 to 500 m, the inclination of the slopes is 10° to 30°. Eastern sites are frequent. Water balance is positive and with more detailed climate data we find an increase in the surplus of water in the soil in accordance with the increase in altitude.
Vineyards cover large surface areas above Fram. Because of plowing, the natural structure of the profile is changed to a P-C profile, and the physical and chemical properties of the soil are also altered. Because of strong fluvial erosion, the ravines of streams are deep and steep, their slopes covered with shallow soil – ranker. Because metamorphic stone weathers quickly, the slopes outside the ravines are wide and the soils on them are thicker, with developed cambic A-(B)-C horizons.

TABLE 27: PROPORTIONS OF LAND USE IN REU F.
PREGLEDNICA 27: DELEŽI RABE TAL V PEE F.

land use	proportion %
meadow	20
meadow/field	35
forest	40
vineyard	5

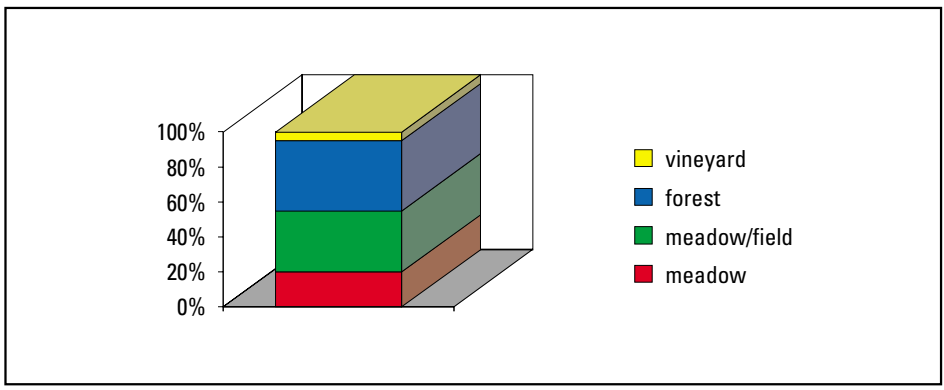


Figure 23: Land Use in REU F.
Slika 23: Raba tal v PEE F.

The prevailing forest and meadow-field use is linked to the dystric soils and ranker on metamorphic stone. Forests cover ravines with strong denuding where medium thick dystric ranker prevails that is very acidic, poorly saturated with bases, and with low KIK. Dystric brown soils on slate are deep (profile II/1-1), but also very acidic and poorly saturated with bases. With the plowing of deep brown soils, horizons have become mixed and below horizon P lies horizon C, metamorphic slate. These soils are devoted to vineyards that in the test area cover 5% of the surface area and form an independent ecotope. Laboratory data on the soils on Pohorje refers to the northeastern part of Pohorje that is also covered by the pedological map for Ptuj.
See figure 18: Map of Ecotopes in Dravsko polje and Eastern Pohorje (map covers the area of TK-25 Pragersko).
Glej sliko 18: Ekotopi na Dravskem polju in Vzhodnem Pohorju (karta obsega list TK-25 Pragersko).

Key for Eastern Pohorje

REU D is defined on the hilly margins of pohorje at the altitude of 280 to 290 m; lithologically this area is composed of pleistocene loam with sands and gravels, on which eutric brown and pseudogleyic soils have developed, because of its location at the juncture of two natural units, this area is quite densely built-up.
EG D1 – deep eutric, pseudogleyic soil on non-carbonate colluvium
U $D1_1$ – meadows on eutric brown, pseudogleyic soil
U $D1_2$ – pine forest with chestnut on eutric, pseudogleyic soil
U $D1_3$ – built-up
EG D2 – slope pseudogley on loam
U $D2_1$ – meadows on slope pseudogley
U $D2_2$ – acidophilic beech and chestnut forest on slope pseudogley

REU F is defined in hills of metamorphic stone, at the altitude of 350 to 500 m. on acidic lithological parent material and ravine-ridge relief, ranker and dystric brown soil are developed. the poor porousness of metamorphic stone for water and the humid climate encourage strong denuding, because of which forest use dominates and vineyards are found only on southern slopes.
EG F1 – plowed soil and shallow ranker on gneiss
U $F1_1$ – vineyards on southern sites on ridges above 300 m on plowed soil
U $F1_2$ – acidophilic beech and chestnut forest in ravines of streams on ranker
EG F2 – dystric brown soil on rounded ridges on metamorphic rock
U $F2_1$ – cultivated fields and meadows on dystric brown soil
U $F2_2$ – acidophilic beech and chestnut forest on dystric brown soil
U $F2_3$ – built-up

CONNECTION OF NATURAL ELEMENTS AND REU'S WITH LAND USE IN EASTERN POHORJE

TABLE 28: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 28: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	field/meadow	vineyard	forest
colluvium	0.300	0.040	0.010
gneiss	0.114	0.257	0.029
slates	0.100	0.200	0.070
total	0.514	0.497	0.739

r^2 = 11.8% r = 0.343

TABLE 29: SOILS AND LAND USE.
PREGLEDNICA 29: PRSTI IN RABA TAL.

type of soil	field/meadow	vineyard	forest
ranker	0.648	0	0.098
dystric brown	0.013	0	0.563
plowed	0	1	0
total	0.661	1	0.661

r^2 = 66.1% r = 0.813

TABLE 30: REGIONAL ECOLOGICAL UNITS AND LAND USE.
PREGLEDNICA 30: POKRAJINSKO EKOLOŠKE ENOTE IN RABA TAL.

REU	meadow	field/meadow	vineyard	forest	settled
D	0.303	0.147	0	0	0.152
F	0	0.020	0.124	0.641	0.028
total	0.303	0.167	0.124	0.641	0.180

r^2 = 41.4% r = 0.644

6.1.5. Western Part of Slovenske gorice

The test area in the Western Part of Slovenske gorice is divided into five REU's which differ according to the lithological parent material that influences relief forms, the influence of underground water and precipitation, and the development of soils. Lithological differences are even present in the flatland, and two directions of soil development therefore appear: On the more porous sediments the soils are non-gleyic, while on silty alluvia they are gleyic and therefore ameliorated, which the land use reflects.

The influence of climate conditions is also reflected in land use. The Western Part of Slovenske gorice is wooded in the north, cultivated fields and meadows are on the tops of ridges, and there are meadows in the valleys; however, around 60% of the surface area is covered with forest. In the northern part of the test area there are no vineyards, with the exception of two surface areas. The situation is different in the southern part, which is settled in a much more dispersed way: There is less forest, and vineyards appear on many smaller surface areas. Differences in the amount of precipitation are not significant: 940 mm fall in the northern part and 933 mm in the southern.

The water balance for the Western Part of Slovenske gorice indicates that from May to August more water evaporates than falls in the form of precipitation, and therefore the supply of water in the soil is used up. The deficit is greatest in July and totals 18 mm. The annual deficit of water reaches 52.34 mm while the annual surplus of water is 187.8 mm, giving a soil moisture index of 20.49.

The following REU's were defined:

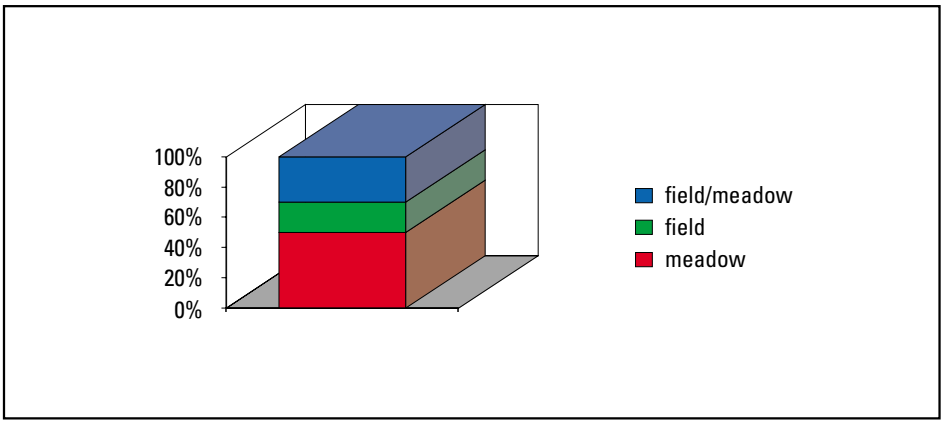
REU A is defined in flatland in the valleys of tributaries of the Pesnica River that are composed of Holocene sandy clay and loam alluvia, at the altitude of 240 to 250 m. Due to recent accumulation and flow of slope waters into the valleys, retained water periodically occurs in the lower parts of riverbank soil profiles.

Prevailing meadow use in the REU A area is a reflection of recent accumulation, shallow riverbank soils, and the periodic influence of underground water.

REU B is defined in flatland in the valley of the Pesnica River that is composed of Pleistocene and Holocene silty loam alluvia, at the altitude of 230 to 240 m. Due to its valley site and the silty loam lithological parent material, water is regularly retained in the soil profile causing the processes of gleying and hydromorphic soils. For the needs of agriculture, the soils have been hydroameliorated and their purpose completely changed.

TABLE 31: PROPORTIONS OF LAND USE IN REU A.
PREGLEDNICA 31: DELEŽI RABE TAL V PEE A.

land use	proportion %
meadow	50
field	20
field/meadow	30



Fugure 24: Land Use in REU A
Slika 24: Raba tal v PEE A.

TABLE 32: PROPORTIONS OF LAND USE IN REU B.
PREGLEDNICA 32: DELEŽI RABE TAL V PEE B.

land use	proportion %
field	90
meadow	8
infertile	2

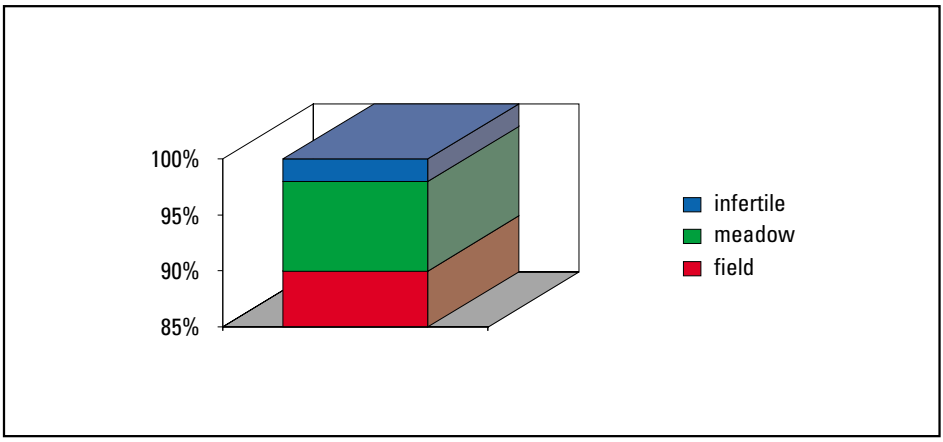


Figure 25: Land Use in REU B.
Slika 25: Raba tal v PEE C.

The prevailing cultivated field land use in REU B is not the consequence of natural conditions but of anthropogenic encroachments.

REU C is defined in marl hills in the central part of the test area with the altitude of 280 to 400 m. Due to strong surface denuding, solifluction material is found at the transition of hills to flatland. Here slope pseudogleys have developed, while on the denuded surfaces and ridges eutric and dystric soils have developed.

TABLE 33: PROPORTIONS OF LAND USE IN REU C.
PREGLEDNICA 33: DELEŽI RABE TAL V PEE C.

land use	proportion %
field	50
meadow	10
meadow/field	25
forest	30
built-up	10

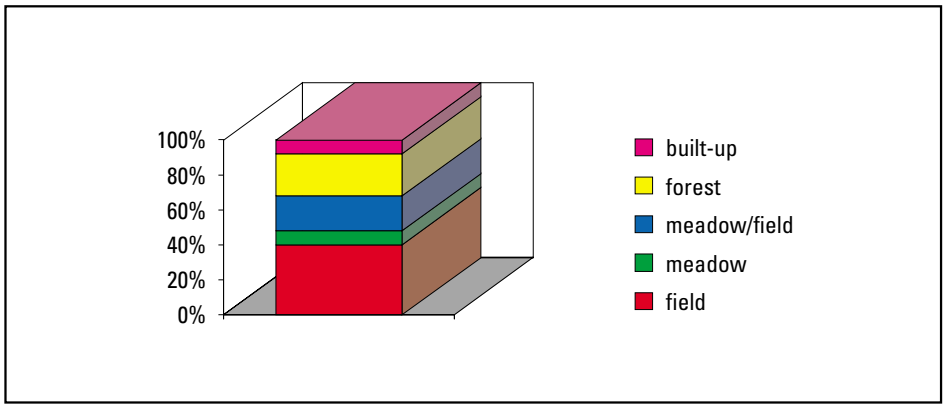


Figure 26: Land Use in REU C.
Slika 26: Raba tal v PEE C:

Mixed use is characteristic of all hilly regions, because the form of use is always determined on one hand by natural factors and on the other by human factors.

REU D is defined in hills composed of plio-Quaternary sands and gravels in the northeastern part of the Slovenske gorice test area. Due to the varying resistance of the lithological parent material, the relief with altitudes from 300 to 500 m is undulating On unbound lithological parent material, eutric and dystric soils with the prevailing forest use are interwoven.

The high percentage of forest use is determined by the less favourable properties of the soils and the undulating relief that hinders machine cultivation of the land.

REU E is defined in the hills of Tertiary limestone (lithotamnium) and lime sandstone. The undulating relief at the altitude of 350 to 500 m south of the Pesnica Valley is the consequence of the resistance of limestone to physical weathering. On hard carbonate stone, pseudokarstic processes and denuding dominate. On limestone, rendzinas are found, and on lime sandstone, eutric and dystric soils.

The prevailing field-meadow use is the consequence of relief and lithological conditions. Lime sandstone weathers relatively quickly; therefore, the relief forms are soft and the development and properties of the soil are favourable for agricultural cultivation.

TABLE 34: PROPORTIONS OF LAND USE IN REU D.
PREGLEDNICA 34: DELEŽI RABE TAL V PEE D.

land use	proportion %
meadow/field	15
forest	90
vineyard	5

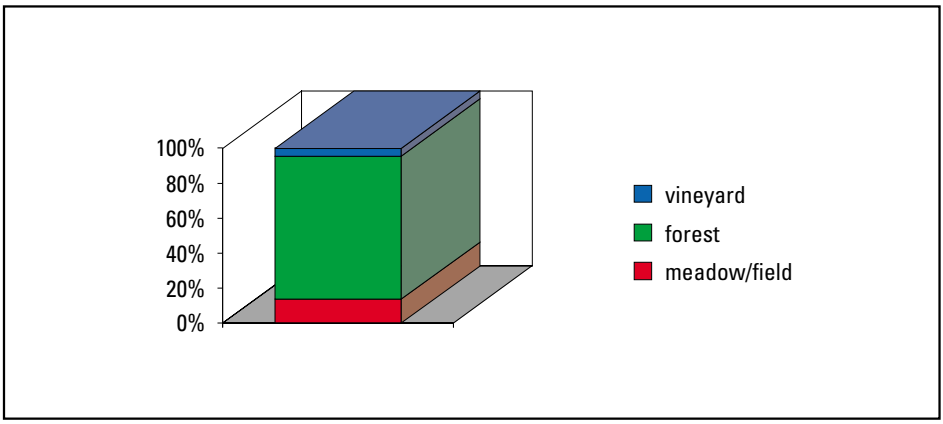


Figure 27: Land Use in REU D.
Slika 27: Raba tal v PEE D.

TABLE 35: PROPORTIONS OF LAND USE REU E.
PREGLEDNICA 35: DELEŽI RABE TAL V PEE D.

land use	proportion %
meadow/field	64
forest	20
vineyard	6

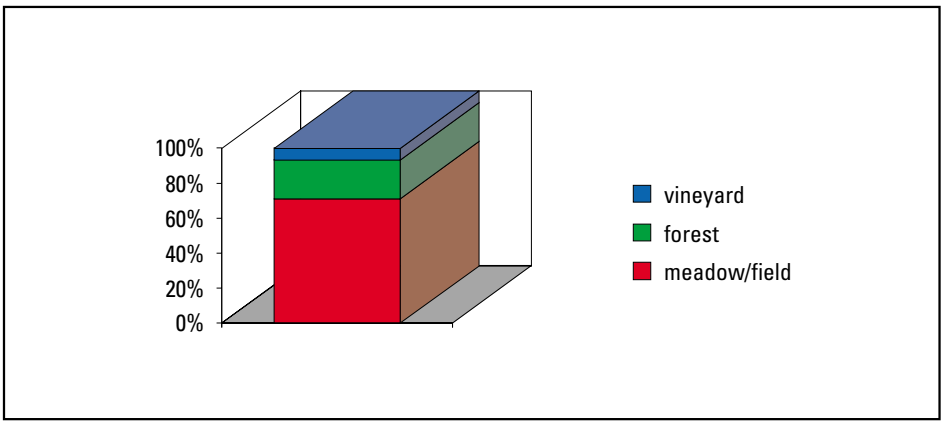


Figure 28: Proportions of Land Use in REU E.
Slika 28: Raba tal v PEE E.

CONNECTION OF NATURAL ELEMENTS AND REU'S WITH LAND USE IN THE WESTERN PART OF SLOVENSKE GORICE

TABLE 36: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 36: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	field	meadow	field/meadow	forest
Pl alluvia	0.423	0.063	0.002	0.002
marl	0.058	0.103	0.316	0.040
sandstone	0.012	0.050	0.050	0.113
lithotamnium, limestone	0	0.007	0	0.257
sands	0.008	0.030	0.003	0.033
total	0.501	0.253	0.371	0.445

r^2 = 19.0% r = 0.435

TABLE 37: RELIEF FORMS AND LAND USE.
PREGLEDNICA 37: RELIEFNE OBLIKE IN RABA TAL.

relief forms	field	meadow	field/meadow	forest
valleys	0.511	0.036	0.009	0.002
slopes of hills	0.020	0.245	0.045	0.320
ridges of hills	0.003	0.010	0.400	0.025
total	0.534	0.291	0.454	0.347

r^2 = 31.3% r = 0.559

TABLE 38: SOILS AND LAND USE.
PREGLEDNICA 38: PRSTI IN RABA TAL.

type of soil	field	meadow	field/meadow	forest
rendzina	0	0.007	0	0.257
eutric brown	0.053	0.053	0.120	0.003
dystric brown	0.011	0.178	0.040	0.044
slope pseudogley	0.011	0.069	0.025	0.178
riverbank	0.020	0.080	0.045	0.005
gleyic-ameliorated	0.028	0.010	0.044	0
total	0.375	0.397	0.274	0.487

r^2 = 17.7% r = 0.422

TABLE 39: REGIONAL ECOLOGICAL UNITS AND LAND USE.
PREGLEDNICA 39: POKRAJINSKO EKOLOŠKE ENOTE IN RABA TAL.

REU	field	meadow	field/meadow	vineyard	forest	built-up	infertile
A	0.034	0.367	0.067	0	0	0	0
B	0.704	0.009	0	0	0	0	0.02
C	0.002	0.015	0.047	0	0.069	0.1	0
D	0	0	0.017	0.023	0.492	0	0
E	0	0	0.306	0.033	0.030	0	0
total	0.740	0.391	0.437	0.056	0.591	0.1	0.02

r^2 = 33.4% r = 0.578

Key for Western Part of Slovenske gorice

REU A is defined in flatland in the valleys of tributaries of the pesnica river that are composed of holocene sandy clay and loam alluvia, at the altitude of 240 to 250 m. Due to recent accumulation and flow of slope waters into the valleys, retained water periodically occurs in the lower parts of riverbank soil profiles.

EG A1 – riverbank soil along the streams is locally gleyic on sandy clay loam alluvia

U $A1_1$ – Meadows on Riverbank Soil
U $A1_2$ – Cultivated fields on Riverbank Soil

REU B is defined in flatland in the valley of the pesnica river that is composed of pleistocene and holocene silty loam alluvia, at the altitude of 230 to 240 m. Due to its valley site and the silty loam lithological parent material, water is regularly retained in the soil profile causing the processes of gleying and hydromorphic soils. For the needs of agriculture, the soils have been hydroameliorated and their purpose completely changed.

EG B1 – hydroameliorated hypogley on silty loam alluvia

U $B1_1$ – ameliorated cultivated fields on hypogley
U $B1_2$ – infertile

REU C is defined in marl hills in the central part of the test area with the altitude of 280 to 400 m. Due to strong surface denuding, solifluction material is found at the transition of hills to flatland. Here slope pseudogleys have developed, while on the denuded surfaces and ridges eutric and dystric soils have developed.

EG C1 – slope pseudogley at the foot of slopes on solifluction material

U $C1_1$ – cultivated fields, meadows, and scattered settling on gentle slopes on slope pseudogley
U $C1_2$ – acidophilic beech and chestnut forest on steep northern slopes on pseudogley

EG C2 – plowed soil and eutric brown, pseudogleyic on clay marl

U $C2_1$ – plowed soil with vineyards
U $C2_2$ – cultivated fields and meadows and scattered settling on eutric, brown, pseudogleyic soil
U $C2_3$ – acidophilic beech and chestnut forest on eutric brown, pseudogleyic soil

EG C3 – eutric brown soil on sandy marl

U $C3_1$ – cultivated fields and meadows on eutric brown soil
U $C3_2$ – acidophilic beech and chestnut forest on steep northern sites on eutric brown soil
U $C3_3$ – built-up

REU D is defined in hills composed of plio-quaternary sands and gravels in the northeastern part of the slovenske gorice test area. Due to the varying resistance of the lithological parent material, the relief with altitudes from 300 to 500 m is undulating on unbound lithological parent material, eutric and dystric soils with the prevailing forest use are interwoven.

EG D1 – eutric brown soils and plowed soils on sands and gravels

U $D1_1$ – cultivated fields and meadows on eutric brown soil
U $D1_2$ – vineyards on plowed soils
U $D1_3$ – hornbeam forest along the catchment areas of streams on eutric brown soils
U $D1_4$ – acidophilic beech and chestnut forest on eutric brown soils

REU E is defined in the hills of tertiary limestone (lithotamnium) and lime sandstone. The undulating relief at the altitude of 350 to 500 m south of the pesnica valley is the consequence of the resistance of limestone to physical weathering. On hard carbonate stone, pseudokarstic processes and denuding dominate. On limestone, rendzinas are found, and on lime sandstone, eutric and dystric soils.

EG E1 – rendzina on lithotamnium limestone

U $E1_1$ – meadows on rendzina
U $E1_2$ – hornbeam forest with *Luzula luzuloides* (Lam.) along the catchment areas of streams on rendzina
U $E1_3$ – acidophilic beech and chestnut forest on rendzina

EG E2 – eutric brown soil on tertiary limestone and sandstone

U $E2_1$ – cultivated fields and meadows on eutric brown soil
U $E2_2$ – acidophilic beech and chestnut forest on eutric brown soil

EG E3 – dystric brown and plowed soil on lime flint sands

U $E3_1$ – vineyards on plowed soil
U $E3_2$ – cultivated fields and meadows on dystric brown soil
U $E3_3$ – acidophilic beech and chestnut forest on dystric brown soil

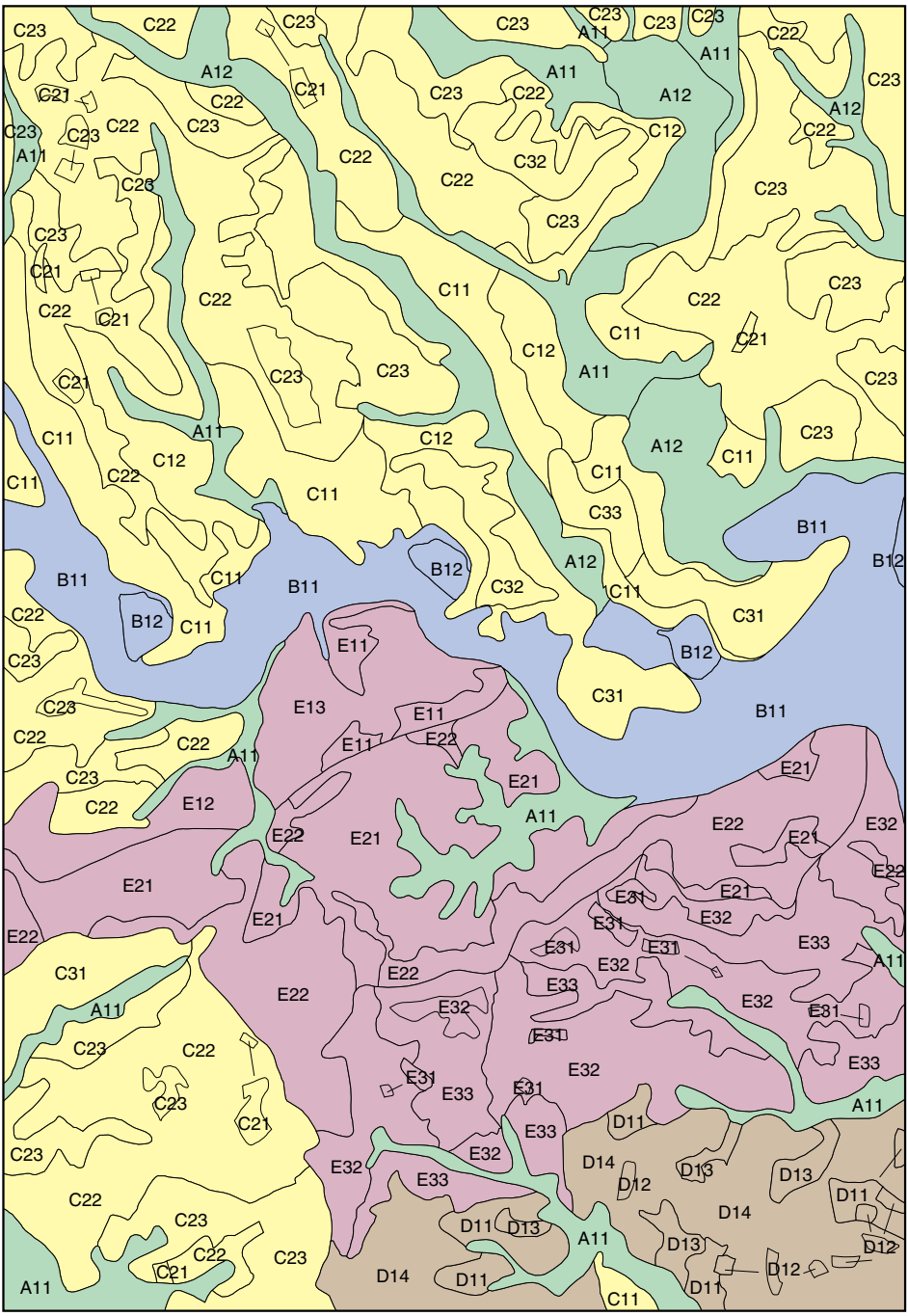


Figure 29: Map of Ecotopes in the Western Part of Slovenske gorice (map covers the area of TK-25 Lenart).
Slika 29: Ekotopi zahodnega dela Slovenskih goric (karta obsega list TK-25 Lenart).

The representative profile for Slovenske gorice is III/1-D in the central part of the hills.

Profile III/1-D
REGIONAL ECOLOGICAL UNIT: E
ECOTOPE GROUP: E3
ECOTOPE: $E3_8$
SITE: SLOVENSKE GORICE
Altitude: 410 m
Slope: 18°
Exposure: W
Relief Form: Hills
LITHOLOGICAL PARENT MATERIAL: Clay Loam
WATER CONDITIONS:
Potential Evapotranspiration (corrected) annual: 661.8 mm
Difference (precipitation – PE corrected) annual: 250.8 mm
Surplus of water: 187.8 mm
Deficit of water: 52.34 mm
Soil Moisture Index: 20.49
Climate type: $B_1rB_2b_3$
CLIMATE:
Temperatures: Mean Annual: 9.9 °C
Mean April–September: 16.2 °C
Precipitation: Annual Amount: 933 mm
Number of Days > 20 mm: 7.5
Mean Quantity April–September 549 mm
VEGETATION/USE OF SOIL: Chestnut and Beech Forest (*Castaneo Fagetum sylvaticae*)
SOILS: gleyic acidic loam clay soil, PVK 159 mm

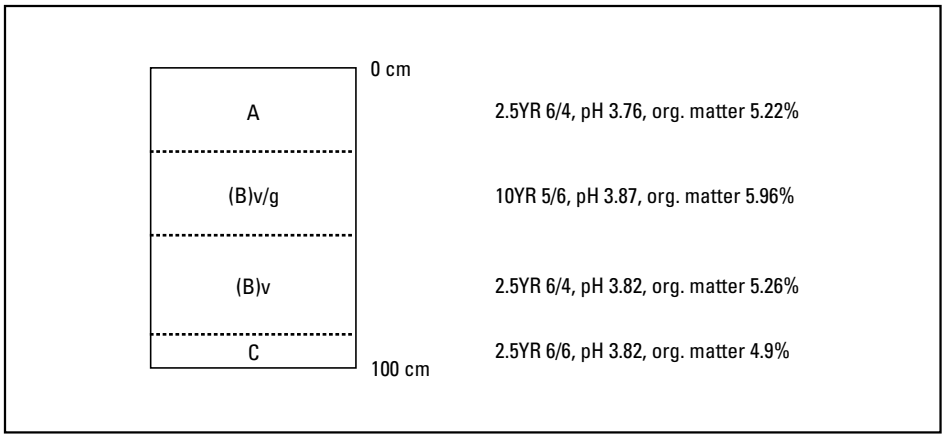


Figure 30: Description of profile III/1-D.
Slika 30: Opis profila III/1-D.

TABLE 40: MECHANICAL COMPOSITION OF PROFILE III/1-D.
PREGLEDNICA 40: MEHANSKA SESTAVA ZA PROFIL III/1-D.

horizon	sand % 2–0.02 mm	silt % 0.02–0.002 mm	clay % < 0.002 mm
A	35.1	34.9	30.0
(B)v/g	39.7	26.6	34.1
(B)v	46.6	26.2	27.2
C	49.5	29.5	21.0

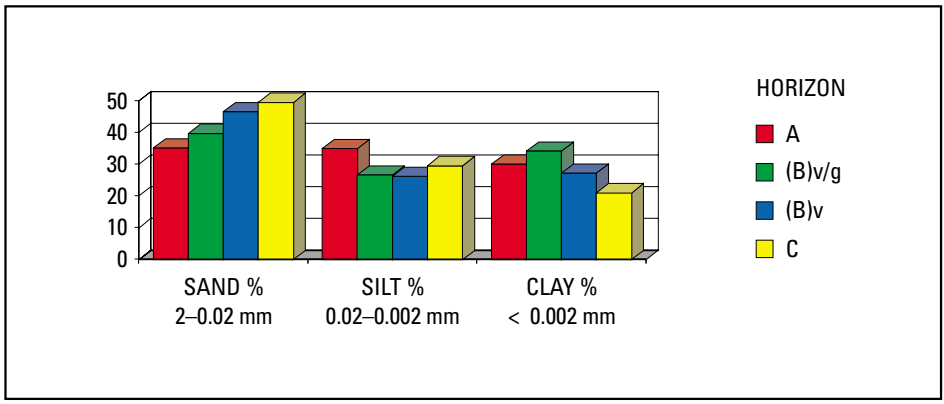


Figure 31: Mechanical Composition of Profile III/1-D.
Slika 31: Mehanska sestava za profil III/1-D.

TABLE 41: VOLUME OF MATTER, AIR, AND WATER IN PROFILE III/1-D.
PREGLEDNICA 41: PROSTORNINA SUBSTANCA, ZRAKA IN VODE V PROFILU III/1-D.

horizon	volume of matter %	volume of air %	volume of water %
A	55.2	0	46.0
(B)v/g	50.2	7.9	42.0
(B)v	52.6	7.4	40.0
C	53.9	4.1	42.0

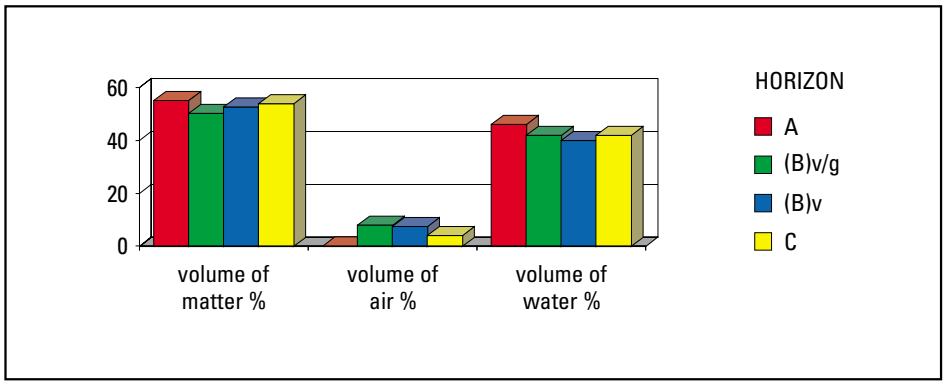


Figure 32: Volume Composition of Profile III/1-D.
Slika 32: Prostorninska sestava za profil III/1-D.

TABLE 42: OTHER PROPERTIES OF THE SOIL OF PROFILE III/1-D.
PREGLEDNICA 42: DRUGE LASTNOSTI PRSTI ZA PROFIL III/1-D.

horizon	depth cm	texture	Vkmax %	Kf cm/sec · 10^{-3}	V %
A	0–25	IG	46.5	2.52	23.7
(B)v/g	25–50	IG	59.4	2.67	24.1
(B)v	50–75	GI	57.0	2.57	22.6
C	75–100	GI	51.9	3.46	22.3

Explanation of profile: yellow-brown horizon A has IG texture. It is very acidic, rich with humus, and moist. Horizon (B)v/g contains 34.1% clay and reflects pseudogleying. below it, at the depth of 50 cm lies horizon (B)v, directly above the bedrock. Less than 10% of the volume of pores is filled with air while the remaining pore space is filled with water, and therefore the soil is moist.
On growing areas where pseudogleying appears due to the surplus of water, acidophilic chestnut and beech forest (*Castaneo Fagetum sylvaticae*) grow.

6.1.6. The Prekmurje Plain

Two REU's are defined in the Prekmurje Plain:
REU A is defined in flatland composed of Holocene gravel alluvia at the altitude of 180 to 190 m. Its soils are mostly well porous for water, and at the depth of around 50 cm the influence of underground water appears. Dystric gleyic soils have developed, among which prevail dystric non-gleyic, rankers, pseudogleys, and riverbank soils with prevailing field use.
The REU A area encompasses the gravelly part of the Prekmurje Plain (in the test area south of Murska Sobota) and Sebeborska terasa. Its altitude increases toward the north: In the southern part of REU A, the most frequent altitude is 180 m, while in the north it is 200 to 230 m. The average annual temperature is 9.2 °C, in the vegetation period 15.7 °C, in the summer 18.4 °C, and in the winter –0.8 °C. The annual precipitation of 817 mm does not suffice for evaporation, and for six months the quantity of precipitation is lower than the height of evapotranspiration. The annual deficit of water totals 35.2 mm and because the annual surplus (34.26 mm) is lower than the deficit, a negative value for the soil moisture index of –1.6 appears, which means a subhumid climate.
The prevailing types of soils are ranker, dystric brown, and flatland pseudogley. The latter developed on the terrace below the foot of Goričko where the slowly running Goričko streams deposit eroded material. Distinct cultivated field use prevails, especially on ranker, while on flatland pseudogley forest appears along smaller streams.

TABLE 43: PROPORTIONS OF LAND USE IN REU A.
PREGLEDNICA 43: DELEŽI RABE TAL V PEE A.

land use	proportion %
field	64
meadow	10
meadow/field	6
forest	5
built-up	8
infertile	2

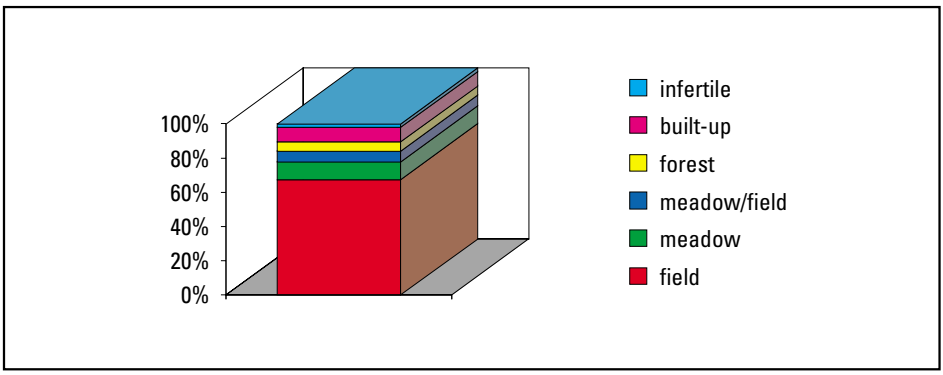


Figure 33: Land Use in REU A.
Slika 33: Raba tal v PEE A.

Cultivated field land use in the REU A area is linked to riverbank soils and rankers that, according to the data on the *Pedological Map of Murska Sobota* (*Osnovna pedološka karta*, 1983), are loam in texture and belong to the first or second quality class for agriculture. Laboratory data for profile IV/3-1 indicates riverbank eutric soil devoted to cultivated field use. According to findings (Stepančič, 1984), this type of soil is porous for water with a low PVK and acidic reaction and consequently a low degree of saturation with bases and is therefore poorly supplied with nourishment. In spite of these natural limitations, there are cultivated fields on riverbank soils and rankers, although they are sensitive to drought.

REU B is defined in flatland composed of Pleistocene and Holocene loam and silty loam alluvia at the altitude of 180 to 200 m where the percolation of water is hindered. Due to permanently retained water in the soil profile, processes of gleying prevail. For agricultural use, extensive surfaces of hydromorphic soils have been hydroameliorated.

The REU B area encompasses the central part of the Prekmurje Plain that is composed of Pleistocene and Holocene clay and silty alluvia that are poorly porous for water; thus, the soils are gleyic and marshy. These hypogleys are largely hydroameliorated, covered by compact agricultural surfaces. Furthermore, the streams are all regulated, and the Ledava River has been bypassed with a channel. The soils in the REU B area have therefore been very much changed by man.

TABLE 44: PROPORTIONS OF LAND USE IN REU B.
PREGLEDNICA 44: DELEŽI RABE TAL V PEE.

land use	proportion %
field	30
meadow	30
meadow/field	4
forest	30
built-up	5
infertile	1

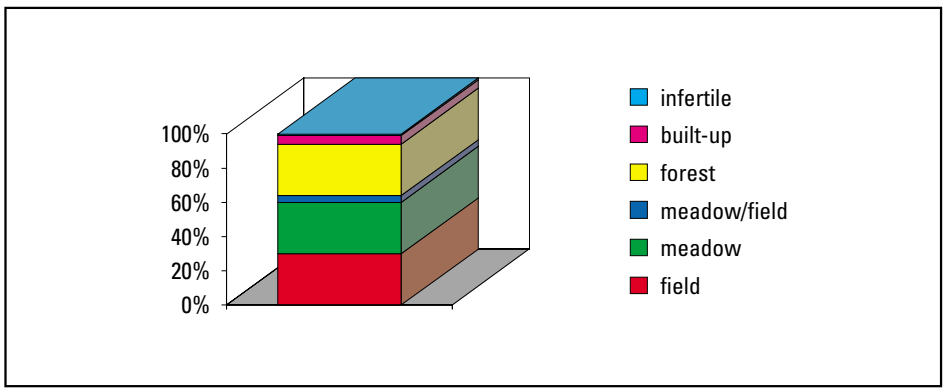


Figure 34: Land Use in REU B.
Slika 34: Raba tal v PEE B.

On the silty and loam alluvia, heavy soils according to texture developed, hypogleys and amfigleys that are a natural growing place for marshy meadows, although today, due to amelioration, there are also cultivated field surfaces. Cultivated fields, meadows, and forests are similarly represented in the test area, even though the hydromorphic soils are only in the fourth class according to land classification. Excavated profiles showed an unnatural structure of the profiles on ameliorated surfaces (profile IV/3-A).

Key for the Prekmurje Plain

REU A is defined in flatland composed of holocene gravel alluvia at the altitude of 180 to 190 m. Its soils are mostly well porous for water, and at the depth of around 50 cm the influence of underground water appears. Dystric gleyic soils have developed, among which prevail dystric non-gleyic, rankers, pseudogleys, and riverbank soils with prevailing field use.

EG A1 – dystric brown soils on Holocene gravel alluvia, with field and forest use
U $A1_1$ – cultivated fields on dystric brown, gleyic soil
U $A1_2$ – cultivated fields on dystric brown, non-gleyic soil
U $A1_3$ – meadows on dystric brown, gleyic soil
U $A1_4$ – hornbeam forest with *Luzula luzuloides* (Lam.) with meadows on dystric gleyic soil
U $A1_5$ – built-up

EG A2 – shallow riverbank soils on gravel alluvia
U $A2_1$ – cultivated fields on riverbank soil
U $A2_2$ – hornbeam forest with *Luzula luzuloides* (Lam.) on riverbank soil
U $A2_3$ – built-up
U $A2_4$ – infertile

EG A3 – dystric ranker on gravel alluvia
U $A3_1$ – cultivated fields on dystric ranker
U $A3_2$ – meadows on dystric ranker
U $A3_3$ – infertile
U $A3_4$ – built-up

EG A4 – flatland pseudogley on loam gravel terrace
U $A4_1$ – cultivated fields on flatland pseudogley
U $A4_2$ – cultivated fields and meadows on flatland pseudogley
U $A4_3$ – hornbeam forest with *Luzula luzuloides* (Lam.) on flatland pseudogley
U $A4_4$ – built-up
U $A4_5$ – infertile

EG A5 – riverbank soils on sandy loam alluvia along streams
U $A5_1$ – meadows on riverbank soils
U $A5_2$ – hornbeam forest with *Luzula luzuloides* (Lam.) on riverbank soil
U $A5_3$ – *Alnus glutinosa* (L.) and *Carex elongata* (L.) on riverbank soil

REU B is defined in flatland composed of pleistocene and holocene loam and silty loam alluvia at the altitude of 180 to 200 m where the percolation of water is hindered. Due to permanently retained water in the soil profile, processes of gleying prevail. For agricultural use, extensive surfaces of hydromorphic soils have been hydroameliorated.

EG B1 – hypogley on clay alluvia
U $B1_1$ – ameliorated cultivated fields on hypogley
U $B1_2$ – meadows on hypogley
U $B1_3$ – hornbeam forest with *Luzula luzuloides* (Lam.)
U $B1_4$ – built-up

EG B2 – strong mineral hypogley on silty clay alluvia
U $B2_1$ – meadows on strong mineral hypogley

EG B3 – dystric gleyic soil on clay alluvia
U $B3_1$ – meadows and cultivated fields on dystric gleyic soil
U $B3_2$ – ameliorated cultivated fields on dystric gleyic soil
U $B3_3$ – built-up
U $B3_4$ – infertile

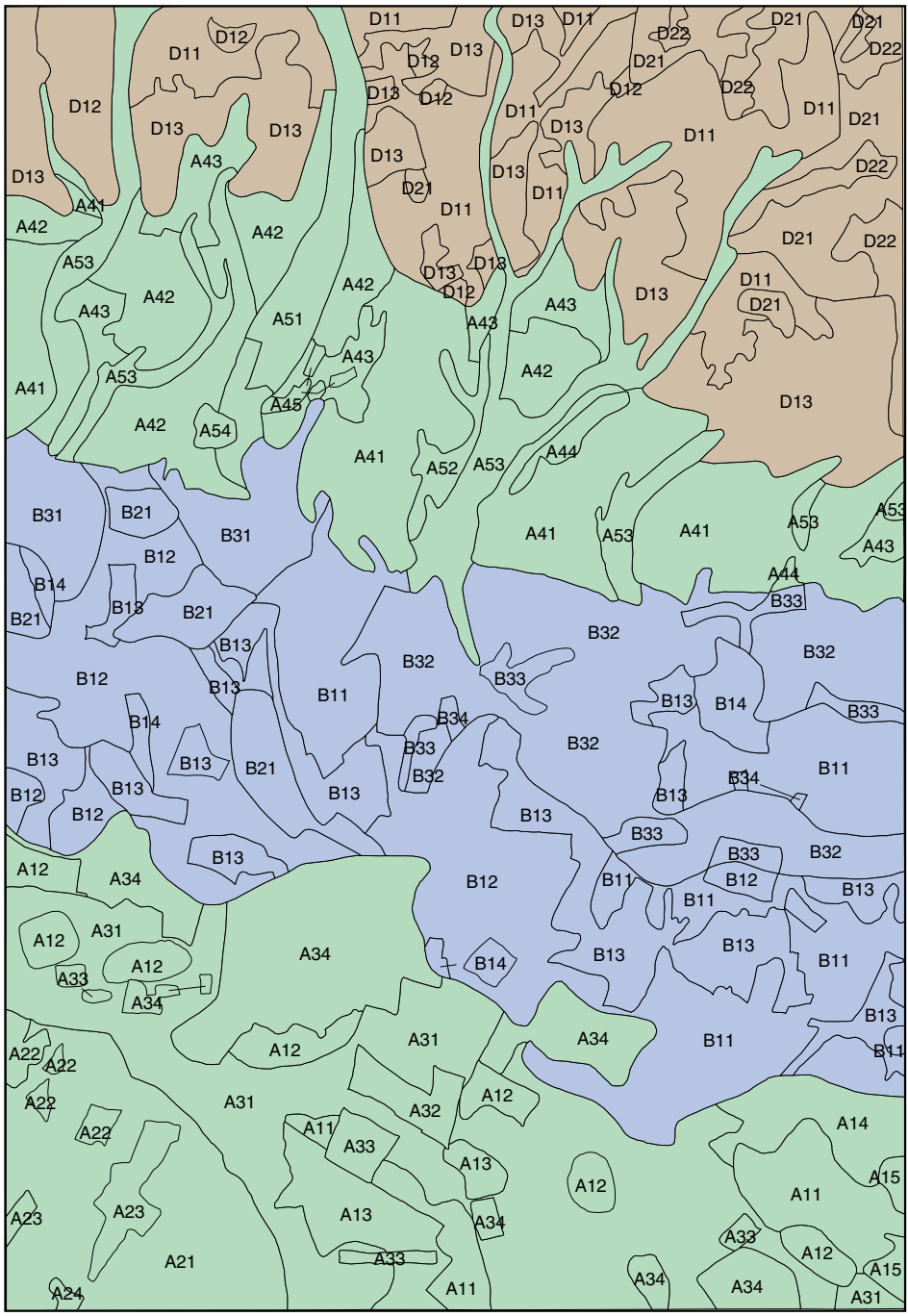


Figure 35: Map of Ecotopes in the Prekmurje Plain and Southern Goričko (map covers the area of TK-25 Murska Sobota).
Slika 35: Ekotopi na Pomurski ravani in južnem Goričkem (karta obsega list TK-25 Murska Sobota).

CONNECTION OF NATURAL ELEMENTS AND REU'S WITH LAND USE IN THE PREKMURJE PLAIN

TABLE 45: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 45: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	field	meadow	field/meadow	forest	settled
gravel	0.189	0.033	0.064	0.021	0.131
clay, silt alluvia	0.052	0.181	0.136	0.206	0.081
total	0.241	0.214	0.200	0.227	0.212

r^2 = 9.4% r = 0.306

TABLE 46: SOILS AND LAND USE.
PREGLEDNICA 46: PRSTI IN RABA TAL.

type of soil	field	meadow	field/meadow	forest	built-up
ranker	0.090	0.003	0.010	0.022	0.16
dystric brown	0.003	0.008	0.008	0.008	0.033
pseudogley	0.005	0.080	0.005	0.080	0
riverbank	0.013	0.212	0.053	0.090	0.037
ameliorated gleyic.	0.135	0.007	0.167	0.027	0.042
total	0.246	0.310	0.243	0.227	0.272

r^2 = 7.45% r = 0.273

TABLE 47: REGIONAL ECOLOGICAL UNITS AND LAND USE.
PREGLEDNICA 47: POKRAJINSKO EKOLOŠKE ENOTE IN RABA TAL.

REU	field	meadow	field/meadow	forest/meadow	forest	built-up	infertile
A	0.435	0.025	0.036	0.007	0.007	0.049	0.001
B	0.096	0.225	40.016	0.257	0.257	0.019	0.001
total	0.531	0.250	0.052	0.264	0.264	0.068	0.002

r^2 = 16.7% r = 0.409

The representative profile for ecotopes in the Prekmurje Plain lies in an ameliorated area encompassing the northern part of the Prekmurje Plain to the terraced foot of Goričko.

Profile IV/2-C
REGIONAL ECOLOGICAL UNIT: B
ECOTOPE GROUP: B3
ECOTOPE: $B3_2$
SITE: THE PREKMURJE PLAIN
Altitude: 220 m
Slope: –
Exposure: –
Relief Form: flatland
LITHOLOGICAL PARENT MATERIAL: loam alluvia
WATER CONDITIONS:
Potential Evapotranspiration (corrected.) annual: 709.5 mm
Difference (Precipitation – PE corrected.) annual: 104.5 mm
Surplus of Water: 43.9 mm
Deficit of Water: 44.2 mm
Soil moisture index: 0

Climate Type: $C_2rB_1b_3$
CLIMATE:
Temperatures: Mean Annual: 9.2 °C
Mean April–September: 15.7 °C
Precipitation: Annual Amount: 817 mm
No of Days with >20 mm: 6.5
Mean April–September: 516 mm
VEGETATION/LAND USE: cultivated field
SOILS: ameliorated gleysol with PVK 119 mm

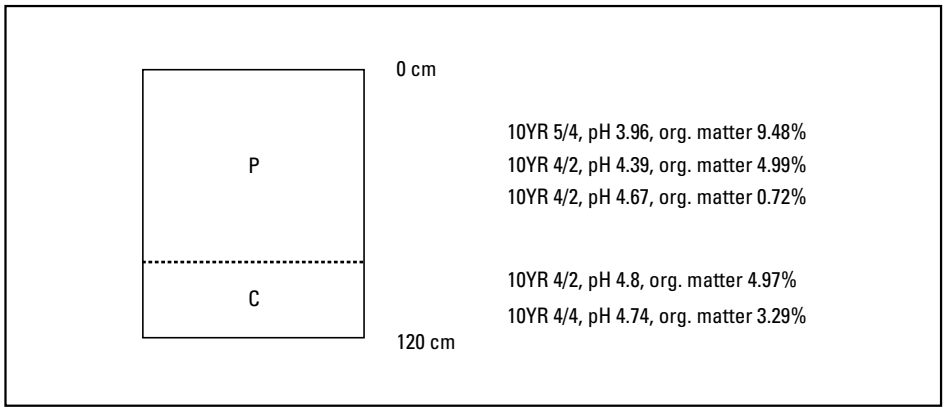


Figure 36: Description of profile IV/2-C.
Slika 36: Opis profila IV/2-C.

TABLE 48: MECHANICAL COMPOSITION OF PROFILE IV/2-C.
PREGLEDNICA 48: MEHANSKA SESTAVA ZA PROFIL IV/2-C.

horizon	sand % 2–0.02 mm	silt % 0.02–0.002 mm	clay % <0.002 mm
P	62.6	30.6	6.8
P	53.2	21.2	25.6
P	37.8	27.0	35.2
C	63.0	8.0	29.0
C	70.2	10.5	19.3

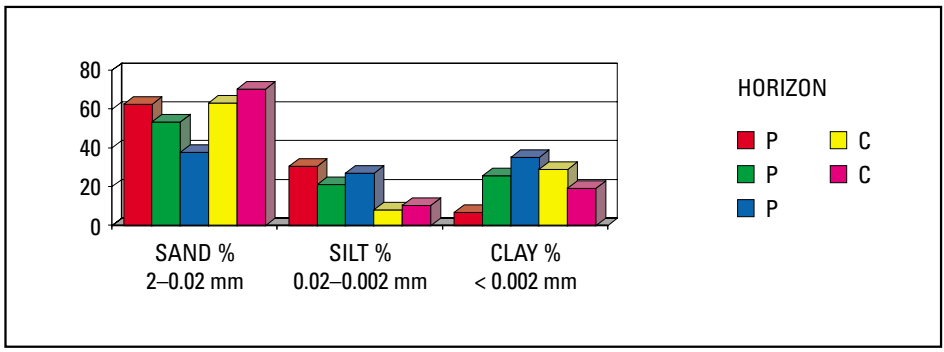


Figure 37: Mechanical Composition of Profile IV/2-C.
Slika 37: Mehanska sestava za profil IV/2-C.

TABLE 49: VOLUME OF MATTER, AIR, AND WATER OF PROFILE IV/2-C.
PREGLEDNICA 49: PROSTORNINA SUBSTANCE, ZRAKA IN VODE ZA PROFIL IV/2-C.

horizon	volume of matter %	volume of air %	volume of water %
P	41.6	15.4	43.0
P	46.9	18.1	35.0
P	69.5	0	43.0
C	–	–	–
C	–	–	–

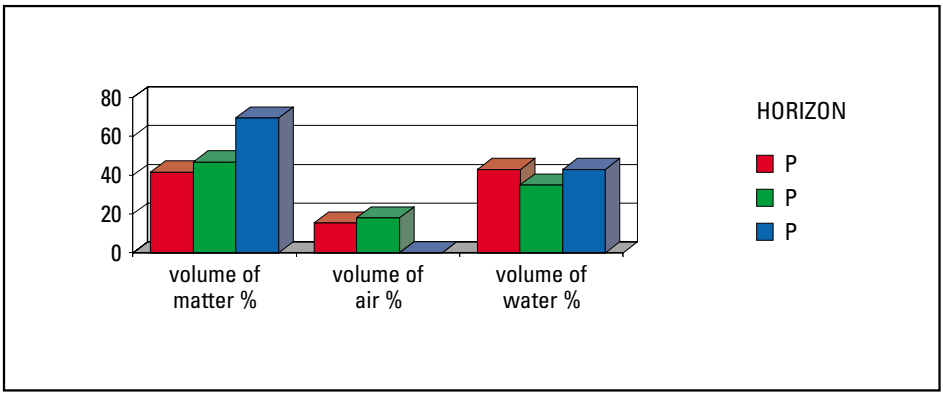


Figure 38: Volume Composition of Profile IV/2-C.
Slika 38: Prostorninska sestava za profil IV/2-C.

TABLE 50: OTHER SOIL PROPERTIES OF PROFILE IV/2-C.
PREGLEDNICA 50: DRUGE LASTNOSTI PRSTI ZA PROFIL IV/2-C.

horizon	depth cm	texture	Vkmax %	Kf cm/sec · 10^{-3}	V %
P	0–25	I	53.9	1.72	29.3
P	25–50	IG	43.8	4.17	20.7
P	50–75	IG	49.1	2.21	26.5
C	75–100	PG	–	–	17.2
C	100–120	PGI	–	–	11.0

Explanation of the profile: properties of gleysol are unnatural due to amelioration encroachments. In the past, the northern part of the Prekmurje Plain was overgrown with wet meadow and forest while today there are cultivated fields on these growing places. The plowed horizon is deeper than it is in unameliorated cultivated fields and reaches 75 cm deep. Pores are up to three quarters filled with water which still indicates moist conditions.

6.1.7. Southern Goričko

The test area is defined as a single REU with interacting natural and human elements:
REU D is defined in gentle hills composed of Pliocene loam with flint gravel at an altitude of 270 to 350 m. The prevailing soils are slope pseudogleys that are interwoven with dystric brown soils; rankers are found on the tops of ridges with strong denuding.
Southern Goričko as a whole is defined as REU D. The average annual temperature is 9.3 °C, in the vegetation period 15.6 °C, in the summer 18.3 °C, and in the winter –0.3 °C. The annual precipitation of 806 mm does not suffice to cover the demands of evapotranspiration, and therefore a deficit

of water of 20.56 mm occurs from May to September. Because the annual surplus of water in the soil is 81.99 mm and because the slope pseudogley has a high PVK (122 mm), drought affects the slope pseudogleys less than the rankers on gravel. The soil moisture index is thus positive and totals 19.09.

TABLE 51: PROPORTIONS OF LAND USE IN REU D.
PREGLEDNICA 51: DELEŽI RABE TAL V PEE D.

land use	proportion %
meadow/field	45
forest	54
vineyard	1

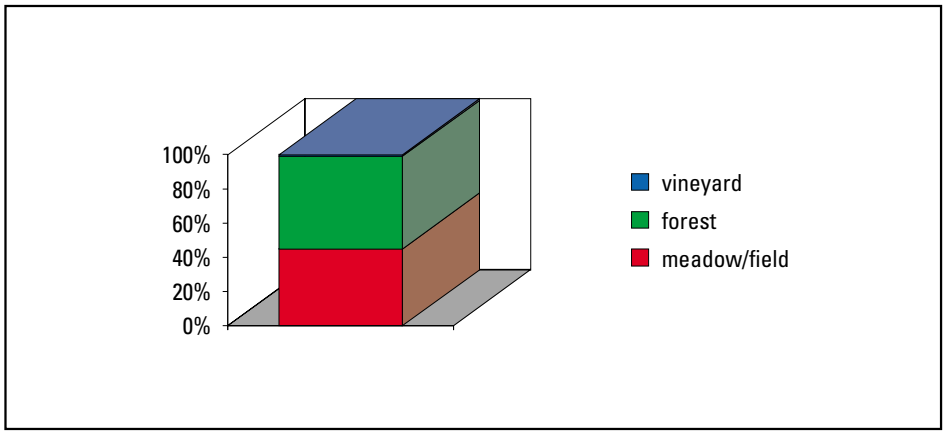


Figure 39: Land Use in REU D.
Slika 39: Rava tal v PEE D.

The prevailing forest land use in Southern Goričko is an interacting of unfavourable natural conditions and excessive human encroachment in the past. Rankers have developed on the Pliocene loam with flint gravel on the ridges, dystric soils on the slopes, and pseudogleys at the transition to the Prekmurje Plain, which according to the *Pedological Map of Murska Sobota* classify into third, fifth, and sixth quality groups, respectively. The poor properties, especially the lack of water, low PVK, and poor saturation with bases are reflected in profile IV/3-4.
See figure 35: Map of Ecotopes for the Prekmurje Plain and Southern Goričko (map covers the area of TK-25 Murska Sobota).
Glej sliko 35: Ekotopi na Prekmurski ravani in v južnem Goričkem (karta obsega list TK-25 Murska Sobota).

Key for Southern Goričko

REU D is defined in gentle hills composed of pliocene loam with flint gravel at an altitude of 270 to 350 m. The prevailing soils are slope pseudogleys that are interwoven with dystric brown soils; rankers are found on the tops of ridges with strong denuding.

EG D1 – slope pseudogley and plowed soils on Pliocene loam
U $D1_1$ – meadows on slope pseudogley
U $D1_2$ – vineyards on plowed soil
U $D1_3$ – association of *Pinus silvestris* and *Galium rotundifolium* (L.) on slope pseudogley
EG D2 – dystric brown soil and ranker on loam with flint gravels
U $D2_1$ – cultivated fields on dystric brown soil
U $D2_2$ – association of *Pinus silvestris* with *Galium rotundifolium* (L.) on dystric ranker

CONNECTION OF NATURAL ELEMENTS AND REU'S WITH LAND USE IN SOUTHERN GORIČKO

TABLE 52: LITHOLOGICAL PARENT MATERIAL AND LAND USE.
PREGLEDNICA 52: LITOLOŠKA OSNOVA IN RABA TAL.

lithological parent material	field/meadow	forest
gravel	0.072	0.223
loam	0.441	0.291
total	0.513	0.514

$r^2 = 2.7\%$ $r = 0.164$

TABLE 53: SOILS AND LAND USE.
PREGLEDNICA 53: PRSTI IN RABA TAL.

type of soil	field/meadow	forest
ranker	0.007	0.257
dystric brown	0.402	0.152
pseudogley	0.150	0.150
total	0.559	0.559

$r^2 = 11.8\%$ $r = 0.343$

The calculated correlation coefficients point to a medium to very high degree of connectedness among the natural elements, the REU, and land use. Areas that have been anthropogenically less altered show the highest degree of connectedness, and vice versa.

7. The Importance of Delineating Regional Ecological Units

Knowing the extent, surface area, and characteristics of an REU enables comparison with existing land use. Individual kinds of land use demand certain conditions that are interactively created by abiotic and biotic factors. The importance of delineating REU's is based on ascertaining the appropriateness of land use especially with regard to natural conditions whose reciprocal interweaving forms the REU's. It has been demonstrated roughly that land use (in test areas) is determined by the natural conditions, but a more detailed analysis of land use showed deviations in the direction of anthropogenic encroachments that direct the use of land.

Table 54 shows the prevailing land use in REU's A, B, C, D, E, and F by test areas where the land use depends on natural factors in REU A and REU E, on human factors in REU B, and on natural and human factors in REU C, REU D, and REU F.

Land use is connected with specific natural elements with varying intensity. Below, the test areas are classified according to the intensity of connectedness between natural elements and land use, which is denoted with a rank of connectedness. Comparison of test areas according to this ranking shows the importance of individual elements for land use.

TABLE 54: LAND USE ACCORDING TO REGIONAL ECOLOGICAL UNITS.
PREGLEDNICA 54: RABA TAL PO POKRAJINSKO EKOLOŠKIH ENOTAH.

test areas – REE	A	B	C	D	E	F
Dravinjske gorice	meadow	ameliorated field. forest	meadow, field. vineyard, forest	forest, meadow, field	–	–
Bočko hribovje	–	–	–	–	forest	forest
Dravsko polje	field, settled	ameliorated field, meadow, forest	–	–	–	–
Eastern Pohorje	–	–	–	meadow, built-up	–	vineyard, forest, meadow
Western. Part of Slovenske gorice	meadow	ameliorated field	meadow, field, vineyard, forest	meadow, field, forest	meadow, forest	–
Prekmurje Plain	field, settled	ameliorated field	–	–	–	–
Southern Goričko	–	–	–	meadow, forest	–	–

TABLE 55: CONNECTEDNESS OF LITHOLOGICAL PARENT MATERIAL AND LAND USE BY TEST AREA.
PREGLEDNICA 55: POVEZANOST LITOLOŠKE OSNOVE IN RABE TAL PO TESTNIH OBMOČJIH.

test area	r^2 %	r	rank of connectedness
Dravinjske gorice	59.2	0.769	1. hills
Bočko hribovje	21.8	0.467	2. mountains
Slovenske gorice	19.0	0.435	3. hills
Pohorje	11.8	0.343	4. mountains
Dravsko polje	10.1	0.317	5. flatland
Prekmurje Plain	9.4	0.306	6. flatland
Southern Goričko	2.7	0.164	7. hills

The importance of lithology for the distribution of individual categories of land use is evident from the rank of connectedness between lithological parent material and land use in hills and mountains (Dravinjske gorice, Slovenske gorice, and Bočko hribovje).

TABLE 56: CONNECTEDNESS OF RELIEF FORMS AND LAND USE BY TEST AREA.
PREGLEDNICA 56: POVEZANOST OBLIK RELIEFA IN RABE TAL.

test area	r^2	r	rank of connectedness
Dravinjske gorice	56.8	0.754	1. hills
Slovenske gorice	31.3	0.559	2. hills

In the test areas of Bočko hribovje, Dravsko polje, Eastern Pohorje, and the Prekmurje Plain, only one relief form occurs, either flatland or hill, and therefore has no decisive role within the individual REU's regarding differences in land use. In the hills, medium high connectedness was indicated.

TABLE 57: CONNECTEDNESS OF TYPES OF SOIL AND LAND USE BY TEST AREA.
PREGLEDNICA 57: POVEZANOST TIPOV PRSTI IN RABE TAL PO TESTNIH OBMOČJIH.

test area	r^2 %	r	rank of connectedness
Bočko hribovje	97.7	0.980	1. mountains
Pohorje	66.1	0.813	2. mountains
Dravinjske gorice	34.8	0.590	3. hills
Slovenske gorice	17.7	0.422	4. hills
Dravsko polje	17.5	0.419	5. flatland
Goričko	11.8	0.343	6. hills
Prekmurje Plain	7.45	0.273	7. flatland

The connection between the properties of soils and land use is most evident in the hills where erosion and denuding processes are most evident and encroachments by man that altered the properties of the soil are least compared to the flatlands where current land use is not just the consequence of soil properties.

TABLE 58: CONNECTEDNESS OF REU'S AND LAND USE BY TEST AREA.
PREGLEDNICA 58: POVEZANOST PEE IN RABE TAL PO TESTNIH OBMOČJIH.

test area	r^2 %	r	rank of connectedness
Bočko hribovje	98.5	0.992	1. mountains
Pohorje	41.4	0.644	2. mountains-hills
Dravsko polje	38.5	0.620	3. flatland
Southern Goričko	38.1	0.617	4. hills
Slovenske gorice	33.4	0.578	5. hills
Dravinjske gorice	29.8	0.545	6. hills
Prekmurje Plain	16.7	0.409	7. flatland

The closest connection between REU's and land use exists on landscapes homogeneous in the lithological, relief. and pedological features that also enabled the delineation of the REU's.
The comparison of land use according to abiotic and biotic factors thus indicates:

1. Land use depends on natural factors in smaller valleys, while in larger valleys and flatlands it is determined by human factors (hydro- and agroameliorations and commassation).
2. Favourable natural conditions (relief, climate, soils) do not necessarily mean intensive land use due to historic and human influences. Sixty-five per cent of Dravinjske gorice, for example, is covered with forest although its relief forms are mild, the soils are eutric, and there is no lack of water. The reason is the general lack of development of the region; in Southern Goričko, acidophilic pine forest prevails although according to its climate and pedological conditions, a different forest association could thrive there. The reason lies in the degradation of forest growing places in the past.
3. Specific kinds of land use also appear on naturally unfavourable sites, and often the presence of only one "favourable" natural or human element is enough for intensive land use: cultivated fields and settlements appear on amfigleys because the influence of water has been mitigated (hydroamelioration); vineyards appear on marl lithological parent material in spite of northern sites and smaller slopes; vineyards and orchards are found on warm exposures in spite of acidic and dystric soils; and cultivated fields are found on eutric soils in spite of steeper slopes.

The correspondence of land use with natural elements reflected in interaction with the properties of the soils varies in the test areas in northeastern Slovenia:

1. LAND USE IN HARMONY WITH NATURAL ELEMENTS:
   - Bočko hribovje – (very high connectedness 0.98), steep relief – altitude above 500 m – humid climate – rendzinas – forest
   - Eastern Pohorje – (very high connectedness 0.813), hills above valley bottom – metamorphic lithological parent material – warm sites – eutric soils – vineyards and mountains – altitude over 500 m – steep relief – dystric soils – forest

2. LAND USE PARTLY IN HARMONY WITH NATURAL ELEMENTS:
   - Dravinjske gorice – (medium connectedness 0.59), valleys of rivers and streams – sandy loam alluvia – riverbank soils – meadows and built-up areas) and hills composed of loam with sand and gravel – gentle slopes – eutric brown soil – forest
   - Western Part of Slovenske gorice – (medium connectedness 0.422), marl lithological parent material – steep slopes – eutric soils – cultivated fields and ridges of slopes – gentle slopes – eutric and dystric soil – cultivated field, meadow, and forest use
   - Dravsko polje – (medium connectedness 0.419), silty clay alluvia – flatland – hydromorphic gleyic soils – cultivated fields and acidic gravel – flatland – dystric ranker – cultivated fields
3. LAND USE NOT IN HARMONY WITH NATURAL ELEMENTS
   - Southern Goričko – (low connectedness 0.343), gently rounded slopes – Pliocene loam with gravel – dystric soils – forest
   - Prekmurje Plain – (low connectedness 0.273), acidic gravel – flatland – dystric ranker – cultivated fields and clay alluvia – flatland – hydromorphic gleyic soils – cultivated fields

Disharmony of land use with natural elements is shown in various forms of degradation of the soil:
1. Sliding of weathered mouldy soil on marl where brown pseudogleyic soils with (B)v/g horizons and pseudogleys with Bg horizons prevent the undisturbed percolation of water through the soil. Slides can easily be caused by inappropriate road cuts (examples: Laporje, Hošnica, Zbelovska gora).
2. Machine cultivation of hydroameliorated surfaces causes the exhaustion of the soil to depths of 20 cm, as shown by laboratory tests for the soils of the REU B area.
3. Intensive agricultural cultivation of shallow rankers is not in harmony with the natural capability of soils that contain a low proportion of clay and have a low KIK, large porousness for water, and low shock absorptive capability. Agricultural protection agents are therefore quickly washed from the surface through the blanket of weathered mouldy soil into the underground water, as shown by the pollution of the groundwater in Dravsko polje.
4. Built-up areas on eutric brown soil whose physical and chemical properties rank it among good farming soils can also testify to the degradation of the soil (northwestern part of Dravsko polje).
5. The association of *Pinus silvestris* that covers a considerable part of Goričko additionally contributes to the acidity and poor fertility of soils that in the past were more used for agriculture.

8. Conclusions

The following test regional ecological units were delineated in northeastern Slovenia:

Dravinjske gorice Test Area:
1. REU A is defined in flatland in the valley of the Dravinja River and along its tributaries at the altitude of 250–270 m where there are Holocene sandy loam and sandy clay alluvia originating in recent accumulation; where the influence of underground water is periodic, there are deeply gleyic and pseudogleyic soils, and riverbank soils with meadow use dominate.
2. REU B is defined in flatland in the Ložnica Valley at the altitude of 250 m, where Pleistocene and Holocene silty loam and silty clay loam alluvia are found that result in regular standing water in the soil profile and the development of hydromorphic soils with processes of gleying. For this reason the soils have been partly hydroameliorated.
3. REU C is defined in relief dissected hills of marl at the altitude of 300 to 450 m where due to the poor porousness of marl for the underground percolation of water, strong denuding occurs. Dystric and eutric soils originating on marl are devoted to mixed field-meadow and forest use.
4. REU D is defined in gently dissected hills composed of Pleistocene loam mixed with gravel and sand. On the tops of ridges strong denuding occurs with colluvium at their feet. Because of the lack of resistance of the lithological parent material and the humid climate (periodic retained water in the soil profile), processes of pseudogleying occur in the soils.

Bočko hribovje Test Area

1. REU E is defined in hills of limestone and dolomite. On steep slopes, at the altitudes of 350 to 980 m, pseudokarstic processes dominate. On hard carbonate stone, rendzinas cover steeper slopes and terra fusca soils cover less steep sites; both are covered by forest to a large extent.
2. REU F is defined on the margins of Bočko hribovje, at the altitude of 300 to 600 m where clay slate appears. Because of the poor porousness of the rock for water, strong denuding occurs. The slopes are covered by dystric soils with prevailing forest use.

Dravsko polje Test Area

1. REU A is defined in flatland where there are terraces of fluvioglacial gravel that is very porous for water, at the altitude of 240 to 250 m. Shallow riverbank and deeply gleyic soils and dystric ranker developed on the acidic gravel. Degraded growing places are covered by Pinus silvestris forest with bilberry shrub; otherwise cultivated field use prevails.
2. REU B is defined in flatland with an altitude of 250 to 260 m; it is composed of Pleistocene and Holocene clay loam alluvia which are poorly porous for water, causing retained water in the soil profile and the processes of pseudogleying and gleying.

Eastern Pohorje Test Area

1. REU D is defined on the hilly margins of Pohorje at the altitude of 280 to 290 m; lithologically this area is composed of Pleistocene loam with sands and gravels, on which eutric brown and pseudogleyic soils have developed. Because of its location at the juncture of two natural units, this area is quite densely built-up.
2. REU F is defined in hills of metamorphic stone, at the altitude of 350 to 500 m. On acidic lithological parent material and ravine-ridge relief, ranker and dystric brown soil are developed. The poor porousness of metamorphic stone for water and the humid climate encourage strong denuding, because of which forest use dominates and vineyards are found only on southern slopes.

Western Part of Slovenske gorice Test Area

1. REU A is defined in flatland in the valleys of tributaries of the Pesnica River that are composed of Holocene sandy clay and loam alluvia, at the altitude of 240 to 250 m. Due to recent accumulation and flow of slope waters into the valleys, retained water periodically occurs in the lower parts of riverbank soil profiles.
2. REU B is defined in flatland in the valley of the Pesnica River that is composed of Pleistocene and Holocene silty loam alluvia, at the altitude of 230 to 240 m. Due to its valley site and the silty loam lithological parent material, water is regularly retained in the soil profile causing the processes of gleying and hydromorphic soils. For the needs of agriculture, the soils have been hydroameliorated and their purpose completely changed.
3. REU C is defined in marl hills in the central part of the test area with the altitude of 280 to 400 m. Due to strong surface denuding, solifluction material is found at the transition of hills to flatland. Here slope pseudogleys have developed, while on the denuded surfaces and ridges eutric and dystric soils have developed.
4. REU D is defined in hills composed of plio-Quaternary sands and gravels in the northeastern part of the Slovenske gorice test area. Due to the varying resistance of the lithological parent material, the relief with altitudes from 300 to 500 m is undulating On unbound lithological parent material, eutric and dystric soils with the prevailing forest use are interwoven.
5. REU E is defined in the hills of Tertiary limestone (lithotamnium) and lime sandstone. The undulating relief at the altitude of 350 to 500 m south of the Pesnica Valley is the consequence of the resistance of limestone to physical weathering. On hard carbonate stone, pseudokarstic processes and denuding dominate. On limestone, rendzinas are found, and on lime sandstone, eutric and dystric soils.

Prekmurje Plain Test Area

1. REU A is defined in flatland composed of Holocene gravel alluvia at the altitude of 180 to 190 m. Its soils are mostly well porous for water, and at the depth of around 50 cm the influence of underground water appears. Dystric gleyic soils have developed, among which prevail dystric non-gleyic, rankers, pseudogleys, and riverbank soils with prevailing field use.

2. REU B is defined in flatland composed of Pleistocene and Holocene loam and silty loam alluvia at the altitude of 180 to 200 m where the percolation of water is hindered. Due to permanently retained water in the soil profile, processes of gleying prevail. For agricultural use, extensive surfaces of hydromorphic soils have been hydroameliorated.

Southern Goričko Test Area

1. REU D is defined in gentle hills composed of Pliocene loam with flint gravel at an altitude of 270 to 350 m. The prevailing soils are slope pseudogleys that are interwoven with dystric brown soils; rankers are found on the tops of ridges with strong denuding.

In determining the REU's, the following factors played a dominant role:

1. REU's in flatland do not everywhere depend only on types of soils; we can only talk about dependency in smaller valleys, while in larger valleys REU's are determined by human influences (for example: there is a meadow on hypogley in the Dravinja Valley, and a cultivated field on Dravsko polje).
2. In the hills, REU's depend on relief and the properties of the lithological parent material; soils that differ because of recent morphological processes are also an important factor and have an important influence on land use and vegetation (for example, on loam with sand on the tops of ridges rankers are found covered with forest, and on the lower parts of slopes brown soils are found with cultivated field-meadow use and scattered settlements)
3. As dominant factors for limiting the REU's in the test areas, the following elements stand out:
   - porousness of lithological parent material for water, which influences the course of morphological processes and retained water in the soil;
   - general climate conditions that determine a surplus or deficit in the water balance;
   - field water capacity that allows plants to use reserve water, including during drought periods;
   - degree the surface is covered by forest; and
   - anthropogenic encroachments on the landscape.

Comparison of land use with abiotic and biotic factors shows that land use depends on natural factors in smaller valleys, while in larger valleys it is directed by human factors. Advantageous natural conditions do not automatically mean intensive land use for historical or human reasons, just as on naturally unfavourable sites specific kinds of land use appear only because of one "advantageous" factor that makes such use possible. Land use out of harmony with abiotic and biotic factors is also a consequence of insufficient knowledge of regional relationships. Harmony of use with abiotic and biotic factors changes with time and place. This means that naturally advantageous site cannot always be devoted to the same use if the consequences of existing use do not change (for example, the pollution of soil and groundwater in Dravsko polje due to intensive agriculture and the threat to endangered protected common oak (*Quercus robur*) forest due to ameliorations in the Ložnica Valley).
A comparison of REU's and the ecotope groups and ecotopes defined in them show that in individual REU's the criteria for limiting the ecotope groups and ecotopes differ due to varying dominant parameters:

- in REU A – water conditions in the soil, influence of groundwater;
- in REU B – degree of gleying, agro- and hydrotechnical encroachments;
- in REU C – relief (exposure, slope) and land use;
- in REU D – microrelief (position at the foot of or on a slope) due to denuding-colluvial processes and resistance or lack of resistance of lithological parent material to weathering;
- in REU E – relief (altitude, exposure, slope), microclimate, and growth;
- in REU F – morphology of the surface (ravines and rounded slopes) and exposure;

The definition of REU's by means of more numerous parameters shows advantages in the fact that REU's are presented not only one-sidedly from the view of the prevailing landscape factors and their effects (relief, lithology) but also from the view of the internal structure of individual REU's. By studying a larger number of parameters, including the properties of the soils that directly reflect processes in the REU's, it is possible to define smaller homogeneous units, that is, ecotope groups and ecotopes and their contents. Knowledge of the properties and characteristics of ecotopes serves to ascertain optimal land use according to the growing conditions of individual ecotopes.

A step forward in regional ecological studies is the definition of homogeneous units which serves to ascertain optimal land use according to growth conditions as well as provide knowledge of the landscape from the point of view of abiotic, biotic, and human factors. Due to constant interaction between natural and human elements, it is important to know the processes that direct the formation of homogeneous units as well as the existing balance. It is important to consider that an increasing number of processes are determined anthropogenically, and therefore the human factor (land use) appears as an important criteria in limiting the REU's. The influence of man is seen in amelioration-commassation encroachments and the introduction of monocultures and the exploitation of sand, gravel, and stone. Such changes cause "artificial" ecotopes. Uniform "artificial" ecotopes have a weak inner balance and are degraded by excessive encroachments. Because the regional ecological composition of a particular landscape influences the degree of degradation, it is important to know, along with the regional ecological composition, the properties and role of the soils that direct land use. This was one of the important goals of this study.

The test areas were divided into homogeneous units (REU's) through vertical and horizontal synthesis. The calculated determination coefficients between the distribution of REU's and land use in test areas indicate that 42.3% of the differences in land use can be explained by differences between the test areas, which measured by correlation coefficient means a high connection – 0.629.

It is clear from the graph that the study results revealed three levels of harmony of land use with natural elements: perfect harmony of land use with natural elements (very high connection), partial harmony (medium to high connection), and disharmony (low degree of connection).

The lowest harmony of land use with natural elements is noticeable in the Prekmurje Plain, Dravinjske gorice, and Slovenske gorice. In the Prekmurje Plain, the disharmony is connected with anthropogenic changes in the land use of naturally wet land; in Dravinjske gorice, soils naturally suitable for agriculture are covered with forest; and the situation is similar in the Western Part of Slovenske gorice where wet valleys have been ameliorated.

Degraded landscape can also be discussed from the point of view of the properties of the soil in the Prekmurje Plain as well as in Dravsko polje, as the analysis of drinking water and pedological analyses of harmful substances in the ground have shown. The sliding of weathered mouldy soil on marl is evident in Dravinjske gorice because of inappropriate encroachments in the landscape, the exhaustion of cultivable land occurs in the Ložnica and Pesnica valleys and the ameliorated parts of Dravsko polje and the Prekmurje Plain, while the expansion of *Pinus silvestris* forest increases poor soil properties in Goričko.

It is not appropriate to draw conclusions regarding the occurrence of degradation only on the basis of considering calculated connections between natural elements and land use, because the coeffi-

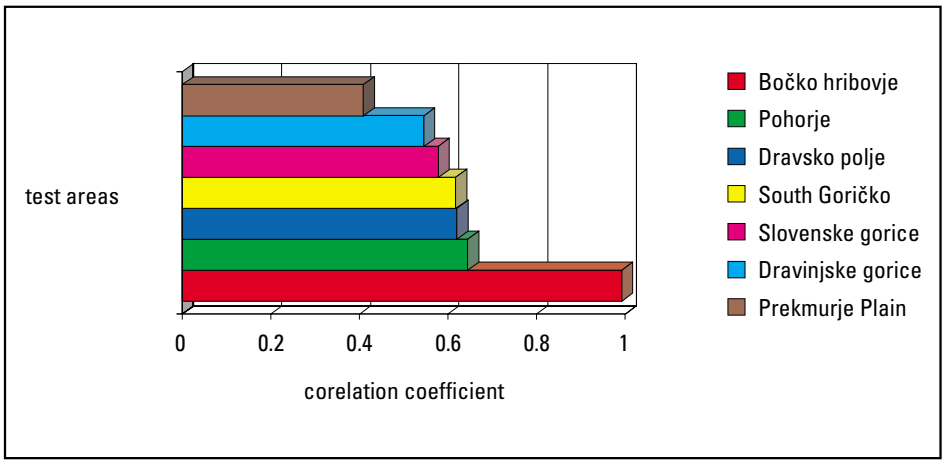


Figure 40: Harmony of Land Use with Natural Elements – Correlation and Determination Coefficients.
Slika 40: Skladnost rabe tal s prirodnimi elementi – korelacijskimi in determinacijskimi koeficienti.

cients relate to degrees of connection and not to the quality of the connections. With pedological analyses, the kind and intensity of degradation can be proved. Unfortunately, the necessary corresponding analysis of the contents of the harmful substances was not feasible as the necessary equipment was unavailable.

In future, it would be good to utilize the results of this study toward establishing more ecologically sound development of the treated regions and an ecological typification on which basis the ecological dissection of the test areas in northeastern Slovenia could be undertaken. Models should be used with input data as diverse as possible that would enable predicting in particular the negative energy and material changes due to simulated human encroachments and prevent their realization in the region in time.

9. **Bibliography**

Bat, M., 1988: Navodila za določanje pokrajinsko ekoloških enot. Tipkopis. Filozofska fakulteta, Ljubljana.

Bat, M., 1990: Vpliv fizičnogeografskih dejavnikov na rabo tal na primeru treh krajev v predalpskem hribovju Slovenije. Geografski zbornik XXX, Ljubljana, str. 69–126.

Birkeland, P.W., 1974: Pedology, Weatherin and Geomorphological Research. Oxford University, Press London-New York-Toronto.

Bračič, V., 1985: Dravinjske gorice. Založba Obzroja Maribor, Maribor

Celovit razvoj podeželja – Dravinjska dolina. BF, Agronomija, Katedra za pedologijo, prehrano rastlin in ekologijo, Ljubljana.

Černe, A., Klemenčič, M., Plut, D., 1981: Metodologija opredeljevanja pokrajinskih enot na primeru tržiške občine. 12. zborovanje slovenskih geografov, Kranj – Bled.

Farmer, K., 1987–89: Öko-System – Analyse: multidisziplinäre Forschungergebnisse zur Umveltsituation. Leykam, Graz, 416 s.

Gams, I., 1959: Geomorfologija in izraba tal v Pomurju. Geogr. zbornik, SAZU, Ljubljana, str. 207–247.

Gams, I. et al, 1974: Prispevek k prirodno geografski tipologiji pokrajine v porečju Voglajne in zgornje Sotle. Voglajnsko – sotelska Slovenija, 9. zborovanje geografov v Rogaški Slatini 1973, Ljubljana.

Gams, I., 1975: Pokrajinska ekologija soseske Soča. 10. zborovanje slovenskih geografov Tolmin – Bovec, Ljubljana, str. 313–323.

Gams, I., Lovrenčak, F., Plut, D., 1978: Soča, Breginj in Kamno v pokrajinsko-ekološki primerjavi. Zbornik 10. zborovanje slovenskih geografov, Ljubljana, str. 335–347.

Gams, I., 1979: K pokrajinsko ekološki razčlenitvi mariborske regije. 11. zborovanje slovenskih geografov, Mariborsko Podravje, Geografsko društvo Maribor, str. 37–51.

Gams, I., 1981: Pokrajinsko ekološka sestava Gorenjske. 12. zborovanje slovenskih geografov Kranj – Bled, Ljubljana.

Gams, I., 1983: Landschafsokölogische Gliederung Slowenies. Klagenfurter Geographische Schriften, Heft 4, Klagenfurt.

Gams, I., 1984: Geomorfološke in pokrajinsko-ekološke razmere srednje Krške doline z zaledjem. Dolenjska in Bela krajina, 13. zborovanje slovenskih geografov, Ljubljana.

Gams, I., 1986: Osnove pokrajinske ekologije. Univerza Edvarda Kardelja v Ljubljani, Filozofska fakulteta, Oddelek za geografijo, Ljubljana, str. 149.

Gregori, J., 1990: Prispevek k poznavanju ekologije in favne ptičev na Cigonci. Zbornik Občine Slovenska Bistrica, Zveza kulturnih društev občine Slovenska Bistrica, Ljubljana, str. 473–480.

Grubner, E., 1990: Landwirtschaftliche Gliederung und landschafsökologische Parameter sowie deren Bewertung unter besonderer Berücksichtigung des Bodens. Diplom Arbeit, Universität Wien, 247 s.

Heeb, J., 1991: Haushaltsbeziehungen in landschaftsökosystem topischer Dimensionen in einer Elementarlandschaft des Schweizerischen Mittelandes: Modelvorstellungen eines Landschaftsökosystems. Geogr. Institut der Universität Basel, 198 s.

Heeb, J., 1991: Landschafsökologische Modellvorstelungen: Standortmodelle zum Stoffhaushalt im alpennahen Mitteland der Schweiz. Regio Basiliensis 32(1991)2, Basel, str. 5–16.

Heinritz, G., 1994: Studienführer Geographie. Braunschweig, Westermann, (Das Geographische Seminar), 194 s.
Ilešič, S., 1972: Pokrajinsko ekološka razčlenitev Slovenije. Ljubljana.
Ilešič, S., 1985: Severovzhodna Slovenija in njena regionalna razčlenitev. Ljubljana.
Kalan, J., 1989: Pedološke razmere na Boču. Inštitut za gozdarstvo pri Biotehniški fakulteti v Ljubljani, Ljubljana.
Karte gozdnih združb za List TK 1 : 50000 Poljčane, Pragersko, Lenart in Murska Sobota. Biološki Institut Jovana Hađija, Ljubljana. Legende dopolnjene po novem kodeksu (M. Zupančič).
Kert, B., 1959: Geomorfologija severozahodnih Slovenskih goric. Geogr. zbornik, Ljubljana, str. 141–159.
Klimatski podatki za meteorološke postaje v Sloveniji 1961–1990. Hidrometeorološki zavod republike Slovenije, Ljubljana.
Leser, H., 1976: Landschafsökologie. Stuttgart.
Letalski posnetki 1 : 17500, ciklično aerofotosnemanje Slovenije za TK-25 Poljčane, Pragersko, Lenart in Murska Sobota 1990, 1992, 1993, 1994. Geodetski zavod Slovenije, Ljubljana.
Lobnik, F., s sodelavci, 1992: Raba in varstvo tal v Sloveniji. Onesnaževanje in varstvo okolja – Geologija in tehnika za okolje, Ljubljana, str. 129–139.
Lovrenčak, F., Bat, M., 1989: Zveze med pokrajinotvornimi elementi in določanje pokrajinsko ekoloških enot. Ljubljana.
Lovrenčak, F., 1979: Laboratorijski priročnik za geografe. Univerza v Ljubljni, Filozofska fakulteta, Ljubljana
Lovrenčak, F., 1991: Pedogeografska regionalizacija Pomurske ravnine. Dela 8, Geografska problematika Severovzhodne Slovenije, Filozofska fakulteta, Ljubljana, str. 64–69.
Marinček, L., 1984: Gozdne združbe Pohorja. Komentar h karti gozdnih združb 1 : 25000, Ljubljana.
Marinček, L., 1984: Gozdne združbe Pohorja. Komentar h karti gozdnih združb 1 : 25000, Ljubljana.
Marinček, L., 1973: Bukovi gozdovi na Slovenskem. Ljubljana.
Marinček, L., 1984: Gozdne združbe Pohorja. Komentar rokopisnih kart gozdnih združb za Pohorje. Zavod za naravno in kulturno dediščino Maribor, Ljubljana.
Marušič, J., 1992: Tipologija slovenskih krajin. Krajinska regionalizacija Slovenije – osnutek. Biotehniška fakulteta, Katedra za krajinsko arhitekturo, Ljubljana.
Mioć, P., Žnidarič, M., 1987: Tolmač za lista Maribor in Leibnitz. Osnovna geološka karta 1 : 100000, Beograd.
Mlakar, J., 1985: Dendrologija. Drevesa in grmi Slovenije. Ljubljana.
Nagl, H., 1990: Proseminar für Landschafsökologie. Universität Wien, Institut für Geographie, Wien, 220 s.
Nagl, H., Verginis, S., 1984: Landschafsökologische Grundalgen für die Landschafsplanung. Schriftenreihe des Instituts für Landschaftsplanung und Gartenkunst der Technischen Universität Wien, Heft 6, Wien.
Neef, E., 1967: Die theoretische Grundlagen der Landschafslehre. Leipzig, 152 s.
Osnovna pedološka karta SFRJ, List Ptuj 1 : 50000 (rokopisna karta 1 : 25000). Biotehniška fakulteta Ljubljana, Agronomija, Ljubljana, 1986.
Osnovna pedološka karta Murska Sobota 1 : 50000, Biotehniška fakulteta, Agronomija, Ljubljana, 1986.
Pedološka karta Maribor 4 1 : 50000, Biotehniška fakulteta 1969, Ljubljana in Pedološka karta Ptuj 1 : 50000, Biotehniška fakulteta 1986, Ljubljana.
Plut, D., 1977: Fizičnogeografska regionalizacija Koprskega primorja s pomočjo faktorske analize. Geografski vestnik 49, Ljubljana, str. 177–190.
Plut, D., 1980: Raziskovalne zasnove in delovne metode pokrajinske ekologije. Geografski vestnik 52, Raziskovalne metode, Ljubljana, str. 87–95.
Šilih, F., 1960: Naravni viri in izraba tal v Svečinskih goricah. Geogr. obzornik 1960, Ljubljana, str. 10–17.
Perko, D., 1987: Pokrajina in raba tal v Pokokrju. Geografski zbornik 27, SAZU, Ljubljana.
Perko, D., 1989: Vzhodna Krška kotlina – pokrajinska sestava in prebivalstvo (primer ugotavljanja povezanosti med naravnimi in družbenimi pokrajinskimi prvinami). Geografski zbornik XXIV, Ljubljana, str. 79–143.
Perko, D., 1991: Uporabnost DMR za določanje morfoloških enot. Geografski vestnik 35, št. 2, Ljubljana, str. 66–71.

Patrick, F.E.A., 1983: Soils, Their Formation, classification and distribution. Longman Scientific Technical, England.
Rastlinski svet Evrope, 1988. Ilistrirana enciklopedija, Mladinska knjiga, Ljubljana.
Remic, C., 1975: Gozdovi na Slovenskem. Založba Borec, Ljubljana.
Richling, A., 1990: System of landscape classifications in Poland. Miscellaea Geogr., Warsawwa, str. 5–15.
Robič, D., 1974: Fitocenoza, biocenoza, biogeocenoza in ekosistem. Gozdarski vestnik 32, št. 2–4, str. 77–86.
Rokopisna karta gozdnih združb 1 : 50000 list Murska Sobota. Biološki inštitut Jovana Hadžija, Ljubljana.
Rokopisna geološka karta, List Poljčane 1 : 25000. Geološki zavod Slovenije, Ljubljana.
Rokopisna geološka karta 1 : 25000, list Pragersko. Geološki zavod Ljubljana.
Rokopisna karta gozdnih združb za List Poljčane, 1 : 50000. Biološki inštitut Jovana Hađija, Ljubljana.
Rokopisna geološka karta list Murska Sobota 1 : 25000. Geološki zavod Ljubljana.
Rokopisne geološke karte 1 : 25000 za List TK Poljčane, Pragersko, Lenart in Murska sobota. Geološki zavod Ljubljana.
Seznam pedosistematskih enot (delovno gradivo), 1994. Biotehniška fakulteta, Katedra za pedologijo, Ljubljana.
Stefanović, V., 1986: Fitocenologija. Sarajevo.
Stein, N., 1992: Geoökologische Raumgliederung in Nordthailand: methodische Ansatze und bisherige Ergebnisse. Geogr. Rundschau 44(1992)1, Braunschweig, str. 48–56.
Stritar, A., 1990: Krajina, krajinski sistemi. Raba in varstvo tal v Sloveniji. Partizanska knjiga, Ljubljana, str. 23.
Stritar, A., 1990: Krajina, krajinski sistemi. Raba in varstvo tal. Založba Borec, Ljubljana.
Stepančič, D., 1984: Komentar k Listu Murska Sobota. Osnovna pedološka karta SFRJ, Pedološka karta Slovenije 1 : 50000, Ljubljana, str. 13.
Stepančič, D., 1985: Komentar k Listu Ptuj. Osnovna pedološka karta SFRJ, List Ptuj, Biotehniška fakulteta, Ljubljana.
Šifrer, M., 1974: Kvartarni razvoj Dravinjskih goric in bližnjega obrobja. Geografski zbornik XIV, Ljubljana.
Troll, C., 1970: Landschaftsökologie (Geoecology) und Biogeocenologie – eine terminologische Studie. Bucarest, str. 9–10.
Verginis, S., 1981: Beiträge zur physichen Geographie des Nord-Peloponnes. Grund-und Integrativwissenschafltiche Fakultät der Universitat Wien, 225 s.
Vergins, S., 1986: Beiträge zur physischen Geographie des Nord-Peloponnes (Grichenland). Habilitationsschrift, Universität Wien.
Verginis, S., 1990: Mehanische Boden- und Sedimentanalyse. Laborpraxis I, Institut für Geographie der Univ. Wien
Verginis, S., 1990: Chemische Boden- und Sedimentanalyse. Laborpraxis II, Instutu für Geographie der Univ. Wien.
Verginis, S., 1992: Die geographische Bodenforschung und ihre praktische Bedeutung. Schriften des Vereines zur Verbreitung naturwissenschaftlicher Kenntnisse in Wien, Heft 130/131, Wien.
Vovk, A., 1993: Vpliv reliefa na lastnosti prsti med Dravinjskimi goricami in Bočem. Magistrsko delo, Filozofska fakulteta, Ljubljana.
Walters, M., 1989: Umweltverträglichkeitsprufüng: ein Prufstein für die Umweltpolitik. Arbeitskreis für Regionalforschung. Wien, 167 s.
Wraber, M., 1951: Gozdno vegetacijska slika in gozdnogojitveni problemi Prekmurja. Geogr. vestnik, GDS, Ljubljana str. 179–225.
Zupančič, M., Seliškar, A., 1986: Vegetacija. Komentar k Listu pedološke karte Ptuj. Osnovna pedološka karta SFRJ, List Ptuj, Biotehniška fakulteta, Agronomija, Ljubljana.
Zupančič, A., A. Čarni, 1988: Nova združba rdečega bora v slovenskem predpanonskem obrobju. Biološki vestnik, 36(198893, Ljubljana, str. 107–126.
Zupančič, M., A., Seliškar, 1984: Vegetacija. Komentar k pedološki karti Murska Sobota, Ljubljana.
Žlebnik, L., 1982: Hidrogeološke razmere na Dravskem polju. Geologija 25/1, Ljubljana, str. 151–164.

10. Povzetek – Summary

Pokrajinsko ekološke enote severovzhodne Slovenije

Ana Vovk

Primerjava rabe tal s prirodnimi elementi kaže, da je vrsta rabe odvisna od prirodnih dejavnikov le v manjših dolinah in na strmih pobočjih, medtem ko jo na ravninah in blagem gričevju usmerjajo antropogeni posegi. Toda ugodne prirodne razmere še ne pomenijo intenzivne kmetijske rabe zaradi različnih zgodovninskih in socialnih posledic. Tudi na prirodno neugodnih legah se pojavljajo intenzivne oblike rabe tal, ki je pogojena z antropogenimi posegi.
V posameznih PEE se kriteriji za omejitev homogenih enot razlikujejo zaradi različnih dominantnih parametrov. V PEE A so dominantni elementi vodne razmere v prsti in vpliv podtalnice, v PEE B stopnja oglejevanja in agro-hidrotehnični posegi, v PEE C relief (ekspozicija in naklon) ter raba tal, v PEE D mikrorelief in stopnja intenzivnosti denudacijskih procesov, v PEE E relief, mikroklima in rastje ter v PEE F morfologija površja in ekspozicija.

Pri izločanju PEE so imeli dominantno vlogo naslednji dejavniki:

1. PEE v ravnini niso odvisne povsod od tipov prsti, o odvisnosti lahko govorimo le v manjših dolinah, medtem ko so v večjih dolinah PEE pogojene z družbenimi vplivi (npr. na hipogleju je v dolini Dravinje travnik, na Dravskem polju pa njiva).
2. V gričevju so PEE odvisne od reliefa in lastnosti litološke osnove, pomemben dejavnik pa so tudi prsti, ki se razlikujejo zaradi recentinih morfoloških procesov in pomembno vplivajo na rabo tal in vegetacijo (npr. na ilovicah s peski so na vršinah slemen rankerji, pokriti z gozdom, na spodnjih delih pobočij pa rjave prsti, z njivsko – travniško rabo in razpršeno poselitvijo).
3. Kot dominantni dejavniki za omejitev PEE v testnih območjih izstopajo:
   - prepustnost litološke osnove za vodo, kar vpliva na potek morfoloških procesov in zadrževanje vode v prsti
   - splošne klimatske razmere, ki pogojujejo vodno bilanco z viškom oz. primanjkljajem vode,
   - poljska vodna kapaciteta, ki omogoča rastlinam koristiti rezervno vodo tudi v sušnih obdobjih,
   - stopnja pokritosti površja z gozdom in
   - antropogeni posegi v pokrajino.

V severovzhodni Sloveniji so bile na testnih območjih omejene naslednje pokrajinsko ekološke enote:

Testno območje v Dravinjskih goricah:

1. PEE A: je opredeljena v ravnini, v dolini Dravinje in ob pritokih, v nadmorski višini 250–270 m, kjer so holocenske peščeno ilovnate in peščeno glinaste naplavine, nastale z recentno akumulacijo, kjer je vpliv podtalne vode občasen so globoko oglejene in psevdooglejene prsti, sicer prevladujejo obrečne prsti s travniško rabo.
2. PEE B: je opredeljena v ravnini, v dolini Ložnice, v nadmorski višini 250 m, kjer so pleistocenski in holocenski meljasto ilovnati in meljasto glinasto ilovnati nanosi, ki povzročajo redno zastajanje vode v profilu prsti in razvoj hidromorfnih prsti s procesi oglejevanja, zaradi česar so bile te prsti delno hidromeliorirane.
3. PEE C: je opredeljena v reliefno razčlenjenem gričevju iz laporjev, v nadmorski višini 300 do 450 m, kjer se zaradi slabe prepustnosti laporjev za podzemni odtok vode uveljavlja močna denudacija. Na laporjih nastale distrične in evtrične prsti so namenjene mešani njivsko – travniški in gozdni rabi.
4. PEE D: je opredeljena v blago razrezanem gričevju iz pleistocenskih ilovic, ki sta jim primešana prod in pesek. Na vršinah slemen se uveljavlja močna denudacija in ob vznožjih pobočij koluviacija. Zaradi neodpornosti litološke osnove in humidne klime (občasnega zastajanja padavinske vode v profilu prsti), se v prsteh uveljavljajo procesi psevdoogljevanja.

Testno območje na Bočkem hribovju

1. PEE E je opredeljena v hribovju iz apnencev in dolomitov. Na strmih pobočjih v nadmorski višini 350 do 980 m se uveljavljajo psevdograviklastični procesi. Na trdih karbonatnih kamninah pokrivajo rendzine strmejša pobočja in pokarbonatne prsti manj strme lege, oboje porašča v pretežni meri gozd.
2. PEE F: je opredeljena na obrobju Bočkega hribovja, v nadmorski višini 300–600 m, kjer se pojavljajo glinasti skrilavci. Zaradi slabe prepustnosti kamnin za vodo se uveljavlja močna denudacija. Pobočja pokrivajo distrične prsti s prevladujočo gozdno rabo.

Testno območje na Dravskem polju

1. PEE A: je opredeljena v ravnini, kjer so terase iz fluvioglacialnega proda, ki je močno prepusten za vodo, v nadmorski višini 240 do 250 m. Na kislem produ so se razvile plitve obrečne in globoko oglejene prsti ter distrični ranker. Degradirana rastišča pokriva gozd rdečega bora z borovničevjem, sicer prevladuje njivska raba.
2. PEE B: je opredeljena v ravnini v nadmorski višini 250 do 260 m, ki je iz pleistocenskih in holocenskih glinasto ilovnatih naplavin, ki so slabo prepustne za vodo, kar povzroča zastajanje vode v profilu prsti ter procese psevdoogljevanja in oglejevanja.

Testno območje na vzhodnem Pohorju

1. PEE D: je opredeljena na gričevnatem obrobju Pohorja, v nadmorski višini 280 do 290 m, litološko je to območje sestavljeno iz pleistocenskih ilovic s prodi in peski, na katerih so se razvile evtrične rjave in psevdooglejne prsti, ki so zaradi lege ob stiku dveh prirodnih enot precej gosto pozidane.
2. PEE F: je opredeljena v hribovju iz metamorfnih kamnin, v nadmorski višini 350 do 500 m. Na kisli litološki podlagi in grapasto – slemenastem reliefu sta razvita ranker in distrična rjava prst. Slaba prepustnost metamorfnih kamnin za vodo in humidna klima pogojujeta močno denudacijo, zaradi česar prevladuje gozdna raba, le na južnih pobočjih so vinogradi.

Testno območje v zahodnem delu Slovenskih goric

1. PEE A: je opredeljena v ravnini, v dolinah pritokov reke Pesnice, ki so iz holocenskih peščeno glinastih in ilovnatih naplavin, v nadmorski višini 240 do 250 m. Zaradi recentne akumulacije in stekanja pobočnih voda v doline se pojavlja občasno zastajanje vode v spodnjih delih profilov prsti.
2. PEE B: je opredeljena v ravnini, v dolini reke Pesnice, ki je iz pleistocensih in holocenskih meljasto ilovnatih naplavin, v nadmorski višini 230 do 240 m. Zaradi dolinske lege in meljasto ilovnate litološke osnove voda v profilu prsti trajno zastaja, kar povzroča procese ogljevanja in hidromorfne prsti. Za potrebe kmetijstva so prsti hidromeliorirali in jim popolnoma spremenili prvotno namembnost.
3. PEE C: je opredeljena v lapornatem gričevju v osrednjem delu testnega območja z nadmorsko višino 280 do 400 m. Zaradi močne površinske denudacije je na prehodu gričevja v ravnino soliflukcijski material. Na njem so se razvili pobočni psevdogleji, na denudiranih pobočjih pa evtrične in distrične prsti.
4. PEE D: je opredeljena v gričevju iz plio-kvartarnih peskov in prodov v severovzhodnem delu testnega območja Slovenskih goric. Zaradi različne odpornosti litološke osnove je relief z nadmorsko višino 300 do 500 m razgiban. Na nevezani litološki osnovi se prepletajo evtrične in distrične prsti s prevladujočo gozdno rabo.
5. PEE E: je opredeljena v gričevju terciarnih apnencev (litotamninskih) in apnenih peščenjakov. Razgiban relief v nadmorski višini 350 do 500 m južno od doline Pesnice je posledica odpornosti apnencev proti fizikalnemu preperevanju. Na trdih karbonatnih kamninah se uveljavljajo psevdograviklastični procesi in denudacija. Na apnencih so rednzine, na apenenih peščenjakih pa evtrične in distrične prsti.

Testno območje v Prekmurski ravnini

1. PEE A: je opredeljena v ravnini iz holocenskih prodnih naplavin, v nadmorski višini 180 do 190 m. Prsti so večinoma dobro prepustne za vodo, kjer se v globini okrog 50 cm pojavljajo vplivi podtalne vode, so se razvile distrične oglejene prsti, sicer prevladujejo psevdogleji ter distrične neoglejene prsti z rankerji in obrečne prsti. Največji delež zavzema njivska raba.
2. PEE B: je opredeljena v ravnini iz pleistocensih in holocenskih ilovnatih in meljasto ilovnatih naplavin, v nadmorski višini 180 do 200 m, kjer je odtok vode otežen. Zaradi stalnega zastajanja vode v profilu prsti prevladujejo procesi oglejevanja. Za kmetijsko rabo so obsežne površine hidromeliorirali.

Testno območje na južnem Goričkem

1. PEE D: je opredeljena v položnem gričevju, ki je sestavljeno iz pliocenske ilovice s kremenovimi prodniki in sega od nadmorske višine 270 do 350 m. Prevladujoče prsti so pobočni psevdogleji, ki se prepletajo z distričnimi rjavimi prstmi, na vršinah slemen z močno denudacijo so rankerji.

Pomen omejevanja PEE temelji na ugotavljanju skladnosti rabe tal s prirodnimi razmerami. Raba tal je v grobem pogojena z naravnimi sestavinami, vse bolj pa jo usmerjajo antropogeni posegi. S prirodnimi razmerami je raba v skladu na Bočkem hribovju (korelacijski koeficient 0,98) in na vzhodnem Pohorju (0,813). Delno je raba tal v skladu s prirodnimi razmerami v Dravinjskih goricah (0,59), v zahodnih Slovenskih goricah (0,422) in na Dravskem polju (0,419). Najmanjša skladnost obstoječe rabe tal s prirodnimi elementi je zaznana na južnem Goričkem (0,343) in v Prekmurski ravnini (0,273).