# ECOLOGICAL LANDSCAPE UNITS OF THE DOBREPOLJE-STRUGE KARST

# NARAVNE ENOTE DOBREPOLJSKO-STRUŠKEGA KRASA

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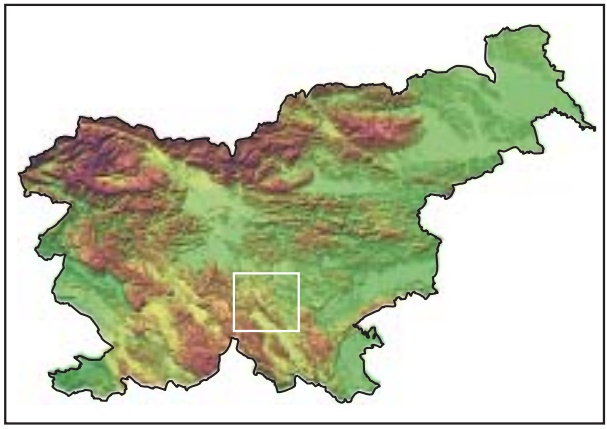
Wetland meadows in Mlake below the steep hillslopes of Mala gora (photography Mauro Hrvatin).
Mokrotni travniki v Mlakah pod strmim pobočjem Male gore (fotografija Mauro Hrvatin).



Abstract

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# Ecological landscape units of the Dobrepolje-Struge karst

**KEY WORDS: ecological landscape unit, geographical information system, Dobrepolje, Struge, Dinaric karst, Slovenia**

The Dobrepolje-Struge polje is a typical karst polje of Slovenia's Dinaric karst region. Distinctly prolonged in the direction of the Dinaric Alps, it lies in a deep trough between the Mala gora and Suha krajina plateaus. The bottom of the Dobrepolje-Struge polje, the karst corrosion plain around Ponikve, and the neighbouring hillslopes of Mala gora, Suha krajina, and the Čušperk plateau comprise the Dobrepolje-Struge karst, so named after its central relief unit.

Among the natural elements that form the Dobrepolje-Struge karst, rock, relief, soil, and vegetation were found to be of greatest importance. The natural elements of the Dobrepolje-Struge karst are closely connected and interdependent. The most typical and most significant combinations of natural elements form ecological landscape units. We determined these units by overlapping content layers of rock, relief, soil, and vegetation employing the Geographical Information System.

From 648 theoretically possible combinations, nineteen units were actually established, but based on the criteria of typicality and significance, we further identified six ecological landscape units in which similar or identical conditions appear relative to rock, relief, soil, and vegetation.

Izvleček

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# Naravne enote Dobrepoljsko-Struškega krasa

**KLJUČNE BESEDE: naravne enote, geografski informacijski sistem, Dobrepolje, Struge, Dinarski kras, Slovenija**

Dobrepoljsko-Struško polje spada med tipična kraška polja Dinarskega krasa Slovenije. Močno razpotegnjeno v dinarski smeri leži v globoki kotanji med Malo goro in Suho krajino. Dno Dobrepoljsko-Struškega polja, kraški ravnik v okolici Ponikev ter okoliška pobočja Male gore, Suhe krajine in Čušperške planote oblikujejo pokrajino, ki smo jo po osrednji reliefni enoti poimenovali Dobrepoljsko-Struški kras.

Med naravnimi prvinami, ki sooblikujejo Dobrepoljsko-Struški kras, smo kot najbolj pomembne izpostavili kamnine, relief, prsti in rastje. Naravne prvine so med seboj tesno povezane in medsebojno odvisne. Najbolj tipične in najpomembnejše kombinacije posameznih kategorij naravnih prvin tvorijo naravne enote. Te smo poskušali ugotoviti s prekrivanjem posameznih vsebinskih slojev v okviru geografskega informacijskega sistema.

Od 648 teoretično možnih kombinacij kategorij naravnih prvin, se jih dejansko pojavlja 19. Na temelju kriterijev tipičnosti in pomembnosti smo ugotovljene kombinacije kategorij združili v šest naravnih enot.

# Contents – Vsebina

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# 1. Introduction

The Dobrepolje-Struge polje lies in the west of the Dolenjska region in a deep trough between the Mala gora and Suha krajina plateaus. According to its shape, it is distinctly prolonged in the direction of the Dinaric Alps and is some fourteen kilometers long. It is widest in the north where it measures three kilometers, in the central section it narrows to barely three hundred meters, and in the south it again widens to 1.5 kilometers. The surface drops in a gentle slope from the north toward the south. At Predstruge, the altitude is 450 meters, at Kompolje 434 meters, and in Struge 416 meters. This polje is therefore composed of two or three parts, and the local people divide it into Dobrepolje in the north and Struge in the south. Between the two lies a small area of marshy land named Mlake.

Between Mala gora in the west and Suha krajina in the east, the polje indents in a wedge shape from the northwest to the southeast and south of Struge shrinks to a narrow valley. On the north side it is enclosed by the Čušperk plateau (Čušperška planota) and only in the northwest is it connected to a narrow dry valley with the Ponikve corrosion plain.

In the geographical literature, the Dobrepolje-Struge polje is cited as a characteristic example of a dry polje because it has no permanent surface water flow. The local waters, which have their catchment areas in the Velike Lašče area and belong to the Krka River drainage basin, flow underground for the major part of the year. Only during long periods of rain do they flow to the surface from numerous karst caves at the foot of Mala gora and flood the surrounding land. Simultaneously, the Rašica River swells heavily and floods, extending its course all the way to Dobrepolje. Meze (1983) studied flood areas along the Rašica and in Dobrepolje and Struge in detail.

We shall call the area encompassing the bottom of the Dobrepolje-Struge polje, the karst corrosion plain around Ponikve, and the neighbouring hillslopes of Mala gora, Suha krajina, and the Čušperk plateau the

Figure 1: View of Dobrepolje from Zdenska vas with the Gorica hum on the left and Mala gora in the background (photography Mauro Hrvatin).
Slika 1: Pogled na Dobrepolje z Zdenske vasi. Na levi je opazen hum Gorica, v ozadju Mala gora (fotografija Mauro Hrvatin).

*Dobrepolje-Struge karst* after its central relief unit. The total surface of the studied area measures almost sixty square kilometers.

To date, geographical studies of the Dobrepolje-Struge karst have been aimed at explaining the geomorphological development of the landscape. Melik (1955) believed that the trough of the polje was shaped by a water flow that ran in a southeast-northwest direction, the opposite direction of the polje's current slope. He further hypothesized that the landscape was possibly shaped by two almost parallel water flows oriented toward the Grosuplje basin.

Šifrer (1967) devoted himself primarily to the analysis and interpretation of the Pleistocene sediments that cover the entire bottom of the polje. In his opinion, the material of the first accumulation phase that reaches from twenty-five to thirty-five meters above the lowest plain is from a pre-Riss glacial period, probably the Mindel period. The material of the second accumulation phase lies five to eight meters above the lowest plain and in all probability is from the Würm period. Šifrer hypothesized that corrosion processes played an important role in the creation of extensive terraces on permanently marshy soil or during frequent flooding in the Pliocene epoch. He agreed with Melik's evaluation that the bedrock of the polje was already level before its alluviation by streams from the impermeable neighbouring areas during the Pleistocene epoch.

In contrast to his predecessors, Habič (1988) was convinced that tectonic and karst processes played the decisive role in the shaping of the Dobrepolje-Struge karst. According to Habič, the bottom of the polje was formed on the stagnating lenticular blocks of the Dobrepolje fault zone along which the neighbouring units of Mala gora, Suha krajina, and the Čušperk plateau rose from one hundred to five hundred meters. On the raised units, karst dissection continued, and therefore rock outcroppings and uneven shelves furrowed by sinkholes and small karst dolines dominate. On stagnant structural units, corrosion level-

Figure 2: Struge extends in a narrow belt of meadowland between the forests of Suha krajina and Mala gora. In the background are the Ribnica-Kočevje polje, Velika gora, and Stojna (photography Jurij Senegačnik).
Slika 2: Struge obsegajo ozek pas travniškega sveta med gozdovi Suhe krajine in Male gore. V ozadju Ribniško-Kočevsko polje ter Velika gora in Stojna (fotografija Jurij Senegačnik).

ing began to occur at the height of the water table. According to Habič, border corrosion was of secondary significance.

In this study, the basic characteristics of the rock, relief, soil, and vegetation of the Dobrepolje-Struge karst are presented. On this basis, ecological landscape units were defined with the help of the Geographical Information System.

# 2. Natural geographical characteristics of the Dobrepolje-Struge karst

Among the natural elements that form the Dobrepolje-Struge karst, rock, relief, soil, and vegetation were revealed to be of greatest importance. We did not treat climatic and water conditions separately because we believe that they are sufficiently reflected in the treated elements. The climate, for example, has a strong influence on the distribution of vegetation, and water conditions are indirectly evident in the different types of soil.

## 2.1. Rocks and sediments

The bottom of the polje is covered with a thick layer of alluvium of various depths deposited in the Quaternary by surface streams. The alluvium once covered the entire bottom of the polje since the remains of fluvial sediments are preserved in rocky pockets along the eastern half of the polje, at its southeasternmost end, and on the Ponikve corrosion plain.

Analyses of gravel and sand in the alluvium indicate that the sediments on the Ponikve corrosion plain and in the northern part of Dobrepolje were carried by the Rašica River from its catchment area, which is composed of quartz conglomerate and sandstone, shale, and dolomite (*Osnovna geološka karta – Basic Geological Map* 1968). The gravel and sand material in Mlake and Struge differs considerably in structure and size from the alluvium in Dobrepolje. We hypothesize that these sediments were deposited by the waters that flowed periodically from the nearby karst caves and not from the Rašica.

On the basis of rock composition of gravel and sand and the level of weathered material, Šifrer (1967) separated Pliocene sediments and three distinct types of Pleistocene alluvia. Pleistocene river sediments are preserved only in fragments and are composed of tiny flint gravel with a small admixture of brown-red loam. Field studies of suspected Pliocene river sediments indicated that at least in some cases, the material was undoubtedly deposited in now denuded roofless karst caves.

Older Pleistocene gravel-loam alluvia to a large extent cover the terraces on the Ponikve corrosion plain, the eastern half of Dobrepolje, and the area of Rapljevo in the very south of the polje. In this weathered debris, noncarbonate gravel of iron bauxite and quartz of various sizes are present, while limestone and dolomite gravel is almost completely weathered. Insoluble elements were left behind in the form of large quantities of loam.

The youngest Pleistocene gravel-loam alluvia cover the lowest bottom along the western half of Dobrepolje and in Struge. In contrast to the older alluvia, carbonate gravel from dolomite and limestone breccia dominate in the younger alluvia, while gravel from noncarbonate rock is present to a lesser degree. Only the alluvium in Mlake is of completely different structure since there is no gravel and sand in the upper layer, only loam-clay deposits. Gravel-sand material appears again in the top layer south of Mlake in Struge, but it differs substantially from the material in the northern part of Dobrepolje since it is tinier and contains no carbonate particles.

The remaining area is composed entirely of Mesozoic carbonate rock. The hillslopes above the polje as well as the bottom of the Dobrepolje-Struge polje and the Ponikve corrosion plain are composed of Jurassic


Figure 3: The Dobrepolje-Struge karst.
Slika 3: Dobrepoljsko-Struški kras.

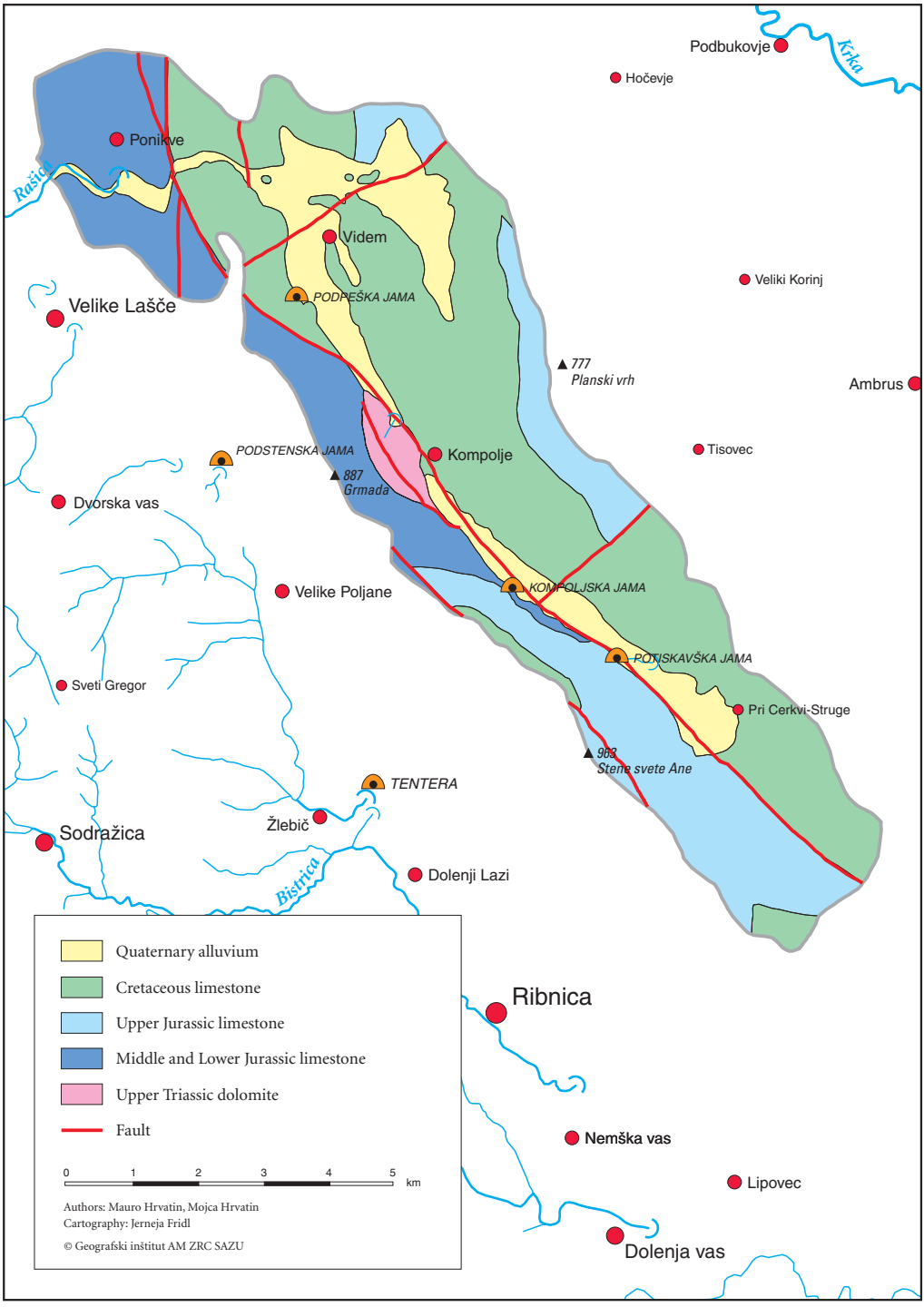


Figure 4: Rocks and sediments.
Slika 4: Kamnine.

and Cretaceous limestone, between which there are smaller dolomite interstices in some places. The limestone is heavily karstified everywhere, and the surface is therefore stony in many places and bare karst dominates. The most diverse karst phenomena occur very frequently, primarily sinkholes as well as karst shafts and caves. The oldest rocks in the landscape are the Triassic dolomites at the foot of the hillslopes of Mala gora between Podgora and Kompolje.

## 2.2. Relief

The landscape studied is composed of many relief units. Within the polje, we distinguish alluvial flatland, terraces, and hums, while largely high and steep hillslopes rise above the polje.

The lowest bottom in the north and along the western part of the polje is alluvial flatland. It is distinguished from the rest of the polje bottom by its completely flat surface. The bedrock is entirely covered with younger Pleistocene alluvium. The western part of the flatland is occasionally reached by flooding water.

The alluvial flatland can be divided into three parts. The Dobrepolje fan was deposited by the Rašica River at the end of the Pleistocene epoch. From Predstruge, the completely smooth and flat surface of the fan drops evenly to the east toward Cesta and Zdenska vas to Zagorica and to the southeast toward Podgora. On the western edge of the fan is a less distinct gully that is occasionally flooded by the Rašica. The Mlake area spreads across the narrowest part of the polje and is distinguished from the other parts not only in relief but also in its hydrological features. The name »Mlake« meaning »pools, puddles« well illustrates the basic natural characteristic of this part of the flatland. A negligible incline, modest sinkholes, and poorly permeable bedrock are the reason for wet soil and the high level of the groundwater. Struge comprises a completely unique part of the polje that is given its special appearance by its network of sinkholes, estavelles, and short gullies. During heavy rains, they are filled with water for a short period. The gullies in Struge are geomorphologically and hydrologically the most active part of the polje where erosion and karst processes are interwoven and create a detailed dissected surface.

Terraces rise several meters above the alluvial flatland. They are well preserved around Rapljevo, along the entire eastern part of Dobrepolje, and on the Ponikve corrosion plain. On the surface of the terraces, the limestone bedrock appears in some places, while rock pockets are filled with older Pleistocene alluvium. Because the alluvium on the terraces is older and more weathered than the alluvium of the alluvial flatland, its surface is uneven and karstified. In many places we can observe numerous dolines and even karst caves. However, the fluviokarst dolomite terrace between Podgora and Kompolje is completely different. This terrace is only slightly karstified and is dissected by the deep bed of the Krkovo stream that sinks at the contact of dolomite with limestone to the northwest of Kompolje.

Between Mala vas, Podgorica, and Zagorica, the Gorica hum rises thirty-five meters above the bottom of the polje. Because of the gentle inclination of its hillslopes and the proximity of the karstified terrace, it is not particularly distinct.

The bottom of the polje is bordered by the hillslopes of Mala gora, Suha krajina, and the Čušperk plateau. Above the western edge of the polje, the three hundred to five hundred meter hillslopes of Mala gora rise smoothly with an even inclination that indicates a tectonic structure (Kranjc 1981). From the Ponikve corrosion plain, the hillslope rises in steps while southeast from Grmada (887 meters), it is less dissected. The Mala gora ridge reaches its highest point at the Stene Sv. Ane peak (963 meters). Because the plateau is composed entirely of carbonate rock, it has no surface waters. Waters from the Velike Lašče area and the Ribnica polje run through it, and for the greater part of year, they also flow away underground below the Dobrepolje-Struge polje toward the Krka River. There are shallow dolines on the saddles and on smaller flat areas of the Mala gora ridge and hollowed out karst caves along its foot.

On the eastern edge, the more gradual hillslopes of Suha krajina rise 160 to 340 meters above the bottom of the polje. It rises highest to Planski vrh (777 meters), where the hillslope protrudes and the polje nar-

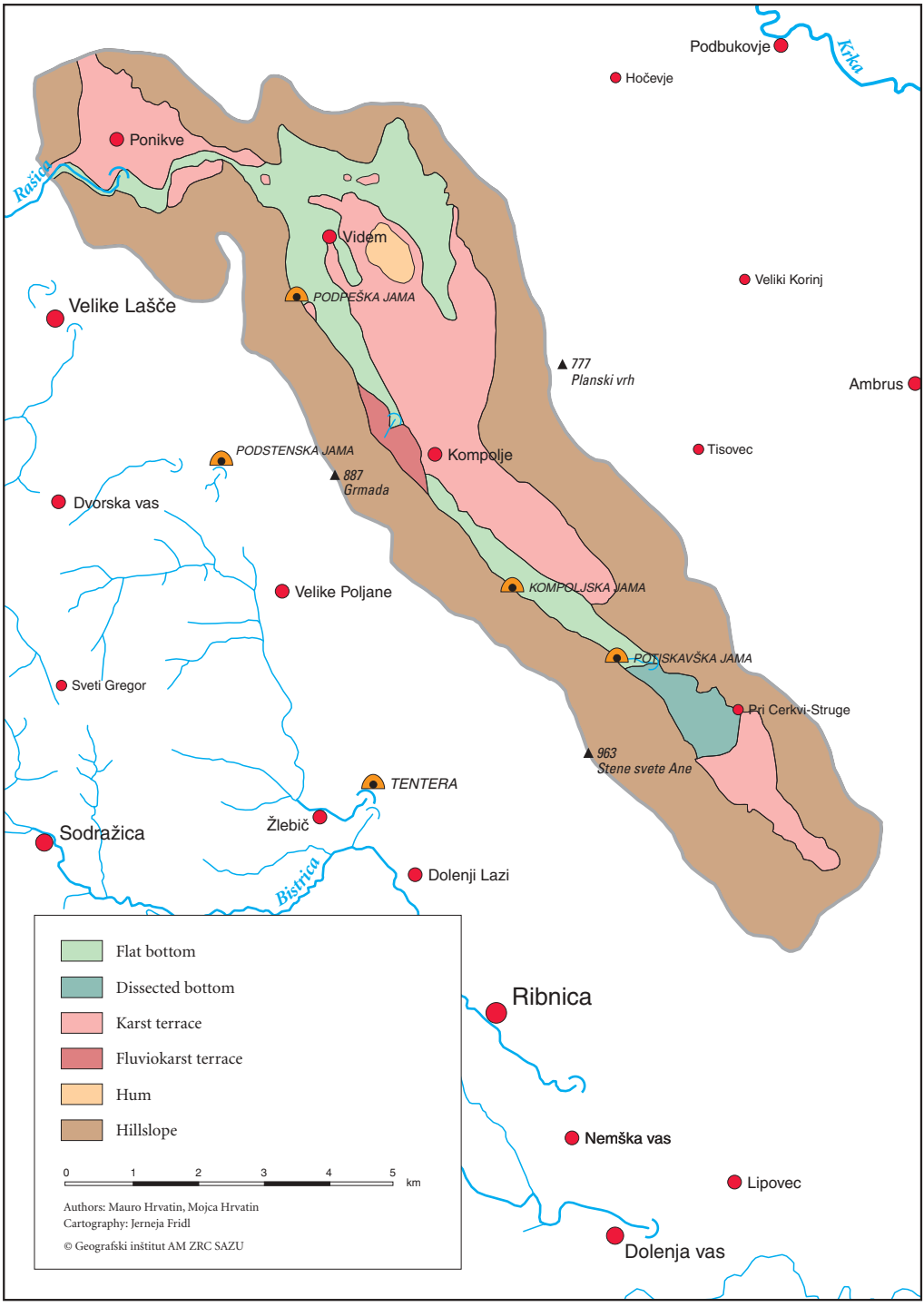


Figure 5: Relief.
Slika 5: Relief.

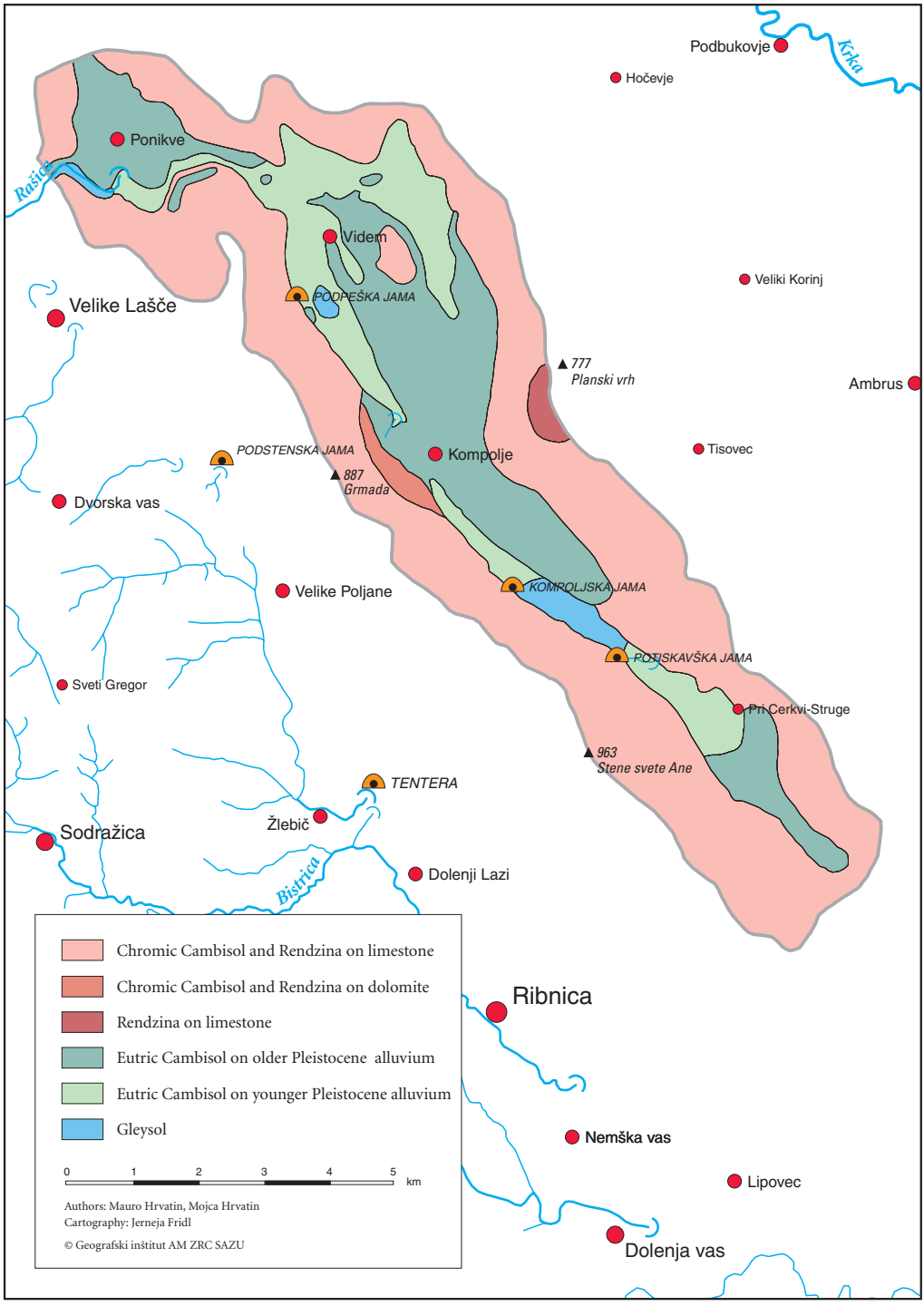


Figure 6: Soils.
Slika 6: Prst.

rows. A second narrowing occurs between Čatež and Lipa. Due to the limestone composition, there are frequent karst caves in the hillslope, among which the more than one hundred meter deep Krviška okroglica shaft is the best known.

The northern part of the polje is bordered by the Čušperk plateau, whose highest peak is Limberk (687 meters). The plateau rises only about 150 meters above the bottom of the polje with heavily karstified gentle hillslopes where there are also a few smaller karst caves.

## 2.3. Soils

The soils of the Dobrepolje-Struge karst developed in close dependence on the parent rock, which is composed of limestone, dolomite, and river alluvia.

On the hillslopes above the polje, various types of soil developed on limestone and dolomite: shallow rendzina, chromic cambisol, and chromic leached cambisol. Due to heavy karstification, a characteristic karst surface was formed on the limestone with fissures and pockets where insoluble loam residues accumulated. The soils on limestone are mostly shallow and stony, and their depth changes rapidly. A more even soil thickness is characteristic on dolomite.

In the creation of the soil on the bottom of the polje, the age and composition of the river alluvium played a decisive role since the distribution or the continuity of the soil blanket depends on them. Eutric chromic soils developed on older as well as on younger Pleistocene gravel-loam alluvia. They differ mostly in the depth of the profile, continuity, and the quantity and composition of fragments of the weathered parent rock. Because the terraces with older Pleistocene alluvium are heavily karstified, the depth of the soil changes over short distances. Because of the rock outcroppings that penetrate the surface, the soil is not continuous. It is less stony since the carbonate gravel was weathered and the more resistant and mostly smaller particles remained. Because the soils here are older, the process of washing out clay particles to lower horizons is already present in some places, indicating the transition of eutric chromic soils into leached soils.

The eutric cambisol on younger Pleistocene alluvium is thicker, evenly deep, and continuous and still contains a considerable amount of carbonate fragments. Because the alluvial flatlands with younger Pleistocene alluvium are flat and smooth, the most advantageous conditions for cultivating fields are here. Long-term cultivation has changed the properties of these soils and plowing has reshaped their profiles. Anthropomorphic soils therefore dominate in these areas.

A special type of soil developed in the Mlake area on younger loamy-clay deposits where due to the flat relief and high groundwater level, conditions existed for the development of gley soils. Smaller areas of gley soil appear outside Mlake only at Ratike near Podpeč and on a narrow stretch along the Rašica River where the type of the soil is probably pseudogleyed chromic cambisol.

## 2.4. Vegetation

The vegetation of the Dobrepolje-Struge karst belongs to pre-Dinaric phytogeographical region, characteristic of which are lowland hornbeam and fir forests and pure beech submontane and montane forests (Wraber 1969). Meadows are the consequence of human activity since the entire landscape would otherwise be overgrown with forest.

The bottom of the polje is covered by meadows. The exception is the eastern karstified part of the polje, which is in the rapid process of afforestation. The floral structure of species on the meadows depends on the methods of cultivation (mowing, pasture, meliorations, manuring) and local natural conditions such as the bedrock, the height of the groundwater, and the slope. Among the meadow plant communities, marshy meadow communities with characteristic hydrophilic plants having no fodder value stand out.

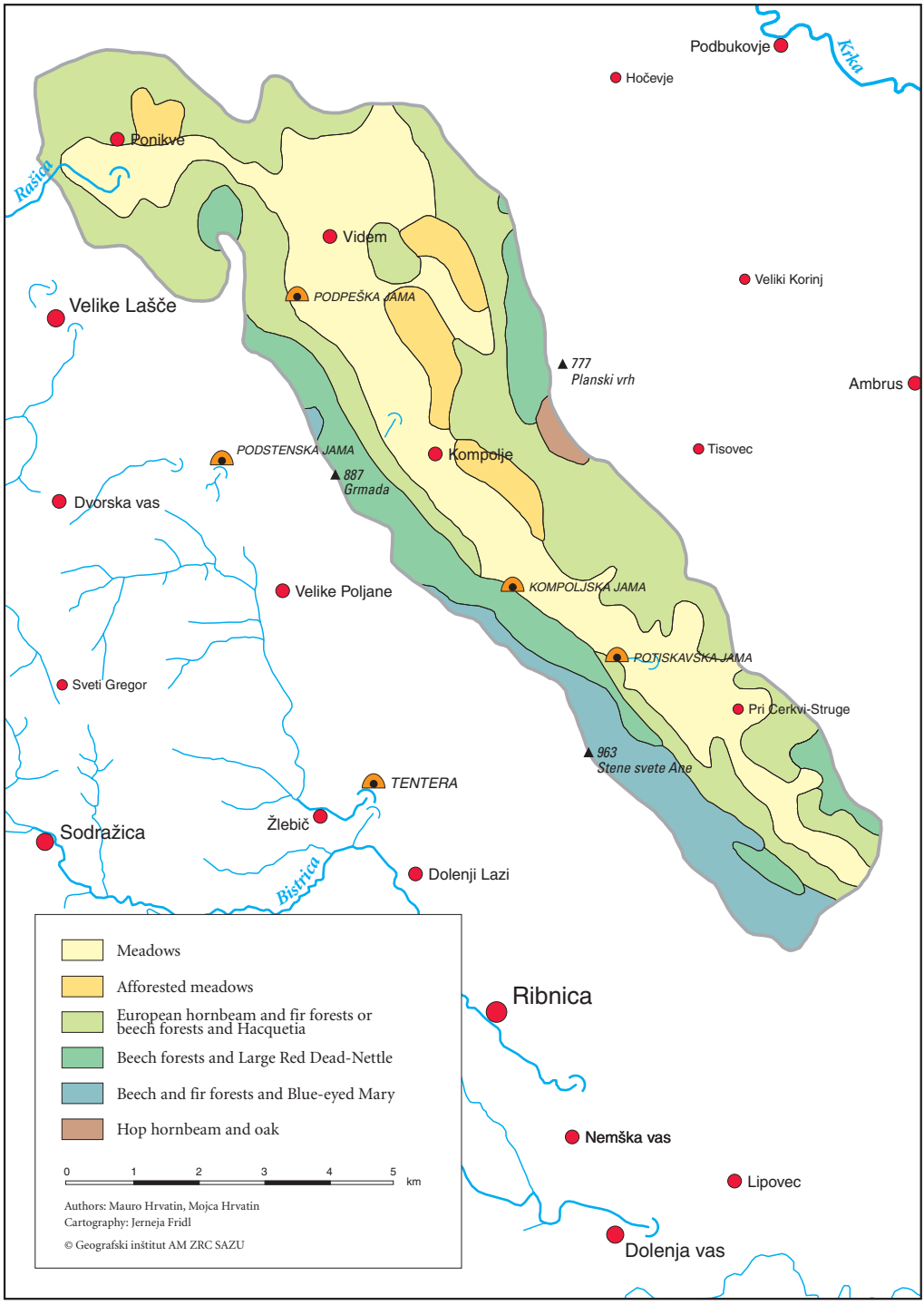


Figure 7: Vegetation.
Slika 7: Rastje.

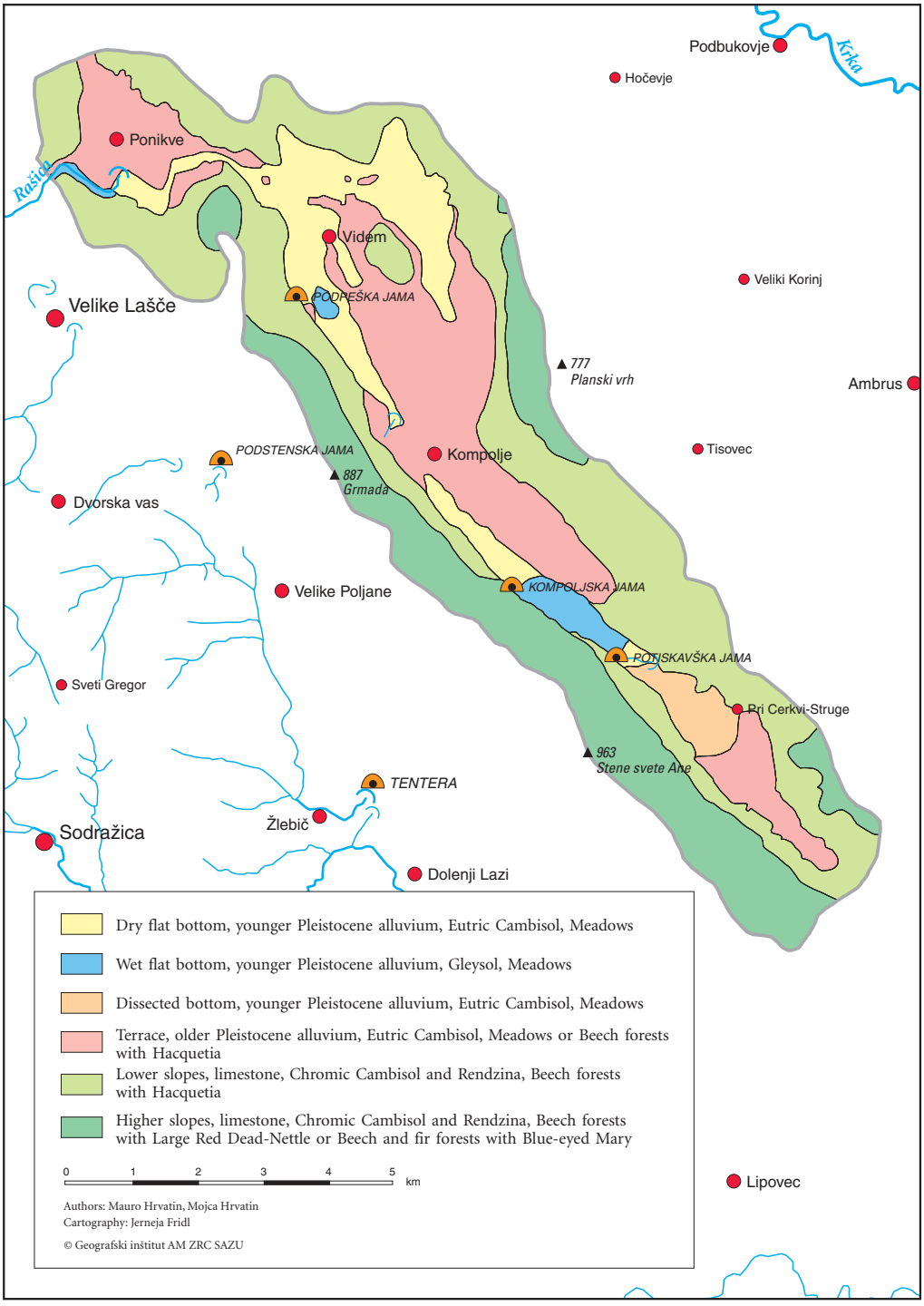


Figure 8: Ecological landscape units.
Slika 8: Naravne enote.

With the abandoning of intensive farming processes, the consequence of postwar deagrarization, the natural process of afforesting meadows began. Former meadows are most frequently afforested with hornbeam and fir (*Abieti albae-Carpinetum).*

The higher rim of the polje is almost entirely overgrown by forest that in some places reaches into the lower areas. The decisive factor in the distribution of forest associations is the relief since the climatic elements and the types of soil change with the altitude, and with them the vegetation. According to the altitude span, which stretches from 420 meters to 960 meters above sea level, forest associations can be classified into several vegetation belts (Čampa 1970).

The lowland vegetation belt reaches from the bottom of the polje to about 550 meters above sea level and is mostly overgrown by pre-Dinaric hornbeam and fir forest (*Albieti albae-Carpinetum*). This forest association is frequent on the northeastern and eastern edges of Dobrepolje, around Ponikve, and on the edge of Struge where it overgrows flat and karstified regions of moderate inclination. Because of the proximity of settlements, the lowland forest has always been under the strong influence of man because he has been converting forests into pasture since settlement began here.

The submontane vegetation belt covers the hillslopes between 450 meters and 700 meters above sea level, which are afforested with various beech associations. Associations of beech with Hacquetia (*Hacquetio-Fagetum)* are found in the area of Ponikve and on the hillslopes of Suha krajina. The more rocky, steep, and warmer hillslopes found mainly on Planski vrh are covered with low thermophilic forests of hop hornbeam and oak (*Querco-Ostryetum*). The upper part of the submontane zone and the lower part of the montane zone have been occupied by beech forest with Large Red Dead-Nettle (*Lamio orvalae-Fagetum).* This forest association has overgrown large areas on Mala gora, Planski vrh, Javhe, Smrekovec, and Kamen vrh.

The montane vegetation belt encompasses only the highest peaks on Mala gora, which are overgrown by a forest association of beech and fir with Blue-eyed Mary (*Omphalodo-Fagetum).* This association is among the most important economically in the entire region.

# 3. Division of the Dobrepolje-Struge karst into ecological landscape units

The natural elements of the Dobrepolje-Struge karst described above are closely connected and interdependent. The most typical and most significant combinations of natural elements form ecological landscape units. We determined these units by overlapping content layers of rock, relief, soil, and vegetation employing the Geographical Information System.

We obtained the content layers for the Geographical Information System by digitizing the appropriate maps. For the rock layer, we used the basic Ribnica 1:100,000-scale geological map and adapted the map of river sediments in the Rašica Valley and in Dobrepolje prepared by Šifrer (1967). The relief layer was created with the help of a simplified map of relief units made in the field through the geomorphological charting of the area, and the soils layer is based on the adapted 1:50,000-scale *Cerknica 2 Pedological Map* published by Biotechnical Faculty of the University of Ljubljana. In preparing the vegetation layer, we used 1:10,000-scale phytocenological maps of the management units of Dobrepolje and Struge from the Bureau of Forest Planning in Ljubljana and the vegetation map published by Puncer (1980) in the appendix of his treatise.

The individual cells of each content layer cover an area of ten meters by ten meters or one are. The Dobrepolje-Struge karst is divided into 592,863 cells totaling 59.29 square kilometers. Each cell of each individual layer is defined by data on the rock, relief, soil, and vegetation.

Because we divided the rock into three categories and the relief, soil, and vegetation into six categories, there are altogether 648 theoretically possible combinations. In fact, we established nineteen existing combinations, which represents only 3% of all the theoretically possible combinations. The data shows that individual natural elements in the landscape are closely connected. Furthermore, the nineteen combinations shown here indicate that natural conditions in a relatively small landscape are not as simple and uniform as they seem at first glance.

Among the nineteen combinations established, the combinations selected in the next step were the most typical and significant for the area. Here, two criteria were considered:
- Units that encompassed at least 6,000 cells or six square kilometers were designated as typical (about 10%).
- Units that appeared considerably more frequently than theoretically expected were designated as significant.

On the basis of these criteria, we identified six ecological landscape units that we believe are typical and significant for the area. Each ecological landscape unit includes one or more related combinations of natural elements. The division indicated that ecological landscape units of the Dobrepolje-Struge karst are primarily formed in dependence on the relief in combination with the underlying rock or sediment. The latter's influence appears mainly at the bottom of the polje where the age of the river alluvia determines the surface shape of the polje bottom, the distribution of the soil blanket, and the use of the land.

The Dobrepolje-Struge karst is composed of the following ecological landscape units:
1. The **dry flat bottom** of the polje covered with younger Pleistocene gravel-loam alluvia occupies a good tenth of the surface (7.01 km$^2$). It encompasses the fan of the Rašica River that extends between Predstruge, Zdenska vas, and Kompolje, a further narrow belt along the dry riverbed of the Rašica, and a smaller area south of Kompolje. Ninety percent of the surface is occupied by cultivated fields and meadows, four percent is overgrown by European hornbeam and fir forests, and six percent is in the phase of afforestation. Because the younger Pleistocene alluvium is undissected and is outside the area of frequent flooding, the best conditions for farming are here. In spite of the fact that the soil lacks mineral elements, this area has been carefully tilled and reshaped into large complexes of cultivated fields separated by meaows.
2. With only a 1.9% share (1.4 km$^2$), the **marshy flat bottom** of the polje over younger Pleistocene loam-clay sediments is the smallest ecological landscape unit. The narrow, completely level Mlake flatland differs from the other units of the Dobrepolje-Struge karst in the higher wetness of the ground that is reflected in heavily gleyed soils and moist meadows with only a few bushes and groups of rush and other hydrophilic plant species visible from a distance. The meadows in Mlake are mostly of lesser fodder value, and due to the more or less permanent saturation of the ground, mowing here is difficult. A smaller patch of marshy flat bottom with gleyed soil occurs near Ratike east of Podpeč.
3. The **dissected bottom** of the polje over younger Pleistocene alluvium ranks among the smaller ecological landscape units and covers only 2.0% (1.21 km$^2$) of the area. The surface of eutric cambisol is dissected by short gullies that limit the Struge farmers to cultivating only small fields, mostly devoted to field crops for domestic use, with larger complexes of meadows between them. This area is less suitable for farming because the fields are exposed to frequent flooding.
4. **Terraces** covered with older Pleistocene gravel-loam alluvia encompass 23.4% of the area (13.9 km$^2$). The largest terrace stretches across the eastern half of the polje from Videm across Kompolje to Četež. Relative to rock and relief, the dolomite fluviokarst terrace west of Kompolje is a unique area, but from the viewpoint of appearance, soil, vegetation, and land use, it does not differ substantially from the other terraces. Similar terraces lie north of Ponikve and around Rapljevo, and remnants of these terraces exist as hummocks near Zdenska vas and Predstruge. On the terraces, eutric cambisol developed that has been leached out in some places. The soil is more moist only on the flood plain along the course of the Rašica River and can be ranked among the pseudogleyed soils. The flood plain is overgrown by the forest association of black alder (*Alnus glutinosa*, also called Common or European alder) with sedge (*Alnetum glutinosae s. lat.*). Broken by dolines, the terraces are less suitable for cultivation, so cultivated fields are limited to the immediate vicinity of the villages while meadows dominate the remaining terraces, covering about one half of their surface area. One fifth of the terrace area, mostly former pasture, is gradually being overgrown by forest. European hornbeam and fir forests cover one quarter of all the terrace area.

TABLE 1: COMBINATIONS OF ROCK, RELIEF, SOIL, AND VEGETATION.

| Geology | Morphology | Soil | Vegetation | Area (km$^2$) | Share (%) | Theoretical frequency | Relative frequency | Ecological landscape unit |
|---|---|---|---|---|---|---|---|---|
| Alluvium | Flatland | Eutric Cambisol on younger Pleistocene alluvium | Meadows | 6.21 | 10.47 | 0.09 | 120.47 | 1 |
| Alluvium | Flatland | Eutric Cambisol on younger Pleistocene alluvium | Afforested meadows | 0.40 | 0.68 | 0.02 | 41.72 | 1 |
| Alluvium | Flatland | Eutric Cambisol on younger Pleistocene alluvium | European hornbeam and fir forests or beech forests with Hacquetia | 0.40 | 0.67 | 0.10 | 6.41 | 1 |
| Alluvium | Flatland | Gleysol | Meadows | 1.14 | 1.92 | 0.01 | 163.59 | 2 |
| Alluvium | Dissected bottom | Eutric Cambisol on younger Pleistocene alluvium | Meadows | 1.21 | 2.04 | 0.01 | 152.22 | 3 |
| Limestone | Karst terrace | Eutric Cambisol on older Pleistocene alluvium | Meadows | 6.60 | 11.13 | 1.47 | 7.59 | 4 |
| Limestone | Karst terrace | Eutric Cambisol on older Pleistocene alluvium | Afforested meadows | 2.98 | 5.02 | 0.28 | 18.23 | 4 |
| Limestone | Karst terrace | Eutric Cambisol on older Pleistocene alluvium | European hornbeam and fir forests or beech forests with Hacquetia | 3.74 | 6.31 | 1.76 | 3.57 | 4 |
| Dolomite | Fluviokarst terrace | Eutric Cambisol on older Pleistocene alluvium | Meadows | 0.58 | 0.97 | 0.00 | 718.43 | 4 |
| Limestone | Hum | Chromic Cambisol and Rendzina on limestone | European hornbeam and fir forests or beech forests with Hacquetia | 0.47 | 0.79 | 0.15 | 5.20 | 5 |
| Limestone | Hillslope | Chromic Cambisol and Rendzina on limestone | Meadows | 3.66 | 6.17 | 9.62 | 0.64 | 5 |
| Limestone | Hillslope | Chromic Cambisol and Rendzina on limestone | Afforested meadows | 0.23 | 0.39 | 1.81 | 0.22 | 5 |
| Limestone | Hillslope | Chromic Cambisol and Rendzina on limestone | European hornbeam and fir forests or beech forests with Hacquetia | 17.98 | 30.32 | 11.57 | 2.62 | 5 |
| Dolomite | Hillslope | Chromic Cambisol and Rendzina on dolomite | European hornbeam and fir forests or beech forests with Hacquetia | 0.46 | 0.78 | 0.00 | 196.27 | 5 |
| Limestone | Hillslope | Chromic Cambisol and Rendzina on limestone | Hop hornbeam and oak | 0.16 | 0.26 | 0.18 | 1.43 | 6 |
| Limestone | Hillslope | Chromic Cambisol and Rendzina on limestone | Beech forests with Large Red Dead-Nettle | 7.55 | 12.74 | 3.91 | 3.26 | 6 |
| Limestone | Hillslope | Chromic Cambisol and Rendzina on limestone | Beech and fir forests with Blue-eyed Mary | 5.09 | 8.59 | 2.55 | 3.38 | 6 |
| Limestone | Hillslope | Rendzina on limestone | Hop hornbeam and oak | 0.23 | 0.39 | 0.00 | 170.50 | 6 |
| Limestone | Hillslope | Rendzina on limestone | Beech forests with Large Red Dead-Nettle | 0.21 | 0.35 | 0.05 | 7.19 | 6 |

Note: The shaded rows mark the basic combinations of individual ecological landscape units.

5. **More gently sloping lower parts of hillslopes** with intervening flatland areas cover 38.5% (22.80 km$^2$) of the Dobrepolje-Struge karst and comprise the largest ecological landscape unit. With the exception of a smaller patch of dolomite above Kompolje, which in outward appearance does not differ from the rest of the hillslope, except perhaps for the two more or less permanent karst springs found here, the hillslope is entirely limestone and therefore karstified. Around 80% of this ecological landscape unit is covered by submontane beech forest, which changes to European hornbeam and fir forest at the foot of the hillslopes. Large areas of meadow have been maintained near villages, for example, above Struge, Rapljevo, and Zdenska vas where the inclinations are gentler.

6. **Steeper and rockier hillslopes over 650 meters above sea level** comprise 22.3% (13.23 km$^2$) of the surface as a separate ecological landscape unit. The hillslopes of the Dobrepolje-Struge karst are composed of two ecological landscape units defined by forest associations that are dependent on the inclination of the hillslope and altitude. The higher parts of the Mala gora hillslopes are covered by the Dinaric forest association of beech and fir forests with Blue-eyed Mary, which on Mala gora extends to the northern edge of its area of continuous distribution. Two thirds of the hillslopes on Mala gora, Planski vrh, and Jermanov laz are covered by various beech forest associations and their degradation forms. The forest associations marking this ecological landscape unit are bound to steeper and rockier habitats and thus differ from the forest associations that cover the lower parts of the hillslopes with moderate inclinations and the intervening flatland areas. On limestone hillslopes, chromic cambisol alternating with rendzina has developed.

# 4. Conclusion

This paper presents the division of the Dobrepolje-Struge karst into ecological landscape units based on overlapping content layers of rock, relief, soil, and vegetation using the Geographical Information System.

From 648 theoretically possible combinations, nineteen units were actually established, but based on the criteria of typicality and significance, we further identified six ecological landscape units in which similar or identical conditions appear relative to rock, relief, soil, and vegetation.

Almost forty percent of the entire area is occupied by limestone hillslopes covered with chromic cambisol and is overgrown with European hornbeam and fir forests or beech with Hacquetia forest associations. Karst terraces on limestone and fluviokarst terraces on dolomite cover just under a quarter of the area. Remnants of older Pleistocene alluvia are preserved on the terraces where eutric cambisol developed. Meadows dominate that mostly at greater distances from the settlements are rapidly becoming afforested. Limestone hillslopes with chromic cambisol and rendzinas occupy a good fifth of the area. They are overgrown to a great extent by forest associations of beech with Large Red Dead-Nettle and beech and fir with Blue-eyed Mary. Somewhat over one tenth of the area is occupied by the flat bottom of the polje, which is covered by younger Pleistocene alluvium with eutric cambisol. Meadows and cultivated fields dominate here. The two smallest ecological landscape units together comprise less than one twentieth of the area. They both lie on the bottom of the polje covered with younger Pleistocene alluvium on which meadows dominate. The first has a flat bottom and gleyed soils, while the surface of the second is dissected and covered with eutric cambisol.

The division showed that individual ecological landscape units were primarily formed depending on the rock composition or on the age and composition of the Pleistocene alluvia. The surface dissection of the bottom of the polje and indirectly of the entire natural and cultural landscape depends on the different ages of the alluvia.

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# 6. Summary in Slovene – Povzetek

## Naravne enote Dobrepoljsko-Struškega krasa

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### 1. Uvod

Dobrepo1jsko-Struško kraško polje leži v osrednjem delu slovenskega Dinarskega krasa v globoki kotanji med Malo goro in Suho krajino. Po obliki je izrazito razpotegnjeno v dinarski smeri in v dolžino sega kar 14 km. Najširše je na severu, kjer meri 3 km, v srednjem delu se zoži na komaj 300 m, na jugu pa se ponovno razširi na 1,5 km. Površje se z rahlim strmcem znižuje od severa proti jugu. Pri Predstrugah je nadmorska višina 450 m, pri Kompolju 434 m in v Strugah 416 m.

Kraško polje je sestavljeno iz dveh oziroma treh delov. Med domačini je živa zlasti delitev na Dobrepolje na severu in Struge na jugu. Med obema leži manjše območje močvirnega sveta z imenom Mlake.

Med Malo goro na zahodu in Suho krajino na vzhodu se kraško polje klinasto zajeda od severozahoda proti jugovzhodu in se južno od Strug zoži v ozko podolje. Na severni strani je zaprto s Čušperško planoto, le na severozahodu je z ozko suho dolino povezano s ponikovskim ravnikom.

V geografski literaturi se Dobrepoljsko-Struško polje navaja kot značilen primer suhega kraškega polja, saj je brez stalnega površinskega vodnega toka. Tamkajšnje vode, ki imajo svoja povirja v Velikolaščanski pokrajini in pripadajo porečju Krke, se namreč večji del leta pretakajo podzemno. Le ob dolgotrajnih deževjih pritekajo na površje iz številnih kraških jam ob vznožju Male gore in poplavljajo okoliška zemljišča. Istočasno močno naraste in poplavlja tudi Rašica, ki svoj tok podaljša vse do Dobrepolja. Poplavna območja ob Rašici ter v Dobrepolju in Strugah je podrobno proučil Meze (1983).

Pokrajino, ki obsega dno Dobrepoljsko-Struškega polja, kraški ravnik v okolici Ponikev ter okoliška pobočja Male gore, Suhe krajine in Čušperške planote smo po osrednji reliefni enoti poimenovali Dobrepoljsko-Struški kras. Skupna površina obravnavanega območja meri skoraj 60 km$^2$.

Dosedanje geografsko proučevanje Dobrepoljsko-Struškega krasa je bilo usmerjeno predvsem k pojasnjevanju geomorfološkega razvoja pokrajine. Melik (1955) je menil, da je kotanjo kraškega polja izoblikoval vodotok, ki je tekel v smeri od jugovzhoda proti severozahodu, torej v nasprotni smeri današnjega strmca. Nadalje je domneval, da sta pokrajino oblikovala morebiti celo dva skoraj vzporedna vodotoka usmerjena proti Grosupeljski kotlini.

Šifrer (1967) se je posvetil predvsem analizi in tolmačenju pleistocenskih usedlin, ki prekrivajo celotno dno polja. Po njegovem mnenju je gradivo prve akumulacijske faze, ki sega od 25 do 35 m nad najnižjo ravnino, predriške, verjetno mindelske starosti. Gradivo druge akumulacijske faze leži od 5 do 8 m nad najnižjo ravnino in je domnevno riške starosti, medtem ko je najmlajša naplavina na dnu polja po vsej verjetnosti würmske starosti. Šifrer je domneval, da so pri izdelavi razsežnih teras odigrali pomembno vlogo korozijski procesi na trajno zamočvirjenih tleh ali ob pogostih poplavah v pliocenu. Strinjal se je z Melikovo oceno, da je bila skalna podlaga kraškega polja uravnana že pred pleistocenskim nasipanjem pritokov z neprepustnega sosedstva.

Za razliko od svojih predhodnikov je bil Habič (1988) prepričan, da so imeli pri oblikovanju Dobrepoljsko-Struškega krasa odločilno vlogo tektonski in kraški procesi. Dno kraškega polja je po njegovem mnenju nastalo na zastajajočih lečastih grudah dobrepoljske prelomne cone, ob kateri so se sosednje enote Male gore, Suhe krajine in Čušperške planote dvignile od 100 do 500 m. Na dvignjenih enotah se je nadaljevalo kraško-denudacijsko razčlenjevanje, zato na njih prevladujejo kuclji in vegaste police, ki so razbrazdane z vrtačami in kraškimi doli. Na zastajajočih strukturnih enotah se je v višini zajezene kraške vode začelo korozijsko uravnavanje. Robna korozija ob stiku z neprepustnim površjem je bila po Habičevem mnenju drugotnega pomena.

V tem prispevku so predstavljene osnovne značilnosti kamnin, reliefa, prsti in rastja Dobrepoljsko-Struškega krasa. Na njihovem temelju so bile s pomočjo geografskega informacijskega sistema določene naravne enote tega območja.

## 2. Naravnogeografske značilnosti Dobrepoljsko-Struškega krasa

Med naravnimi prvinami, ki sooblikujejo Dobrepoljsko-Struški kras, smo kot najbolj pomembne izpostavili kamnine, relief, prsti in rastje. Podnebnih in vodnih razmer nismo posebej upoštevali, ker menimo, da se v zadostni meri odražajo že pri obravnavanih prvinah. Podnebje na primer močno vpliva na razporeditev rastja, vodne razmere pa so posredno razvidne pri različnih tipih prsti.

### 2.1. Kamnine

Dno kraškega polja je prekrito z različno debelo plastjo naplavine, ki so jo v kvartarju odložile površinsko tekoče vode. Naplavina je nekdaj prekrivala celotno dno polja, saj so ostanki rečnih usedlin ohranjeni tudi v skalnih žepih vzdolž vzhodne polovice kraškega polja, na skrajnem jugovzhodnem koncu polja in na ponikovskem ravniku.

Analize proda in peska v naplavini kažejo, da je usedline na ponikovski ravnik in na severni del Dobrepolja prenesla Rašica iz svojega povirja, ki je zgrajeno iz kremenovega konglomerata in peščenjaka, skrilavega glinovca ter dolomita (Osnovna geološka karta 1968). Prodno in peščeno gradivo na Mlakah in v Strugah se po sestavi in velikosti precej razlikuje od naplavine v Dobrepolju. Domnevamo, da so te usedline odložile vode, ki občasno pritekajo iz kraških jam in ne Rašica.

Na temelju kamninske sestave proda in peska ter stopnje preperelosti gradiva je Šifrer (1967) ločil pliocenske usedline in tri različne vrste pleistocenskih naplavin. Pliocenske rečne usedline so ohranjene le še

fragmentarno, sestavlja pa jih droben kremenov prod z majhno primesjo rjavordeče ilovice. Terensko raziskovanje domnevnih pliocenskih rečnih usedlin je pokazalo, da gre vsaj v nekaterih primerih zanesljivo za gradivo, ki je bilo odloženo v sedaj denudiranih, brezstropih kraških jamah.

Starejše pleistocenske prodnato-ilovnate naplavine pokrivajo v velikem obsegu terase na ponikovskem ravniku, vzhodno polovico Dobrepolja in okolico Rapljevega na skrajnem jugu kraškega polja. V tej preperini so prisotni različno debeli nekarbonatni prodniki železovega boksita in kremena, medtem ko so apnenčevi in dolomitni prodniki skoraj v celoti prepereli. Za njimi so ostale netopne sestavine v obliki velike količine ilovice.

Najmlajše pleistocenske prodnato-ilovnate naplavine prekrivajo najnižje dno vzdolž zahodne polovice Dobrepolja in v Strugah. Za razliko od starejših naplavin prevladujejo v mlajših karbonatni prodniki iz dolomita in apnčeve breče, medtem ko so prodniki iz nekarbonatnih kamnin zastopani v manjši meri. Povsem drugačne sestave je le naplavina na Mlakah, saj v zgornji plasti ni ne proda, ne peska, marveč le ilovnato-glinasti nanos. Prodno-peščeno gradivo se v vrhnji plasti zopet pojavi južno od Mlak v Strugah, a se bistveno razlikuje od gradiva v severnem delu Dobrepolja, saj je drobnejše in ne vsebuje karbonatnih delcev.

Preostalo ozemlje je v celoti zgrajeno iz karbonatnih kamnin mezozojske starosti. Pobočja nad poljem kot tudi dno Dobrepoljsko-Struškega polja ter ponikovski ravnik gradijo jurski in kredni apnenci, med katerimi so ponekod manjši dolomitni vložki. Apnenci so povsod močno zakraseli, zato je površje marsikje kamnito in prevladuje polgoli kras. Zelo pogosti so najrazličnejši kraški pojavi, predvsem vrtače pa tudi kraška brezna in jame. Najstarejše kamnine v pokrajini so triasni dolomiti ob vznožju pobočja Male gore med Podgoro in Kompoljem.

## 2.2. Relief

Obravnavano pokrajino sestavlja več reliefnih enot. V okviru kraškega polja ločimo aluvialno ravnino, terase in hum, nad poljem pa se dvigajo povečini visoka in strma pobočja.

Najnižje dno na severnem in vzdolž zahodnega dela kraškega polja pripada aluvialni ravnini. Od ostalega dna se loči po tem, da je površje povsem ravno. Skalna osnova je v celoti pokrita z mlajšo pleistocensko naplavino. Občasno jo vsaj vzdolž zahodne polovice polja še doseže poplavna voda.

Aluvialno ravnino lahko razdelimo na tri dele. Dobrepoljski vršaj je nasula Rašica ob koncu pleistocena. Od Predstrug se povsem gladko in nerazgibano površje vršaja enakomerno znižuje na vzhod proti Cesti in Zdenski vasi do Zagorice in na jugovzhod proti Podgori. Na zahodnem robu vršaja je manj izrazita struga, ki služi občasni poplavni vodi Rašice. Mlake se razprostirajo v najožjem delu kraškega polja in se od ostalega dela ločijo ne le v reliefnih, temveč tudi v hidroloških potezah. Že ledinsko ime dobro pojasnjuje naravne poteze ravnine. Neznaten strmec, skromni požiralniki in slabo prepustna podlaga so vzrok za mokrotna tla in visoko gladino talne vode. Struge so povsem svojstven del kraškega polja, ki mu daje poseben videz splet številnih požiralnikov, estavel in kratkih strug. Ob močnejšem deževju jih za krajši čas zapolni voda. Struge predstavljajo geomorfološko in hidrološko najbolj aktiven del polja, v katerem se prepletajo erozijski in kraški procesi ter ustvarjajo v drobnem razčlenjeno površje.

Nekaj metrov nad aluvialno ravnino se dvigajo terase. Dobro so ohranjene okoli Rapljevega, vzdolž celotnega vzhodnega dela Dobrepolja in na ponikovskem ravniku. Na površju teras se ponekod kaže apnenčeva kamninska osnova, medtem ko so skalni žepi zapolnjeni s starejšo pleistocensko naplavino. Ker je naplavina na terasah starejša v primerjavi z naplavino aluvialne ravnine in je že dodobra preperela, je površje vegasto in zakraselo, saj ponekod opazimo precejšno gostoto vrtač in celo kraške jame. Povsem drugačna je fluviokraška dolomitna terasa med Podgoro in Kompoljem. Terasa je le neznatno zakrasela in erozijsko razčlenjena z globoko strugo potoka Krkovo, ki na severozahodnem obrobju Kompolja ponikne na stiku dolomita z apnencem.

Med Malo vasjo, Podgorico in Zagorico se 35 m nad dnom polja dviga hum Gorica. Zaradi blagega naklona pobočij in bližine zakrasele terase ni posebej izrazit.

Dno kraškega polja omejujejo pobočja Male gore, Suhe krajine in Čušperške planote. Nad zahodnim robom kraškega polja se brez pregiba in z enakomernim naklonom dviga od 300 do 500 m visoko pobočje Male gore, ki kaže na tektonsko zasnovo (Kranjc 1981). S ponikovskega ravnika se pobočje dviga v stopnjah. Od Grmade naprej je sleme enotno in manj razčlenjeno. Najvišjo točko doseže z vrhom Stene svete Ane (964 m). Ker jo v celoti sestavljajo karbonatne kamnine, nima površinsko tekočih voda. Skoznjo se pretakajo vode z Velikolaščanske pokrajine in Ribniškega polja ter večji del leta tudi podzemeljsko odtekajo pod Dobrepoljsko-Struškim poljem proti Krki. Na sedlih in manjših uravnavah so plitve vrtače, v vznožju pa so izvotljene kraške jame.

Na vzhodnem robu se od 160 do 340 m nad dnom polja vzpenja bolj položno pobočje Suhe krajine. Najvišje se dvigne v Planskem vrhu (777 m), kjer se pobočje izboči in kraško polje zoži. Druga zožitev nastopi med Četežem in Lipo. Zaradi apnenčaste sestave so v pobočju pogoste kraške votline, med katerimi je najbolj znano več kot 100 m globoko brezno Krviška okroglica.

Severni del polja obroblja Čušperška planota, katere najvišji vrh je Limberk (687 m). Planota se nad dno polja dvigne le okoli 150 m z močno zakraselim, položnim pobočjem, kjer je tudi nekaj manjših kraških jam.

## 2.3. Prst

Prsti Dobrepoljsko-Struškega krasa so se razvile v tesni odvisnosti od kamninske podlage. Matično podlago prstem predstavljajo apnenec, dolomit in rečne naplavine.

Na pobočjih nad poljem so na apnencu in dolomitu razviti različni tipi prsti: plitve rendzine, rjave pokarbonatne prsti in rjave pokarbonatne izprane prsti. Zaradi močnega zakrasevanja je na apnencu nastalo značilno kraško površje z razpokami in žepi, v katerih se kopiči netopni pokarbonatni ostanek. Prsti na apnencu so večinoma plitve in skeletne, njihova globina pa se hitro spreminja. Bolj enakomerna debelina prsti je značilna za dolomit.

Pri nastajanju prsti na dnu kraškega polja sta imeli odločilno vlogo starost in sestava rečne naplavine, saj je od njiju odvisna razprostranjenost oziroma sklenjenost odeje prsti. Tako na starejši kot na mlajši pleistocenski prodnato-ilovnati naplavini so nastale evtrične rjave prsti. Razlikujejo se predvsem po globini profila, sklenjenosti in po količini ter sestavi drobcev preperele kamninske osnove. Ker so terase s starejšim pleistocenskim nanosom močno zakrasele in vrtačaste, se globina prsti spreminja na kratke razdalje. Zaradi skalnih čokov, ki segajo na površje, prst ni sklenjena. Skeleta je manj, saj so karbonatni prodniki prepereli, ostali odpornejši pa so večinoma bolj drobni. Ker so prsti tod starejše, je v njih ponekod že opazen proces spiranja glinenih delcev v spodnje horizonte, kar kaže na prehod evtričnih rjavih prsti v izprane prsti.

Evtrična rjava prst na mlajšem pleistocenskem nanosu je globlja, enakomerne debeline, sklenjena in vsebuje še precej karbonatnega skeleta. Ker je aluvialna ravnina z mlajšo naplavino uravnana in nerazgibana, so tu najbolj ugodni pogoji za njivske površine. Zaradi dolgotrajnega obdelovanja je človek tem prstem povsem spremenil njihove lastnosti in jim z oranjem preoblikoval profil. Zato na mlajših pleistocenskih naplavinah prevladujejo antropogene prsti.

Poseben tip prsti se je razvil na Mlakah na mlajšem ilovnato-glinastem nanosu, kjer so zaradi uravnanega reliefa in visoke talne vode dani pogoji za tvorbo oglejenih prsti. Manjša površina oglejene prsti se izven Mlak pojavlja še na Ratikah blizu Podpeči in v ozkem pasu ob Rašici, kjer gre verjetno za tip psevdooglejene rjave prsti.

## 2.4. Rastje

Rastje Dobrepoljsko-Struškega krasa pripada preddinarskemu fitogeografskemu območju, za katerega so značilni nižinski gozdovi belega gabra in jelke ter čisti bukovi podgorski in gorski gozdovi (Wraber 1969). Travišča so posledica človekovega delovanja, saj bi bila sicer celotna pokrajina poraščena z gozdom.

Dno kraškega polja pokrivajo travišča. Izjema je vzhodni, zakraseli del polja, ki se hitro zarašča z gozdom. Floristična sestava vrst na traviščih je odvisna od načinov obdelovanja (košnja, paša, melioracije, gnojenje) in krajevnih ekoloških razmer kot so kamninska osnova, višina talne vode, mehanska sestava prsti, nadmorska višina in naklon. Med travniškimi združbami na Dobrepoljsko-Struškem polju izstopajo močvirna travišča z značilnimi vlagoljubnimi rastlinami, ki nimajo krmne vrednosti.

Z opuščanjem intenzivne kmetijske obdelave, ki je posledica povojne deagrarizacije, se je začel naravni proces zaraščanja travišč z gozdom. Nekdanja travišča se najpogosteje zaraščajo z gozdom belega gabra in jelke *(Abieti albae-Carpinetum)*.

Višji obod kraškega polja skoraj v celoti poraščajo gozdovi, ki ponekod sežejo tudi v nižinski pas. Odločilni dejavnik v razvrstitvi gozdnih združb je relief, saj se z nadmorsko višino spreminjajo podnebne prvine in tipi prsti ter s tem rastje. Glede na višinski razpon, ki sega od 420 do 960 m nadmorske višine, lahko gozdne združbe razvrstimo na več višinskih rastlinskih pasov (Čampa 1970).

Nižinski rastlinski pas sega od dna kraškega polja do približno 550 m nadmorske višine in ga večinoma porašča preddinarski gozd belega gabra in jelke *(Abieti albae-Carpinetum)*. Ta gozdni sestoj je pogost na severovzhodnem in vzhodnem robu Dobrepolja, okoli Ponikev in ob robu Strug, kjer porašča uravnana in zakrasela območja zmernih naklonov. Zaradi bližine naselij je bil nižinski gozd že od nekdaj pod močnim vplivom človeka, saj je le-ta že od naselitve naprej spreminjal gozdove v pašnike in steljnike.

Podgorski rastlinski pas prekriva pobočja med 450 in 700 m nadmorske višine, ki jih poraščajo različne bukove združbe. V okolici Ponikev in na pobočju Suhe krajine se je razrasla združba bukve s tevjem *(Hacquetio-Fagetum)*. Bolj skalovita, strma in toplejša pobočja predvsem na Planskem vrhu zarašča termofilni nizki gozd ali grmišče gabrovca in hrastov *(Querco-Ostryetum)*. Zgornji del podgorskega in spodnji del gorskega pasu je zavzel bukov gozd z veliko mrtvo koprivo *(Lamio orvalae-Fagetum)*. Večje površine je omenjena gozdna združba porasla na Mali gori, na Planskem vrhu, Javhah, Smrekovcu in Kamen vrhu.

Gorski rastlinski pas obsega le najvišje vrhove na Mali gori, ki jih porašča gozdna združba bukve, jelke in pomladanske torilnice *(Omphalodo-Fagetum)*. Združba spada med gospodarsko najbolj pomembne na območju Male gore.

# 3. Členitev Dobrepoljsko-Struškega krasa na naravne enote

Predstavljene naravne prvine Dobrepoljsko-Struškega krasa so med seboj tesno povezane in medsebojno odvisne. Najbolj tipične in najpomembnejše kombinacije naravnih prvin tvorijo naravne enote. Te smo poskušali ugotoviti s prekrivanjem vsebinskih slojev o kamninah, reliefu, prsti in rastju v okviru geografskega informacijskega sistema.

Vsebinske sloje geografskega informacijskega sistema smo pridobili z digitalizacijo ustreznih zemljevidov. Za kamninski sloj smo uporabili list Ribnica osnovne geološke karte v merilu 1 : 100.000 ter prirejeni zemljevid rečnih usedlin v dolini Rašice in v Dobrepolju, ki ga je pripravil Šifrer (1967). Reliefni sloj smo izdelali s pomočjo poenostavljenega zemljevida reliefnih enot, ki je nastal ob terenskem geomorfološkem kartiranju območja, sloj o prsteh pa na temelju lista Cerknica 2 prirejene pedološke karte v merilu 1 : 50.000, ki jo je izdala Biotehniška fakulteta v Ljubljani. Pri pripravi sloja o rastju smo upoštevali fitocenološke karte gospodarskih enot Dobrepolje in Struge v merilu 1 : 10.000 Biroja za gozdarsko načrtovanje iz Ljubljane ter vegetacijsko karto, ki jo je v prilogi svoje razprave objavil Puncer (1980).

Posamezna celica vsakega vsebinskega sloja obsega površino 10 × 10 m oziroma 1 ar. Dobrepoljsko-Struški kras je razdeljen na skupno 592.863 celic, kar pomeni 59,29 km$^2$ površine. Vsaka celica posameznega sloja je opredeljena s podatkom o kamnini, reliefu, prsti in rastju.

Ker smo razdelili kamnine na tri kategorije, relief, prsti in rastje pa na šest kategorij, je vseh teoretično možnih kombinacij 648. Dejansko smo ugotovili devetnajst obstoječih kombinacij, kar predstavlja le 3 % vseh teoretično možnih. Ta podatek kaže, da so posamezne naravne sestavine v obravnavani pokrajini med seboj tesno povezane. Po drugi strani pa devetnajst kombinacij, ki se tu pojavljajo, vendarle kažejo na to, da naravne razmere v razmeroma majhni pokrajini niso tako enostavne in enolične, kot se morda zdijo ob bežnem opazovanju.

Za vsako obstoječo kombinacijo smo najprej ugotovili površino, delež pokrajine, ki ga zavzema ter teoretično in relativno pogostnost. Teoretična pogostnost posamezne kombinacije je enaka zmnožku deležev posameznih kategorij upoštevanih naravnih prvin, relativna pogostnost pa je razmerje med dejanskim deležem in teoretično pogostnostjo.

V naslednjem koraku so bile kot nosilke posameznih naravnih enot izbrane tiste kombinacije, ki so za pokrajino najbolj tipične in pomembne. Pri tem sta bila upoštevana dva kriterija:
- kot tipične so bile določene kombinacije, ki zavzemajo vsaj 6000 celic ali 6 km$^2$ površine pokrajine (približno 10 %),
- kot pomembne so bile določene kombinacije, ki se pojavljajo bolj pogosto, kot bi teoretično pričakovali.

Na temelju gornjih kriterijev smo izločili šest naravnih enot, za katere menimo, da so za pokrajino tipične in pomembne. Vsaka naravna enota vključuje eno ali več sorodnih kombinacij kategorij naravnih prvin. Členitev je pokazala, da se naravne enote Dobrepoljsko-Struškega krasa prvenstveno oblikujejo v odvisnosti od reliefa v povezavi s kamninsko sestavo. Slednja pride do izraza predvsem na dnu kraškega polja, kjer starost rečnih naplavin vpliva na površinsko izoblikovanost dna kraškega polja, razprostranjenost odeje prsti in rabo tal.

Dobrepoljsko-Struški kras sestavljajo naslednje naravne enote:
1. Suho uravnano dno kraškega polja, prekrito z mlajšim pleistocenskim prodnato-ilovnatim nanosom zavzema dobro desetino površja (7,01 km$^2$). Obsega vršaj Rašice, ki se razprostira med Predstrugami, Zdensko vasjo in Kompoljem, nadalje ozek pas ob suhi strugi Rašice in manjše območje južno od Kompolja. Devet desetin površja zavzemajo njive in travniki, 4 % porašča gozd belega gabra in jelke, 6 % površin je v fazi zaraščanja z gozdom. Ker je mlajša pleistocenska naplavina nerazčlenjena in je izven območja pogostih poplav, so tod najbolj ugodni pogoji za poljedelstvo. Kljub dejstvu, da prsti primanjkuje mineralnih snovi, je to območje skrbno obdelano in preurejeno v večje komplekse njiv, ki jih prekinjajo travniki.
2. Mokrotno uravnano dno kraškega polja z mlajšim pleistocenskim ilovnato-glinastim nanosom je z 1,9 % deležem (1,14 km$^2$) najmanjša naravna enota. Ozka, povsem gladka ravnina z imenom Mlake se od ostalih enot Dobrepoljsko-Struškega krasa loči po večji mokrotnosti tal, kar se odraža v močno oglejenih prsteh in vlažnih traviščih z redkim grmovjem in že na daleč opaznimi skupinami ločkov ter drugimi vlagoljubnimi rastlinskimi vrstami. Manjša zaplata oglejenih prsti se pojavlja še na Ratikah vzhodno od Podpeči. Na Mlakah so v glavnem travniki slabše krmne vrednosti. Zaradi bolj ali manj stalne namočenosti je tu otežena košnja.
3. Razčlenjeno dno kraškega polja z mlajšim pleistocenskim nanosom spada med manjše naravne enote in mu pripadata le 2,0 % ali 1,21 km$^2$ pokrajine. S kratkimi strugami razčlenjeno površje z rjavo prstjo je omogočilo struškim kmetom ureditev le manjših njivskih parcel, večinoma namenjenih poljščinam za domačo porabo, z vmesnimi večjimi kompleksi travnikov. Za poljedelstvo je ta predel manj primeren, saj so njive izpostavljene pogostim poplavam.
4. Terase s starejšo pleistocensko prodnato-ilovnato naplavino zavzemajo 23,4 % pokrajine oziroma 13,90 km$^2$. Največja terasa se razprostira vzdolž vzhodne polovice kraškega polja od Vidma prek Kompolja do Četeža. V kamninskem in reliefnem pogledu predstavlja samosvoje območje dolomitna fluviokraška terasa zahodno od Kompolja, vendar se po siceršnjem pokrajinskem izgledu, prsti, rastju in rabi tal ne razlikuje bistveno od preostalih teras. Starejši terasi ležita še severno od Ponikev in okoli

PREGLEDNICA 1: KOMBINACIJE MED KAMNINAMI, RELIEFOM, PRSTMI IN RASTJEM.

| kamnina | relief | prst | rastje | površina (v km$^2$) | delež (v %) | teoretična pogostnost | relativna pogostnost | naravna enota |
|---|---|---|---|---|---|---|---|---|
| naplavina | uravnano dno | rjava prst na mlajši pleistocenski naplavini | travišče | 6,21 | 10,47 | 0,09 | 120,47 | 1 |
| naplavina | uravnano dno | rjava prst na mlajši pleistocenski naplavini | travišče v zaraščanju | 0,40 | 0,68 | 0,02 | 41,72 | 1 |
| naplavina | uravnano dno | rjava prst na mlajši pleistocenski naplavini | gozd belega gabra in jelke ali gozd bukve in tevja | 0,40 | 0,67 | 0,10 | 6,41 | 1 |
| naplavina | uravnano dno | glej | travišče | 1,14 | 1,92 | 0,01 | 163,59 | 2 |
| naplavina | razčlenjeno dno | rjava prst na mlajši pleistocenski naplavini | travišče | 1,21 | 2,04 | 0,01 | 152,22 | 3 |
| apnenec | kraška terasa | rjava prst na starejši pleistocenski naplavini in na apnencu | travišče | 6,60 | 11,13 | 1,47 | 7,59 | 4 |
| apnenec | kraška terasa | rjava prst na starejši pleistocenski naplavini in na apnencu | travišče v zaraščanju | 2,98 | 5,02 | 0,28 | 18,23 | 4 |
| apnenec | kraška terasa | rjava prst na starejši pleistocenski naplavini in na apnencu | gozd belega gabra in jelke ali gozd bukve in tevja | 3,74 | 6,31 | 1,76 | 3,57 | 4 |
| dolomit | fluviokraška terasa | rjava prst na starejši pleistocenski naplavini in na dolomitu | travišče | 0,58 | 0,97 | 0,00 | 718,43 | 4 |
| apnenec | hum | rjava pokarbonatna prst ali rendzina na apnencu | gozd belega gabra in jelke ali gozd bukve in tevja | 0,47 | 0,79 | 0,15 | 5,20 | 5 |
| apnenec | pobočje | rjava pokarbonatna prst ali rendzina na apnencu | travišče | 3,66 | 6,17 | 9,62 | 0,64 | 5 |
| apnenec | pobočje | rjava pokarbonatna prst ali rendzina na apnencu | travišče v zaraščanju | 0,23 | 0,39 | 1,81 | 0,22 | 5 |
| apnenec | pobočje | rjava pokarbonatna prst ali rendzina na apnencu | gozd belega gabra in jelke ali gozd bukve in tevja | 17,98 | 30,32 | 11,57 | 2,62 | 5 |
| dolomit | pobočje | rjava pokarbonatna prst ali rendzina na dolomitu | gozd belega gabra in jelke ali gozd bukve in tevja | 0,46 | 0,78 | 0,00 | 196,27 | 5 |
| apnenec | pobočje | rjava pokarbonatna prst ali rendzina na apnencu | grmišče gabrovca in hrastov | 0,16 | 0,26 | 0,18 | 1,43 | 6 |
| apnenec | pobočje | rjava pokarbonatna prst ali rendzina na apnencu | gozd bukve in velike mrtve koprive | 7,55 | 12,74 | 3,91 | 3,26 | 6 |
| apnenec | pobočje | rjava pokarbonatna prst ali rendzina na apnencu | gozd bukve, jelke in pomladanske torilnice | 5,09 | 8,59 | 2,55 | 3,38 | 6 |
| apnenec | pobočje | rendzina na apnencu | grmišče gabrovca in hrastov | 0,23 | 0,39 | 0,00 | 170,50 | 6 |
| apnenec | pobočje | rendzina na apnencu | gozd bukve in velike mrtve koprive | 0,21 | 0,35 | 0,05 | 7,19 | 6 |

Opomba: S senčenjem so označene temeljne kombinacije kategorij posameznih naravnih enot.

Rapljevega, ostanke iste terase pa predstavljajo še grbine pri Zdenski vasi in Predstrugah. Na starejših terasah se je razvila rjava prst, ki je ponekod izprana. Le na poplavnem svetu ob strugi Rašice je prst bolj vlažna in jo lahko uvrstimo med psevdooglejene prsti. Porašča jo gozdna združba črne jelše in podaljšanega šaša. Z vrtačami razčlenjene terase so manj primerne za njivske površine. Le-te so omejene na bližnjo okolico vasi, medtem ko prevladujejo na preostalih površinah travniki. Njim pripada približno polovica površine teras. Petina površine, predvsem nekdanji pašniki, se postopoma zarašča z gozdom. Gozd belega gabra in jelke pokriva četrtino vseh teras.

5. Nižji, položnejši deli pobočij z vmesnimi vrtačastimi uravnavami so z 38,5 % deležem ali 22,80 km$^2$ največja naravna enota. Z izjemo manjše zaplate dolomita nad Kompoljem, ki se v pokrajinskem izgledu ne loči od ostalega dela pobočja, razen morda zaradi dveh bolj ali manj stalnih kraških izvirkov, ki tod pritečeta na površje, je pobočje v celoti apnenčasto in zato zakraselo. Kar štiri petine omenjene naravne enote pokrivajo podgorski bukovi gozdovi, ki v vznožju prehajajo v gozdove belega gabra ter jelke. Večje površine travišč so se ohranile v bližini vasi, na primer nad Strugami, Rapljevim in Zdensko vasjo, kjer so nakloni pobočij manjši.
6. Deli bolj strmih in skalovitih pobočij nad 650 m nadmorske višine predstavljajo z 22,3 % oziroma 13,23 km$^2$ površine samostojno naravno enoto. Pobočja Dobrepoljsko-Struškega krasa sestavljata dve naravni enoti, ki ju določajo gozdne združbe v odvisnosti od naklona pobočja ter nadmorske višine. Višje dele pobočij Male gore porašča dinarska gozdna združba bukve, jelke in pomladanske torilnice, ki na Mali gori doseže rob svojega strnjenega areala razširjenosti. Dve tretjini pobočij, na Mali gori, Planskem vrhu in Jermanovem lazu, pripadata raznim bukovim združbam in njihovim degradacijskim oblikam. Gozdne združbe, ki se uveljavljajo v tej naravni enoti, so vezane na bolj strma in skalovita rastišča in se po tem ločijo od gozdnih združb, ki poraščajo nižje dele pobočij z zmernimi nakloni in vmesnimi zakraselimi uravnavami. Na apnenčevih pobočjih je razvita rjava pokarbonatna prst v menjavi z rendzino.

## 4. Sklep

V prispevku je prikazana členitev Dobrepoljsko-Struškega krasa na naravne enote. Opravili smo jo s prekrivanjem vsebinskih slojev kamnin, reliefa, prsti in rastja v okviru geografskega informacijskega sistema.

Med 648 teoretično možnimi kombinacijami kategorij naravnih prvin je bilo dejansko ugotovljenih devetnajst. Na temelju kriterijev tipičnosti in pomembnosti smo nato izločili šest naravnih enot, v katerih se pojavljajo z vidika kamnin, reliefa, prsti in rastja istovrstne ali sorodne razmere.

Skoraj štiri desetine celotne pokrajine zavzemajo apnenčeva pobočja z rjavo pokarbonatno prstjo, ki jih poraščajo gozdne združbe belega gabra in jelke ter bukve s tevjem. Slaba četrtina ozemlja pripada kraškim terasam na apnencu in fluviokraški terasi na dolomitu. Na terasah so ostanki starejših pleistocenskih naplavin, na katerih se je razvila rjava prst. Prevladujejo travišča, ki se predvsem v večji oddaljenosti od naselij hitro zaraščajo z gozdom. Dobro petino pokrajine obsegajo apnenčeva pobočja z rjavo pokarbonatno prstjo in rendzino. V veliki meri so poraščena z gozdnima združbama bukve in mrtve koprive ter bukve, jelke in pomladanske torilnice. Nekaj več kot desetino ozemlja zavzema uravnano dno kraškega polja, ki ga prekriva mlajša pleistocenska naplavina z rjavo prstjo. Prevladujejo travniki in njivski kompleksi. Najmanjšima naravnima enotama skupaj pripada manj kot dvajsetina površine pokrajine. Obe ležita na dnu kraškega polja, ki je prekrito z mlajšo pleistocensko naplavino, na kateri prevladujejo travišča. Prva ima uravnano površje in oglejene prsti, medtem ko je površje druge razgibano in prekrito z rjavo prstjo.

Členitev je pokazala, da se posamezne naravne enote prvenstveno oblikujejo v odvisnosti od kamninske sestave oziroma od starosti in sestave pleistocenskih naplavin. Od različne starosti usedlin je namreč odvisna površinska razčlenjenost dna kraškega polja in s tem posredno celotna naravna, pa tudi kulturna pokrajina.