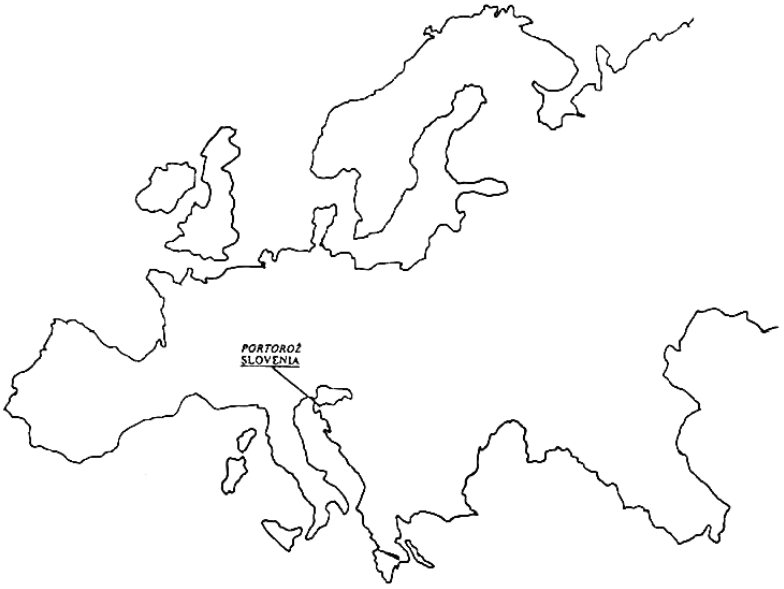
WORKSHOP

ENGINEERING IN KARST



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During the IMWA 1996 Workshop, fourteen national and international colleagues presented their experience about engineering and mining in karstic regions. The papers presented were not published in a proceedings volume, but handed out to the delegates as paper copies.

This PDF is one of those documents provided to the delegates.

All other papers can be downloaded from www.IMWA.info

Land Use in Karst

Land use, in its strictly technical sense, has been traditionally considered as an indicator of economic capability of different regions. It can be, from an other point of view, taken also as an indicator of human interventions in the environment and, consequently, also as an analytical tool for environmentally sound considerations of a region. The twofold nature of the land use should, therefore, be starting point of any discussion on the land use and on the types of landscapes it produces.

Land use is by no means the most essential characteristic of a region and creator of any cultural content of landscapes. The specific character of Karst landscapes originates from the rough relief conditions. The later are those factors that forced early farmers on the Karst land to adapt their cultivation patters in much greater extent. E.g., fields normally rectangular in shape become rounded in the Karst area due to the adaptation to the shape of the bottom of the sink holes. The structure of the land use pattern is much more important here than quantitative figures of cultivated land.

Not more than hundred years ago Karst landscapes represented barren rocky landscapes with some smaller spots of degraded forest and bushes, small spots of fields and meadows. The later have been made through centuries by an enormous input of work. The afforestation activities, that started in the middle of last century, and particularly the new economic and employment possibilities that industrialisation brought to the country, have transformed Karst into green area with waste areas of coppice forests. For the municipality of Sežana, one of the most characteristic municipalities in the Karst region the figures of forest cover are:

Year	Percentage of forest
1896	7,3 %
1938	33,3 %
1995	40,7 %

The statistical figures of to-day situations do not represent the real picture as many areas that are officially considered as pastures are already overgrown.

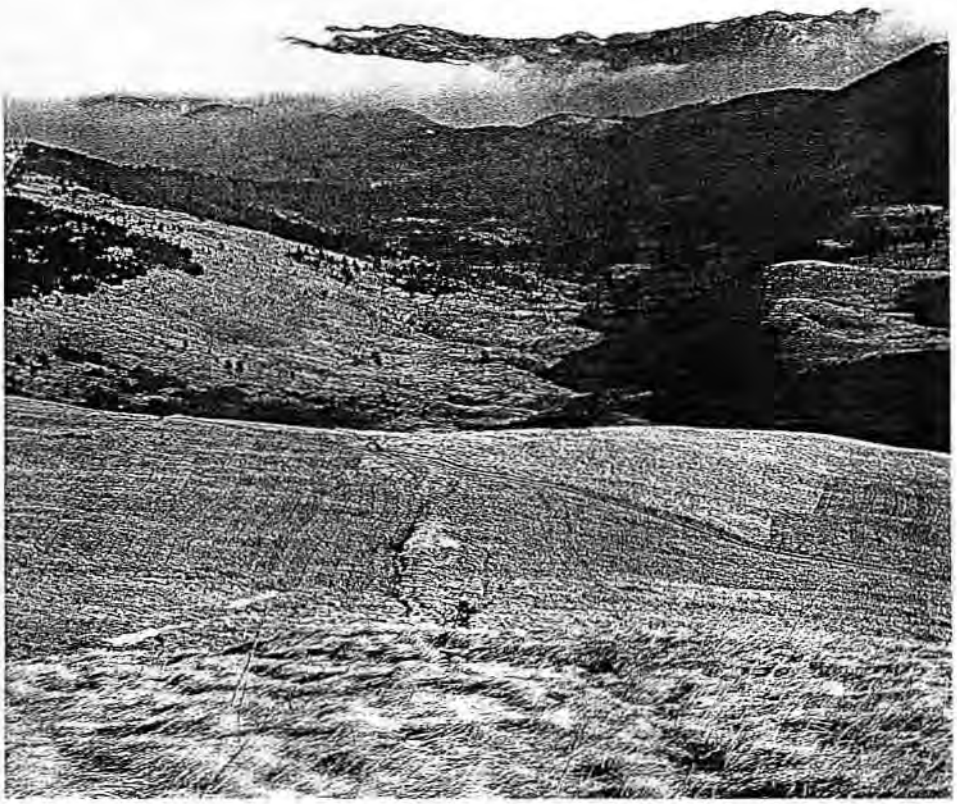
The afforestation process represents a restoration of the nature of the Karst. In the same time it also represents a process of unification of the landscapes and thereafter a threat to the biotic diversity. Many rich and

diverse biotops have been established through the intensive human use of Karst lands that have created rich ecosystems all over the Karst area. Many of the conservation problem originates here, although new development - housing, industry zones, infrastructure lines - can also be considered as serious conservation problems.

There are several approaches that could be implemented to cope with the conservation problems. Establishing protected areas is one of them. There are several proposals to establish protected areas in the Karst region. Unfortunately, protected areas cannot cover all Karst regions. Thereafter, a sensible physical and landscape planning should be introduced as a tool for establishing environmentally sound land use in future.

International Mine Water Association Workshop 1996 Portoroz, Slovenia

KRAŠKE KRAJINE NOTRANJE SLOVENIJE



INTERIOR KARST LANDSCAPES OF SLOVENIA

Kraške krajine notranje Slovenije označujejo višje planote, ki dosežejo največje višine v Snežniški in Nanoški planoti. Slednja je na sliki. Na teh najvišjih planotah se travinje prepleta z višjim rastlinjem, ki le s težavo kljubuje surovim vremenskim razmeram. Te niso take samo zaradi višine, temveč predvsem zato, ker se tu srečujeta sredozemski in celinski prostor.

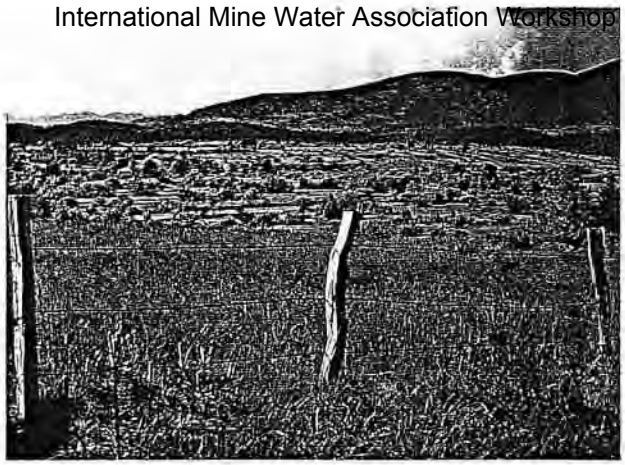
The Karst landscapes of interior Slovenia are characterised by higher plateaus reaching the maximum heights on Snežniki and the Nanos plateau. The latter is shown in this picture. On these highest plateaus the grass is intermingled with higher plants which only with maximum difficulty defy the rough weather conditions. This is not so just because of the height, but above all because the Mediterranean and continental space meet here.

Matična kamnina – apnenec – je tu opredelilna za ustvarjanje krajinskih vzorcev. Ta določa tako rabo tal, in s tem površinski pokrov, kot tudi oblikovitost reliefa z značilnimi kraškimi pojavi. Z vidika geomorfoloških pojavov so krajine tega dela Slovenije podobne primorskim kraškim krajinam. Od slednjih pa se razlikujejo predvsem zaradi drugačnega podnebja, večje humidnosti, ki ni le rezultat večje količine padavin, temveč tudi njihove boljše razporeditve in nižjih temperatur. Tako podnebje omogoča veliko večjo gozdnatost, obenem pa povzroča tudi več vodnih pojavov na površini, na primer lokalna zamočvirjenja, krajše vodotoke – ponikalnice, občasna jezera. Gozdovi so večinoma strnjeni, prostorsko pogosto zelo obsežni. Pretežno jih oblikuje bukovje ali jelovo–bukovi sestoji. V manjših izkrčitvah se pojavljajo kraški pašniki. Krčitve so obsežnejše v nižjih legah, lahko so to obsežne senožeti na rahlo valovitih in vrtačastih tleh. Obsežnejše strnjene površine njiv so na povsem ravnih kraških poljih. Njive so nekdaj urejali tudi v dnu vrtač ali na položnejših pobočjih. S terasami so tu ustvarjali globlja tla za obdelavo. Sledovi preteklega čiščenja tal so vidni v kupih kamenja ali podpornih zidovih.

■ *Čeprav apnenec označuje Kras, tudi tega v notranji Sloveniji, pa se ponekod lahko pojavi mehkejša kamnina, ki oblikuje značilno valovito krajino, na primer na Banjški in Postojnsko–Pivški planoti. Krajina je značilno drugačna, mehkejša, z več kmetijskimi zemljišči, lahko tudi v obliki strnjenih obdelovalnih enot. Slednje so rezultat povojnih prizadevanj za kolektivne oblike kmetovanja.* ■ *Although limestone is a distinguishing feature of the Karst, and thus also of this part in the interior Slovenia, softer bedrock may appear here and there, forming the characteristic undulating landscape, e.g. on the Banjška plateau and the Postojna–Pivka plateau. The landscape is typically different, softer, with extensive agricultural land, even in the form of integrated cultivated areas. The latter are a result of the post–war endeavours to introduce collective forms of agriculture.* ■

Kraška polja prav presenetljivo kažejo ponavljajoči se in značilen vzorec njivske ureditve in poselitve od Banjške planote na zahodu do Kočevske na jugovzhodu. Vzorec je značilen, pa naj gre za manjši zaselek v dnu manjšega kraškega polja ali za obsežnejša kraška polja. Splošna usmeritev prostora kaže dinarsko smer – od severozahoda proti jugozahodu. To je tudi smer večine kraških polj. Ponekod je kamnina na površini mehkejša, kar ustvarja vmesne planote rahlo razgibanega reliefa, na primer Banjščic, Postojnska planota. Na nekaterih krajih pa odsotnost vode daje krajinam bolj trd in izrazit dinarski videz – Trnovska planota – Lokovci, Gora. Krajinsko sliko skorajda dosledno okvirjajo višji kopasti vrhovi in manj izraziti grebeni.

■ *Travinje prevladuje tudi na nižjih planotah. Večinoma je nastalo po obsežnem čiščenju površin in odstranjevanju kamenja, tako da kraško krajino odkrivajo samo še večji geomorfološki pojavi – vrtače in doli.* ■ *Grassland prevails on lower plateaus as well. Mostly it is a result of extensive cleaning of land and removal of stones, so that the Karst landscape is revealed only by large–scale geomorphologic phenomena – sinkholes and bigger dolinas.* ■



■ *Nekdanji skupni pašniki – "gmajne" so bili ob času prosvetljenih vladarjev razdeljeni med prebivalce vasi v obliki pravilnih trakastih parcel. Danes jih prepoznamo po vrstah grmovnic, ki pa se postopoma izgubljajo v spontani zarasti. Ta se z opuščanjem paše ali košnje postopoma širi. Trakasta zarast, ki se kaže tudi v izmenjavanju poraščenih in neporaščenih parcel, je ena od bolj opaznih značilnosti slovenskih krajin v vsem kraškem prostoru, pa tudi v predalpskih krajinah.* ■ *At the time of the enlightened rulers village commons – "gmajne" – were divided among the village inhabitants in regular strip–shaped parcels. Today they can be recognised by the rows of bushes which are gradually disappearing in the spontaneous growth which keeps expanding as a result of abandoned grazing and mowing. The overgrowth in strip–like pattern which also shows in alternating overgrown and barren parcels, is one of the more distinctive features of the Slovenian landscapes in all Karst region, and also in the sub–Alpine hills.* ■

■ *Značilen krajinski vzorec ustvarjajo tudi s skalami podzidane terase. Te običajno niso v takem pravilnem vzorcu, kot ga kažejo sredozemske. Lahko so zgolj posledica postopnega premikanja zemlje pri obdelovanju. Značilne so za vse kraške krajine notranje Slovenije, toda tudi za kraške primorske krajine.* ■ *A characteristic landscape pattern is also created by terraces with retaining stone–walls. Usually, these are not arranged in such a regular pattern as displayed by Mediterranean ones. These terraces can be just a result of gradual shifting of land during cultivation. They are typical for all Karst landscapes of interior Slovenia, and for the coastal Karst area as well.* ■

Here, the bedrock – limestone is determinative for the creation of landscape patterns. It determines land use and consequently surface cover as well as the shape of relief with characteristic karst phenomena. In the aspect of geomorphologic phenomena the landscapes of this part of Slovenia are similar to coastal Karst landscapes. They differ from the latter primarily due to a different climate, i.e. higher humidity, not only because of a higher degree of precipitations, but also their better distribution and lower temperatures. Such climate results in considerably more extensive presence of forests and also more aqueous phenomena on the surface, e.g. local marshes, short waterways – sinking streams, periodic lakes. The forests are mostly dense, and often covering a large area. Mainly they are composed of beech trees or a combination of beeches and firs. Karst pastures appear in smaller clearings. Larger areas of cleared woodland appear in lower–lying positions. In these clearings there may be extensive meadows on gently hilly ground with sinkholes. Large concentrated areas of fields are situated on completely flat karst fields. The fields used to be made at the bottom of sinkholes or on gently rising slopes. Irregular terraces made in these places helped to create a deeper layer of soil for cultivation. Traces of the past cleaning of soil can still be seen in the heaps of stones and retaining walls.

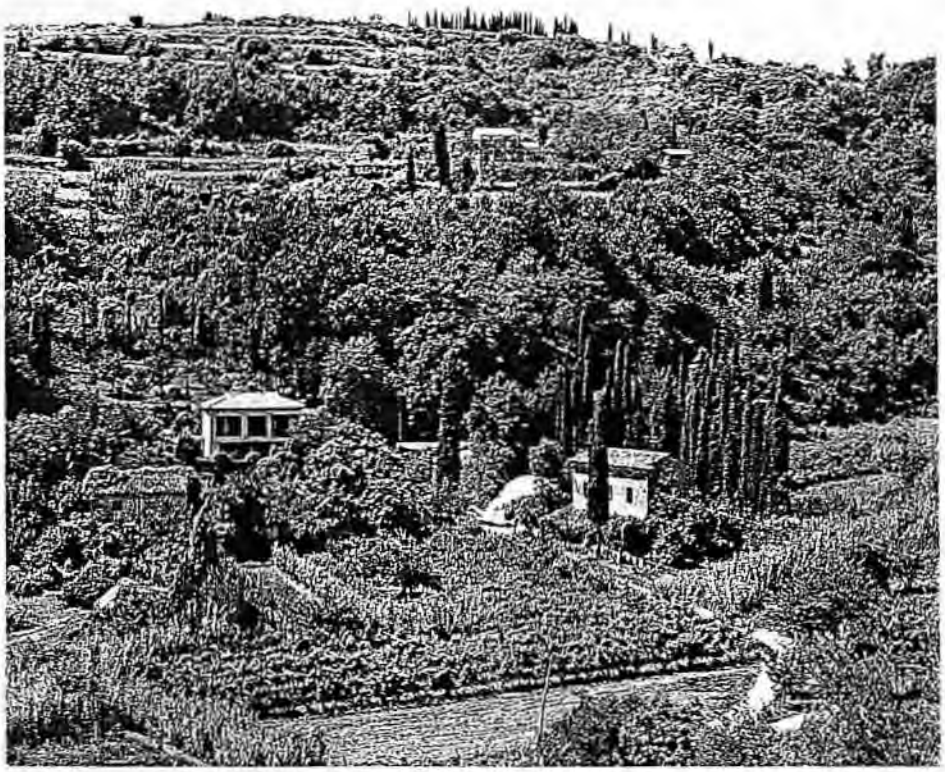
Karst fields – poljes – quite surprisingly show the repeating and characteristic pattern of field arrangement and settlement, from the Banjš ica plateau in the west to the Ko evje plateau in the south–east. The pattern is typical, either if it concerns a small settlement at the bottom of a smaller karst polje or more extensive one. The general direction of space indicates dinaric direction – from north–west to south–east. This is also the direction of a majority of karst poljes. In some places there is softer bedrock which creates intermediate plateaus with lightly varied relief, such as Banjši e, Postojna plateau. Here and there the absence of water gives the landscapes a harder and more distinctive dinaric character – Trnovska plateau – Lokovci, Gora. The landscape image is almost consistently framed by higher rounded hill–tops and less distinctive ridges.

■ *Kraška polja pomenijo edini pravi ravninski svet na Krasu. Značilen vzorec ravnega sveta, utopljenega in povsem obkroženega s pobočji, poraščenimi z gozdom, je posebnost. Srečamo jo od čisto zahodne Banjške planote – na sliki je Grgarsko polje – preko Notranjske do Suhe krajine in Kočevske na jugovzhodu.* ■ *Karst poljes are the only real plains in the Karst. The characteristic pattern of flat land, swallowed and completely surrounded by forest–covered slopes is a peculiarity. It can be found from the west–most Banjška plateau – the picture shows the Grgarsko polje plain – through Notranjska to Suha krajina and to the Kočevje plateau in the south–east.* ■

■ *Ponikalnice so značilnost kraških polj. Voda odteka v podzemlje. Zato velikokrat poplavljajo – na primer Radensko polje – in na njih se lahko oblikujejo presihajoča jezera. Običajno stalni vodotoki v ravnicah kraških polj meandrirajo, lahko pa oblikujejo tudi vrsto zanimivih vodnih pojavov – požiralnike, estavele itd.* ■ *Sinking streams are a characteristic feature of karst poljes. The water runs off them into the underground. For this reason they often flood – e.g. the Radensko polje plain – and periodic lakes can be formed on them. Normally, the permanent streams in the plains of karst poljes meander, but they can also create a series of interesting aqueous phenomena – ponors, estavelles etc.* ■

■ *Kmetijske površine se tudi v kraških območjih notranje Slovenije oblikujejo kot večji ali manjši celki sredi strnjenih območij gozda. Kmetijstvo izrablja reliefne uravnave, kraška polja in vrtače. Na poselitev in kmetijsko rabo pa je vplivala tudi prisotnost vode na površini, ki je omogočala življenje v prostoru. Dolina Krke ni kraško polje, kljub temu pa pomeni bolj izravnan relief v širšem, bolj razgibanem prostoru, ki kaže značilne vzorce kraške krajine notranje Slovenije.* ■ *Also in the Karst regions of interior Slovenia the cultivated areas are formed as bigger or smaller "celek" enclosures in the middle of dense forest regions. The agriculture exploits level parts of the relief, karst poljes and sinkholes. The settlement and cultivation were also influenced by the presence of water on the surface which meant life for this area. The Krka valley is not a karst polje, but anyway it means a flatter relief within a wider rougher area, showing the cahracteristic patterns of a Karst landscape of interior Slovenia.* ■

PRIMORSKE KRAJINE



SLOVENIAN COASTAL REGION LANDSCAPES

Tradicionalni krajinski vzorec slovenskega obalnega pasu oblikuje bujno rastje s prepletom naravnih rastlinskih prvin, okrasnega rastlinja in kmetijskih kultur. Oblike pridelovalnega prostora označujejo manjše kvadratno zasnovane površine, ki se v pobočjih oblikujejo kot terase. Širino teras določa strmina pobočja. Za kmetijska zemljišča je značilna "mešana kultura" – splošno sredozemski pridelovalni vzorec, v katerem se mešajo pridelava zelenjadnic, tudi poljedelskih kultur, vinske trte in sadnega drevja. Tako "mešano pridelovanje" omogočajo večja osvetljenost in višje temperature sredozemskega podnebja.

The traditional landscape pattern of the Slovenian coastal area is formed by a wealth of lush vegetation, blending natural vegetation elements, decorative plants and farming cultures. The cultivated areas are arranged in rather small square–shaped segments. On hillsides they take the form of terraces. The width of terraces is determined by the gradient. A so–called "mixed culture" is representative for these agricultural areas – a generally Mediterranean cultivation pattern of a mixture of vegetables, field crops, vineyards and fruit trees. Such "mixed cultivation" is enabled by more intensive light and higher temperatures of Mediterranean climate.

Slovenske primorske krajine opredeljuje blažje submediteransko podnebje.
Toda krajine se tudi tu pomembno razlikujejo med seboj, predvsem zaradi različne matične kamnine.
Fliš označuje celotno Slovensko Istro in obalni pas, toda tudi dele Vipavske doline in Goriška Brda.
Ti dve območji ločuje apnenčasti Kras, ki na italijanski strani sega vse do morja.
Tudi kulturni vzorec rabe tal je v obeh primorskih flišnih območjih različen.
Drobna terasiranost in manjše bolj ali manj kvadratno oblikovane poljske enote so značilnost obalnega pasu in Istre, ki jo spreminjajo šele sodobne obnove kmetijskih nasadov.
Večje ravnice so nastale ob izlivih rek v morje. V preteklosti so bile tu obsežne površine solin, ki so danes deloma spremenjene v kmetijska zemljišča, na primer Bonifika pri Kopru in v Strunjanski dolini, deloma se na njih še pridobiva sol, deloma propadajo. Tradicionalno je bila tu, tako kot drugje v Sredozemlju, osnovna oblika pridelovanja "coltura mista" – "mešana kultura".
To je značilen ureditveni vzorec kmetijskih zemljišč, pri katerem
se prepletajo vinska trta,
sadna drevesa in poljski pridelki oziroma zelenjadnice.

Kraška območja označuje odsotnost vode – suhe travnate površine, pašniki in kraške gmajne.
Nekdanji skupni pašniki so se danes spremenili v manj vreden gozd panjevec, ki že močno porašča Kras.
Pogozdovanja so na Krasu zapustila neizbrisne sledove v temnejših borih, ki ponekod rastejo v večjih sestojih, ponekod pa se spontano širijo med avtohtonim rastjem.
Občasno jih prizadene požar, kar ustvarja nenavadne krajinske podobe.
Za kraška tla so značilne skale na površini in predvsem tanek skeletni sloj tal.
Globlja tla so v vrtačah ali plitvejših depresijah, deloma tudi ustvarjena s čiščenjem in odstranjevanjem skal.
Skalnat in suh kraški svet se na nekaterih mestih omehča.
Večja obdelanost takih
otokov sredi skalnatega Krasa je znak mehkejše matične kamnine, na primer okrog Tomaja, Rodika.
Dolina Reke in Brkini so izrazita območja prehoda Primorja v kraški svet notranje Slovenije, prepletanje z mehkejšo kamnino še poudarja to prehodnost.

■ *Tradicionalni vzorec "mešane kulture" izpodriva sodobna ureditev kmetijskih pridelovalnih zemljišč. Ta opušča nekdanje terase na strmih pobočjih in ureja večje strnjene pridelovalne površine. Osnovni vzorec pa ohranjajo sredozemske okrasne rastline in sredozemsko naravno rastje, ki postopno zarašča tudi terase v strmih legah.* ■ *A traditional pattern of "mixed culture" is being superseded by modern cultivation practices. Former terraces on steep slopes are thus abandoned and continuous cultivated areas are formed. The basic pattern is preserved by Mediterranean ornamental plants and natural growth, gradually overgrowing even the terraces on steep slopes.* ■

■ *Flišni svet v notranjem Primorju ni tako strnjen kot v obalnem Primorju. Zato se pojavlja v obliki več območij gričevnatega sveta – brd – Goriška Brda, Vipavska Brda. V dolinskem dnu je erozija ustvarila težja, globoka tla, ki so velikokrat zamočvirjena. Vinska trta je dosledno sajena po plastnicah, večinoma na zemeljskih terasah in, ker je obnova stalna, v obsežnejših kompleksih. Ravnino zasedajo njive ali sodobni nasadi sadnega drevja, na mokrih ravninskih zemljiščih so travniki.* ■ *The flysch area in the interior coastal region is not so uniform as along the coast. For this reason it appears in the form of several regions of hills – highlands – Goriška brda, Vipavska brda. At the bottom of the valleys erosion created heavier deep soil. The grapevine is consistently grown along contours, mostly on earth terraces, and due to continuous cultivation in extensive complexes. The flat land is occupied by fields or modern plantations of fruit trees, and meadows on wet flat land.* ■

■ *Svojevrsten je kraški svet. Tega povezuje kraški relief z notranjeslovenskimi krajinskimi vzorci, višje temperature in manjši obseg padavin pa mu vendarle dajejo značaj Primorja. Kras oblikujejo planote z značilnimi doli in kopastimi vrhovi, ki se komaj opazno povezujejo v grebene. Tla so plitva, skeletna, tudi z golim skalovjem na površini. Nekoč so bili na skeletnih tleh večinoma pašniki, danes jih zarašča gozdno rastje – pionirski črni bor in avtohtono rastlinje. Kjer se je nabirala zemljina, so bile njive ali vinska trta. Njive se danes spreminjajo v travnike, intenzivne kulture se ohranjajo v večjih strnjenih zemljiščih, na primer vinogradi s teranovko.* ■ *Specific again is the Karst environment. The Karst relief connects it with the landscape patterns of interior Slovenia, but higher temperatures and lower degree of precipitations still give it the character of a coastal region. The Karst is formed of plateaus with characteristic dry valleys and rounded hill-tops which are almost imperceptibly linked into ridges. The soil is shallow, rocky, even with bare rocks on the surface. Pastures prevail on rocky soil. Today they are being overgrown by forest vegetation – pioneer black pine and native plants. In those places where soil had accumulated there used to be fields or vineyards. The fields are nowadays changing into meadows; intensive cultures are preserved in larger continuous areas, e.g. vineyards with locally specific "teran" grapevine.* ■

Slovenian coastal region is determined by gentle sub–Mediterranean climate. But even there the landscapes differ significantly, especially due to the variations in bedrock. Flysch destinguishes the entire Slovenian Istria and the coastline belt, but also parts of Vipava valley and Goriška Brda. These two regions are separated by limestone Karst, which on the Italian side of the border extends all the way to the sea. But the cultural land use pattern is different in both flysch areas of the coastal region. A division in small terraces and smaller, more or less square–shaped field units are the features of the coastal belt and Istria, and they being changed by contemporary renewals of rural land. Larger plains were created around river estuaries. In the past, there used to be extensive areas of saltpans.

These are nowadays changed partly into agricultural land, e.g. in Bonifika near Koper and in the Strunjan valley, partly they are used for salt extraction, and partly they are decaying.

Traditionally, the basic form of cultivation there, like elsewhere in the Mediterranean, used to be "coltura mista" – "mixed culture". This is a characteristic pattern of agricultural land arrangement, with a blend of vineyards, fruit trees and field crops or vegetables.

Karst areas are determined by the absence of water – dry grassy areas, pastures and karst woods. Former commons have changed into inferior and thin karst wood which has largely overgrown the Karst.

The forestation activities have left indelible traces in the Karst region by way of the black pines, brought from the Austrian Alpine regions, which in places grow in big groups, and in other places spontaneously spread among natural growth. Periodically they are affected by fire, and this creates unusual landscape images.

The Karst ground is characterised by typical rocks on the surface and above all a thin layer of rocky soil. A deeper layer of soil can be found in sinkholes or shallow depressions, partly also created by cleaning and removal of rocks. Rocky, dry Karst world becomes softer in places. Such islands in the middle of the rocky Karst aremore intensively cultivated, this being a sign of softer bedrock, e.g. around Tomaj, Rodik.

The Reka valley and Brkini are distinctive areas of the transition of the coastal region into the Karst land of interior Slovenia. The intermingling with softer bedrock emphasises this transitivity even more.

■ *Stare fotografije kažejo naš primorski Kras, na katerem so bile vrtače, doli in mesta z debelejšo zemljino nekakšne zelene oaze. Danes so ohranjeni le še redki otoki skalnatega površja. Pionirski bor, ki so ga na Kras zanesla načrtna pogozdovanja, se tudi sam širi in zarašča nekdanje pašne površine. Občutljiv je za požare. Tudi ti prispevajo k eni od značilnosti kraških krajin, k temu namreč, da so v njej zelo opazni sukcesijski procesi.* ■ *Old photographs show our coastal Karst in which sinkholes, bigger dolinas and places with thicker soil were some kind of green oases. Today only infrequent islands of rocky surface are preserved. Black pine which was brought to the Karst by planned forestations has spread by itself and overgrown former pastures. It is sensitive to fires. They too contribute to one of the features of the Karst landscapes: namely, successions can be seen very clearly here.* ■

■ *Značilnost primorskih krajin v notranjosti so ostri prehodi v visoke kraške planote. To je izrazit reliefni vzorec, ki ga opažamo pri prehodu flišne Istre v Kras – Kraški rob, iz Vipavske doline na Trnovsko planoto in iz doline Reke v Snežnik. Krajine pobočij oblikujejo značilne prehodne vzorce, od terasastih njiv in vinogradov v gozdna in nazadnje v skalna pobočja.* ■ *A significant feature of the coastal region in the interior are sharp transitions to high Karst plateaus. This is a distinctive relief pattern which can be seen at the transition of Istrian flysch to the Karst – Karst edge, from the Vipava valley to the Trnovska plateau and from the Reka valley to Snežnik. The landscapes of hillsides form typical transitional patterns, from terraced fields and vineyards to forested and finally rocky slopes.* ■

■ *Prehod v alpsko krajino je omejen na sorazmerno ozko območje ob spodnji Soči. Tu se ustvarjajo vzorci s sadnim drevjem, travinjem in manjšimi terasasto urejenimi njivami in posameznimi vrstami vinske trte. Vzorec je značilen za mnoge doline južnih obronkov Alp – Beneška Slovenija, obrobja Karnijskih Alp, Dolomitov itd. Podobni vzorci se sicer pojavljajo tudi v prehodih h kraškim krajinam notranje Slovenije – Brkini, dolina Reke.* ■ *The transition into the sub-Alpine region is limited to a relatively narrow area along the lower Soča. Patterns with fruit trees, grassland and smaller fields arranged in terraces, as well as particular sorts of grapevine are created here. The pattern is typical for many valleys of the southern slopes of the Alps – Beneška Slovenia, the fringes of the Carnian Alps, the Dolomites etc. Similar patterns also appear at the transitions to the Karst regions in Slovenia – Brkini, the Reka valley.* ■