

original scientific paper
received: 14. 12. 2001

UDC 502/504:574.4(497.4-14)

DESERTIFICATION PROCESSES IN THE ADJACENT MEDITERRANEAN HILLY REGION (BRKINI AND ČIČARIJA)

Lidija GLOBEVNIK

Water Management Institute, SI-1000 Ljubljana, Hajdrihova 28

Andrej SOVINČ

Science and Research Centre of the Republic of Slovenia Koper, Institute of Biodiversity Studies, SI-6000 Koper, Garibaldijska 18

Mitja KALIGARIČ

University of Maribor, Pedagogical Faculty, SI-2000 Maribor, Koroška 160

Science and Research Centre of the Republic of Slovenia Koper, Institute of Biodiversity Studies, SI-6000 Koper, Garibaldijska 18

E-mail: mitja.kaligarc@uni-mb.si

ABSTRACT

The hilly region of Brkini and Čičarija (NW Slovenia) is situated along the line that divides the Mediterranean part of Slovenia from its more continental part. The changes in its socio-economic conditions, particularly in land-use, as well as its depopulation processes and afforestation have in the last two hundred years had a strong impact on the structure of bird and plant species of the area. In spite of all these changes, however, the marginal Mediterranean area of Brkini and Čičarija still have a great value in respect of biodiversity and especially regarding the number of endemic and threatened species, as well as species that in this area reach the edge of their range.

Key words: Mediterranean, flora, vegetation, forest, avifauna, sustainable development, nature conservation, desertification

PROCESSI DI DESERTIFICAZIONE NELLE MONTAGNE MEDITERRANEE LIMITANTI (BRKINI E CICERIA, SLOVENIA SUD-OCCIDENTALE)

SINTESI

La zona di Brkini e della Ciceria (Slovenia sud-occidentale) funge da area limitante tra le parti mediterranea e continentale della Slovenia. I cambiamenti delle condizioni socio-economiche (soprattutto quelli nell'utilizzo del suolo e i processi di depopolazione) nonché il rimboschimento dell'area negli ultimi duecento anni, hanno influenzato la struttura e la composizione di uccelli, piante ed associazioni vegetali. Nonostante tali cambiamenti, l'area mediterranea limitante di Brkini e della Ciceria mantiene un valore particolare in termini di biodiversità, in particolare in merito al numero di specie endemiche, minacciate, o specie che in quest'area raggiungono il limite dell'areale di estensione. Nell'area mediterranea limitante, con fattori climatici discreti, il potenziale naturale di rigenerazione risulta maggiore che nel Mediterraneo centrale. Alcuni dei processi di desertificazione, come ad esempio l'erosione, gli incendi boschivi e le attività antropogeniche tradizionali (es. l'agricoltura) si rivelano necessari e bramati per il mantenimento di alcune specie strettamente specializzate. L'abbandono delle attività di utilizzo del suolo, l'allargamento boschivo e i processi di depopolazione influenzano lo sviluppo socio-economico dell'area, l'aspetto naturale e le particolarità floristiche e faunistiche della zona.

Parole chiave: Mediterraneo, flora, vegetazione, bosco, uccelli, utilizzo durevole, tutela dell'ambiente, desertificazione

INTRODUCTION

Edges and transitional geographical regions have an important role in the study of the changes occurring in our environment. Through analyses of the past human involvement in nature phenomena and the socio-economic characteristics, ecosystem parameters such as vulnerability, recoverability and predictability can be defined and recommendations for sustainable management proposed. On the basis of the study of the northernmost part of the Mediterranean bordering mountainous range in Slovenia we present a description of the boundary state of the Mediterranean basin environment. Climate in the research area, also described as adjacent Mediterranean hilly regions, is not as extreme as in typical Mediterranean mountainous areas, so the interference between nature and humans and disturbances due to inappropriate management of the area have different consequences on ecological and socio-economic stability. The objectives of the study are thus to give a fair evidence of the past and present the state of the ecological and socio-economical conditions of the Slovenian Mediterranean mountainous region, to identify the relationships between human and natural influences on the region's degradation of natural resources, to assess the future desertification trends, and to propose measures for sustainable management of the area.

METHODS

The first land-use data were provided by the Austrian Monarchy, whose cartographers divided the Monarchy into cadastral communities and established land-use and ownership data base through maps (1:2880) and tables (Korošec, 1978). The first land-use table data for cadastral units in the research area (Fig. 1) are available for the end of the 18th century (Območna geodetska uprava Koper, 1995a). They have been mostly renewed at the beginning of the 20th century and in the 60's

(Republiška geodetska uprava, 1994; Območna geodetska uprava Koper, 1995b). The National Institute of Agriculture has recently carried out a land-use census for cadastral units (Republiška geodetska uprava, Zavod RS za statistiko, 1983), interpreted from aerial photography (Kmetijski inštitut Slovenije, 1995). The two historic maps from 1780 in scale 1: 28,000 (Rajšp & Trpin, 1997) and 1900 in scale 1: 33,000 (retrieved from a private archive; Korošec, 1995), give the oldest geographical information on forest cover. For the 20th century, some ample cartographic material is at hand (Korošec, 1995): the Italian army map from 1929, the first Yugoslav Army map from 1955, and the latest national topographic maps on scales of 1: 5,000, 1: 25,000 and 1: 50,000. In the analysis, data on forest cover extension, digitalised from maps on a scale of 1: 50,000 (Vodnogospodarski inštitut, 1993) are used. Most data on climate are available from 1951 (Ministrstvo za okolje in prostor, Hidrometeorološki zavod RS, 1988a, 1988b, 1995a, 1995b), on hydrology from 1971 (Ministrstvo za okolje in prostor, Hidrometeorološki zavod RS, 1998). Data on demography and socio-economy have been compiled from the national statistical data sources (Zvezni zavod za statistiko, 1953, 1961, 1971, Zavod RS za statistiko, 1981, 1984, 1991) and other studies (Vilfan, 1953; Savnik, 1968; Valenčič, 1984, 1989, 1994; Bilc, 1994; Orožen *et al.*, 1995).

Geographical descriptions of the area (Vilfan, 1953; Melik, 1960; Savnik, 1968; Roglič, 1987) as well as geological (Zvezni geološki zavod, 1975), climatological, pedological (Stepančič *et al.*, 1980; Vodnogospodarski inštitut, 1990; Zavod za pogozdovanje in melioracijo krasa Sežana, 1990, 1992, 1993a, 1993b), hydrological (Vodnogospodarski inštitut, 1987), floristic/vegetational (Kaligarič, 1992a, 1992b), historical (Kos, 1953; Vilfan, 1953; Melik, 1960; Valenčič, 1989; Darovec, 1992) and socio-economic data were collected, integrated and analysed (Globevnik *et al.*, 1996). Cartographic material, national cadastral data and land-use data were georeferenced and integrated into geographical information system. Analysis of land-use and forest cover characteristics was made for four different units of the research area, i.e. Čičarija SW, Čičarija NE, Brkini W and Brkini E (see figure 2). Comparison of historical data and current state of the environment was also made to show degradation or improvement of human and natural resources in the area. For the period from 1800 to 1995, land-use characteristics were defined and demographic/economic description of the area made.

Flora and vegetation types are described for the three vegetation subunits in the Čičarija area [Kraški rob (Karst Edge, subunit 1a), Kraška planota with Mt. Slavnik (Karst plateau with Mt. Slavnik, subunit 1b), Matarsko podolje (subunit 1c)] and for the Brkini area (subunit 2). Refer-

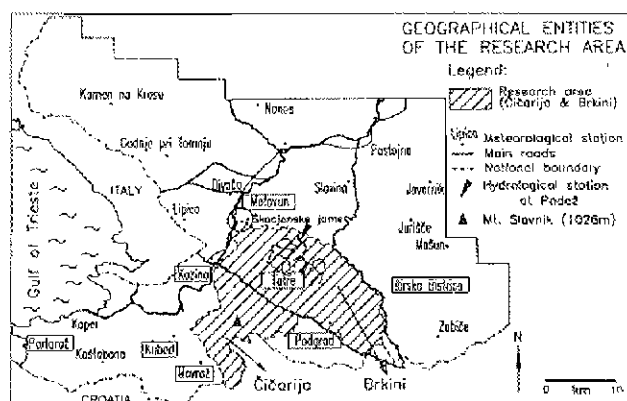


Fig. 1: Geographical position of the research area.
Sl. 1: Geografski položaj raziskovanega območja.

ence map for the vegetation subunits is shown in figure 2. The importance of the vegetation (flora) of the areas is described with the use of natural value parameters, such as endemic species (E), rare species (R), endangered species (En), species in their range border (BA) and special indicator species (SI). The ornithofauna was chosen as the main ecological indicator. Basic information on the avifauna of the area was collected through available data from literature (Vallo, 1885; Škornik *et al.*, 1990; Tome, 1991, 1992; Geister, 1995; Sovinc, 1995) and some field excursions. The recent as well as historic data on birds were collected for the period of some last 200 years.

Study area

The research area is part of the Dinaric mountain range bordering the Adriatic Sea on its eastern side. It is divided into two subregions, Čičarija and Brkini. Brkini is a border region of the Mediterranean water catchment basin to the Black Sea water basin and is a kind of transitional area between the Mediterranean geo-region and the inland. It is also a buffer zone for the Mediterranean to Central Europe with interesting nature and social indicators of both. Brkini (233.75 km²) is a hilly, rural area with well-developed water network. The area of Brkini was further divided into Brkini West and Brkini East. From Brkini to the coast spreads a karst region of the littoral NW edge of the Dinaric range (108.9 km²) named Čičarija with the highest peak of Mt. Slavnik (1028 m). The region (Matarsko podolje) between Brkini and Čičarija is a flat area, with the main transit road between Rijeka (Croatia) and Trieste. For a more detailed analyses, Čičarija was further divided into two subareas, *i.e.* Čičarija South-West (Čičarija SW) and Čičarija North-East (Čičarija NE).

Geology, relief: Brkini is mostly composed of Eocene flysch (sandstone, marlstone, breccia), while Čičarija consists of Cretaceous limestone and dolomite, with its mountainous region on the south-western part consisting of Palaeocene limestone. The northern part of Brkini is made up of limestone as well. The karst phenomena are clearly present in all limestone and dolomite areas. The Brkini area is extremely varied in its relief, due to its well-developed water network. Valleys are deep and narrow, while hill ridges are flat. The higher mountainous region of Čičarija extends in NW-SE direction.

Climate: The climate of the research area is sub-Mediterranean in Čičarija, but with a great continental influence in Brkini. The highest annual rainfall goes to Ilirska Bistrica, situated in the easternmost (inland) part of the area. The lowest precipitation was recorded at Kubed and Movraž, the westernmost (coastal) part of the area. The average annual precipitation is 1400 mm on the western side and 1500 mm on the eastern side of the research area. In the wettest year of the study period

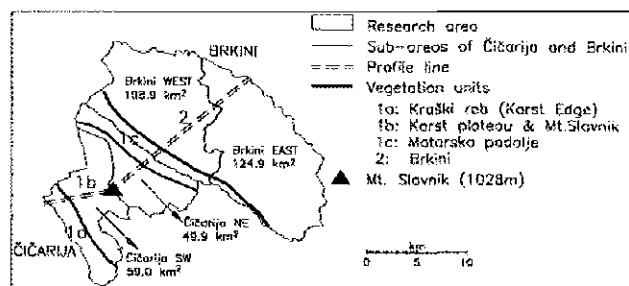


Fig. 2: Reference map for vegetation (sub)units (1a – Karstic plateau (Karst edge), 1b – Karst plateau & Mt Slavnik, 2 – Brkini).

Sl. 2: Referenčna karta vegetacijskih (pod)enof (1a – Kraški rob, 1b – kraška planota s Slavnikom, c – Brkini).

(1965), Čičarija had 1800 mm of rain on the coastal side and 2200 mm of rain on Mt. Slavnik. The driest year was 1983 with 1000 mm of rain on the western side and 1400 mm on the eastern side. On the westernmost (coastal side) of the research area (Kubed), the average temperature was 11.6 °C, while on the inlandmost side (Ilirska Bistrica) it reached 9.5 °C. January was the coldest, with the average 3.2 °C (Kubed), July the warmest month (20.1 °C at Kubed and 18.3 °C at Ilirska Bistrica).

Pedology: Čičarija: The limestone substratum is covered by rendzina, terra fusca and terra rossa. Rendzina is the most important soil type. Terra fusca covers the northern side of Mt. Slavnik. There is eutric deeper brown soil. At the edge of Matarsko podolje occurs alluvial terra fusca with very shallow humose layer and acid reactions. Typical terra rossa is found only locally at the foothills of Mt. Slavnik. At the junction between flysch and limestone, calcocambisol had developed. These areas are more stable, with fewer erosion processes. Brkini: On the flysch background, different types of dystic cambisols, regosol and ranker had developed. In this region, some carbonate substratum also occurs, where rendzina, litosol, calcocambisol, luvisol and eutric cambisol had developed.

Hydrology: The Brkini area has a strong hydrographic network on the northern part, where surface water flows to the Reka river. The general flow direction of the Reka river is SE-NW. The river valley borders Brkini to the inland and ends at the Škocjan Caves. The caves, where Reka has its swallowhole (ponor) to the karst region of Tržaško-Komenski Kras (Trieste-Komen Karst) is under UNESCO's protection as a World Natural Heritage Site. The Reka river then flows underground and reappears in many springs along the coast of the Gulf of Trieste. The main source of the underground course of the Reka is the Timavo at Duino in Italy. The Timavo spring has been declared a potential drinking water supply for the town of Trieste. Surface water from the southern part of Brkini flows into the streams in the dead karst dolines (Krivic *et al.*, 1989; Mihevc, 1994). The streams disappear into

numerous holes to the subsurface and flow through underground connections mainly to the Rižana spring (Krivic *et al.*, 1989), which is the main drinking water supply for the Slovenian coast.

RESULTS AND DISCUSSION

Sociological and economic characteristics

History

The history of human settlements began in the times of Haalstatt culture. Under the Roman rule (178 AD - 476 AD), the inhabitants were primarily hunters and peasants. Beside the fact that agriculture as well as certain trades and architecture were well developed in it, the area was an important transportation zone. At the end of the Antiquity, the power over Istra was changing in the same direction as the power over the northern Italic states (Odoacer, Ostrogoths). In 553, Istra came, together with the Venetian state, under the rule of Byzantium. This lasted until 788, when Istra came under the rule of the Franks. In 952, Otto the Great, king of the Franks, annexed Istra and Friuli to the German state as part of the Duchy of Carinthia. The period from the 11th to the 15th centuries was characterised by feudal land particularities and different political power holders in specific parts of Istra (the patriarch of Aquileia, the counts of Duino and Gorizia, the Venetian Republic, and the 14th century Habsburgs). After 1516 (Austrian-Venetian war), Istra was divided by two political rulers, the Habsburgs and Venice. The period of Napoleonic Wars changed the political organisation of the area. With the French victory at Wagram (1809), the

Habsburgs had to cede the Carinthia, Carniola, Istra and Gorizia provinces to Napoleon. Istra was returned to Austria in 1813 after declaring war to France. Until 1918, Brkini and Čičarija administratively belonged to Austria. Such political regime lasted until 1919/20, when the Istran part of the Habsburg Monarchy became part of Italy. During the Second World War, the Italian Army surrendered, and from 1943 to 1945 this area was under German military rule. After the war, *i.e.* from 1945 to 1954, the area was under Yugoslav military administration. With the international agreement in 1954, the area became part of Yugoslavia. Since 1991, when Yugoslavia ceased to exist, this area has belonged to the Republic of Slovenia. The estimated number of inhabitants is shown in table 1.

Tab. 1: Estimated number of inhabitants until 1850.

Tab. 1: Ocenjeno število prebivalcev do leta 1850.

Year	0 AD	500 AD	1000 AD	1350 AD	1400 AD	1600 AD	1850 AD
Estimated No. of inhabitants	1500	2000	3500	11000	10500	8400	16200

Socio-economic status of the people and households

There are 68 villages in Brkini. They are situated on flat hill slopes. In the narrow and steep valleys abandoned watermills and sawmills can be seen. In the Čičarija area (108.9 km²), there are only 8 villages. The tables present some basic statistics of the socio-economic character.

Tab. 2: Number of inhabitants and population density (per km²) (Slovenia in 1991-98).

Tab. 2: Število prebivalcev in gostota prebivalstva (na km²) (Slovenija v letih 1991-98).

Year		1869	1880	1900	1910	1931	1948	1953	1961	1966	1971	1981	1991
No. of inhabitants	BRKINI	13987	14403	14898	14795	13444	12177	11479	9708	9105	8419	7727	7469
	ČIČARIJA	2218	2481	2647	2616	2662	1961	1799	1535	1381	1223	1011	874
Population density	BRKINI	59.8	61.6	63.7	63.3	57.5	52.1	49.1	41.5	38.9	36.0	33.1	32.0
	ČIČARIJA	20.4	22.8	24.3	24.0	24.4	18.0	16.5	14.1	12.7	11.2	9.3	8.0

Tab. 3: Social structure of inhabitants.

Tab. 3: Socialna struktura prebivalstva.

	Sex structure		Age structure				Education: over 15 years			
	Male	Fem.	0-14 years	14-65 years	over 65 years	Ageing Index	Without elem. sch.	Elemen. school	High school	Uni-vers. College
BRKINI	49.8%	50.2%	17.9%	64.7%	17.4%	97	35.2%	27.9%	33.6%	3.2%
ČIČARIJA	51.1%	48.9%	14.2%	60.5%	25.3%	178	51.2%	15.8%	31.2%	1.8%
SLOVENIA	48.5%	51.5%	20.6%	65.5%	10.9%	53	17.3%	30.3%	43.4%	8.9%

Ageing Index = (No. of inh. over 65 years/No. of children up to 15 years)*100

Tab. 4: Percentage of employed people per sectors of employment.

Tab. 4: Odstotek zaposlenih po posameznih sektorjih zaposlovanja.

	Employed	Primary sector	Secondary sector	Tertiary sector	Quartary sector	Day migration of employed inhab. (% of the employed)
BRKINI	44.7%	24.2%	47.7%	19.7%	8.4%	59.7%
ČIČARIJA	36.3%	19.2%	38.3%	31%	11.5%	72.8%
SLOVENIA	40.9%	15%	44.2%	22.4%	17.9%	55.3%

Primary Sector: Agriculture, Forestry, Fishery; Secondary Sector: Industry, Minery, Watermanagement, Craft; Tertiary Sector: Transportation, Marketing, Tourism, Hotel-Restaurant-Pub facilities, Municipal infrastructure; Quartary Sector: Education, Science, Culture, Medical & Social Care

Tab. 5: Number of households with/without farming for 1981 and 1991.

Tab. 5: Število gospodinjstev, ki so se leta 1981 in 1991 ukvarjala s kmetovanjem ali pa ne.

	1981	1981	1981	1991	1991	1991
	No. househo.	No. househo. with agriculture(%)	No. househo. without agriculture(%)	No. househo.	No. househo. with agriculture(%)	No. househo. without agriculture(%)
BRKINI	2,369	71.2	28.8	2,465	51.9	48.1
ČIČARIJA	295	74.2	25.8	280	54.0	55.0
SLOVENIA	6,487	49.5	50.5	640,195	24.5	75.5

Tab. 6: Number of livestock for 1971, 1981, 1991 (source: Institute of Agriculture of the Republic of Slovenia, 1995).

Tab. 6: Število glav živine za leta 1971, 1981 in 1991 (vir: Kmetijski inštitut Slovenije, 1995).

	1971 (sum: 9255)				1981 (sum: 7220)				1991 (sum: 5047)			
	cattle	pigs	sheep	horses	cattle	pigs	sheep	horses	cattle	pigs	sheep	horses
BRKINI W (38 villages)	2223	985	150	163	1540	824	198	71	1138	167	121	23
BRKINI E (32 villages)	2557	1967	138	520	1995	1205	45	266	1961	1196	54	263
ČIČARIJA (7 villages)	381	156	10	5	323	103	249	1	158	41	24	1
Sum	5161	3108	298	688	4258	2132	492	338	3257	1304	199	287

Infrastructure

The central road passing through Matarsko podolje is also a transit road between Trieste and Rijeka. In the 70's, the "Brkini hill ridge road" was built, but it was too late for the severe depopulation rate of that time. The Brkini water supply system was built in the 80's, but there are still 21 villages without drinking water in West Brkini and in the entire Čičarija. Regular water supply is guaranteed only along Matarsko podolje. The system for waste removal has also been partially solved. All of the villages have been recently given waste containers. There are still 65 wild dump sites in the test area. Sewage system has been built only for the major settlements (Kozina-Hrpelje and Podgrad).

Economic and social activities in the area

The test area has only one urban centre, *i.e.* Kozina/Hrpelje, where all vital socio-economic activities are held. The town is the administrative centre of the

Hrpelje/Kozina county with 4,163 (1991) inhabitants (NE part of Čičarija, southern part of West Brkini and Matarsko podolje). There are an elementary school (350 children in the county), children day care centre, health/social centre, county administrative offices, banking and trading posts with traffic/transportation facilities. There is only one more elementary school in the county, *i.e.* at Materija. In East Brkini, there is a school at Podgrad. Children go to school also to Ilirska Bistrica and Divača (both outside Brkini). Industry has developed in few centres, *i.e.* at Podgrad, Hrpelje, Gradišče, Kozina, Hrpelje, Materija. In Čičarija, there is no industry, no schools, and no food stores. Inhabitants migrate every day either to Matarsko podolje or to the Koper region.

Land-use

In table 7, today's land-use characteristics of the Brkini and Čičarija area (divided into SW and NE part) are presented. Land-use changes from 1800 to 1995 are presented in table 8.

Tab. 7: Land-use in 1995.

Tab. 7: Raba tal v letu 1995.

	ČIČARIJA SW	ČIČARIJA NE	BRKINI
No. cadastral units	5	12	35
Total area of cadastral units	5530 ha	13211 ha	16437 ha
Unproductive	111 (2%)	264.2 (2%)	657.5 ha (4%)
Fields, gardens	183.1 ha (3.3%)	333.7 ha (2.5%)	1448.4 ha (8.8%)
Grassland (meadows, pastures)	2138.0 ha (38.7%)	3090.2 ha (23.4%)	3674.1 ha (22.4%)
Orchards, vineyards	7.0 ha (0.1%)	27.5 ha (0.2%)	364.9 ha (2.2%)
Agric. land under overgrowing process (not fully developed forest)	1,291.6 ha (23.4%)	6763.7 ha (51.2%)	3273.4 ha (19.9%)
Developed forest	1797.3 ha (32.5%)	2731.7 ha (20.7%)	7018.7 ha (46.7%)
Forest area (sum)	55.9%	71.9 %	66.6%

Tab. 8: Historical view of land-use in % of the area (numbers in parenthesis for subareas).

Tab. 8: Zgodovinski pogled na rabo prostora v % raziskovanem območju (s številkami za podobmočja v oklepajih).

	Land-use (%)	1800	1900	1930	1955	1975	1995
BRKINI F: 233.8 km ²	unproductive	(3;5) 4%		(3;5) 4%	(3;5) 4%	(3;5) 4%	(3;5) 4%
	fields, orchards	(15;19) 17%		16%	14%	10%	10%
(West, East)	grassland	69%		50%	46%	43%	21%
	-meadows	(16;20) 18%			25%		
(West, East)	-pastures	(54;48) 51%			21%		
(West, East)	forest-	(12;8) 10%			36%	43%	67%
	cadastral	(28;14) 15%	(30;19) 24%	(43;20) 30%			
ČIČARIJA F: 108.9 km ²	unproductive	(2;2) 2%		(2;2) 2%	(2;2) 2%	(2;2) 2%	(2;2) 2%
	fields, orchards	(8;10) 9%			5%	3%	(3;3) 3%
(SW, NE)	grassland	81%			70%	53%	(39;23) 32%
	-meadows	(5;9) 7%			5%		
(SW, NE)	-pastures	(81;65) 74%			65%		
(SW, NE)	forest-	(4;14) 8%	(19;30) 14%	(14;25) 9%	25%	42%	63%
	cadastral	(4;16) 9%					
(SW, NE)	-maps						

The socio-economic potential of the research area is not favourable. The area that has had a rural character for centuries is losing its cultural and landscape identity. People do not subsist on local natural resources, but mostly depend on the national economic processes. The abandoning of farming has been noticeable mainly in the last few decades, though the processes of depopulation, which began already in the previous century, reached their peak during the world economic crisis (1930) but became more moderate after WWII. The population density today is one third of the Slovene average in Brkini, but less than one tenth in Čičarija. Age and education structure of the population in Brkini and

Čičarija is far under the Slovenian average, especially in Čičarija. The communities that have reached the national level are those along the main road, with administrative, transportation or industrial centres (Hrpelje, Podgrad and Gradišče). The percentage of the people employed in Brkini exceeds the Slovenian average, while the percentage of those in Čičarija is smaller. Day migration is by far greater than the Slovenian average in Čičarija. People go to work mainly to the coast and to the main centres in Matarsko podolje and Ilirska Bistrica.

At the beginning of the eighties, three quarters of the households cultivated the land, today a little more than

half are still sustaining their farms, but the economic revenue from agricultural products concerns just one quarter of them. The number of persons in one farm-household is smaller than the Slovenian average. The trend of abandoning farming has been strong due to the reconstruction of the socio-economic profile of the rural society: employment, depopulation and abandoning livestock raising. Traditionally, the farm character of households in the area is changing to the non-farm character. Young people tend to move to larger urban centres. If they stay in the area, they do not engage in farming. The number of households with income from agriculture is under the national average. In Čičarija, the non-agricultural income has almost completely prevailed. In Brkini, the income situation in farm households follows that in Slovenia, as well as the structural change of farming recently. There are some villages that are different. In the Tatre community, 90% of farms do not get any income through farming, in Gradišče 86,7%. The number of cattle decreased by 60% in Čičarija in the 1971-1991 period, by 50% in Brkini West, and by 77% in Brkini East. Livestock has been an important source of income for the people in Brkini, but in the last thirty years the number of livestock decreased by more than half. The same is true for the number of pigs and this clearly shows that people have lost their interest in farming. The abandonment of intensive sheep raising and the decrease in cattle numbers corresponds with the intensive overgrowing processes that started four decades ago.

General conclusion is that the area still has rural character with small farms, although they have lost their basic productive function. The age and education structures of the people do not favour land cultivation in the future development of the area. The sex structure of the population shows that the area cannot easily support regeneration of the human potential.

Water

The land-use changes, predominantly overgrowing of pastures and meadows in the Brkini area, may have in turn changed the hydrological regime (Globevnik, 1999). To test this possibility, we made a hydrological analysis of the river Padež, which collects water from the Brkini central area (watershed area 41.6 km²). The minimal discharge in the 1958-1994 period is 0.010 m³/s, yearly average 1.03 m³/s. The highest measured peak was 74.5 m³/s. Linear trends of the annual average and maximum peak discharges are negative ($y = -0.0094x + 1.2059$, $y = -0.6521x + 40.166$), whereas the trend of minimum peak discharges is slightly positive ($y = 0.001x + 0.0283$). The trend of annual precipitation quantities is negative (Tatre: $y = -13.626x + 1778$). The trend analysis of frequency of appearance reveals that the number of days of drought water flow (0.0 -

0.125 m³/s) is decreasing, but that the number of days with discharges between 0.125 to 0.50 m³/s is increasing. Duration of higher water flows (0.5 - 20.0 m³/s) is decreasing. The reason might be the forest cover expansion in the last 30 years (from 40% to 70% of the area), where water storage capacity and use is higher than in grassland areas. We may thus conclude that water is distributed more equally over the year today as it was decades ago. There are less drought days and less days with high water peaks.

Water pollution risk is high in the entire area, moreover, drinking water supply for all Slovenian coast regions is under high risk due to the highly fissured area of the karst (Kranjc et al., 1991). Water of the Reka river is also under risk of pollution, due to the uncontrolled waste water seepage into the river, wild dump sites and residuals of the past chemical pollution in the river bottom (Kogovšek, 1988). The ecological state of underground habitats (karst caves) is degraded and vulnerable as well (Globevnik et al., 1996).

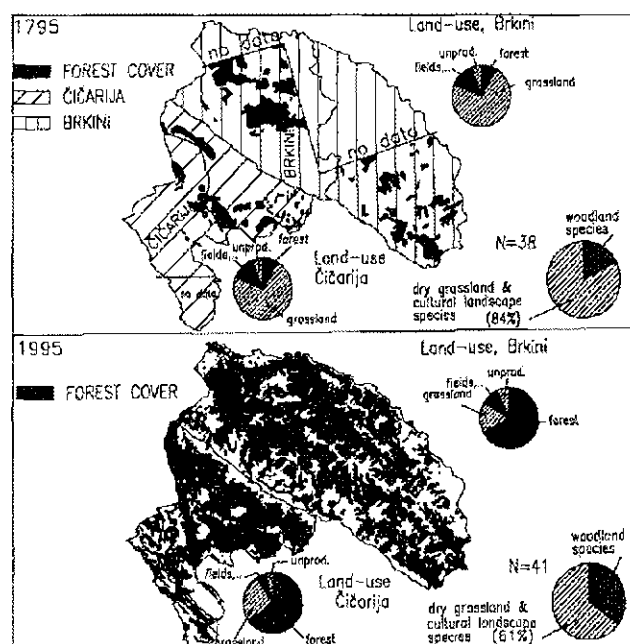


Fig. 3: Changes in land use (forest, arable, grassland and other areas) and characteristics bird species of cultural landscape (1795-1995).

Sl. 3: Spremembe v rabi tal (delež gozda, obdelanih, travniških in drugih površin) ter značilnih ptičjih vrst kulturne krajine (1795-1995).

Flora and vegetation cover

Flora and vegetation types are given in table 9 for the Kraški rob (Čičarija, subunit 1a), Karst plateau, Mt. Slavnik and Matarsko podolje (Čičarija, subunits 1b and 1c) and Brkini (unit 2).

Tab. 9: List of plant species of special value.

Tab. 9: Seznam florističnih vrst posebne vrednosti.

ČIČARIJA, subunit 1a	ČIČARIJA, subunit 1b, 1c	BRKINI, unit 2
(1) <i>Quercus ilex</i> - R, En, BA, SI <i>Phyllirea latifolia</i> - R, En, BA <i>Laurus nobilis</i> - R, En, BA <i>Pistacia terebinthus</i> - R, SI <i>Smilax aspera</i> - R, BA, SI <i>Rubia peregrina</i> - R, BA, SI	(1) <i>Jurinea mollis</i> - R, SI <i>Gentiana lutea symphiandra</i> - R, En, SI <i>Narcissus radiiflorus</i> - SI <i>Linum narbonense</i> - SI <i>Laserpitium siler</i> - SI <i>Lilium carniolicum</i> - R, En, SI <i>Asphodelus albus</i> - SI <i>Eryngium amethystinum</i> - SI <i>Satureja subspicata liburnica</i> - SI <i>Gentiana tergestina</i> - E <i>Stipa eriocalis</i> - SI <i>Echinops ritro rutenicus</i> - R, SI <i>Centaurea rupestris</i> - SI <i>Carex humilis</i> - SI <i>Serratula radiata</i> - SI, R, BA <i>Pulsatilla montana</i> - SI <i>Crepis chondrilloides</i> - SI <i>Astragalus carniolicus</i> - R, SI, E <i>Pedicularis frederici-augusti</i> - R, E, E, BA <i>Iris errerhiza</i> - (Kojnik locus class.) - R, E	(1) <i>Quercus petraea</i> - SI <i>Melampyrum vulgatum</i> - SI <i>Castanea sativa</i> - SI <i>Quercus cerris</i> - SI (2) <i>Fagus sylvatica</i> - SI, <i>Luzula albida</i> - SI <i>Quercus petraea</i> - SI, <i>Castanea sativa</i> - SI (3) <i>Carpinus betulus</i> - SI, <i>Ornithogallum pyrenaicum</i> - SI, <i>Galanthus nivalis</i> - an example of carpinal mesophilous species <i>Melittis melisophyllum</i> - an exam- ple of submediterranean thermo- philous species <i>Lamium orvala</i> - an example of non-acid illiric species (4) <i>Anacamptis pyramidalis</i> - SI, <i>Linum flavum</i> , SI, R, <i>Nepeta pannonica</i> - R (5) <i>Arrhenatherum elatius</i> . (SI) (6) <i>Gladiolus illyricus</i> (SA)
(2) <i>Cleistogenes serotina</i> - R <i>Onobrychis arenaria tommasinii</i> - R, En <i>Trigonella gladiata</i> - R, BA <i>Teucrium flavum</i> - R, BA <i>Hyssopus officinalis</i> - R	(2) <i>Satureja subspicata liburnica</i> - SI <i>Gentiana tergestina</i> - E <i>Stipa eriocalis</i> - SI <i>Echinops ritro rutenicus</i> - R, SI <i>Centaurea rupestris</i> - SI <i>Carex humilis</i> - SI <i>Serratula radiata</i> - SI, R, BA <i>Pulsatilla montana</i> - SI <i>Crepis chondrilloides</i> - SI <i>Astragalus carniolicus</i> - R, SI, E <i>Pedicularis frederici-augusti</i> - R, E, E, BA <i>Iris errerhiza</i> - (Kojnik locus class.) - R, E (2) <i>Serratula lycophilolia</i> - R, E, SI (IUCN Globally threatened species in Europe). <i>Scorzonera villosa</i> - SI, <i>Knautia illyrica</i> - SI <i>Senecio lanatus</i> - En, <i>Senecio doricum</i> - R <i>Gladiolus illyricus</i> - R, En, <i>Scorzonera hispanica</i> - R, <i>Nepeta pannonica</i> - R <i>Danthonia alpina</i> SI,	
(3) <i>Quercus ilex</i> - R, E, BA <i>Moehringia tommasinii</i> - R, En, E, SI <i>Sedum maximum</i> - SI <i>Teucrium flavum</i> - R, BA <i>Campanula pyramidalis</i> - SI <i>Cephalaria leucantha</i> - R, SI <i>Sempervivum tectorum</i> - SI <i>Iris illyrica</i> - SI	(3) <i>Helleborus multifidus istriacus</i> - SI, E <i>Quercus pubescens</i> - SI, <i>Sorbus domestica</i> - R (4) <i>Helleborus multifidus istriacus</i> - SI, E, <i>Digitalis laevigata</i> - SI, R, BA <i>Paeonia officinalis</i> - SI, <i>Ostrya carpinifolia</i> - SI (5) <i>Fagus sylvatica</i> - S, <i>Sesleria autumnalis</i> - SI (6) <i>Fagus sylvatica</i> - SI, <i>Lamium orvala</i> - SI, <i>Hacquetia epipactis</i> - SI, <i>Vicia oroboides</i> - SI, <i>Dentaria spec.</i> - SI, <i>Epimedium alpinum</i> - SI	
(4) <i>Genista sericea</i> - SI <i>Athamanta turbith</i> - SI <i>Scorzonera austriaca</i> - SI <i>Ruta divaricata</i> - SI <i>Iris illyrica</i> - En, SI <i>Globularia cordifolia</i> - SI <i>Daphne alpina</i> - SI		

As Čičarija and Brkini spread along the border of the Mediterranean area and Central Europe, they constitute a kind of a climate border. This implies specific vegetation cover. Climax vegetation is not evergreen but deciduous thermophilous vegetation. Oak, black beech and beech forest includes in its bottom layer (herb vegetation) many Mediterranean species, which are giving this area its Mediterranean character. This type of vegetation is called sub-Mediterranean. In Čičarija and Brkini, different profiles of this environment are followed. The vegetational particulation of this relatively small territory is large and distinct due to human/nature interference, such as forest cutting and changing landscape to mosaic structure of dry meadows, stony pastures and bush fences. The contrasts in the areas of Brkini and Čičarija resemble natural factors (Čičarija:

warm climate, low precipitation, limestone substratum, Brkini: harsh climate, high precipitation, flysch substratum) and diverse land-use (Čičarija: small population density, pastures, Brkini: greater population density, livestock agronomy, agriculture) as explained in previous chapters.

The natural value indexes (NVI), such as endemity, rarity, threat status and species on the border of the range (E, R, En, BA), show that Kraški rob with Kraška planota, Mt. Slavnik and Matarsko podolje are of great natural importance. There are 16 plant species at Kraški rob and 26 at Kraška planota reported as important. Some species have more than one value of natural importance. In Brkini, there are 2 rare species (national level). Because the area exerts a strong continental climatic influence, there are numerous miscellaneous

vegetation communities of Illyrian, Central-European and sub-Mediterranean character. The area acts as an important buffer zone between the inland and the Adriatic. The natural value importance corresponds with the percentage of grassland area. This fact is further discussed in the following chapters.

Forest

The forest exploitation began in the Neolithic, but the forests had not been overexploited until the Roman times. Due to the extensive use of wood, clear cutting (ship building and deforestation for grazing), the karst area became bare in the Middle Ages. It stayed deforested until the previous century. The forest of Brkini was also overexploited by farmers and wood traders (Globevnik *et al.*, 1996). Probably the land has never been completely bare, but the percentage of the forest cover has fallen under 10% in the Middle and New Ages. In the mid-twentieth, an extensive afforestation programme began with the black pine (*Pinus nigra*), which is a nonindigenous species, but was best suited to the ecological conditions there. In the 20th century, some large spruce plantations were introduced to Brkini due to their important economic value. The non-deciduous forest is nonindigenous in the area. At the beginning of the 19th century, less than 10% of the area was covered with forests in Čičarija and less than 20% in Brkini. The use of forest as an energy source was very intensive. The majority of land had been cleared in the past and used for grazing at the end of the 19th century. The extensive overgrowing began in the first decades of the 20th century, following the depopulation trends. The extreme progression of the forest landscape is characteristic of the last two decades due to the changes in the socio-economic conditions in Slovenia and to the different life style. Today the forest landscape is typical of almost 70% of Brkini and more than 60% of Čičarija.

Ownership characteristics

Most of the forest cover in Brkini area is private, but the opposite is true of the karst Čičarija. Čičarija is traditionally scarcely populated area, the forest has never been economically interesting due to unfavourable ecological conditions. These are the reasons why the state owns the majority of the forest land.

Ecological state of forest communities

Past distinctive management practices in the forest have led to the vulnerable ecological conditions of the forest today (Čehovin, 1992). There are many different development stages of areas under forest cover, such as young forest cover, pole forest cover, trunk forest cover, coppice forest cover, bush cover, plantage forest cover

(Zavod za pogozdovanje in melioracijo krasa Sežana, 1990, 1992, 1993a, 1993b). In Brkini, the forest is mostly coppice and bush forest. The coppice forest is old, ecologically unstable and very susceptible to severe climatologic events. In Čičarija, the bush and poles forest cover spread with pine plantation islands. There is almost 11% of the entire area covered with non-deciduous forest (17% of forest cover), whereas on the karst plateau 50% of the forest is black pine.

Avifauna

Altogether, 8 of the so-called dry-grassland species were typical of the study area. *Melanocorypha calandra*, *Calandrella brachydactyla*, *Oenanthe oenanthe* and *O. hispanica* have become extinct (or nearly so) in the period of intensive afforestation with pine and changes in land-use and agricultural practices. The remaining four dry grasslands species are also declining. The most important fact is that it was only in this sub-Mediterranean region of Slovenia that these dry grassland species have had suitable conditions needed for their survival. For some of them (*M. calandra*, *C. brachydactyla*, *O. hispanica*), this region was, of course, also on the northernmost edge of their breeding range (Harrison, 1982). After the period of dominating dry grasslands, the so-called traditional cultural landscape has become typical of the study area, still offering conditions for some dry grassland species, but at the same time very attractive for another group of endangered birds. These are species favouring mixture of grasslands, small fields and scattered settlements in a mosaic manner. Typical representatives are: *Upupa epops*, *Otus scops*, *Circaetus gallicus*, *Lullula arborea*, *Hippolais polyglotta*, *Emberiza* spp., etc. The historic data for the last decades of the 19th century (dominating traditional cultural landscape) have shown that the abundance of the traditional cultural landscape species was much higher than nowadays. Besides the great decline of almost all those species, at least 3 species have become extinct (or nearly so). For two of them, namely *Sylvia hortensis* and *Emberiza melanocephala*, the study area was the only breeding area for this region and on the edge of their global range. The main reasons for the disappearance of these species and large decline in the populations of other "cultural landscape" species is the overgrowing of the area.

On the other hand, a comparison of the historic data shows that the number of species as well as populations of some woodland species have dramatically increased within the last 200 years. Among them, the following species could be outlined: *Dendrocopus major*, *Dryocopus martius*, *Certhia brachydactyla*, *Sitta europaea*, *Parus ater*, *Parus palustris*, *Parus cristatus*, *Regulus regulus*, *Turdus philomelos*, *Erithacus rubecula* (Schia-vuzzi, 1883). Some of these species, *Regulus regulus*,

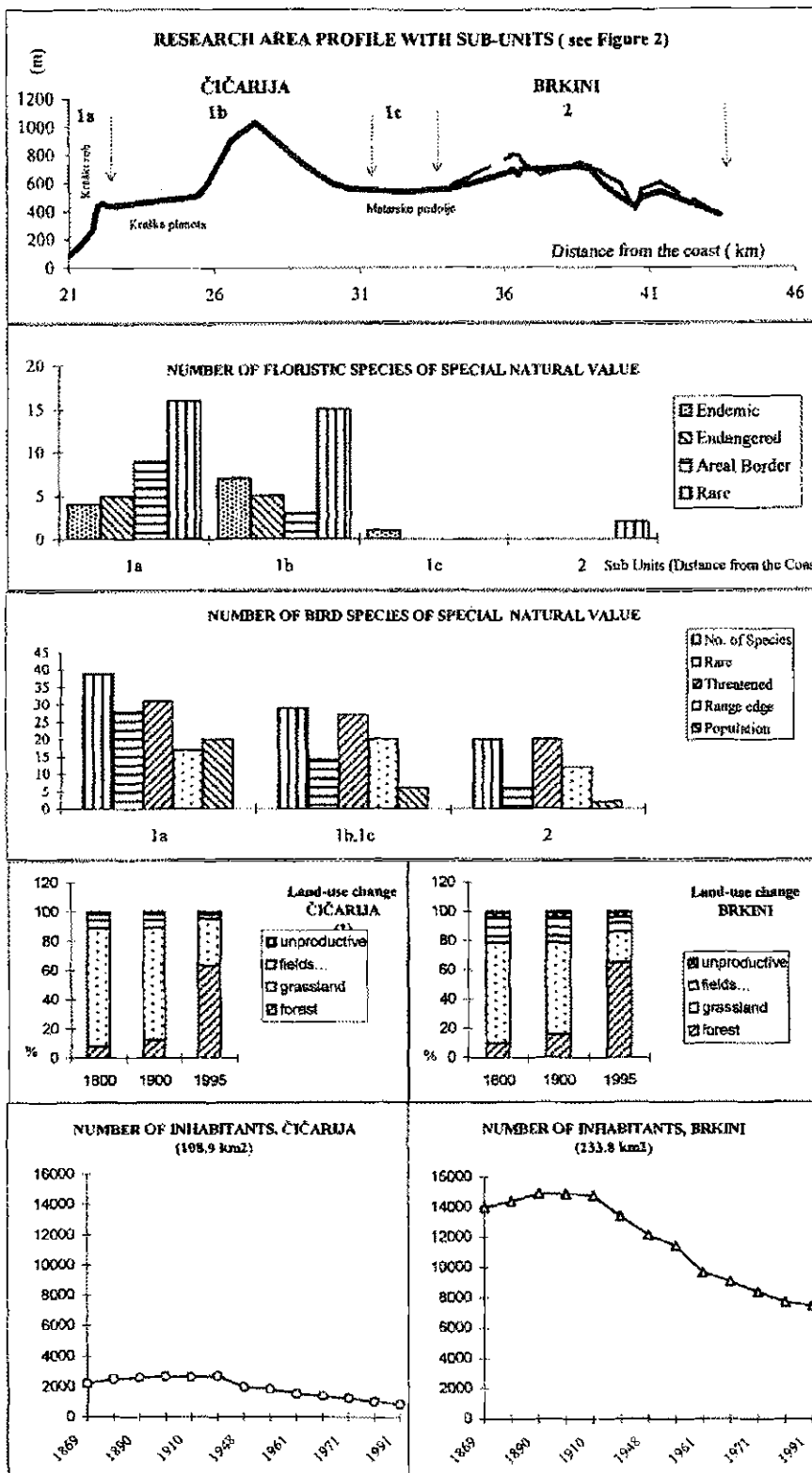


Fig. 4: Floristic and bird natural value index along the research area as per land-use and population census.
 Sl. 4: Indeks naravne vrednosti florističnih in ptičjih vrst vzdolž profila razskovanega območja glede na rabo tal in popis prebivalstva.

Parus ater, *Parus cristatus* (Geister, 1994), have inhabited the study area only after the period of intensive afforestation with pine. The great majority of these "new-comers" are not endangered species (IUCN, 1994; Tucker & Heath, 1994).

CONCLUSIONS

The area was almost deserted two hundred years ago, due to the extensive exploitation of natural resources by humans that had started in the Middle Ages. When man began to artificially afforest the area with introduced species (mostly black pine) at the end of the 19th century, the economic value of natural resources (wood production) began to increase and erosion declined. After some time, the spreading of black pine continued in a natural way. The depopulation processes, which started at the beginning of the 20th century, consequently caused additional overgrowing of the agricultural land. The benefit of this recovering process for the natural value of the area is questionable. With the increase of overgrown land and related changes in land-use (Fig. 3), the proportion of dry grassland and cultural landscape species in relation to woodland bird species has changed. Nowadays, the number and abundance of forest species is higher (they constitute almost 40% of the selected characteristic bird species from the area), while 200 years ago this percentage was lower, reaching only 16%. Though the number of bird species and their population have increased, the "quality of species" decreased. Highly sensitive and specialised birds, especially dry grassland and cultural landscape species (Tucker *et al.*, 1991; Marčeta, 1993; Bračko *et al.*, 1994), are decreasing or have even become extinct and replaced by more common, mainly woodland species.

The special natural value, the species endemity, threat status, rarity or biogeographical particularities (species on their range edge) show that Kraški rob, with its Kraška planota, Mt. Slavnik and Matarsko podolje, is of a great natural importance. There are 16 plant species on Kraški rob and 26 on Kraška planota with high natural value index (NVI). In the Brkini area, there are 2 species that are rare at the national level. The same counts for the bird species. On the Kraški rob, there are almost 80 different bird species of special natural value (NVI 140), 40 on Kraška planota with Mt. Slavnik (NVI 100) and 35 in Brkini (NVI 60). The area is of a special conservation value as it includes the northernmost edge of the global range of many Mediterranean species. Populations on their range edge are of special importance for their global survival.

The described natural character of the area is also supported by human activities that in fact sustain ecological conditions for many flora and bird species. Due to the socio-economic reasons, such as recent depopulation and decline in traditional agriculture, degradation

of cultural landscape is present in the area. Once traditional farm character of households in the area is changing to the post-industrial/non-farm character that implies land-use changes. Pastures are being abandoned in Čičarija and meadows, orchards and more remote fields in Brkini. The rate of overgrowing processes by bush, pioneer tree species and aggressive nonindigenous tree species (progression of forest, regression of cultivated land) is high, which is also discussed herewith (Čehovin, 1992; Kosiček, 1993). The forest in Brkini is degraded due to the prolonged exploitation practices in the past. The sociological potential, sex, age and education structures of the people of Brkini and Čičarija are not in favour of progress, though the depopulation almost stopped (Globevnik *et al.*, 1996). The development potential is concentrated along the main, central road in Matarsko podolje, where industrial, marketing, educational, social and cultural centres of the area are concentrated. Details regarding flora, bird natural value, land-use and population are shown in Fig. 4.

Uncultivated areas exposed to erosion (bare substratum and solid limestone rocks) constitute an extremely important habitat for wildlife. Desertification phenomena, such as erosion and wildfires, are therefore desired to a certain degree. Erosion (water, wind), wildfires, slow regeneration of the substratum in connection with dry and warm climate on the limestone basis generate conditions for some highly ecologically specialised species, once commonly distributed over the research area. Without regular maintenance (grazing, moving) and possible managed nature reserves, the future of these important habitats is uncertain. We conclude that desertification processes, shown as land abandonment, overgrowing and human resources decline, have had, in general, impacts on the socio-economic development of the area, landscape character and on the wildlife and habitats.

Recommendations for sustainable development

On the basis of our study, the following general recommendation for sustainable development are proposed: (a) to initiate modern farm products market network, (b) to support traditional fruit production (apple, plum) in Brkini, (c) to support sustainable sheep breeding in Čičarija, (d) to organise better employment opportunities for non-farmers, (e) to prevent further abandoning of agricultural land, (f) keep remote pastures and fields to sustain natural and landscape diversity, (g) to follow sustainable forest management measures (diverse structure, non-leaf picking, indigenous species...), (h) to promote clean environment (keep waste dumping under control, solid waste and waste water neutralisation, modern concept industry/manufacture), (i) to develop programmes to support sustainable use of natural resources (soft tourism, bio-agriculture, traditional craft).

(j) to protect natural monuments and nature conservation important areas and declare more nature reserves within the region, and (k) to promote the entire area as a landscape protected area.

DEZERTIFIKACIJSKI PROCESI V ROBNEM SREDOZEMSKEM HRIBOVJU (BRKINI IN ČIČARIJA, JZ SLOVENIJA)

Lidija GLOBEVNIK

Vodnogospodarski inštitut, SI-1000 Ljubljana, Hajdrihova 2B

Andrej SOVINČ

Znanstveno raziskovalno središče Republike Slovenije Koper, Inštitut za biodiverzitetne studije, SI-6000 Koper, Garibaldijeva 18

Mitja KALIGARIČ

Pedagoška fakulteta, Univerza v Mariboru, SI-2000 Maribor, Koroška 160

Znanstveno raziskovalno središče Republike Slovenije Koper, Inštitut za biodiverzitetne studije, SI-6000 Koper, Garibaldijeva 18

E-mail: mitja.kaligaric@uni-mb.si

POVZETEK

Območje Brkinov in Čičarije (JZ Slovenija) leži na ločnici med sredozemskim in celinskim delom Slovenije. Zaradi sprememb v socio-ekonomskih razmerah (predvsem sprememb v rabi tal in depopulacijskih procesov) in gozdovanja območja v zadnjih dvesto letih sta se med drugim spremenila tudi vrstna sestava in zastopanost ptic, združb in rastlinskih vrst. Kljub tem spremembam ima robno sredozemsko območje Brkinov in Čičarije še vedno posebno vrednost v pogledu biodiverzitetne, predvsem po številu endemičnih, ogroženih vrst ali pa vrst, ki tu dosežejo rob areala razširjenosti. Na robnem sredozemskem območju z zmernimi klimatskimi dejavniki je naravni regeneracijski potencial višji kot v osrednjem Sredozemlju. Nekateri dezertifikacijski procesi, kot npr. erozija in gozdni požari pa tudi tradicionalne človekove dejavnosti (npr. kmetijstvo), so potrebni in zaželeni za obstoj nekaterih ozko specializiranih vrst. Opuščanje rabe tal, zaraščanje z gozdom in depopulacijski procesi vplivajo na socio-ekonomski razvoj območja, krajinsko sliko ter floristične in favnistične posebnosti območja.

Ključne besede: Sredozemlje, flora, vegetacija, gozd, ptice, trajnostna raba, varstvo narave, dezertifikacija

REFERENCES

- Bilc, J. (1994):** Krajopisje, Čičarija in pa Čiči. Bistriški zapisi, 4/1994, 17-19.
- Bračko, F., A. Sovinc, P. Trontelj & M. Vogrin (1994):** Rdeči seznam ogroženih ptic gnezdil Slovenije. *Acrocephalus*, 71.
- Čehovin, S. (1992):** Razvoj in varstvo gozdov na Krasu. *Gozd*, V, 294-304.
- Darovec, D. (1992):** Pregled zgodovine Istre. Zgodovinsko društvo za južno Primorsko in Primorske novice, Knjižnica Annales, Koper, 78 str.
- Enciklopedija Slovenije (1987):** Mladinska knjiga, Ljubljana.
- Geister, I. (1995):** Ornitološki atlas Slovenije. DZS, Ljubljana.
- Globevnik, L. (1999):** Analiza sprememb rabe tal, hidrološkega režima in erozijskih procesov v porečju Dragonce. *Annales Ser. hist. nat.*, 15, 51-62.
- Globevnik, L., I. Kovačič, A. Sovinc, L. Čampa, M. Pintar, R. Fazarinc, M. Ajdič, D. Burja, B. Korošec, M. Kaligarič, A. Barbič, M. Brodnik-Lodewijk, A. Kranjc, S. Šebela, T. Cunder & B. Lampič (1996):** MEDIMONT-PECO SLOVENIA. A multinational, multi-disciplinary research programme on the role and the place of the Mediterranean mountains in the desertification process or the Mediterranean: a case of Slovenia: Brkini and Čičarija. Final report. Vodnogospodarski inštitut, Ljubljana.

- Harrison, C. (1982):** An Atlas of the Birds at the Western Palearctic. Collis, London.
- IUCN (1994):** The 1994 IUCN Red List of Threatened Animals.
- Kaligarič, M. (1992a):** Rastlinski svet Slavnika in okolice. Zbornik obalnega planinskega društva Koper: 1949-1989, str. 32-45.
- Kaligarič, M. (1992b):** Rastlinstvo Kraškega roba. Proteus, 54, 224-230.
- Kmetijski inštitut Slovenije (1995):** Agrokarta, sedanja in možna raba kmetijske zemlje v izbranih katastrskih občinah ter njihova produktivnost, posebna obdelava. Ljubljana.
- Korošec, B. (1978):** Naš prostor v času in projekciji. Oris razvoja zemljemstva, kartigrafije in prostorskega urejanja na osrednjem Slovenskem. Geodetski zavod SRS, Ljubljana.
- Korošec, B. (1995):** Podatki in analiza starejših topografskih kart območja Brkinov. Obdelava kartografskega gradiva za Medimont projekt. Vodnogospodarski inštitut, Ljubljana.
- Kos, M. (1953):** Zgodovina Slovencev. Ljubljana.
- Košiček, B. (1993):** Spontano vračanja gozda na Kras. Gozd, V, 250-259.
- Kogovšek, J. (1988):** Impact of human activity on Škocjanske jame. Acta carsologica, XXIII/5, 73-80.
- Kranjc, A., S. Šebela & N. Zupan (1991):** Contribution to the problematics of road communications on karst and their impact on environment. Studia carsologica, 5, Brno.
- Krivic, P. & M. Bricelj & M. Zupan (1989):** Podzemne vodne zveze na področju Čičarije in osrednjega dela Istre (Slovenija, Hrvatska, NW Jugoslavija). Acta carsologica, 18, 265-295.
- Marčeta, B. (1993):** Strokovne osnove za vzpostavitev režima na območju Kraškega roba. DOPPS, Ljubljana.
- Melik, A (1960):** Slovensko Primorje. Slovenska matica, Ljubljana.
- Mihevc, A. (1994):** Brkini contact karst. Acta carsologica, XXIII/5.
- Ministrstvo za okolje in prostor, Hidrometeorološki Zavod Republike Slovenije. (1988a):** Klimatografija Slovenije, Prvi zvezek: Temperature zraka 1951-1980. Ljubljana.
- Ministrstvo za okolje in prostor, Hidrometeorološki Zavod Republike Slovenije (1988b):** Klimatografija Slovenije, Drugi zvezek: Padavine 1951-1980. Ljubljana.
- Ministrstvo za okolje in prostor, Hidrometeorološki zavod Republike Slovenije (1995a):** Klimatografija Slovenije, Temperature zraka. Ljubljana.
- Ministrstvo za okolje in prostor, Hidrometeorološki zavod Republike Slovenije (1995b):** Klimatografija Slovenije, Padavine 1961-1990. Ljubljana.
- Ministrstvo za okolje in prostor, Hidrometeorološki zavod Republike Slovenije (1998):** Površinski vodotoki in vodna bilanca Slovenije. Ljubljana.
- Območna geodetska uprava Koper (1995a):** Franciscejski katastrski arhiv 19. stoletja (K.O. Tatre, Podgorje, Vatovlje, Kozjane, Misliče). Sežana.
- Območna geodetska uprava Koper (1995b):** Računalniški izpiski iz Zemljiškega katastra. Sežana.
- Orožen, A. M., D. Perko & D. Kladnik (1995):** Krajevni leksikon Slovenije. Geografski inštitut Znanstveno raziskovalnega centra SAZU, DZS, Ljubljana.
- Rajšp, V. & D. Trpin (1997):** Slovenija na vojaškem zemljevidu 1763-1787 (1804). 3. zvezek. ZRC SAZU, Arhiv Republike Slovenije, Ljubljana.
- Republiška geodetska uprava, Zavod Republike Slovenije za statistiko (1983):** Površine občin in katastrskih občin v SR Sloveniji po podatkih zemljiškega katastra, stanje 31. 12. 1982. Ljubljana.
- Republiška geodetska uprava (1994):** Podatki zemljiškega katastra o površini katastrskih kategorij po katastrskih občinah. Ljubljana.
- Roglič, J. (1987):** Čičarija. Enciklopedija Jugoslavije, Zagreb, 3, 59-60.
- Savnik, R. (ur.) (1968):** Krajevni leksikon Slovenije. Zahodni del Slovenije, I. knjiga. DZS, Ljubljana.
- Schiavuzzi, J. B. (1883):** Materiali per un'avifauna del territorio di Trieste fino a Monfalcone e dell'Istria. Boll. Soc. Adr. Sci. Nat. Trieste, 8, 3-78.
- Sovinc, A. (1995):** Zimski ornitološki atlas Slovenije (The Atlas of wintering birds in Slovenia). TZS, Ljubljana.
- Stepančič, D., F. Lohnik & T. Prus (1980):** Razvoj tal na nekarbonatnem flišu v Brkinih, Ljubljana. Vrednost in lastnosti posameznih talnih enot v SR Sloveniji, letno poročilo raziskovalne naloge za leto 1979. Biotehniška fakulteta, VTOZD za agronomijo.
- Škornik, I., T. Makovec & M. Miklavc (1990):** Favnišnični pregled ptic slovenske obale. Varstvo narave, 16, 49-99.
- Tome, D. (1991):** Poročilo o opazovanju ptic na Kraškem robu: interno poročilo. Inštitut za biologijo, Ljubljana.
- Tome, D. (1992):** Najzanimivejše ptice Kraškega roba. Proteus, 54(6-7), 260-262.
- Tucker, G. (1991):** The status of lowland dry grassland birds in Europe. In: Goriup, P. D., L. A. Batten & J. A. Norton (eds.): The conservation of lowland dry grassland birds in Europe. Joint Nature Conservation Committee, Petersborough, U.K.
- Tucker, G. & M. Heath (1994):** Birds in Europe - Their Conservation Status. BirdLife International.
- Valencič, V. (1984):** Nekdanji Bistriški okraj v Terezijanskem katastru. Bistriški zapisi, 2/1984, 1-35.
- Valencič, V. (1989):** Gospodarske in družbene razmere Bistriškega okraja v 19. stoletju. Bistriški zapisi, 3/1989, 1-53.
- Valencič, I. (1994):** Demografske značilnosti občine Hirska bistrica. Bistriški zapisi, 4/1994, 95-97.
- Vilfan, S. (1953):** Slike iz Brkinov. Kronika, 1, Ljubljana.

Vallo, A. (1885): Note ornitologiche. Estrato dal Bolletino della Societa adriatica di scienze naturali in Trieste, Vol. IX.

Vodnogospodarski inštitut (1987): Hidrološka študija Notranjske Reke. Ljubljana.

Vodnogospodarski inštitut (1990): Vodnogospodarske osnove Slovenije. Ljubljana.

Vodnogospodarski inštitut (1993): Baza digitalnih geografskih podatkov za območje povodja Reke. Digitalizacija Inštitut za kartografijo in fotogrametrijo. Strokovne osnove za projekt "Azioni preliminari di studio del piano di risanamento delle acque superficiali e sotterranee del bacino idrografico del fiume Timavo", Fisica S.p.A, Torino.

Zavod RS za statistiko (1981): Popis prebivalstva, gospodinjstev in stanovanj v SR Sloveniji 31. 3. 1981, Rezultati raziskovanj, št. 228, Ljubljana.

Zavod RS za statistiko (1984): Popis prebivalstva, gospodinjstev in stanovanj v SR Sloveniji 31. 3. 1981. Rezultati raziskovanj, št. 346, Ljubljana.

Zavod RS za statistiko (1991): Prvi začasni podatki popisa prebivalstva, gospodinjstev, stanovanj in kmečkih gospodarstev v Republiki Sloveniji v letu 1991 po občinah, naseljih in krajevnih skupnostih. Rezultati raziskovanj, št. 538, Ljubljana.

Zavod za pogoždovanje in melioracijo krasa Sežana (1990): GCN Brkini I, 1989-1998. Sežana.

Zavod za pogoždovanje in melioracijo krasa Sežana (1992): GCN Brkini II 1989-1998. Sežana.

Zavod za pogoždovanje in melioracijo krasa Sežana (1993a): GCN Čičarija 1989-1998. Sežana.

Zavod za pogoždovanje in melioracijo krasa Sežana (1993b): GCN za kraško gozdnogospodarsko območje, 1991-2000: povzetek. Sežana.

Zvezni geološki zavod Beograd (1975): Osnovna geološka karta, List Ilirska bistrica, Koper, Gorica, Postojna, 1:100 000. Beograd.

Zvezni zavod za statistiko (1953): Popis prebivalstva in stanovanj v letu 1953. Beograd.

Zvezni zavod za statistiko (1961): Popis prebivalstva in stanovanj v letu 1961. Beograd.

Zvezni zavod za statistiko (1971): Popis prebivalstva in stanovanj v letu 1971. Beograd.