Project Report

"Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

Dekons-Ema and Macedonian Ecological Society

Book 2

Biodiversity of the Bregalnica River Watershed

Final Report

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Abbreviations:

SPA	Spatial Planning Agency
FVA	Food and Veterinary Agency
GEF	Global Environment Fund
SSO	State Statistical Office
PA	Protected Area
EPR	East Planning Region
CLC	CORINE Land Cover
IUCN	International Union for Conservation of Nature
MOEPP	Ministry for Environment and Physical Planning
NBSAP	National Biodiversity Strategy and Action Plan
NP	National Park
WA	Wilderness Area
NPr	Nature Park
MA	Multipurpose Area
RNPA	Representative Network of Protected Areas
SNR	Strict Nature Reserve
UNDP	United Nations Development Programme
CDEPR	Centre for Development of East Planning Region

1 Introduction

The Bregalnica River watershed biodiversity report was developed in the framework of the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed" which is a part of the Nature Conservation Programme financed by the Swiss Development and Cooperation Agency.

The main goal of this project activity is the ecological data gap analysis and the ecological sensitivity map development for the region of the Bregalnica River watershed, as well as completing confirmed gaps which represent a basis for biodiversity conservation and sustainable use through analysis of existing data, robust field research and recommendations for establishing protected areas. The gap analysis was done during the first phase of the project (mostly in 2014) when all existing data on biodiversity was collected from scientific literature and numerous reports from other projects (consult **First period project report** from December 2014).

The development of this document was coordinated with other project activities from the Bregalnica River watershed. During the implementation of this project activity, many expert meetings with various stakeholders were organized including the representatives from the Centre for Development of East Planning Region (CDEPR) and the Ministry of Environment and Physical Planning (MOEPP). The meetings were used as a forum for presenting and reviewing current results. This report will also be useful to the Spatial Planning Agency (SPA) in the development of the natural heritage portion of the Spatial Plan for the East Planning Region. For detailed information of the project implementation, the organizational structure, project team, research dynamics, collaboration with students and other organizations and institutions please consult the **Integral Report.**

The report depicts the Bregalnica watershed biodiversity based on expert reports on separate taxonomy groups viz. algae, fungi, plants, mammals, birds, herpetofauna, ichthyofauna, selected groups of invertebrates and aquatic invertebrates, as well as habitat diversity. These expert reports were the basis for the development of proposals for protected areas in the Bregalnica watershed which would provide conservation of the most important habitats and species in the region (consult: **Report on the Status of Protected Areas in the Bregalnica River Watershed).** Studies prepared for the needs of the Spatial Plan for the Eastern Planning Region by the Spatial Planning Agency (SPA) were used as a base for providing a description of the geological and geomorphological characteristics of the area, hydrography, the state of forestry, hunting and fishing, as well as socio-economic characteristics of the area.

During the digital processing of the data special attention was paid to the alignment of the data bases (literature data and field data), criteria for selection of important species, data digitalization etc. The analysis of digital data for certain taxonomy groups was further used in the definition of proposed protected areas (consult **Report on the Status of Protected Areas in the Bregalnica River Watershed**) and the development of the ecological sensitivity map (consult **Ecological Sensitivity Map**).

This document is an integral document focused on the diversity of habitats, wild species and agrobiology. Habitat diversity is explored in a separate report (consult: **Habitats Diversity**). The information on biodiversity is in fact a summary of the separate expert reports developed in the project activity:

1. Kostadinovski, M. (2015). **Habitats in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

2. Matevski, V. (2015). **Plant Diversity in the Bregalnica River Watershed**. Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

1. Rusevska, K. (2015). **Fungi in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

2. Levkov, Z. (2015). **Diatomic flora in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

3. Stojanov, A., Ivanov, Gj., Melovski, D. (2015). **Mammals in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

4. Velevski, M. (2015). **Birds in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

5. Tomovic, Lj., Sterijovski, B. (2015). **Amphibia and Reptiles in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

6. Melovski, D. (2015). **Daily Butterflies in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

7. Slavevska-Stamenkovic, V. (2015). **Macroinvertebrates in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

8. Kitanova, D. (2015). **Dragonflies and Damselflies in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

9. Hristovski, S. (2015). **Ground Beetle Diversity (Coleoptera, Carabidae) in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

10. Ivanovska, S. (2015). **Plant Agrobiodiversity in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

11. Dzabirski, V., Todorovska, A. (2015). **Biodiversity in Domestic Animals in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

12. Velkovski, N., Pejovic, S. (2015). **Forest Diversity in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

13. Melovska, N. (2015). **Ecosystem Services in the Bregalnica River Watershed.** Final expert report for the project activity "Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"

In should be taken into consideration that all final expert reports were developed based on the progress from the four periodic expert reports of December 2014, April 2015, June 2015 and September 2015.

In addition to the biodiversity data, this report also contains data on natural characteristics of the region (climate, geology, geomorphology, and hydrology), administrative organization, socio-economic characteristics, land-use and separately ecosystem services. Descriptions provided for forestry, hunting and fishing were necessary as chief economic sectors influencing biodiversity through use of natural resources. The final part of the document addresses main threats as well as recommendations for biodiversity conservation.

2 Geographic Characteristics

2.1 Geographic Range

The biodiversity analysis was conducted along the Bregalnica river watershed. The largest part of this watershed belongs to the East Planning Region, but parts of this planning region are also outside of the watershed. This is why the defined **area of interest** represents the union of the Bregalnica River watershed and the territory of the East Planning Region (Fig. 1 and 2).

The source of the Bregalnica River is under Chengino Kale at 1690 meters above sea level, which is also the Eastern most part of its watershed. The southern border of the watershed goes along the crest of Plachkovica Planina Mountain, the source and the valley of the Kriva Lakavica River near the mine Buchim and Radovish. The western border goes along the lowest foothills of Konechka Planina Mountain, than until its mouth in Vardar and the western side of Ovche Pole i.e. the course and mouth of Svetinikolska Reka River. The norther border of the watershed runs along the highest peaks of Osogovo Mountain, until the state border with the Republic of Bulgaria close to the peak Ruen. The border with Bulgaria is also the natural eastern border of the watershed.

The altitude range of the watershed moves between 143 m a.s.l. at the mouth of Bregalnica River in Vardar River and 2202 m a.s.l. at the peak Mal Ruen on Osogovo Mountain.

The Bregalnica watershed includes parts of the Osogovo Mountains, Maleshevski Planini Mountains, Plachkovica Mountain, Konechka Planina Mountain, Vlaina Planina Mountain, Golak Mountain, Obozna Mountain, Bajaz Tepe, Gradishtanska Planina Mountain, Mangovica Mountain, Ovche Pole, Kochansko Pole, Probishtip valley and the valley of Lakavica River and Slan Dol. The border of this area covers the highest peaks of the above mentioned mountains: Dzami Tepe (1801 m a.s.l.) of the Maleshevski Planini Mountain, Lisec (1754 m a.s.l.) of Plachkovica Mountain, Kadiica (1932 m a.s.l.) of Vlaina Planina Mountain and the ridge of Osogovo Mountain with the peaks Carev Vrv (2084 m a.s.l.) and Mal Ruen (2202 m a.s.l.).

The Bregalnica River is the largest tributary of the Vardar River (225 km long) and is the largest river in Eastern Macedonia. Some of the most important tributaries to Bregalnica River are: (from the right) Pehchevska Reka, Zhelevica Reka, Gabrovska Reka, Ochipalska Reka, Lukovichka Reka, river Kamenica, Orizarska Reka, Kochanska Reka, Zletovska Reka and Svetinikolska Reka; (from the left) Ratevska Reka, river Kamenica, Budinarska Reka, Biglanska Reka, river Zarovec, river Osojnica, Gradeshka Reka, Zrnovska Reka, river Plachkovica, river Kozjak, Suva Reka, river Otinje and Kriva Lakavica.

The area of interest (Fig. 1 and 2) has surface area of 4663.3 km^2 and includes the Bregalnica River watershed and the East Planning Region of Macedonia. The Bregalnica River watershed has the area of 4315.5 km^2 i.e. 16.78% of the territory of the Republic of Macedonia. The East Planning Region has a territory of 3548.7 km^2 or 13.8% of the territory of the Republic of Macedonia.

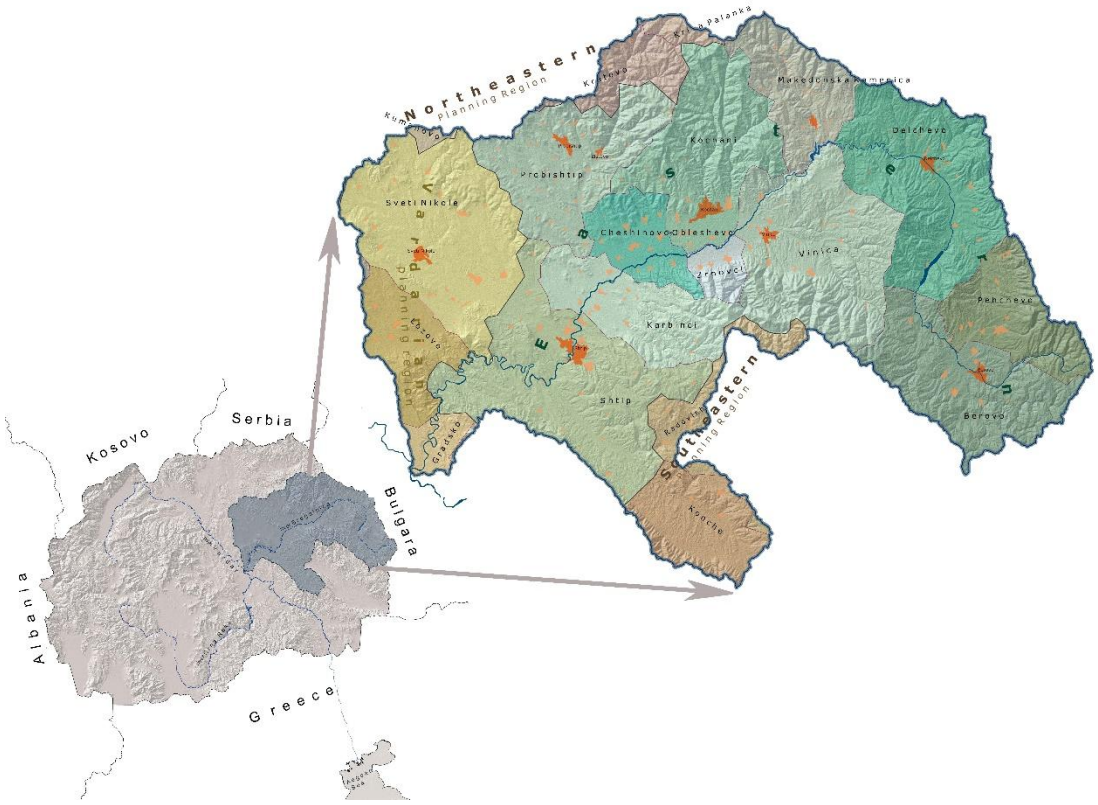


Fig.1: Geographical position of the Bregalnica River watershed

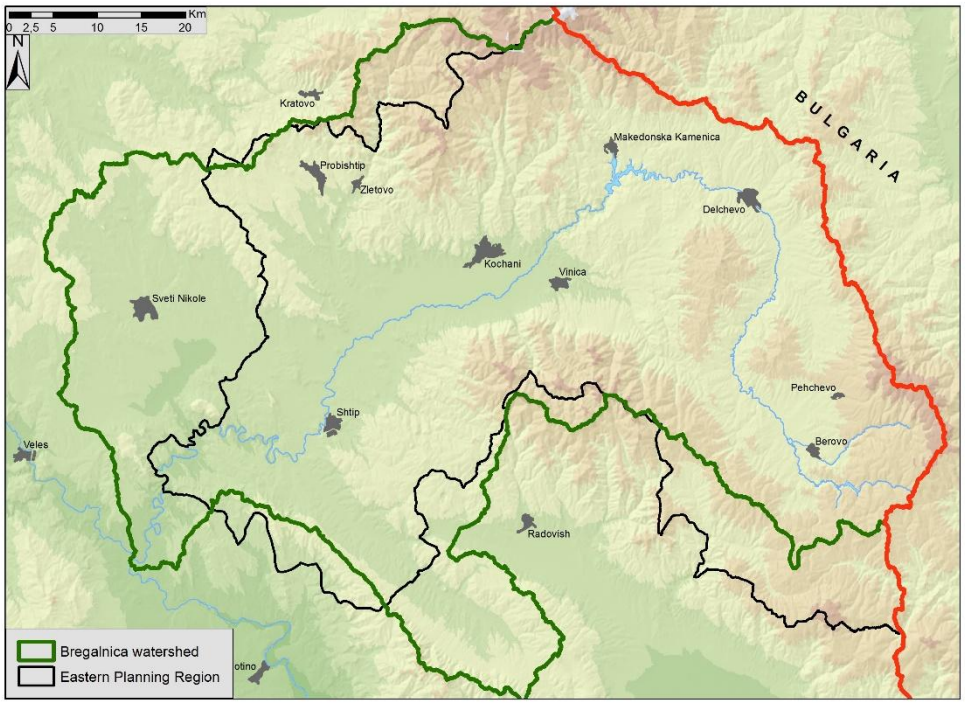


Fig. 2. Geographical range of the area of interest (Bregalnica River watershed and East Planning Region)

2.2 Administrative Division

The area of interest belongs to four planning regions: East, Northeast, Vardar and Southeast region (Fig. 3). Five municipalities from the Vardar region are partially included in the Bregalnica watershed: Veles, Sveti Nikole, Lozovo, Gradsko and Negotino. Three municipalities from the Northeast region are partially included in the Bregalnica watershed: Kratovo, Kriva Palanka and Kumanovo. Two municipalities from the Southeast region are partially included in the Bregalnica watershed: Radovish and Konche.

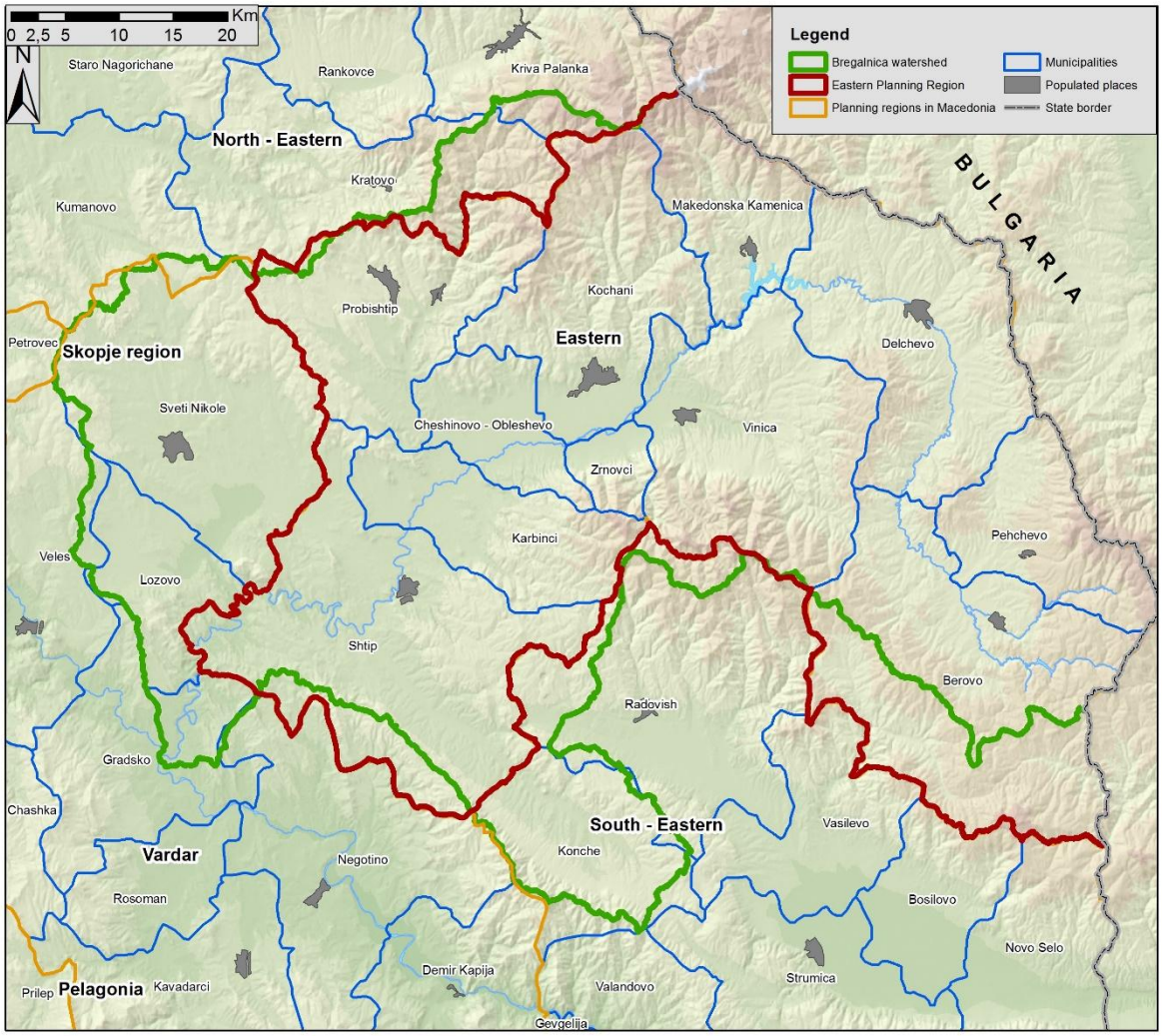


Fig. 3. Administrative division of the area of interest: planning region and municipalities

In the area of interest there are 22 municipalities. The municipalities of Negotino and Petrovec are included in the watershed with very small areas which is probably a result of imprecisely defined municipality borders.

The East planning region includes 11 municipalities: Berovo, Pehchevo, Delchevo, Shtip, Vinica, Zrnovci, Karbinci, Makedonska Kamenica, Kochani, Cheshinovo-Obleshevo and Probishtip. All of them together create 74.12% of the area of the Bregalnica watershed. The rest of the area is divided among the neighbouring planning regions, especially: Sveti Nikole, Konche, Lozovo, Radovish and Kratovo. Also, the municipalities of Gradsko, Kriva Palanka, Kumanovo and Veles take up a significant amount of the Bregalnica watershed area (between 13 and 52 km^2) (Table 1).

Table 1. Municipality areas belonging to the Bregalnica watershed i.e. East Planning Region and the area of interest

Municipality	Municipality area (km^2)	Municipality Area in the watershed (km^2)	% of municipality area in the watershed	Municipality Area in East Planning Region (km^2)	% of municipality area in the east planning region	Municipality area in the area of interest (km^2)	% municipality area in the area of interest
1. Berovo	601	335	56	601	100	125	62,5
2. Pehchevo	205	205	100	205	100	205	100
3. Delchevo	424	424	100	424	100	424	100
4. Shtip	598	522,6	87,4	598	100	598	100
5. Vinica	430	430	100	430	100	430	100
6. Zrnovci	51	51	100	51	100	51	100
7. Karbinci	230	230	100	230	100	230	100
8. Makedonska Kamenica	190	190	100	190	100	190	100
9. Kochani	360	360	100	360	100	360	100
10. Cheshinovo-Obleshevo	133	133	100	133	100	133	100
11. Probishtip	326	318	97,6	326	100	326	100
12. Lozovo	153	150	98	-	-	150	98
13. Sveti Nikole	483	467	96,7	-	-	467	96,7
14. Konche	235	193	82	-	-	193	82
15. Kratovo	375	96,55	25,75	-	-	96,55	25,75
16. Radovish	505,2	98,6	19,5	-	-	98,6	19,5
17. Gradsko	285	52	18	-	-	52	18
18. Kriva Palanka	480	30	6,2	-	-	30	6,5
19. Veles	439	18	4	-	-	18	4
20. Kumanovo	511	12,8	2,5	-	-	12,8	2,5
21. Negotino	418	2,15	0,005	-	-	2,15	0,005
22. Petrovec	203	0,3	0,0015	-	-	0,3	0,0015

2.3 Climate Characteristics

The diversity of relief characteristics in the Bregalnica River watershed, its direction, the altitudinal gradient, as well as the large surface area enables the influence of several climate types (Lazarevski 1993).

The middle of the watershed is characterized by the presence of a moderate continental climate which gradually turns into continental towards northeast. In the lower part of the watershed and along the river valleys there is a characteristic presence of a modified warm continental climate with Mediterranean influence (Lazarevski 1993; Zikov 1995; Filipovski at al. 1996). The mountains which define the Bregalnica watershed have a mountain climate (Zikov 1988). Generally, typical mountain climate is present in the higher parts of Osogovo Mountain, while the rest of the mountain ranges in the Bregalnica watershed do not have typical mountain climate (Fig. 4 and 5).

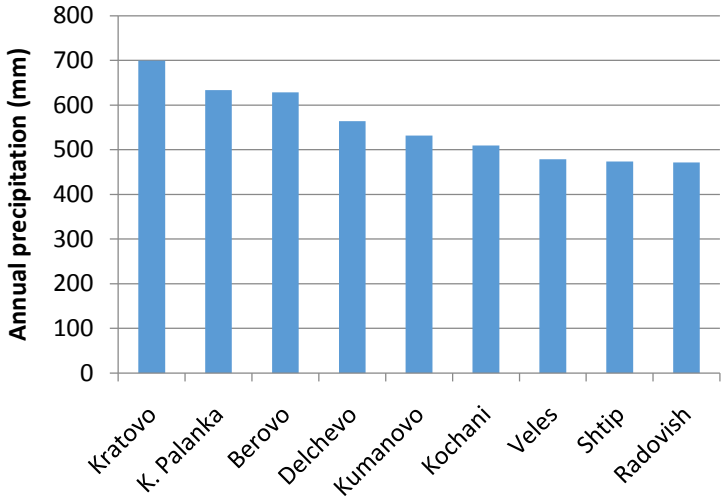


Fig. 4. Average annual precipitation measured at meteorological stations in the wider region.

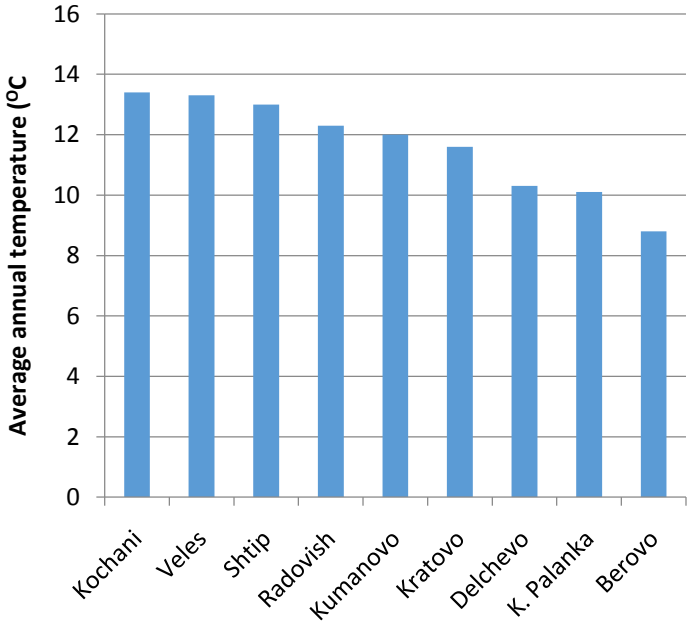


Fig. 5. Average annual temperature measured at meteorological stations in the wider region.

Because of the hills and the low altitudes of the Ovche Pole region, there is some Mediterranean climate influence which affects and modifies the distinctly moderate continental climate. The region has characteristically warm summers and moderately cold winters. The average annual temperature is 13°C. Precipitation during the year is unevenly distributed and affects increased frequency of draughts. Precipitation is most common in May and the annual amount of precipitation is 473.3 mm (Fig. 6).

The climate of the Kochani Valley is under a distinct influence of the Osogovo range from the north and the Plachkovica range from the south. The average annual temperature of the Kochani Valley is the same as that of Ovche Pole and is 2.4 °C higher than the temperature of Delchevo. The annual precipitation amount is 400-500 mm. Precipitation-wise the region has a local orographically significantly modified Mediterranean climate with characteristics of continental influence. (Fig. 6).

The Delchevo Valley has a more distinct influence of the moderate continental climate. The average annual minimal temperature is 4.1 °C. The average annual precipitation sum is 563.9 mm Regarding the precipitation regime this region also has a modified continental influence (Fig. 6). The Delchevo Valley is also windier than the aforementioned regions.

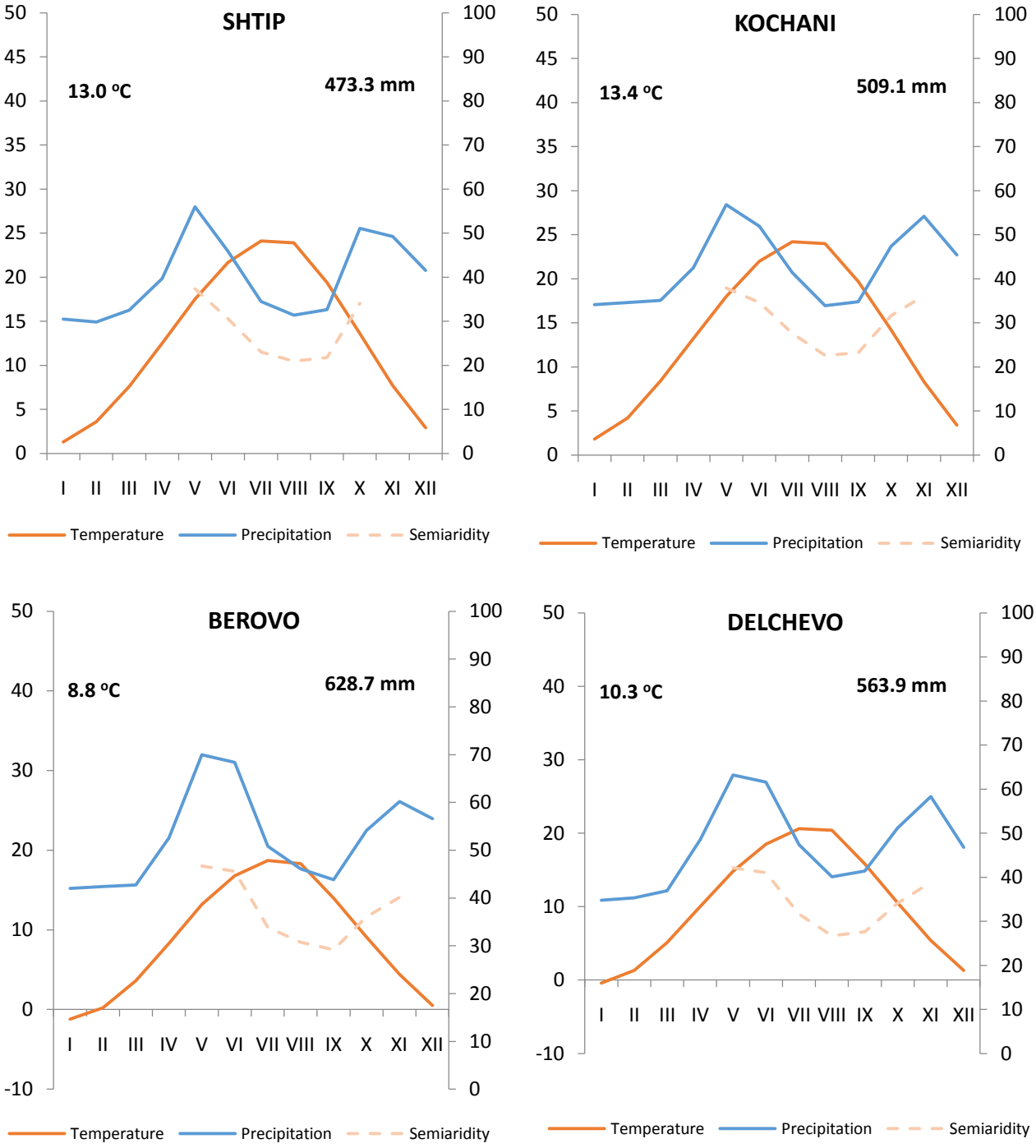


Fig. 6. Climate diagram for Shtip, Kochani, Berovo and Delchevo

The Berovo Valley is under distinct influence of the continental climate. The specificities of the altitude of this valley enable the presence of temperature inversion. The average annual minimal temperature is 2.8 °C and 4.1 °C lower than that of Ovche Pole. Around 60% of the average annual precipitation (628.7 mm) falls during the vegetation period which lasts from February to November (Fig. 6). Surrounding mountains have a noticeable influence in climate conditions of the Berovo Valley. This allows the presence of mountain climate which is especially distinct at altitudes above 1200 m a.s.l. The influence of mountain climate is noticeable in the Delchevo Valley as well.

However, the Delchevo Valley is lower and open towards the Istibanja Gorge and thus the mountain climate is less distinct (Filipovski et al. 1985).

Figures 7 and 8 clearly illustrate the difference between the western and eastern part of the area of interest. The temperatures are especially high close to the Vardar River course. The high temperatures spread along the course of the Bregalnica River up to Delchevo. The distribution of precipitation is similar in the area of interest i.e. the heaviest precipitation occurs in the eastern mountainous part and the lightest in Ovche Pole, Slan Dol and the fields around Shtip.

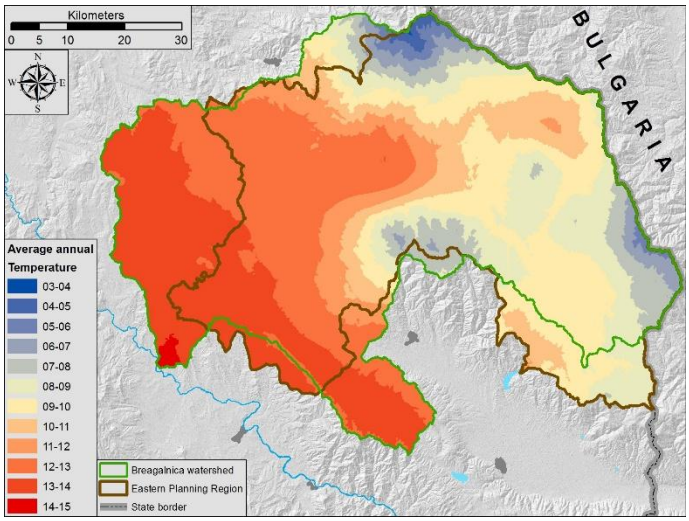


Fig. 7.Map of Isotherms in the Area of Interest

According to a digital model for the mid-year temperature and precipitation of Macedonia (Milevski, 2015)

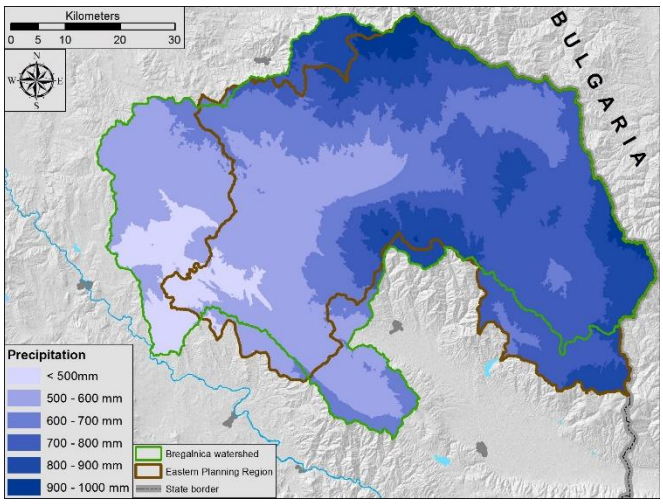


Fig. 8. Isohyet map of the area of interest

According to a digital model for midyear temperatures and precipitation for Macedonia (Milevski, 2015)

2.4 Geological characteristics

The area of the Bregalnica River watershed belongs to the Serbo-Macedonian and Vardar geotectonic unit, and as a geological formation it has developed Pre-Cambrian metamorphous rocks, Lower Palaeozoic rocks and migmatites, Upper Palaeozoic rocks, Mesozoic sediments, Tertiary and Quarter volcanic rocks and migmatites (Fig. 9).

The Precambrian metamorphous rocks are the oldest geological formation and among the most widely distributed rocks in the Bregalnica watershed. The rocks of this type are most commonly found in the mountain ranges which surround the course of the Bregalnica River (Vlaina Mountain, Golak Mountain, Osogovo Mountain, Plachkovica Mountain and Ograzhden Mountain).

Representatives of the Precambrian metamorphous rocks are: gneisses and their complex creations which amount to the largest part of this geological formation, followed by mica, leptinolith creations, amphibolic rocks and slates, quartzes and granites.

The gneisses and their varieties, composition and distribution are part of all mountains from the watershed. These gneisses can contain quartz, feldspar, granite, muscovite, biotite, apatite and epidote. They are all high metamorphic and depict the transit to other metamorphous rocks.

Mica and leptinoliths lie over a layer of double-folded gneiss. The larger portion of this type of rock is mica, based on the presence of feldspars it can become lepthinolith or gneiss.

Amphibolic rocks and amphibolic slates occur as layers between gneisses. They are characterized by a well-defined border which sets them apparat from other types of rocks. They are mostly constructed from amphibole and plagioclase, with noticeable quartz, chlorite, feldspar, granite etc.

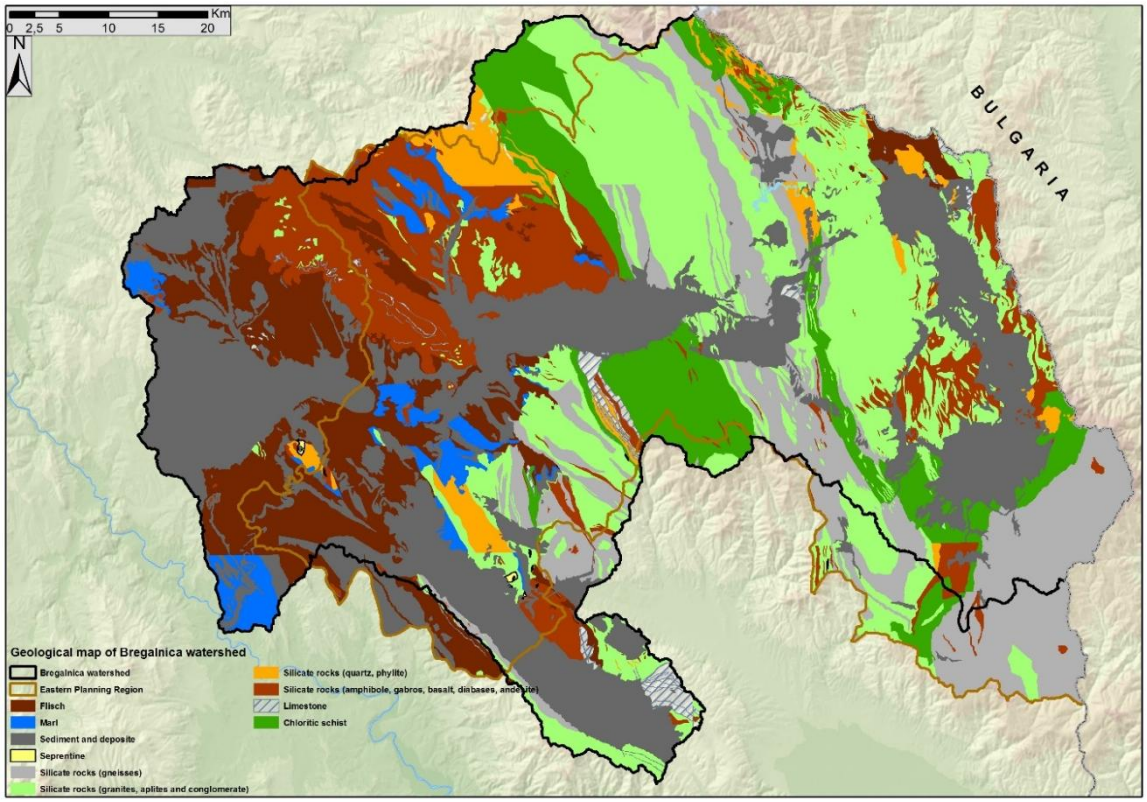


Fig. 9. Geological map of the area The map was made on the basis of the corresponding cartographic sheets of Basic geological map of Yugoslavia, prepared by the Geological Institute Skopje, edited and published by the Federal Geological Survey Belgrade and WGI. Note: The separate geological types are congregated in order to provide a general overview of the geology in the investigated area.

The Lower Palaeozoic rocks are located in the central parts of the researched area, in the Osogovo and Plachkovica Mountains. These types of rock are Riphey-Cambrian metamorphous and are concordant to other classes or rocks which are below. Lower Paleozoic rocks fall into two groups of rocks: slates from the “green series” and metagabbro- diabasis. The green slate can be found on the upper parts of the Lower Paleozoic and its green colour clearly sets it apart from other rocks. The colour is the result of phemic minerals which are part of this type of rocks. The lower layers have diabase which are volcanic sediments and represent transitions in other metamorphous formations.

The Upper Palaeozoic rocks are slate with Riphey-Cambrian rocks on top, and in exposed ruptures they appear as serpentines. These rocks have developed in the central part of the watershed. As a geological formation they appear in the area of Orlov Kamen, Ratkova Skala and the gorge part of Zletovska River. They mostly contain sericite, muscovite, chlorite and rarely quartz.

Mesozoic sediments in the Serbo-Macedonian geotectonic zone represent formations from the Lower Triassic and the Mid-Upper Triassic period. The Lower Triassic period saw the creation of quartz sand which can be found in the eastern part of the watershed, or more precisely in the southeast part of the Osogovo and Vlaina Mountain which stretch in the direction of northwest-southeast. The Mid-Upper Triassic period is represented with limestone which stretches in the eastern part of the watershed. These Mesozoic rocks lie in discordance with the neighbouring rocks.

The Vardar geotectonic zone of the researched area has granites and amphibolic slate from the Jurassic period, while the Cretaceous period is represented by limestone, sands and conglomerate complexes.

From the Tertiary period there are sediments from Paleogene and Neogene, volcanic rocks from dacite and marlstone from the Miocene; Pliocene sediments which are relics of lake basins which existed in the area. Miocene sediments lay over ignimbrite rich with flora and fauna; and in the Kratovo-Zletovo volcanic area these supress Paleogene sediments. Pliocene volcanic material is transgressive over Miocene layers. Representatives of the Quarter are volcanic rocks and sediments which can be found predominantly in the valleys of the larger rivers in the Bregalnica basin as well as in the Kratovo-Zletovo volcanic area, the lower parts of the mountain ranges and areas around valleys. The composition of Quarter sediments includes limestone and travertine blocks, alluvial sediment and Diluvium deposits. It is important to note that the Quarter formed volcanic complexes are of economic value. This is why in the Kratovo-Zletovo volcanic area there are materials such as opal and silex, dacite, andesite etc.

As a result of tectonic and magma processes during the Tertiary and Quarter period in the Bregalnica watershed there are noticeable amounts of lead-zink ore. This is above all relevant for the Kratovo-Zletovo area where deposits close to Dobrevo (Municiplaity of Probishtip) are mined for lead-zink ore; Sasa-Toranica area along the Kamenica River i.e. the Sasa Mine is located above the populated area of the Makedonska Kamenica municipality. Close to Radovish there are registered deposits of copper mineralization which is exploited from the Buchim Mine and the chemical composition of the copper ore has traces of gold and silver. Close by is the former Damjan Mine which was exploited for iron ore from the Paleogene sediments, Tertiary volcanic rocks and skarns. It is important to note that the Ovche Pole basin is formed by sediment rocks in the upper Eocene-Oligocene. Similarly the Delchevo basin was created, as well as some other regions in Macedonia. The total thickness of this Eocene-Oligocene layer is estimated to be 3500-4000 m thick. These sediments have numerous fossil remains such as *Cerithium diaboli, C. vivari, Natica vulcaniformis, N. vulcanica* and *Spondilus bifrons*, as well as *Ostrea gigantica* and *Pecten* sp. Besides fossil snails and shells, the top sediments (rich in limestone) have *Nummulites fabiani, N. incrassatus, N. budensis, Operculina alpina* and *Discocyclina angastae*. Top Oligocene sediments have nummulites, corals, snails, shells and echinoderms (Dumurdzanov et al. 2004).

***Ostrea* sp. (cf. *gigantica*) – fossil shell from marlstone at Penush**

***Cerithium diaboli* – fossil snail at saltpans of Gladno Pole**

2.5 Geomorphological Characteristics

2.5.1 Basic Geomorphological Characteristics

Tectonic movement before and especially during the Pliocene has contributed to the separate of four basic relief formations: mountains, wavy-hill relief with lake terraces, diluvial relief and planes (river terraces) (Filipovski et al. 1985).

2.5.1.1 Mountains

Macedonia has approximately 40 mountains which can be separated in categories such as: exceptionally high (over 2500 m), high (2000-2500 m), medium high (1500-2000 m) and low (1000-1500 m). The Bregalnica region does not have any exceptionally high mountains. Osogovo Mountains are the only ones which are high the rest of the mountains are medium high (Maleshevski, Vlaina, Plachkovica, Ograzhden and Golak) and low (Obozna, Bejaz Tepe, Smrdesh).

Osogovo Mountains are morphological heavy and asymmetrical with dominant radial tectonic elements. The two most prominent peaks are Ruen (2252 m) and Carev Vrv (2085 m), and they form a star-shaped range of seven mountain ridges, separated by deep river valleys. The main ridge is the Kostadinechko-Lisechko Ridge on east from Carev Vrv and continues to Sokolsko, while on the east side of Ruen (in Bulgaria) is the Choveshko Ridge. This ridge stretches from southwest to northeast and is 53 km long. Because of the erodible geological composition all of the ridges are wide, flattened and are created from old fluvial and denudation surfaces. Hypsometrically, the Osogovo massive covers the altitudes from 368 m a.s.l. to 2252 m a.s.l. Only 2.64 km^2 or 0.24% are taller than 2000m (taking the Bulgarian part into consideration it comes to 7.08 km^2). Out of them 1.15 km^2 are around Carev Vrv, and 1.49 km^2 around Ruen (5.93 km^2 with the part in Bulgaria). The average height of the massive is 1018 m. The Macedonian part pf the massive, the southwest expositions participate with 17%, the western with 16.3%, the eastern with 12.5% and the smallest part is from the northern expositions with only 9% (MES 2012).

Plachkovica is a medium high mountain composed mainly of silicates and marbles between the villages of Vidovishte and Radovish, as well as a small space near Gaber where it has chalk limestone sands. The highest peak is Lisec (1754 m).

Obozna is a mountain with a meridian direction, with a ridge that is 9.5 km long. The mountain is situated between the Kochani Valley in the west and Razlovechka Gorge in the east where it is intercepted by the Bregalnica River thus separating it from Bajaz Tepe (1346 m). The highest peak is Jastrebac (1278 m).

Golak is actually a continuation of Obozna, separated by a low passage. It also stretches in the direction of the meridians and is 13 km long until it reached Bregalnica in the north. To the east it stretches to the Delchevo Valley and to the west to the Kalimansko Pole and part of the Kochani Valley. Actually, Bregalnica forms a large arch on the Kalimansko Pole going around the mountain. The highest peak is Chavka (1538 m).

Maleshevski Planini are a large massive at the border with Bulgaria and its highest peak is Chengino Kale (1748 m) which is at the eastern most point of Macedonia. The length of the ridge to Bulgaria is 32 km. The ridges are blunt and the highest peak is Dzami Tepe (1801 m). The geological composition is similar to the other mountains with para-slates mixed with marbles and green slates. The lower parts, towards the Berovo Valley, are covered with Neogene sediments.

Valina is a continuation of Maleshevski Planini in the north. The highest peak is Kadiica (1932 m). In the geological composition it has crystalline slates, Palaeozoic gneiss, granitoid pierced by quartz and aplitic strings, and above Delchevo there is a small area of Triassic limestone. The lower parts have Pliocene sands and sandy clays.

Peak Kadiica on Valina Mt. With a view towards Bukovik massive

Bajaz Tepe is geomorphologically well separated from the neighbouring mountains and valleys with an average height of 961 m. It is a horst which is raised from the Berovo-Delchevo trench and separates Malesh from Pijanec. It is mostly composed of silicate rocks just like previous mountains. The climate is continental and for the most part it is covered with Black Pine forests.

Orgazhden is tied onto the Maleshevo Mountain in the south and belongs to Macedonia and Bulgaria. Ograzhden is mainly composed of gneisses and micas, granites and crystalline slates. The mountain ridges are blunt with protruding peaks: Ograzhden (1744 m), Krkan (1564 m), Karamatija (1489 m), Rabush (1465 m) and Adziica (1471 m).

Serta, Gradeshki Planini and Plaush belong to the group of low mountains. They are situated at the border of the Serbo-Macedonian mass towards the Vardar zone. The length of their ridges from the Valandovo Valley to the Bregalnica River is 68 km. The ridges are blunt. The highest peak of Gradeshki Planini is Vuchjak (1158 m), and the other peaks are under 1000 m. Geologically they are mostly composed of crystalline slates, granites, amphiboles, marbles, and Paleogene flysch; while the slopes have some Pliocene sediment. Plaush is considered to be a low continuation of Belasica. Composed of amphiboles, but also has quartz and crystalline slate. The lone peaks end in crystalline grey limestone. The slopes towards Kriva Lakavica and Bela River are traced with abrasive processes and fluvial erosion.

Besides mountains that rise up to 1000 m, the area of interest also has numerous hills such as the Gjupskiot Rid (Crn Rid, 997 m) between Kriva Lakavica and Bregalnica; Smrdesh (Zmiova Dupka 910 m) which frames the Radovish Valley to the south; the hills that frame the Ovche Pole Valley to the south where are Venec, Bogoslovec, Padarnica etc.

2.5.1.2 Valleys and Fields

Among the mountains extand valleys, and in their lowest parts there are flatlands with an altitude between 200 and 700 meters. Moving from north to south they alternate between the Kochani, Pijanec (Delchevo) and Maleshevo (Berovo) valleys. To the west and towards Vardar are the Ovche Pole and Lakavica valleys. All valleys have two clearly separate types of exogenous processes: the valleys have abrasive fluvial-denudation processes and the valley bottommost have fluvial erosion and accumulations which are active to date. Since during the Pliocene, all valleys were turned into lakes, these processes have left clear traces. On the outskirts they are fluvial-denudation and lower abrasive-polygene surfaces, and in the basis there is a large accumulation of lake basins. In the beginning of the Diluvium and after the lakes have leaked to some valleys, and after the tectonic processes were renewed and the Aegean basin was lowered there was a fluvial phase. This is why there was intensive erosion with fluvial-denudation processes. Thus, today the valleys as a result of joint action of endogenous and exogenous processes are formed mainly two types of relief – fluvial-denudation and accumulation with leftovers from polygene forms.

The Ovche Pole Valley is one of the largest in Eastern Macedonia and its bottom is composed of lake sediments. The norther border is made up of higher grounds composed of young eruptive rocks. Because of the fluvial-denudation post-lake processes the Ovche Pole Valley is wavy and rises towards the north where most of the rivers have their sources. Ovche Pole has the lowest amount of rainfall form all of the valleys in Macedonia with an average 490 mm annually.

View of Ovche Pole from Bogoslovec

The Kochani Valley stretches in the middle of the Bregalnica River course and has the surface area of 345 km^2. The lake sediments can be found up to the heights of 880 m. The frame of the valley has abrasive – polygene surfaces.

Kochani Fields

The Berovo-Delchevo trench with the horst of Bajaz Tepe is separated by two valleys, Berovo Valley and Delchevo Valley. The Berovo and Delchevo valleys are the highest valleys in Eastern Macedonia. The two valleys are separated by fault lines where a visible transition from high-mountain to lower valley and hilly area can be seen.

2.5.1.3 Bregalnica River Valley

During the Pliocene the valleys had Pliocene lakes. During the withdrawal of the lakes and with the lowering of the lower erosive base there was an intensive river course indentation.

The Bregalnica River valley is composite (Andonovski 1995; Manakovic and Andonovski 1979) and it has a polygene character composed of several meso-relief forms: valleys, plains and gorges (Manakovic and Andonovski 1979). The source of the river and its headwaters in the area of the Maleshevo Mountains are represented by a young valley cut into gneiss and mica. In the upper flow of Bregalnica, the valleys are alluvial with coarse sands, gravel and clay (Kolchakovski 2004). The valleys of Malesh, Pijanec and Kochani in the Bregalnica watershed are formed by lakes and have a

larger number of river terraces which resemble riverbeds. The Delchevo-Pehchevo-Berovo basin is full of Pliocene (lake) and Quarter sediment (Manakovic and Andonovski 1979; Kolchakovski 2004). In this part the higher river terraces are covered with new river sediments. The part of the Ovche Pole- Istibanja Gorge which is epigenetic, Bregalnica alternatively cuts into Neogene sediment and hard rocks and meanders (Manakovic and Andonovski 1979). In the Kochani basin, the Bregalnica valley has diluvial and proluvial sand deposits, gravel and sandy clay. On the territory of Ovche Pole there are more Pliocene-Quarter sediments and Eocene flysch. Alluvium is represented predominantly along Bregalnica (Kolchakovski 2004). Close to Shtip, Bregalnica cuts into granite and builds symmetrical valley sides. Downstream the river cuts into Paleogene and Neogene sediment and forms distinct meandering forms as well as river enlargements with smaller fields. The valleys of all tributaries are symmetrical (except for Kamenica) and monogenetic (Manakovic and Andonovski 1979).

Meandering forms on Bregalnica at Ubogo

2.5.2 Specific Geomorphological Structures

According to the physical-geographic environment it can be concluded that it is an area with numerous geological, geomorphological, petrological and hydrographic specificities. Some of the most important locations are the mountain peaks, waterfalls, river canyons, erosive-denudation formations etc.

The Osogovo Mountains have several significant geomorphological complexes. Most of them are included in our area of interest:

- The space around the peak **Carev Vrv** (2085 m) is a high-mountain part and has an impressive peak. The altitude has influenced the characteristic morphoplasty with a presence of Periglacial formations.
- **Ruen** covers the area around the highest peak Ruen (2252 m) to 1700 m. The other peaks are Mal Ruen (2203 m) and Sokol (2038 m). This is a typical high-mountain part with characteristic morphoplasty and presence of Periglacial forms, smaller seas of rocks, sliding blocks and several stone-currants.
- The location **Zletovska Reka** is in the western part. It covered the region from the valley of Zletovska River, between the mouth and its left tributaries Emirichka River in the north and Eshterec in the South, and it is 10 km long. The area is important because of several interesting geomorphological formations: deep river valley with a gorge and canyons with large rocks and small denudation forms; several waterfalls, fast-flowing streams and cascades in the riverbed of Zletovska River and its tributaries. The valley is the most striking feature of this river since it cuts into magma rocks and it is very deep (400-500 m) with steep and almost vertical rocky slopes.

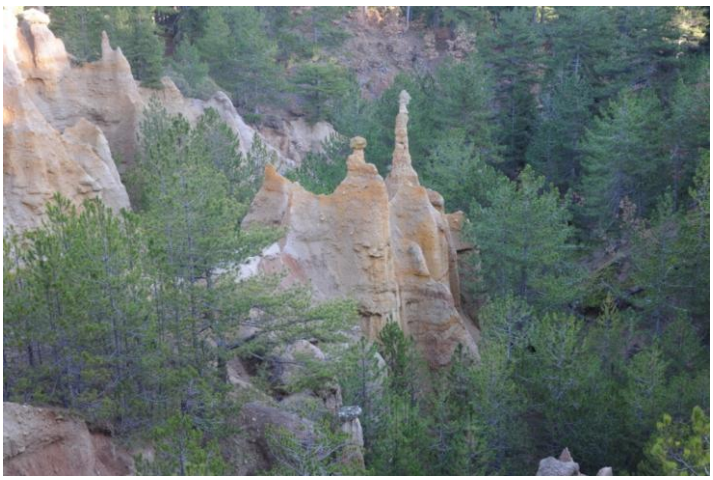
- **Ratkova Skala** is in the southwest part between the Ratkovica River and Sinkovica. It covers the area of the valley of river Shatlkovichka Reka (left tributary of Zletovska Reka), in its upper course and is 2.4 km^2 long. Its valley has a canyon appearance for 1.5 km with slopes which are 400 m deep. Actually, the valley slopes close to Ratkovica are terraced rocks as high as 200 m.
- **Sasa Kosevica** is a locality in the Eastern part of the Osogovo Mountains and it covers the valley of river Kamenichka Reka to the village Sasa and village Kosevica and is 8 km long. Geomorphologically, this area has many processes of severe erosion and accumulation which is a result of favorable natural factors (above all the weak geological composition) and anthropological influence. At Kosevica, in a line of massive valleys there are earth pyramids which form typical badland fields.
- **The Istibanja Gorge** is located in the southern part of the Osogovo massive and covers the right-hand side of the valley frame in the Bregalnica gorge, from the village Kalimanci to the village Istibanja in the length of 8 km. This part is interesting because it has numerous denudation forms mainly in gneiss and mica. Because of its south-facing exposition the rocks are exposed to strong mechanic (thermal and biogenetic) damage and only the firmer parts of the relief remain. Thus interesting forms have been carved out and some resemble mushrooms, pillars, needles or even anthropomorphic or zoomorphic forms. Some rocks are striking and up to 10 m tall.
- **Lesnosvska Kupa** is located in the west, between Probishtip and Zletovo. It is one of the best preserved Paleo-volcanic dome shapes in the Kartovo-Zletovo area and in Macedonia covering a surface of 12 km^2 and a diameter of 4 km.

Part of the Lesnovo Dome (Ilinski Peak) and the Lesnovo village

- **Kundinsko Lake** is located in the west, between Probishtip and Plavica (1297 m). This locality has several interesting geographical forms, such as the large Paleo-volcanic dome and caldera of Plavica, several secondary volcanic domes, numerous erosive forms “badlands” and especially the Kundinsko Lake.
- **The Babakanina River Cascade** (left tributary to Kratovska River) is located 800 m south of Kratovo at an elevation of 670 m to 630 m. The total height is 30 m and the length is around 150 m. It has five waterfalls, the lowest is 6 m tall, the second is 9 m tall, the third is 7 m tall, the fourth us 4,5 m tall and the last one is 3,5 m tall.

The remaining part of the watershed area has erosive-denudation formations, and some of the more interesting ones are:

- **Kukuljeto** is an area in the southwest of Nov Istevnik (Delchevo) at an altitude of 770-1105 m where it has erosive formations (geomorphological formations) – earth pyramids, located on two erosive slopes in a Black Pine forest.



Erosive formations at Kukulje in a Black Pine forest

- **Earth pyramids** at Loshana, Trabotivishe. These are erosive formations resembling pillars, towers and grooves created in Neogene poorly-tied sediments (lake sediments deposited in the final phase of the Pliocene lakes).
- **Earth pyramids at Lukavica.** The earth pyramids at Lukavichka River are well formed morphologically. They are located on the sides of two big neighbouring valleys (out of 12), south of Kosevica, at an altitude of 770 m. They resemble the earth pyramids of Kukuljeto (Boshev 2015).
- **Badlands in the Zhelevica watershed.** The valley of Vinichka River and at several other smaller locations there are deep ribbed cut-outs in Neogene sediment. These great natural cut-outs resemble funnels and the local population calls them “mels” (Boshev 2015).
- **Earth pyramids in Kolachinski Andak – Smojmirovo.** They are located in the right-hand part of the basin on Kolachinski Andak 5 km away from Smojmirovo, Parkach. Intensive line erosion which forms pyramids in the weak sands is over 30 m tall. On top of and around the pyramids there have been naturally growing pines but a fire in 2007 burnt around 1000 ha of forest and vegetation under the pyramids thus intensifying erosion (Boshev 2015).
- Specific denudation forms are located on the right-hand side of the banks of the river Kiselica in the basin of the accumulation Mavrovica – Gjugjance. The forms are concentrated in two “block-rock plateaus” which have an east-southeast exposition. Geomorphological formations are erosive denudation ones, created with the emptying of volcano clastic material. They are made of volcanic tuffs with an andesitic composition. Different denudation forms can be noticed resembling pillars, lone blocks, head-shaped forms, spikes, towers, cup, pyramids and animal forms (Boshev 2015).

Other geomorphological forms include:

- **Pilav Tepe**. In the valley of river Medenska Reka (right tributary of Lakavica), from the right-hand side of the gorge part of Dervenska Gorge, along the road Radovish-Shtip there is a prominent formation a Paleo-volcanic dome Pilav Tepe (601 m). The volcanic dome is the most pronounced morphological formation from the tertiary magmatism in the Buchim-Damjan region.
- **Gjavolski Zid at Bogoslovec**. The locality Gjavolski Zid is located 2 km south-southeast from the top of Bogoslovec and 250 m north of the Bregalnica River, namely its right-hand valley

side at the altitude of around 250 m. The name Gjavolski Zid (Devil's wall – a result of mystic interpretation) is actually applied to the rocky formations i.e. rock lines from Eocene limestone which is strikingly visible in the relief and stretch from east-west-northwest in the lengths of several hundreds of meters.

- **Fossil meandering features of the Bregalnica River at Bekjirlija** represent a specific form of Neo-fluvial fossil relief. Created with the cutting through of the river rendering part of the meandering formations obsolete. This fossil meandering feature is now completely dry.

Fossil meandering features on Bregalnica River at Bekjirlija

The Bregalnica River watershed has a small number of caves. These are small caves, poorly decorated and with scarce fauna. However, these are almost the only caves in East Macedonia which makes them geomorphologically important.

- At the locality **Turtelo,** on Plachkovica at the altitude of 1200 and 1500 m there are several caves. The geological basis is carbonate which has contributed to the formation of caves and other karst formations. The area has five caves: Kjup, Golema Cave, Turtelska Cave, Mlechna Cave and Ponor.
- **The Konjca Dupka Cave** is located in the foothills of Valina Mountain close to Grad, i.e. to the east of Grad on the left-hand side of Vachin Dol. It is a unique limestone complex in the wider area which is a great measure destroyed by the opening of a quarry.
- In the northeast of Delchevo at Kiselica there is a cave called **Kiselichka Cave.** It is a dry cave with a slightly more intensive dripping in the final parts of the channels which form very small stalactites. Other decorations have not been noticed.

Entrance to the Kjup Cave

2.6 Hydrology

2.6.1 Hydrographic network

The Bregalnica River is part of the hydrographic system of the Vardar River – the main watercourse of the Aegean watershed. Bregalnica is the largest left tributary to Vardar and the second largest tributary over all. The total length of the Bregalnica River is 225 km, which ranks as the longest tributary of Vardar (Gashevski 1979). The upper course of Bregalnica begins with the source at Kalimanci (Dimovski and Grupche 1971; Milevski 2008; Milevski et al. 2008). The middle course defined in different terms by different authors (Zikov 1998; Slavevska-Stamenkovic 2013), according to Dimovski and Grupche (1971) is the course between Istibanja and Shtip. The lower course of Bregalnica is the area from Shtip (including the confluence with Kriva Lakavica River) to Bregalnica's mouth in Vardar (Dimovski and Grupche 1971). Only in its upper course Bregalnica has 18 larger tributaries and a series of around 70 larger and smaller rain-fed tributaries (Filipovski et al. 1985). A more detailed approach to hydrographic characteristics of the Bregalnica watershed is provided by Gashevski (1979). According to him, the most significant tributaries of Bregalnica from its source to the mouth are: Ratevska Reka, Kamenica Reka, Budinska Reka, Bigljanska Reka, Zarovec, Osojnica, Plachkovica, Kozjak, Suva Reka and Otinja on the left and Pehchevska Reka, Zhelevica, Gabrovska Reka, Ovchepolska Reka, Lukovichka Reka, Kamenica, Orizarska Reka, Kochanska Reka, Zletovska Reka as right tributaries. The largest left tributary is river Kriva Lakavica and the largest right tributary is Svetnikolska Reka. Additionally, Bregalnica receives a large number of watercourses which have a temporary character and are often locally reffered to as "rivers". Out of all of Vardar's tributaries, Bregalnica is at the lowest altitude (720 m). The medium drop of Bregalnica's water bed is 7‰, while its largest tributaries Kriva Lakavica and Svetnikolska Reka have the lowest relative drop of 7.6‰ and 11.6‰, accordingly. Bigljanska River has the largest relative drop (84.8‰) (Gashevski 1979). According to Zikov (1988) the middle of the Bregalnica watershed is characterized by a high percentage of underwater currents and most of them have either low or medium water levels. A high water level has been registered in Ularci, Obleshevo, Vinica, Vidovishte, Pribachevo, Chiflik, Tarinci, Chardaklija and Saramzalino. Because of the low flow of the streams, the middle of the Bregalnica watershed is one of the driest in Macedonia.

Fifteen accumulations have been constricted in the Bregalnica watershed for the purpose of watering, water supply and energy production. The largest are: Kalimanci and Berovo Lake (on the very river), Gradche on Kochanska Reka, the hydro-system Zletovica (Knezhevo Dam) on Zletovska Reka, the accumulation Mantovo on Kriva Lakavica and Topolnica on Toplnichka Reka.

The creation of a wetland can be observed in the watershed of Svitinikolska and Zletovska River, while Kochani Field can periodically become flooded (Zikov 1988). The largest part of former wetland habitats in the Bregalnica watershed no longer exist today. The levels of underground water are artificially maintained below the surface with two drainage networks: melioration system "Sandanski" in the upper part of the watershed (Filipovski et al. 1985) and the melioration system "Bregalnica" (Gashevski 1979; Zikov 1988). The hydro-melioration system "Bregalnica" serves for irrigation of the agricultural area of 28.000ha, firstly for irrigation of the Kochani rice fields.

2.6.2 Ecological integrity of the watercourse

The assessment of the ecological integrity of the river courses was done by Jovanovska (2014). This evaluation is based on "remote interpretation of types of land use, along the banks and in the basin, next to or upstream of the watercourses of interest".

Table 2. Basic characteristics of the watershed of the larger watercourses in the Bregalnica watershed (watershed surface >10 km^2)

Medium altitude (m)	Watershed surface **(km²)**	Left tributaries		**Right tributaries**	Watershed surface **(km²)**	Medium altitude (m)
1470	13,8	Kriva Reka Reka	**Bregalnica -main recipient- 790 km² surface of the immediate watershed area 457 m medium altitude**	Ljutachka Reka	11,5	1568
980	14,2	Rakitina Reka		Zvegor	12,5	952
1085	15,9	Loshana		Umleska Reka	16,.7	919
575	16,5	Blagovo		Svidnica Reka	17,4	830
991	16,5	Lenishka Reka		Bekirliska Reka	17,7	406
813	18,7	Moroshka Reka		Grashtica Reka	23,3	925
1001	18,8	Vladimirska Reka		Ochipalska Reka	31,6	815
917	21,2	Biglanska Reka		Gabrovska Reka	34,0	873
1065	37,8	Kamenica		Smojmirska Reka	46,3	1122
920	38,7	Gradechka Reka		Zhelevica Reka	110,1	1003
911	40,1	Argulichka Reka		Orizarska Reka	143,6	939
588	51,8	Otinja		Kochanska Reka	147,5	854
825	56,5	Kozjachka Reka		Zletovska Reka	484,2	838
649	63,6	Radanjska Reka		Svetinikolska Reka	520,5	407
1176	73,4	Zrnovska Reka				
1129	139,2	Rateska Reka				
881	322,1	Osojnica				
556	416,1	Kriva Lakavica				

Analyses include assessment of the ecological integrity of a total of 1421 analysed segments of over 250 watercourses. All analysed watercourses fall into the framework of 84 basins (watersheds of main watercourses) with a total surface of 3512.6 km^2, which together with the immediate watershed (basin) of Bregalnica form the entire watershed of Bregalnica with a surface of 4302.6 km$^{2.}$ The watershed of the larger watercourses (Table 2), including both source channels of Bregalnica take up 70% of the Bregalnica watershed.

Results include an assessment of the ecological integrity of numerous smaller watercourses (Fig. 10) which directly flow into Bregalnica (basins with a surface <10 km^2), such as: Tinavec, Ramna Reka, Trebomirska Reka, Petrashovec, Davalica, Crkvenska Reka, Kravin Dol, Selska Reka, Zhuzhela and others with a watershed area of 136.2 km^2. Smaller temporary watercourses with a total watershed area of 58.6 km^2 have been additionally analysed as well as watercourses which do not reach the main recipient i.e. watercourses used for the hydromelioration system “Bregalnica” and for the accumulation Kalimanci (total watershed area of 326 km^2).

Results have indicated that out of a total of 1421 analysed watercourse segment nearly 12% of the analysed segments are assessed as courses with excellent ecological integrity, 23% as having very good ecological integrity, 35% with good ecological integrity, 22% with poor ecological integrity and 8% with bad ecological integrity. The Bregalnica River is divided into 73 segments and out of them 5 were assessed as having excellent ecological integrity, 10 with very good ecological integrity, 22 poor and 8 segments were assessed as having bad ecological integrity. Segments of 37 out of 75 analysed tributaries of Bregalnica, close to the mouth, are assessed as segments having poor and bad ecological integrity.

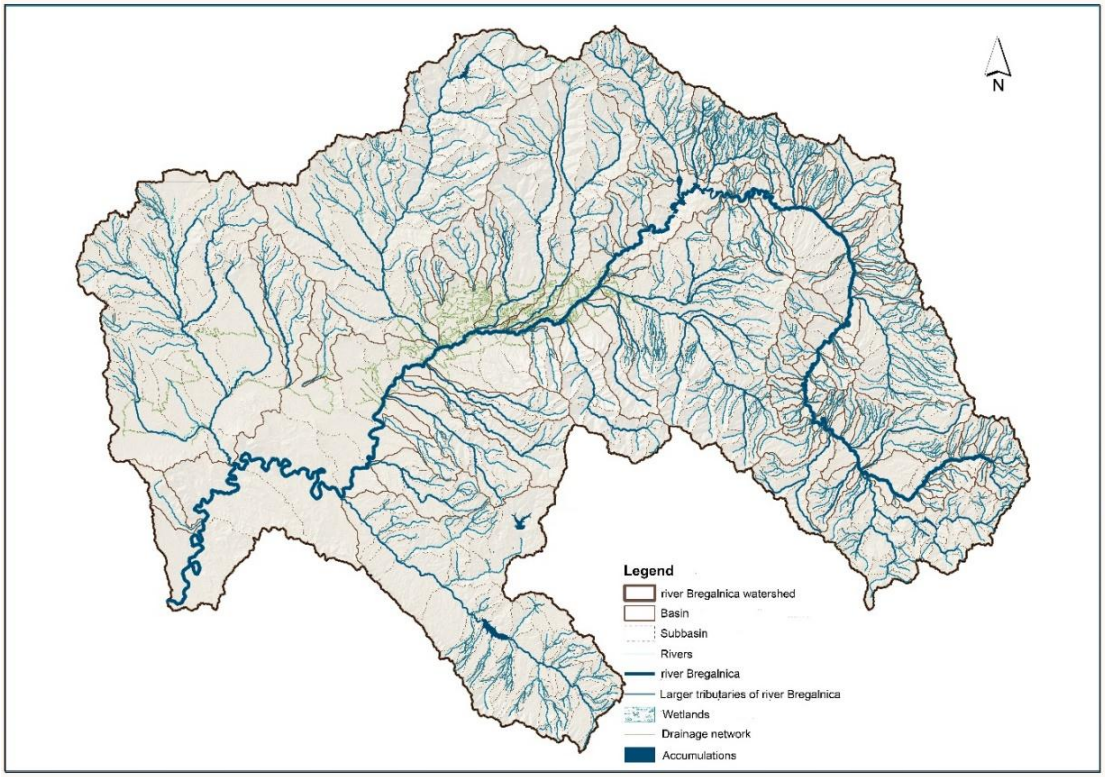


Fig. 10. General illustration of the watershed areas and the main watercourses in the Bregalnica River watershed.

3 Socio-economic characteristics

The area of interest encompasses 20 municipalities, 15 of them are more significant because of the area they take up within the Bregalnica River watershed: Berovo, Delchevo, Zrnovci, Karbinci, Vinica, Makedonska Kamenica, Pehchevo, Probishtip, Cheshinovo-Obleshevo, Shtip, Svetni Nikole, Konche and Lozovo. With the exception of Sveti Nikole, Kratovo, Lozovo and Konche, all municipalities are part of the East Planning Region. The Bregalnica River watershed covers 276 populated areas. From population perspective towns are the largest populated areas, such as Shtip, Kochani, Sveti Nikole, Delchevo, Berovo, Vinica, Probishtip and Makedonska Kamenica. According to data from the 2002 census, as well as the annual statistics for the population which are issued by the State Statistical Office (SSO), the population numbers from the researched area are provided in Table 3. Macedonians are the largest group, followed by Roma and Turks and a very small percentage of other national and ethnical groups. Population density in the Bregalnica watershed area is around 50 residents per km^2.

Table 3. Municipalities, populated areas and population in the researched area

	Municipality	Population 2002	Population (SSO, 2012)	No. of populated areas
1	Sveti Nikole	18497	17966	34
2	Probishtip	16193	15512	36
3	Zrnovci	3264	3112	3
4	Cheshinovo-Obleshevo	7490	7138	14
5	Karbinci	4012	4043	29
6	Shtip	47796	48587	44
7	Kochani	38092	38081	28
8	Vinica	19938	19526	16
9	Makedonska Kamenica	8110	7751	9
10	Delchevo	17715	16730	22
11	Pehchevo	5517	5092	7
12	Berovo	13941	13242	9
13	Konche	3536	3597	14
14	Lozovo	2858	2621	11
Total		206959	202998	276

According to official statistics, the East Planning Region together with the Pelagonija region are the only planning regions in Macedonia that have a decrease of the population with a registered negative annual growth (in 2014 the annual growth index was -335). The estimates for the population as of the middle and the end of the year, as published by the SSO, indicate that in the period between 2005 and 2014 the population of the East Planning Region has decreased by 2750 people or around 320 people annually. But this is data based on administrative registration of demographical actions (births, deaths and migration). If we take into consideration that data from emigration are not taken into consideration then the abovementioned data should be taken with reserve, since this factor has enormous significance for the demographical conditions in Macedonia. Even though, internal migration village-town is present in the entire region, it is most noticeable in the municipalities of Shtip, Karbinci, Kochani and Probishtip. Between 2002 and 2012 the number of villages that have a population density decrease to 50 or below 50 residents is 23. Among them are villages that have 10 or below 10 residents and they are expected to soon join the list of unpopulated villages.

According to stadia of so-called demographical aging, this part of Macedonia has entered the sixth (of seven) stadia of demographical aging. The main reasons for this are the low birth-rate levels (especially in the last 20 years) and the migration processes.

The East Planning Region accounts for around 8.1% of the Macedonian gross domestic product, participates with 9.2% in the average gross domestic product per resident and with 5.2% of the overall investments in the country. From a spatial aspect, the region is characterized by uneven development which is manifested through the domination of the economy in the regional centre of Shtip, followed by Kochani. The rest of the municipalities in EPR have a similar or approximately the same level and dynamic of economic development.

The largest economic activity on EPR with 14.9% is agriculture, forestry and fishing; followed by the processing industry (11.7%); water supply, wastewater removal, waste management and remediation (11.4%); mining and quarrying (11%); trade, vehicle maintenance (8.1%); hospitality industry (7.9%); transport and storage (7.1%); construction (5%) and in the last place financial activities and insurance (Fig. 11).

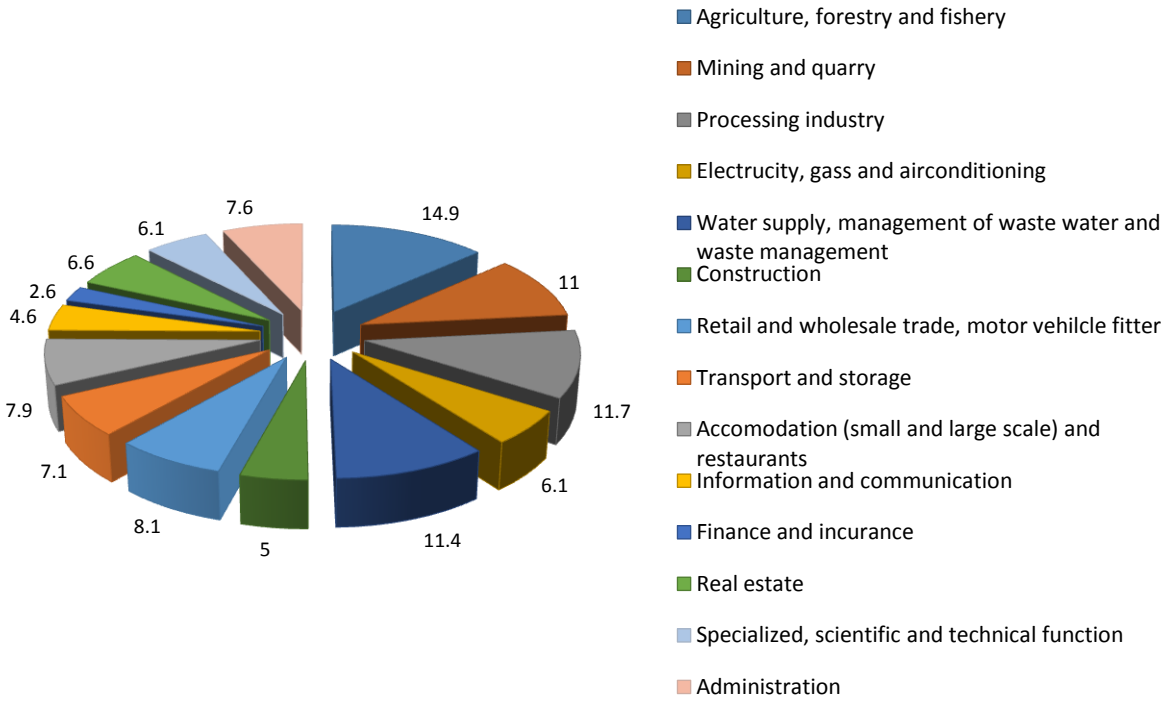


Fig. 11. Share of business entities by activities in the East Region in 2013

The average monthly salary for the region is 15.785 denars, which is the lowest in comparison with the other regions of Macedonia. The employment rate for 2014 was 50.8 and the unemployment rate was estimated to be 20.1.

4 Land use

Everyday human activities continuously change and reshape natural ecosystems. Changes in land use practices are visible in the long run through the change of various types of habitats which surround us. Today there is a need to balance conservation and nature protection with ever-growing pressures for improvement and growth. In developed countries, land use analyses are particulary important in order to maintain the "obligation" to preserve natural values and at the same time address the need of continuous, sustainable use of natural resources. Thus, the initial definition of the condition and further monitoring of land use dynamics in the Bregalnica watershed will provide answers to numerous questions relevant to the definition of developmental policies in the region and even more so, it will contribute to their alignment with the responsibility to conserve natural values.

In order to analyse land use categories in the research area, vector databases for land use were used from the Cadastre and Real-estate Agency of Macedonia. The available land use vector databases were then corrected by intersection with vector layers for CORINE Land Cover (CLC) from 2012.

According to results seven basic categories of land use can be separated in the area of interest. A more detailed overview of the basic land use categories and separate land use types within are provided in Table 4. Below we will only address categories of land use which in the area of interest cover more significant surface. The largest part of the researched area can be characterized as an area with preserved naturalness. As much as 65.76% of the researched area is forests and pastures, while a small portion (0.28%) is rivers and wetlands (Fig. 12 and 13).

Forests areas in the northeast and east as well as partially in the south part of the researched area, especially the inaccessible parts of the Osogovo and Maleshevski Planini Mountains as well as Vlaina and Plachkovica Mountains, are mainly used for collecting forests products and tourist activity as well as for collecting firewood, mostly by the forestry associations. On the other side, forest areas in the south, southwest and northwest part of the research area (mountains Serta, Smrdhes, Mangovica and Gradishtanska) are more accessible and thus are more intensively used by the people (collecting forest products, firewood and partially for recreation). Additionally, large part of the current forest and scrubland areas in this part of the researched are for formerly used as pastures and so the degree of forest degradation has always been more noticeable (Fig. 12 and 13).

Pastures cover 13.60% of the researched area and most of them are hilly pastures. This type of pasture is mostly present in the north and northwest part of the researched area (Mangovica, Kuchukol, Bogoslovec and Slan Dol). Large areas under pastures are also noticed in the southern and partially western slopes of Osogovo, Maleshevo and norther slopes of Plachkovica (Fig. 13).

As a result of the ongoing migration process (village to town) which started in the second half of the past century (State Statistical Office, 2012), the intensity with which pastures are used is significantly lower and continues to drop (Jovanovska & Melovski 2013). Thus, the decrease of agricultural practices (farming) leads to abandonment of surfaces used as pastures which leads to successive shrub encroachment. Traditional farming practices have a special role in nurturing secondary anthropogenic habitats which are significant for the preservation of biodiversity. Hence, in order to preserve these traditional practises of land use the region will have to support and create management policies in order to retain the traditional farming practices.

Table 4. Overview of land use in the researched area

Land use categories	Surface (ha)
NATURAL	
Forests and scrubland	
Coniferous forests	7709.05
Deciduous forests	134181.36
Mixed forests	15442.59
Planted forests	11215.87
Scrubland	73431.41
Pastures	
Pastures	36120.57
Pastures with scrubland	18319.86
Mountain scrubland	5123.73
Rocks	3834.77
Wetlands	
Swamps	96.84
Rivers	302.05
Sand	886.40
ANTHROPOGENIC	
Agricultural land	
Arable land	106927.21
Meadows	32471.16
Vineyards	3991.98
Orchards	3013.98
Rice fields	5753.48
Settlements	
Construction land (tall buildings)	28.88
Construction land (low buildings)	4504.32
Parks	30.82
State institutions	81.08
Public facilities	14.32
Medical centre	18.20
School	89.68
Bus station	4.19
Railway station	17.87
Airport	15.52
Water accumulations	
Lake	926.33
Fishpond	6.11
Artificial	
Archaeological sites	12.38
Religious sites	196.87
Historic sites	0.75
Industrials zones	761.35
Mines	533.99
Depots	48.31
Quarries	110.50
Clay	4.05
Dump sites	97.14
Border crossings	1.71
Unknown	2.49
Total	**466329.16**

High-altitude pastures cover a very small part of the researched area and are characteristic for the highest parts of Osogovo (Kalin Kamen, Sultan Tepe and Ruen), Valina (Kadiica) and Maleshevo (Chengino Kale).

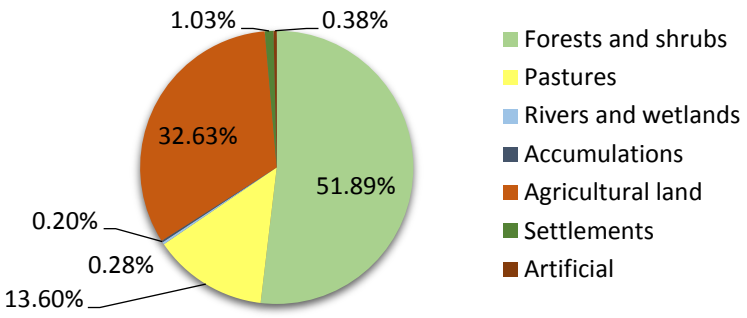


Figure 12- Land use in research area

High-altitude pastures on Vlaina Mt.

Human presence in the area of interest is most prominent along the larger rivers, dominantly along Bregalnica. Here the largest part of the area is used as agricultural land. The agricultural land takes up 32.63% and is mostly extensively or traditionally managed, while most of the arable land and fields are relatively small in surface. This type of land use is more prevalent at the edges of the large plains in the low part of the mountain slopes.

Extensive agricultural production at Stamer

Larger intensively framed fields with cereals, most commonly wheat, oats, barley and rye can be noticed in Ovche Pole, while the main characteristic of Kochani and partially the Shtip are the rice fields. Agricultural land is mostly in the form of fields (70.27%), while a significant part is also meadows (21.34%) and rice fields (3.78%). Long-abandoned arable lands are now mostly embedded with deciduous communities, shrubs and rare low oak trees.

Intensive agriculture in Ovche Pole

The Bregalnica watershed has many populated settlements. However, they take up an insignificant amount of land in the research area (1.03%). With the exception of the villages in the norther part of the watershed, most of the villages are compact by type. The research area has several larger settlements – towns: Berovo, Delchevo, Makedonska Kamenica, Vinica, Kochani, Zletovo, Probishtip, Shtip and Sveti Nikole. According to the last census (SSO, 2002) giving the number of inhabitants (from 8.110 to 20.000 inhabitants) the towns in the research area belong to the group of small towns. Urban features are best represented in the towns of Kochani and Shtip.

Rice Fields in Kochani

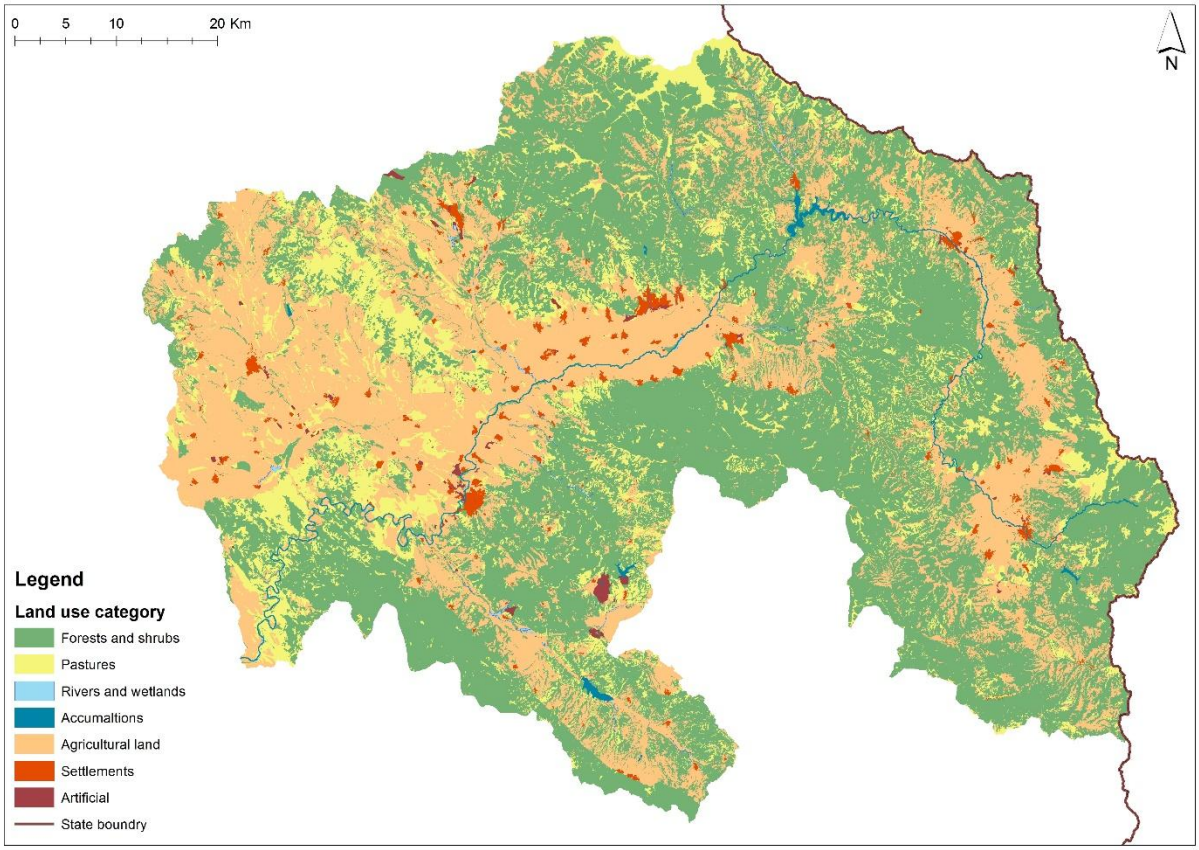


Fig. 13. Visual representation of land use in the research area

5 Ecosystem Services

The area of the Bregalnica watershed by geographic range is similar to the East Region. According to statistics from the annual demographic estimates, the total population in the investigated area in 2012 was about 203.000 residents. Compared to other regions, the East region features the largest area of forest land and is the third region by area used as agricultural land.

Research that encompasses the concept of ecosystem services was intended to reflect the relationship of the population in this part of Macedonia with nature and the benefits they have from the ecosystems. The results are a good basis for a better understanding of the socio-economic situation in the region which will contribute to a better and comprehensive preparation of future development plans. The applied concept of ecosystem services as a contribution to this project follows the world trends which bring us closer in intercepting different targets or actions set by international conventions and strategies.

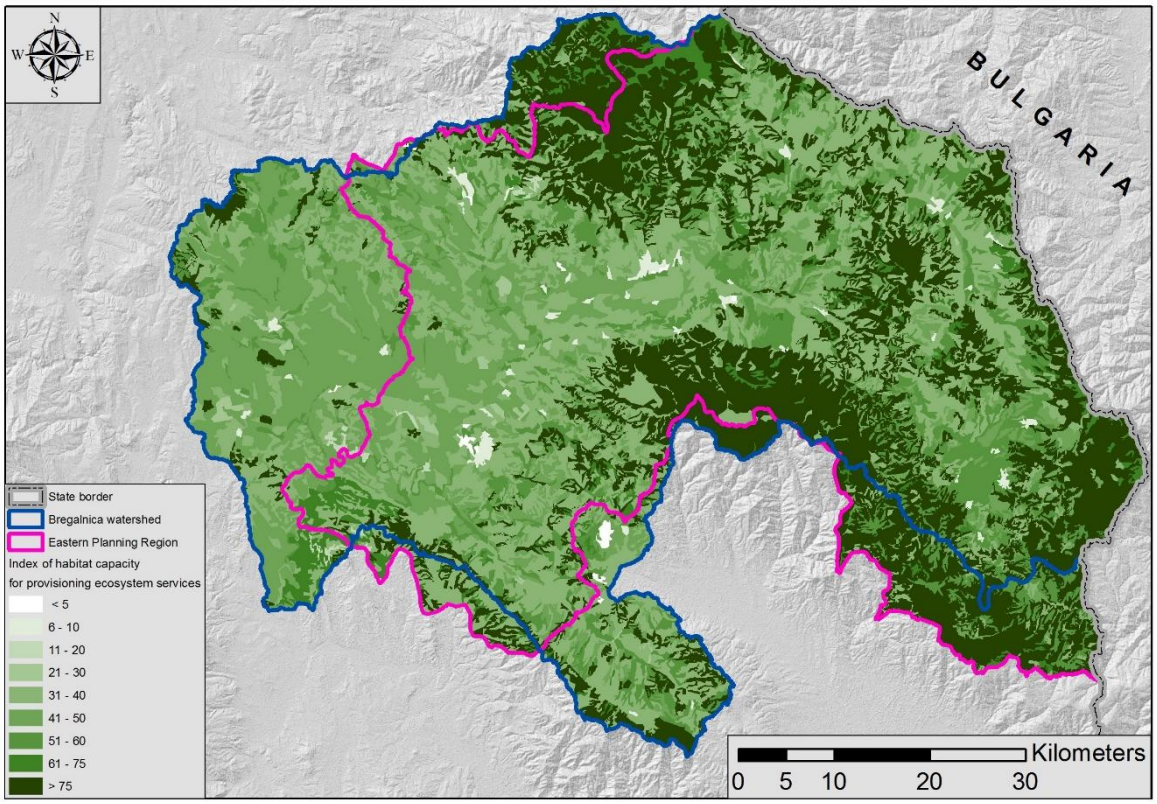


Fig. 14. Ecosystem services capacities from the Bregalnica watershed.

The assessment of ecosystem services was performed by using the method of mapping and non-monetary (social) valuation of ecosystem services. Using quantitative and qualitative data combined with land cover allows observation of land use and the impact of human activities on landscapes. Initial analysis for determining the capacity limits of the investigated area are made using GIS tool. Data from CORINE Land Cover (CLC) level 3 have been used as a starting point for mapping the capacity to provide ecosystem services.

According to the model, broadleaf and mixed forests have a very high potential to support biodiversity as confirmed by the presence of certain species, functional groups of species or species composition (Fig. 14). Other classes of land cover (CLC), such as natural grasslands, scrublands, waterways and water bodies, sclerophyllous vegetation, coniferous forests have also a high potential

and are important for biodiversity conservation. Woodlands and farmland that occupy much of Bregalnica watershed are located in the middle of the scale according to the capacity of providing ecosystem services.

Using the same model, it was also calculated what is the demand for ecosystem services in the research area (Fig. 15). The results show that the requirements for ecosystem services are highest in land covers where human activities dominate. The highest values of the demand can be found in urban, industrial, commercial and plain areas with various crops. In the vicinity of natural land cover types that are generally fewer people and less human activities, consequently have lower rates of demand for ecosystem services. Agricultural land cover types show typical high demands on the regulating and provisioning ecosystem services. The difference of capacity and demand for ecosystem services provides balance. According to the model applied to Bregalnica watershed, there is a clear lack of ecosystem services in land cover types dominated by humans, especially in urban and industrial areas. Land cover types that are wild, natural and unpopulated particularly high mountain areas are characterized by an enormous capacity to supply ecosystem services exceeding the demand.

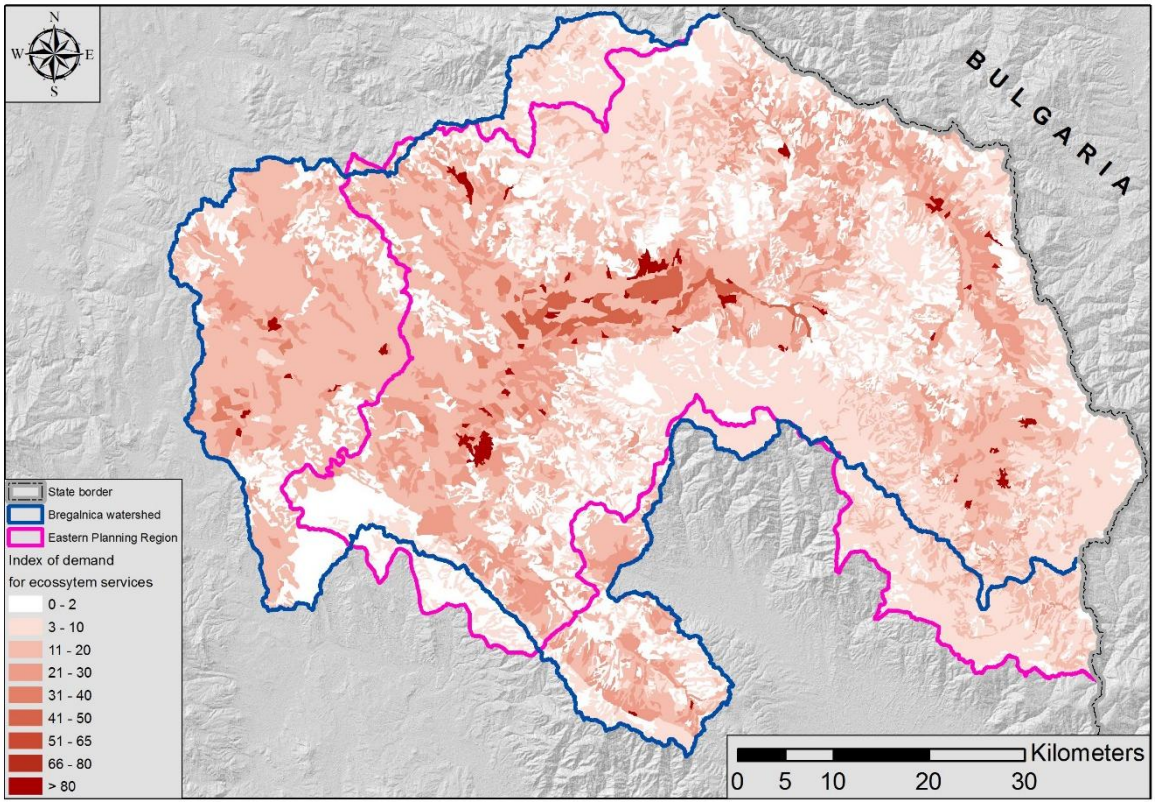


Fig. 15. Demand for ecosystem services in the Bregalnica watershed.

Besides applying an already developed model to assess the capacity and demand for ecosystem services, additional research was done by including part of the population within Bregalnica watershed. For this purpose one of the methods for valuation of previously selected ecosystems and ecosystem services was used. Maleshevo and Pijanec were selected as a pilot areas for this part of the research. A questionnaire was used as a tool for non-monetary valuation of ecosystems and ecosystem services which covered 257 respondents from all populated places of the pilot area. The results show that for most of the respondents the forest ecosystem is the most valuable in many ways such as, economic benefit (selling firewood), clean air or suppliers of firewood (Fig. 16). Respondents from Maleshevo part find the forest ecosystems more valuable compared to those of Pijanec part for which agricultural ecosystems and water bodies are more important. Wood, medicinal and aromatic plants and water are the most used provisioning

ecosystem services (Fig. 17). According to the respondents, non-timber forest products and the opportunity for recreation in nature are the second preferred group of ecosystem services. The firewood is usually supplied through collection from private or state forest or through purchase. According to the survey, the population from Maleshevo part mostly gather firewood from its own private or state forests, whereas residents of Pijanec mostly buy the firewood. The general perception of forests as ecosystems is that they are quite changed from a few years ago (in the questionnaire this time was limited to 30-50 years ago). Commonly cited reason that significantly stands apart from the others mentioned was uncontrolled logging (disorder - as it was named by the respondents themselves). The respondents are familiar with the regulating ecosystem services provided from forest ecosystems. The role of forests in regulating climate and erosion are very well known among the inhabitants whereas the services such as contribution of forests in the process of water cycle in nature were less known. The questionnaire listed a wide range of cultural services, such as sense of place, recreation, the opportunity to develop alternative forms of tourism and so on. Despite the various problems the population of the pilot area is facing with, they have a high opinion of their place of residence and highly appreciate their homeland. Most agree that the region has the potential and is rich in natural and cultural landmarks that can be used for future development of this part of Macedonia. Maleshevo part is ahead when comes to tourism development compared to Pijanec part. This fact has influenced the answers given by the residents of the Municipality of Delcevo, who much less believe tourism can be developed in Pijanec, regardless of the potential. This explains the results from the agreement of the residents to start an alternative form of tourism, where again respondents from Maleshevo part are more ready to take this step unlike the residents of Pijanec.

In this study a selective list of ecosystem services was used for a pilot area which includes locally relevant ecosystems and ecosystem services. The local interpretation of the concept of ecosystem services was analysed. Personal view of the researchers involved in the survey is that the local population takes ecosystem services "for granted" until they experience a significant deterioration in their quantity or quality. Such examples of research are forest ecosystems and river Bregalnica along with its side tributaries.

However, as absurd it may sound, deterioration in the quality or quantity of certain ecosystem services leads to greater awareness for their protection. Rare or endangered ecosystem services are considered more precious gifts of nature, i.e. benefits that can be enjoyed for free if the ecosystem is functioning and they cannot be replaced by others if the functionality of the ecosystem is disrupted. The local population is aware of these problems and seek ways and implement measures to prevent the already felt present negative effects on their well-being. This is a typical situation of anthropological interpretation of the benefits of ecosystems or certain benefits from nature we feel after we have realized that there is a real chance to lose them.

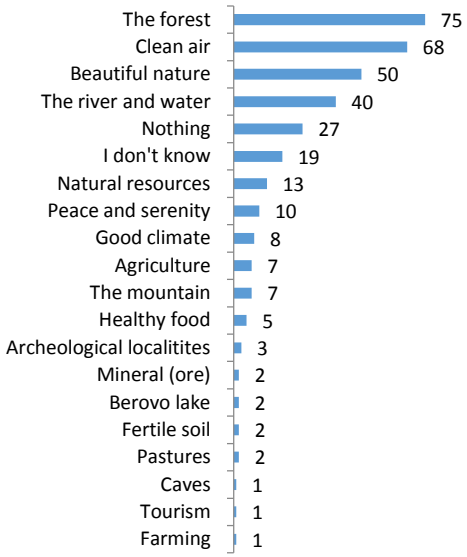


Fig. 16. Answeres from inhabitants to the open-ended question: "According to you, which are the biggest/most valuable natural attributes in the region"

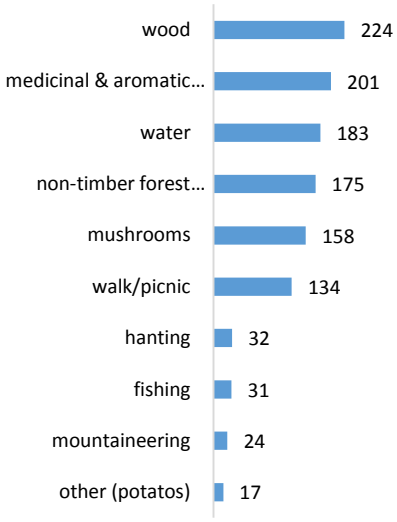


Fig. 17. Ecosystem Services used in the pilot area

Honey production is a significant source of income for people in the rural environments

6 Forests and Forestry

6.1 Forest associations

A difference in landscapes, soil types, climate and hydrological conditions has determined the rich forest diversity in Bregalnica watershed (Fig. 18).

In the lowest parts of the area, most of the forests in the past has been degraded and converted in the agricultural lands and secondary hill pastures. Those low parts are the driest areas with the pronounced dominance of the xero-thermophilic vegetation. In those parts, as well as in the low-lands and low hills, according to the climate conditions the forest association of *Phyllireo-Carpinetum orientalis* = ass. *Querco-Carpineum orientalis macedonicum,* is taking place. This association can be found in the lower part of the Bregalnica area and its tributaries up to 600 m. and in the warmer exposition, can be found even higher.

In the eastern and north-eastern parts of the area, at the latitudes of 400 m.s.l. to 600 m.s.l., at some parts up to 1100 m.s.l. (Spikovo, Pehchevo), according to the climate conditions, the forest association *Quercetum frainetto-cerris macedonicum* can be found. The dominant types are *Quercus frainetto* and *Quercus cerris*, however, other, mainly thermophiles types can be found. Characteristic of this forest association is the presence of the autochthonous species from the wild fruits flora (apples, pears, cherries, etc.). In specific parts at the lower altitudes where this forest association can be found, presence of the sub Mediterranean species can be noticed, those species are denoted as subspecies *Carpinetosum orientalis*, and in the upper parts, and species typical for the oak forest belt can be found. Due to the fire wood usage of this association, it undergoes to regressive succession therefore the forests from generative origin are converted in forests with vegetative origin. At some places the forests have been foraging and brought at high level of degradation, moreover, at specific places are forests area were converted in hilly pastures. At recent time, the decrease of the cattle farming and abandonment of the agricultural practices in the hilly-mountain areas followed by decrease at the use of pastures and meadows led to natural successive groth of the black and the silver fir in this association. This is characteristic for the Malesh and Pijanec area.

At higher altitudes, mainly between 900-1100 m, at some south facing expositions up to 1300 m, the forest association *Orno-Quercetum petraeae* can be found. This association follows the association of *Orno-Quercetum petraeae* established in the lower vegetation belt*,* and occupies the lower mountain part of Obozna, Plachkovica, Goten and Osogovo Mountain. At the warmer exposition and lower terrain in this forest association, the subass *carpinetosum* with the significant presence of thermophiles elements can be found. In this forest belt some non-zonal, respectively, orographic-edaphic determinate associations such as: ass. *Querco-carpinetum betuli macedonicum* in the higher parts on deeper shadow terrains with increased air moisture and ass. *Orno-Quercetum cerris* on south facing terrains can be found. Parts of this forest association which are situated on more flat and deeper soils have been exploited and converted in agricultural lands. Therefore in the parts where the terrain is more accecible larger part of the forests are from vegetative origin, and more preserved are the forests which are further from the populated areas and on less accessible terrains.

Highstemmed beech forest on Maleshevski Mountain

Above the forest association *Orno-Quercetum petraeae* in altitude gradient sense, the beech forest belt connects at the altitude between 1100 m.s.l. and 1650 m.s.l. In the lowest part of this belt, between 1100 and 1300 m.s.l., the established association according to the climate is *Festuco heterophyllae-Fagetum* Em, which at some north facing areas can be found lower down in the beech forest belt. At specific lower and more accessible parts the ass. *Festuco heterophyllae-Fagetum* Em, has been overexploit or converted in pastures therefore common juniper, fern, and other species can be found due to the forest re-establish in the area. At the higher parts, quality beech forests and mixed forests with black and white fir can be found. In the Malesh region at an altitude of 1100 m to 1300 m azonal the ass. *Fagetum submontanum pinetosum nigrae* and ass. *Fagetum submontanum pinetosum silvestris* at altitude of 1100 to 1400 m. can be found. Mainly these associations are mesophilic and neutrophilic, however acidophilic beech forests especially in the Osogovo, Malesh and Pijanec region, can be found as well.

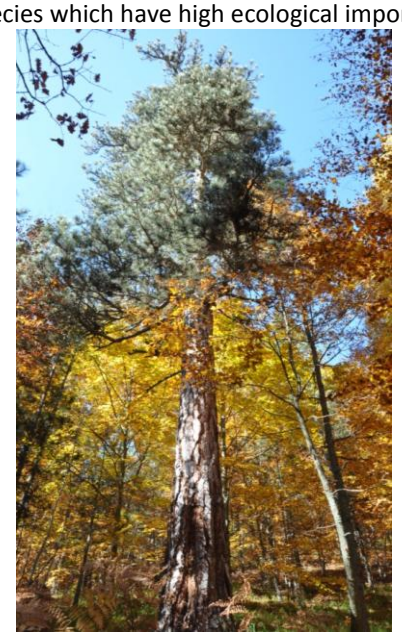
Beech forest in the Zrnovska River valley
Beech trees have specific features due to the branch and leaf use as livestock food.

At the upper part of the beech forest belt from 1300 to 1650 m.s.l. according to the climate the ass. *Calamintho grandiflorae-Fagetum* Em is widespread. It is typical mesophilic association in which the beech is dominant species. Beside the beech, in this forest belt are: acidophilic beech forests (ass. *Luzulo-fagetum macedonicum*), as well as mixed beech-fir forests represented with the associations: ass. *Fago-Pinetum silvestris* on seconday habitats, which can be found in the Malesh region at cold northern exposition at an altitude of 1400 to 1800 m, ass. *Fagetum montanum pinetosum nigrae,* which can be found at the altitude of 1050 to 1450 m; ass. *Fagetum montanum pinetosum silvestris* which can be found in Malesh region at altitude of 1300 to 1700 m; ass. *Fago-Pinetum nigrae* which can be found at Malesh and Plachkovica Mountain at an altitude of 860 to 1725 m; ass. *Pinetum silvestris* which can be found at Plachkovica and in the Malesh region at an altitude of 900-1350 m and ass. *Pinetum silvestris-nigrae* which can be found in Malesh region above the belt of beech forests. Beside the natural forests with black and white fir, in Maleshevo area and the region at many localities, artificial plantations from the aforementioned species have been forested.

Old beech forest at Trebomirski Potok

The best preserved and the best quality forests in the region can be found in the beech forest belt. With special forest value and importance are the virgin and unmanaged beech forests, mixed forest from beech-black pine, beech-white pine, black pine-white pine, enclaves from highforest oak stands, as well as parts from the old ancient trees.

From above stated, it can be concluded that forest associations consisting of 2 or more different tree species which have high ecological importance can be found in the area of interest:



Mixed beech-black pine forest at locality Kartal at Plachkovica

From 860 to 1725 m is ass. *Fago-Pinetum nigrae* Em
From 1400 to 1800 m is ass. *Fago-Pinetum silvestris* Ht et Em
From 1100 to 1300 m azonal is ass. *Fagetum submontanum* Em *pinetosum nigrae* Riz-Dzek (in region of Malesh and Pijanec)
From 1100 to 1400 m develops the ass. *Fagetum submontanum pinetosum silvestris* Em (in region of Malesh and Pijanec)
At altitude of 1050 to 1450 m is ass. *Fagetum montanum pinetosum nigrae* Em (in region of Malesh and Pijanec)
At altitude of 1300 to 1700 m develops the ass. *Fagetum montanum pinetosum silvestris* Em (in the Malesh region)
At altitude of 900 to 1725 m, is ass. *Pinetum silvestris-nigrae* Em (at Malesh region – watersheds of Ratevska River, Zmajanica and Ravna Reka as well as on Plachkovica Mt.)
At altitude of 900 to 1350 m, is forest association of black fir on silicate base represented with the ass. *Pinetum silvestris-nigrae macedonicum* Em (region of Malesh and Pijanec)

At altitude of 1250 to 1400 m, one can find the mixed stand from *Abies borisii-regis, Fagus moesiaca, Pinus sylvestris and Picea excelsa* (Maleshevski Mountain – locality Murite) that has high natural value and it is designated as monument of nature;

With exceptional value are the rare and relict forest associations with special ecological values:

- Between 600 and 700 m.s.l. the ass. *Juglando-Tilietum tomentosae* (in the Zletovska River, above Zletovo) can be found. In this association besides *Juglans regia* and *Tilia tomentosa* other interesting species can also be found, such as: *Ostrya carpinifolia, Tilia officinarum, Corylus colurna, Acer intermedium, Malus florentina, Geranium macrorrhizum, Asplenium adianthum-nigrum,* etc.
- ass. *Fago-Aceretum heldreichi* (Makedonska Kamenica) – is located at the locality Crvena River, on the area of 10 ha and it represents natural reserve of mountain maple *(Acer heldreichii*);
- ass. *Bruckenthalio-Myrtillo-Fagetum* is located in the upper watershed area of Zrnovska River and north faced slopes. Beech forests in this association have acidophilic character, and where the soil is washed out, the beech is aberrant, and still *Bruckenthalia spiculifolia,* a species that grows at headlands is present. Species like *Hypericum rhodopaeum, Deschampisa flexuosa, Calamagrostis arundinacca* are also present. At steep areas where the soil is not washed out, there are stands of *Betula pendula* and *Populus tremula.*
- ass. *Altherboso-Alnetum glutinosae* Em (at specific parts next to the river flow of Bregalnica, preserved parts of alder - *Alnus glutinosa* can be found*)* – high ecological and conservational value;
- ass*. Salicetum albae-fragilis* – riparian forests of aspen and willow (Bregalnica watershed, Orizarska River and other areas) – high ecological and conservational value;
- *ass. Colurno-Ostryetum carpinifoliae* Bleč. 57 (Osogovo Mountain) – relict association with high natural and ecological importance;
- *ass. Querco–Ostryetum carpinifoliae* (Ht. 1938) – (Osogovo Mountain) – relict association with high natural and ecological importance.

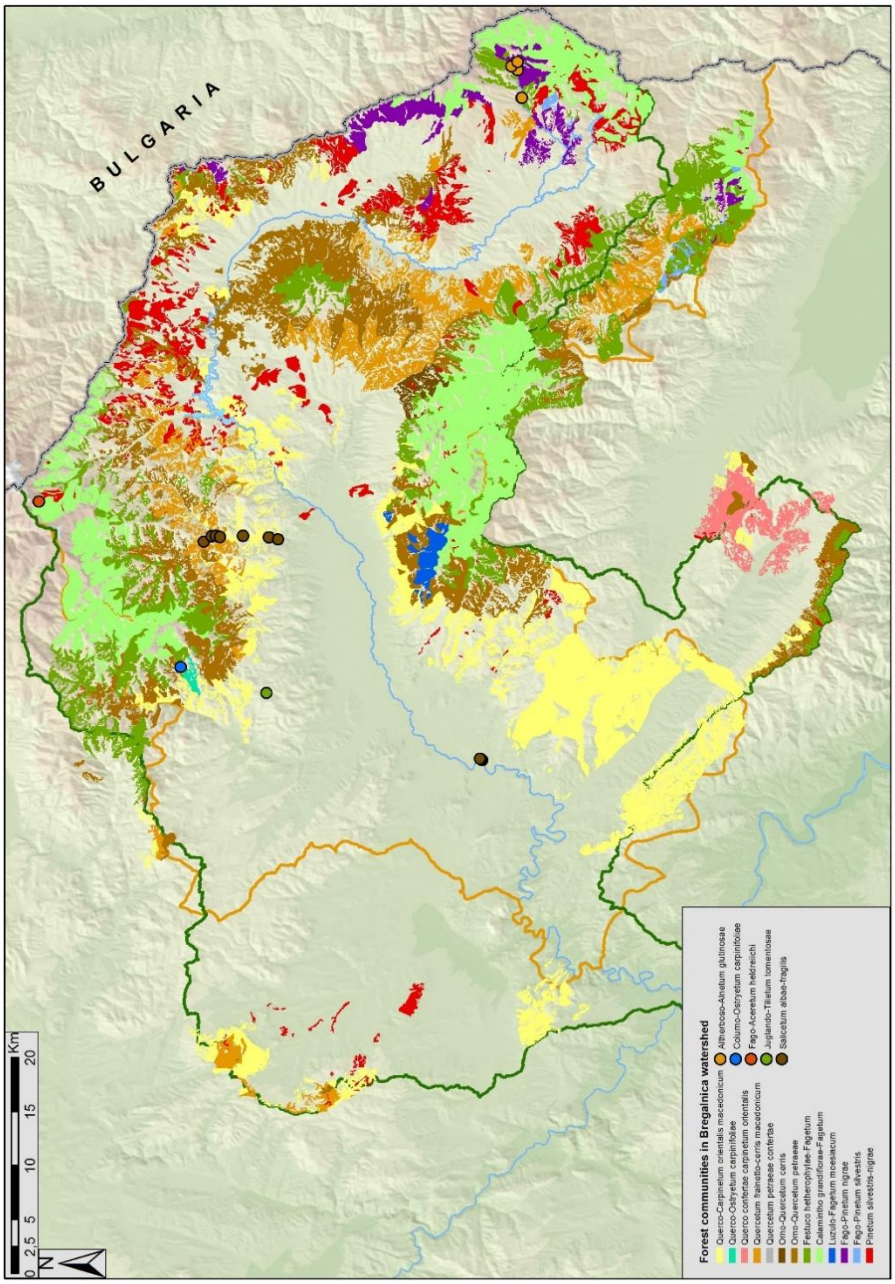


Fig. 18. Recorded forest associations at Bregalnica watershed

***Bruckenthalio-Myrtillo-Fagetum* in the valley for Eden Dere in the upper watershed of Zrnovska River (Plachkovica)**

6.2 Forestry

The largest part of the forests in the area of interest is subject to active management from the Public Enterprise "Macedonian Forests", through their local subsidiaries. In the frame of EPS, there are 29 forest management units. Within the river Bregalnica watershed there are 31 forest management units from which 2 are only partialy in the watershed. Five (5) forest management units which belong to EPR do not belong within the Bregalnica watershed, 7 forest management units which belong to Bregalnica watershed which are administratively managed by subsidiaries that are based in cities which do not belong to East Planning Region.

Total forest area which is covered with forest management units and subsidiaries within administrative headquarters in East Planning Region is estimated to 148031 ha, from which 123854 ha or 84% are covered with forests. In forests the concentration of timber is 16658050m³ or 134.5 m³/ha. The annual growth is 322891 m³ or 2.6 m³/ha. Total forest area which is covered with forest management units, managed by subsidiaries with administrative headquarters outside of East Planning Region, however gravitate towards Bregalnica River is 30143ha, from which 26193ha or 87% are covered with forests. In the forests the concentration of timber is 2131316m³ or 81.4m³/ha. Annual growth is 54387 m³ or 2.1 m³/ha. Total forest area covered with forest management units which are managed by subsidiaries with administrative headquarters in and outside of East Planning Region, however gravitate towards Bregalnica River (not taking into consideration those units which are gravitating in others watersheds) is 155065 ha, from which 131418 ha or 85% are covered with forests. In the forests the timber concentration is 15583869 m³ or 118.6 m³/ha. Annual growth is 321382 m³ or 2.4 m³/ha.

The highest timber quantity per area has the Maleshevski Planini forest management unit -I with 377.3 m³/ha, than Maleshevski Mountains-II -Ratevska River with 272.5 m³/ha, than Plachkovica –II with 257.7 m³/ha followed by Plachkovica –I with 234.2 m³/ha etc. The following forest management units are with lowest timber quantity per area are: Ilandza 15.5 m³/ha, the part of the forest management unit Smrdeshnik in Bregalnica watershed with 23.4 m³/ha, Kalimanci with 33.1 m³/ha, Serta-Pochivalo with 33.1 m³/ha, etc.

Old beech at Osogovo (Mrtvica)

Black pine at Maleshevski Mountain (Ramna River)

The difference between total area (155065 ha) and the one with forest cover (131418 ha) determinate the forest land, which according to the Forestry Legislation (Official Gazette of R. Macedonia No. 64/09) is a land on which there is forest or land which according to its natural characteristics is the most suitable for forest growth as well as land on which there are objects for forest management.

In the forests on Bregalnica watershed there are numerous forest tree types such as: *Fagus moesiaca*, *Pinus nigra, Pinus silvestris, Quercus petreae, Quercus frainetto, Quercus pubescens, Quercus cerris, Carpinus orintalis, Populus tremula, Ostrya carpinifolia, Carpinus betulus, Betula verucosa, Tilia cordata, etc.* Besides these, some foreign species have been introduced in the past decades. Such are: *Pseudotsuga mensiesii*, *Picea abies*, *Abies alba*, *Robinia pseudoacacia*, *Cupresus arizonica*, *Larix europea* and others. The most common tree species is the Beech with 30.95%, followed by: Sessile Oak 20.27%, Black Pine 13.6%, Italian Oak 11.82%, Pubescent Oak 11.75% and Hornbeam 5.53%. Other species have significantly smaller shares (Fig. 19a).

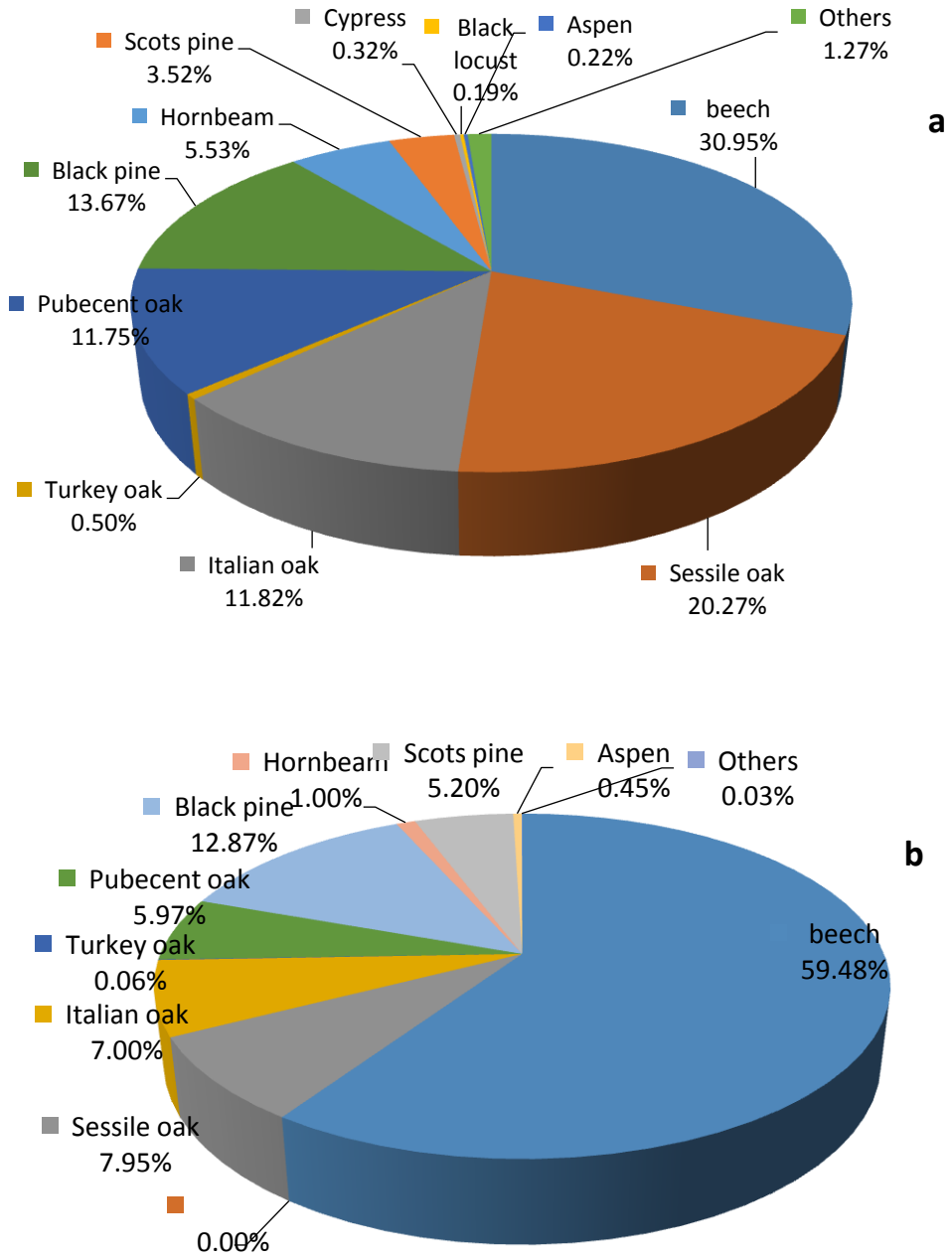


Fig. 19. Land allocation (a) and wood pulp quantity (b) according to tree species

According to the **growing shape** 61634 ha or 47% are highforests, 68244 ha or 52% are from vegetative origin, 1540 ha or 1% are forest cultures. Besides evergreen species, with higher share in highforest stands is beech, which in the higher parts, over 1250 m.s.l. is from generative origin and creates high quality highforest stands. Due to the traditional practices of foraging, clear cuts etc. practised in the oak forest belt in the Bregalnica watershed, the biggest part of the oak forests are with vegetative origin or they are with generative origin with some extend of degradation. It should be mentioned that higher number of areas in the watershed are forested artificially with forest cultures but since those trees has passed the growth age of 20 years they can be considered as artificial forests stand and noted as highforests.

There is a remarkably high share of the forests from vegetative origin (52%) which is the consequence of the forestry practices in the past. Therefore, in the future, measures for more intensive growing management and forest care should be undertaken, aiming towards improving the forest structure and transforming vegetative into highforest stands.

According to the **management**, 39202 ha or 30% are highforest even age forests, 23972 ha or 18% are high uneven age forests, and 68244 ha or 52% are coppice stands. Taking into account that coppice management over long time horizon has negative influence to overall natural and other conditions, in the future this type of management should not be practiced and should be replaced with other management practices. Besides, measures and activities should be undertaken for conversion of the vegetative origin stands into stands with generative origin. This will result in significantly enhanced quality structure of the forests, thereby all other forest functions; therefore permanent sustainable management will be applied.

Foraging oaks at Obozna

According to the **type** 62% or 81269 ha are pure stands, 38% or 50149 ha are mix stands. From the pure stands 83% or (67108 ha) are broadleaved species, 17% or 14161 ha are evergreen. From the mixed stands 66% or (33334 ha) are mixed broadleaved species, 27% or 13499 ha are mixed broadleaved and evergreen species, 7% or 3316 ha are mixed evergreen species.

The largest **tree mass** is concentrated in the Beech 9290441m³, and it covers 59.61% of the total mass in the Bregalnica watershed. The second one is the Black Pine with 2148891 m³ or 13.79%, Sessile Oak 1712640 m³ or 10.99% and Italian Oak 942707 m³ or 6.05%. Other species have less than 5% share.

The current growth of timber is concentrated in the Beech and it amounts to 157218 m³ or 48,92% of the total timber growth in the Bregalnica watershed, followed by Black Pine 64909 m³ or 20,20%, Sessile Oak 35311 m³ or 10,99% , Scots Pine 19492 m³ or 6,07% and Italian Oak 16962 m³ or 5,28%.

The largest share of the **wood pulp** is again from Beech 59.48%, followed by Black Pine 12.87%, Sessile Oak 7.95%, Italian Oak 7.00%, Pubescent Oak 5.97% and Scots Pine 5.20% (Fig. 19.b).

The biggest share of wood pulp quantity is from the beech 59.48%, followed by black pine 12.87%. Of the high importance for the wood pulp quantity are the beech trees followed by the black and white pine since these species are raw materials for the wood industry. The wood pulp quantity which is produced by oak and partly from beech and other species is mainly used as firewood due to the low stands quality of these species and some inadequate forest management practices in the past.

According to **assortment** structure, the biggest share from the annual forest production is 94772 m³ or 48% firewood, 81517 m³ or 41% is raw material, whereby 22980 m³ or 11% is waste.

Open canopy forests is present in the regions where the forest is in good condition in Kochani, Pehchevo, Berovo and Vinica and it estimated to be (7,6-12,1 km/ km^2), whereby in the regions with degraded forest (Sveti Nikole, Delchevo and Shtip) the open forest canopy is estimated (<6 km/ km^2).

There are 37 facilities that have the **capacity for primary wood processing** and their processing capacity is 500-20000 m³, from which mainly in Berovo and Pehchevo, and the biggest is Mebel-Trade Vinica. It should be stressed that in the region around 20 sawmills are present but they all are in the stage of closing. Taking into the account the high accumulative as well as the total wood pulp quantity from raw wood in the Bregalnica watershed (which is estimated to be 81 500 m³) it can be concluded that there is insufficient raw wood – logs for primary processing. This insufficiency for permanent level for capacities for primary processing is estimated to be 30 000m³ logs and this insufficiency is currently being suplemented with import from other countries or from another regions in Macedonia.

7 Hunting and fishing

7.1 Hunting

All activities related with breeding, protection and use of game and its parts are regulated with the Low for hunting ("Official Gazette of the RM ", no. 26/09, 82/09, 136/11, 1/12, 69/13, 164/13 and 187/13"). The government of RM in accordance with the Spatial Plan of RM establishes hunting grounds (HG) and determines their boundaries, area and purpose. According to its purpose, the hunting grounds are divided into hunting grounds for large and small game. The government, through Public Competition gives rights for use of the game in the hunting grounds – as concessions, of home and foreign legal entities, registered for hunting activities. Usage - concessions of large game is given for a period of 20 years, while small game concessions for a period of 10 years. For each hunting ground, a Special hunting economic basis with terms of 10 years that regulates the breeding, reproduction, protection, hunting and use of game and its parts is adopted and approved by the Minister of Agriculture, Forestry and Water Economy.

In the Bregalnica River Basin there are 46 hunting grounds established (Tab. 1), of which 19 for large and 27 for small game. The hunting grounds cover area of one or two municipalities. In the municipalities of Bregalnica, there are: 6 hunting grounds in Berovo and Pehcevo; 7 in Delchevo and Makedonska Kamenica; 7 in Zrnovci, Karbinci and Kochani; 4 in Vinica; 4 in Probishtip; 10 in Cheshinovo-Obleshevo and Shtip; 8 in Sveti Nikole and Lozovo. All these hunting grounds are covered with 3 hunting management areas: Bregalnica (municipalities Shtip, Karbinci, Probishtip, Zletovo, Cheshinovo - Obleshevo, Kochani, Zrnovci and Vinica), Vlainsko-Maleshevska area (municipalities Berovo, Pehcevo, Delchevo and Makedonska Kamenica) and Middle Vardar area (municipalities Sveti Nikole and Lozovo).

Table 5. Overview of hunting grounds in Bregalnica Basin

Number	Name of Hunting Ground	Town	Purpose
1	Saraevo	Berovo	Large game
2	Ratevska River	Berovo	Large game
3	Palazlija	Berovo	Large game
4	Dzami Tepe	Berovo	Large game
5	Machevo	Berovo	Small game
6	Chiflik	Berovo	Small game
7	Polaki	Kochani	Large game
8	Glavovica	Kochani	Large game
9	Zrnovska River	Kochani	Large game
10	Sokolarci	Kochani	Small game
11	Banja	Kochani	Small game
12	Podlog	Kochani	Small game
13	Polaki	Kochani	Large game
14	Gradeshka River	Vinica	Large game
15	Osojnica	Vinica	Large game
16	Dragobrashte	Vinica	Small game
17	Vinica	Vinica	Small game
18	Stanjevci	Sveti Nikole	Large game
19	Sopot	Sveti Nikole	Small game
20	Orel	Sveti Nikole	Small game
21	Mechkuevci	Sveti Nikole	Small game
22	Erdzelija	Sveti Nikole	Small game
23	Bogoslovec	Sveti Nikole	Small game
24	Kishino	Sveti Nikole	Small game
25	Dzumajlija	Sveti Nikole	Small game

Number	Name of Hunting Ground	Town	Purpose
26	Shtalkovica	Probishtip	Large game
27	Dobrevo	Probishtip	Small game
28	Drenok	Probishtip	Small game
29	Gajranci	Probishtip	Small game
30	Vrteshka	Shtip	Large game
31	Konechko	Shtip	Large game
32	Kozjak	Shtip	Large game
33	Gaber	Shtip	Small game
34	Lipov Dol	Shtip	Small game
35	Leskovica	Shtip	Small game
36	Dragoevo	Shtip	Small game
37	Creshka	Shtip	Small game
38	Krivi Dol	Shtip	Small game
39	Balvan	Shtip	Small game
40	Kamenica	Delchevo	Large game
41	Vlaina	Delchevo	Large game
42	Golak	Delchevo	Large game
43	Bigla	Delchevo	Large game
44	Vratislavci	Delchevo	Small game
45	Kiselica	Delchevo	Small game
46	Trebotivishte	Delchevo	Small game

According to the data from the State Statistical Office (SSO) (2015), for 2014 in the Eastern Planning region, only rabbits (small game) and wild boar (large game) were shut. Also, 8 species of birds were shut (Fig. 20).

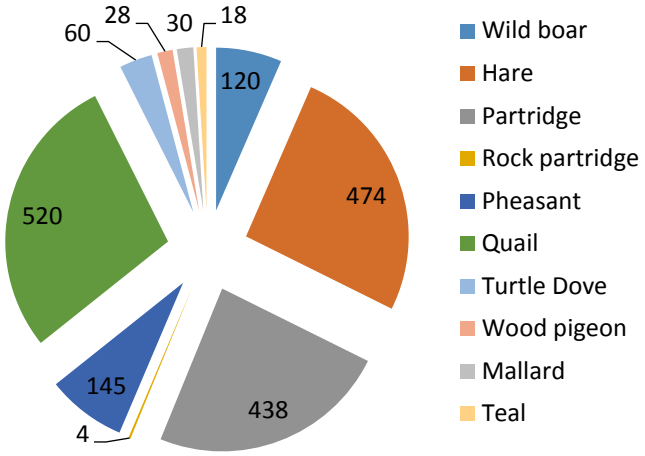


Fig. 20. Overview of game shot in 2014 in the East Planning Region (SSO, 2015)

7.2 Fishing

The management of the fishing waters in the Bregalnica River Basin is regulated with the Law for Fisheries and Aquaculture (Official Gazette of RM 07/2008, 67/2010, 47/2011 and 53/2011). According to the Law, for each fishing water, used for fishing, a fishing basis for a period of 6 years that is approved by the Minister of Agriculture, Forestry and Water Economy is prepared. Furthermore, in accordance with each fishing basis, Annual Plan for protection and management of fish is prepared and submitted to the Ministry of Agriculture, Forestry and Water Economy by the concessionaire.

According the adopted fishing basis for the fishing water "Bregalnica River Basin" for the period 2011-2016 (Official Gazette 66/2011; 35/2015), the fishing basis includes Bregalnica river, from the

spring to the estuary into the river Vardar, all its tributaries, lakes Kalimanci, Gratche, Mavrovica, Lake Ratevsko, the waters from hydrothermal systems of Shtip and Kochani thermal water, and all small micro-accumulations in the territory of the Basin. According to this fishing basis, the fishing waters in the River Bregalnica Basin are determined by the following fishing zones:

- Fishing zone "Bregalnica 1"- covers part of Bregalnica River, from the springs to village Razlovci, including all the tributaries along this part of the river. The concession of this fishing zone is held by Association of sport fishers (ASF) "Ablanica" – Berovo.
- Fishing zone "Bregalnica 2"- covers part of Bregalnica River, from village Razlovci to the estuary in the accumulation "Kalimanci", including all tributaries in this part of the river. This fishing zone has no concessioner.
- Fishing zone "Bregalnica 3"- covers part of Bregalnica River, from the accumulation "Kalimanci", to village Istibanja, including all tributaries in this part of the river. This fishing zone has no concessioner.
- "Fishing zone "Bregalnica 4"- covers part of Bregalnica River from village Istibanja to the estuary of Zletovska River, including all tributaries in this part of the river (excluding Zletovska River). This fishing zone includes recreational zone "Gratche". The concession for this fishing zone is held by ASF "Krap" - Vinica.
- Fishing zone "Bregalnica 5'' - covers part of Bregalnica River from the estuary of Zletovska River to the estuary of Svetinikolska River, including all tributaries in this part of the river (excluding Zletovska River). The concession for this fishing zone is held by ASF "Bregalnica 2011''- Shtip.
- Fishing zone "Bregalnica 6" - covers part of Bregalnica River from the estuary of Svetinikolska River to the estuary of Bregalnica into Vardar, including all tributaries in this part of the river. The concession of this fishing zone is held by Sport Fishing Society (SFS) "Mrena" – Sveti Nikole.
- Fishing zone "Zletovska River" - covers Zletovska River from the spring to the estuary in Bregalnica River, excluding the protection zones where sport and recreational fishing are forbidden according the "Decision for determination of protected zones for protection of waters in the activity area of rivers Zletovska and Kucheshka and accumulation Knezhevo". This fishing zone includes recreational zone "Pishica". The concession of this fishing zone is held by SFS "Zletovica" - Probishtip.

In Bregalnica River Basin there are 6 recreational (fishing) zones:

- Accumulation "Gratche" - no concessioner;
- Accumulation "Ratevska"' - concessioner ASF "Ablanica" - Berovo;
- Accumulation "Kalimanci" - concessioner SFS "Sharan" - Makedonska Kamenica;
- Accumulation "Pishica" - concessioner SFS "Zletovica'' - Probisthip;
- Accumulation "Mantovo" - concessioner AHFS "Studenec'' - Konche;
- Accumulation ",Mavrovica" - concessioner SFS "Mrena'' - Sveti Nikole.

The method of organization of recreational fishing in all mentioned fishing zones is regulated with special fishing basis for each zone. At the fishing water "Bregalnica River Basin" aquaculture and enclosure breeding of fish is allowed. The enclosure breeding is not allowed in the accumulation "Ratevska". In the area there are registered 8 fishponds with trout and carp.

In the Bregalnica River Basin, there the following fishing associations are registered: SFS "Sharan" - Makedonska Kamenica, SFS "Mrena"- Sveti Nikole, SFS "Zletovica" - Probishtip, ASF "Bregalnica 2011" - Shtip, AHFS "Studene"- Konche, HFS "Shti"- Shtip, ASFEC "Kra"-Vinica, ASF "Ablanic"– Berovo and ASFEC "Kochan"- Kochani.

8 Biogeographical characteristics

The Bregalnica River watershed and the East Planning Region belong to the Balkan Highlands Province of the Palearctic Realm. This province actually, belongs to the central part of the Balkan Peninsula. A larger part of Eastern Macedonia including the Bregalnica River watershed belongs to the **European Continental Biogeographical Region** according to the classification of the European Environment Agency.

8.1 Biomes (biogeographical provinces)

The biogeographical characteristics of the Bregalnica River watershed are processed according to identified biomes (biogeographical provinces) according to the division by Matvejev (Matvejev & Puncer 1989; Lopatin & Matvejev 1995). The area covers four biomes according to Matvejev's division (Fig. 21). Currently, we do not have enough data, but it is very likely that the area of interest has elements of one more biome – pedobiome. This pedobiome should include some troglobites (cave-dwelling organisms) as well as endogeic species (currently we only know of those in the Osogovo Mountain, such as the *Duvalius beshkovi*).

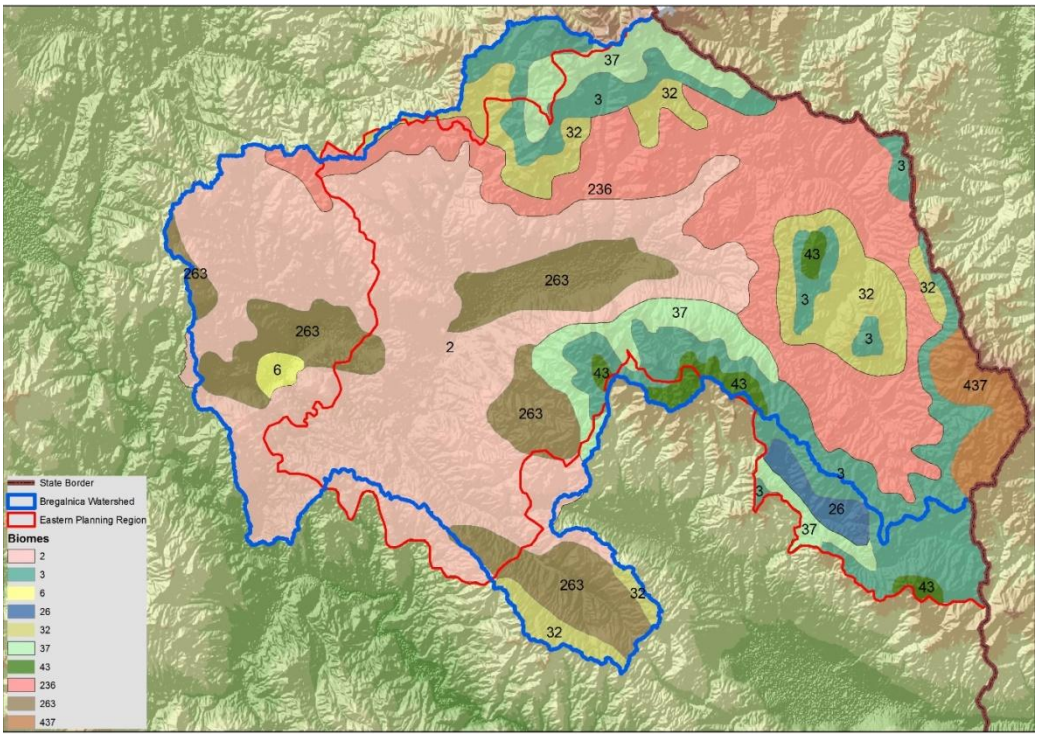


Fig. 21. Biomes (zonobiome and orobiome) in the Bregalnica River Watershed and the East Planning Region (modified from Matvejev & Puncer 1989).

2 - Biome of the Sub-mediterranean, mostly deciduous forests and thickets; 3 – Biome of Southeuropean, mostly deciduous forests; 4 – Biome of European, mostly boreal conifer forests (orobiome of European forests from the type of taiga); 6 – Elements of the steppe and steppe forests biome; 7 – Biome of highmountain screes, pastures and snowpacks. Combination of numbers refers to combination of different types of biomes.

8.1.1 Zonobiome of the Mediterranean Semi Deserts

The Zonobiome of the Mediterranean semi deserts has a segmented areal from Northwest Africa and the Pyrenean Peninsula to Iran in the East. Today it is very difficult to distinguish between natural habitats and man-made ones created for agricultural practices. The Bregalnica watershed

includes Slan Dol and Ovche Pole with the exception of some larger parts with thermophile oak vegetation. Typical natural habitats are open semi-scrubland, grassland and rocky habitats in hills with skeletal soil, dry river beds of sessional rivers and streams.

It is assumed that these territories were land as early as the Paleogene. In the Neogene the territories become more arid and the climate became more continental, even though arid oasis of Balkan Peninsula existed during the Paleogene. With the spreading of aridity these arid oasis also spread and formed a continuous steppe-semi-desert zone from the Pyrenean Peninsula to China. Even in early Pliocene the central and southeast parts of the Balkan Peninsula and Asia Minor were covered with steppe and semi-deserts similar to today's African savannas. Later, with increased aridity and cooling semi-deserts were created. During the Neogene and because of frequent and intensive volcanic eruptions there was a massive destruction of fauna and flora. Such fossils are found close to Karaslari near Veles. Fossils from this region include hipparion, gazelles, antelope, porcupine, giraffe, rhinoceros, steppe tortoise, monkey, mastodon etc. Such deposits, besides the recent occurrence in this biome, can be found in other places which is an indirect proof that Mediterranean semi-deserts stayed fragmented even in glacial.

The recent climate is characterized by dry and very warm summers with pretty cold often snowless winters. Precipitation is low ~500 mm annually.

Mediterranean semi-deserts in the Bregalnica watershed and in Macedonia generally are Aegean-Anatolian rocky semi-desserts. They contain species which are central Asian and rarely African i.e. paleotropical elements.

Characteristic species of plants are: *Carduus hamulosus, Eryngium campestre, Eryngium palmatum, Carthamus lanatus, Rosa spinosissima, Stachys recta, Galium purpureum, Stipa tirsa, Stipa mediterranea, Triticum villosum*. Characteristic species of grasshoppers include: *Calliptamus italicus, Dosciostaurus marrocanus, Oedipoda miniata, Glyphothmetis heldreichii, Asiothmetis limbatus, Paracalopternus caloptenoides, Acrida* sp. Ground beetles: *Harpalus metallinus, Carabus graecus morio, Pachycarus cyaneus, Brachinus brevicollis.* Other invertebrates worth mentioning are *Galeodes elegans, Latrodectus tredecimguttatus, Mesobuthus gibbosus*. Characteristics types of reptiles are: *Testudo graeca, Lacerta erhardii, Elalphe quattuorlineata,* and probably and viper *Vipera ammodytes*. Characteristic bird species include: *Emberiza caesia, Sturnus roseus, Melanocorypha calandra, Burrhinus oedicnemus, Otis tetrax.* Characteristic mammals are: *Vormela peregusna, Microthus guentheri.*

8.1.2 Zonobiome of Sub-Mediterranean Balkan Forests

The biome of the sub-Mediterranean Balkan Forests covers Southeast Europe and Asia Minor. Anthropogenic intervention has turned most of this biome into arable land and rocky slopes which are now part of the zonobiome of the Mediterranean semi-deserts. Most characteristic natural habitats in the Bregalnica watershed are Eastern Hornbeam and Oriental Hornbeam (*Phyllireo-Carpinetum orientalis*) and thermo-mesophilic forests (*Quercetum frainetto-cerris*).

The most important paleogeographic characteristic of these forests is that during the freez-over there was a land connection between the Balkan and the Asia Minor forests, as a continuoation of the Neogene connection. This connection became stronger during the time of the glacials and weakened during the time of the interglacials. It is interesting that this connections functions to date.

The climate of this zonobiome is dry, warm and has a small amount of rainfall, as well as in the previous zonobiome of the Mediterranean semi-deserts, which is expected since these are two zonobiome that are not separated nor have distance between them. The paleoclimate of this biome was probably similar to that of today. Of course, sub-Mediterranean Balkan forests during the glacial periods were supressed by biocenosis from taiga or analogues of today's mesophilic Mid-European

Forests. The sub-Mediterranean Balkan forests were preserved as small oasis with dry winters and cold dry summers.

Some of the characteristic but extinct species for this biome are the cave bear, rhinoceros, cave hyena, etc.

Characteristic plant species include *Quercus pubescens, Q. frainetto, Q. trojana, Q. cerris, Carpinus orientalis, Ostrya carpinifolia, Corylus colurna, Celtis australis, Crateaegus orientalis, Cotinus coggygria, Acer tataricum, A. hyrcanum, A. monspessulanum, Syringa vulgaris, Tilia argentea, Juglans regia*. Reptiles: *Eurotestudo hermanni, Lacerta trilineata, Ablepharus kitaibelii*; Birds: Parus *lugubris, Dendrocopos syriacus, Ficedula semitorquata, Streptopelia decaocto, Accipiter brevipes*; and mammals: *Dryomis nitedula, Apodemus flavicollis, Glis glis, Erinaceus roumanicus.*

8.1.3 Zonobiome and Orobiome of the Balkan Central European Forests

This biome covers an area with a centre in the northwest part of the Balkans and the east foothills of the Alps. This region includes the Eastern Alps, Illyricum and Balkan regions. The average altitudes are between 500 and 800 m. During the glacial period the forests were absent from a large part of the biome of the south European, mostly deciduous forests. These areas were under ice and snow or cold open fields of the arctic-alpine type. The forests were formed during the Alluvium. In the previous periods, the forests existed only in some refuges.

An important biogeographical characteristic of the recent living creatures is the expansion of the areal of some species of Virmic refuges. This process created the typical communities of today. The Southern Balkan refuges were characterized by an abundance of species. They had the largest number of species which can now be found in Central Europe. This is why it is assumed that the flora and fauna of Central Europe today, for the most part, comes from the Balkan Peninsula. Such is the case with the Beech trees which have spread from the Balkans to all of Europe. But we should not forget that in the post-Diluvium period some species from Southwest Europe migrated to the Balkans.

This zonobiome in the Bregalnica watershed includes the belts of *Orno-Quercetum petraeae* forests, *Festuco heterophyllae-Fagetum* and *Calamintho grandiflorae-Fagetum* forests as well as mixed or monoculture forests of Black Pine, Scots Pine and Beech. The occurrence of small communities of fir trees and spruce at the Murite locality is also a part of this orobiome, even though these two species are more characteristic for a different orobiome which we consider to not be present in the Bregalnica watershed, and that is the Taiga-type European Forests orobiome (even though its elements are represented on Fig. 21).

Some of the characteristic plant species: *Fagus sylvatica, Fraxinus excelsior, Carpinus betulus, Corylus avellana, Quercus petraea, Berberis vulgaris, Sorbus aucuparia, Evonymus europaea, Acer campestre, Acer pseudoplatanus, Sorbus torminalis, Tilia platyphyllos, Ligustrum vulgare, Prunus cerasus.* Amphibians and reptiles: *Salamandra salamandra, Rana dalmatina, Hyla arborea, Anguis fragilis, Lacerta agilis, Natrix natrix*. Характеристични птици се: *Phylloscopus sibilatrix, Turdus ericetorum, Parus caeruleus, Sylvia curruca, Phoenicurus phoenicurus, Erithacus rubecula, Dendrocopos leucotos, Coccothraustes coccothraustes, Strix aluco, Parus palustris*. Mammals: *Capreolus capreolus, Clethrionomys glareolus, Glis glis, Muscardinus avellanarius.* Ground beetles are represented by several species and a significant number of them are endemic: *Platynus scrobiculatus bulgaricus*, *Aptinus merditanus*, *Tapinopterus balcanicus, Molops rufipes denteletus* and *Xenion ignitum*

8.1.4 Orobiome of the High-altitude Rocks, Tundra and High-altitude Mountain Pastures

The orobiome of the high-altitude rocks, tundra and high-altitude mountain pastures is present today on the peaks of the European mountains. The Balkan mountains in this orobiome can be included with peaks above 2000 m asl Current ecological conditions of this orobiome are probably very similar to those of the Pliocene. During the glacial period this orobiome was under snow and ice and the typical biocenosis were lower.

Characteristic plant species include: *Vaccinium uliginosum, Arctostaphyllos uva-ursi, Nardus stricta, Sesleria coerulans, Poa alpina, Cerastium alpinum.* Characteristic bird species: *Acanthis flammea, Anthus spinoletta, Eremophila alpestris, Montifringilla nivalis, Prunella collaris, Pyrrhocorax graculus.* Herpetofauna includes: *Zootoca vivipara и Vipera berus*. Ground beetles: *Amara nigricornis, A. erratica, A. messae, Trechus priapus medius.*

In the Bregalnica watershed, elements of this orobiome are only present on the highest peaks of the Osogovo Mountains, or more precisely the space between Carev Vrv and Ruen which continues to the Republic of Bulgaria. The most typical habitats of this orobiome can be found in a small space around the peak Ruen.

8.2 Climate-vegetation-soil zones

The Bregalnica River watershed has six out of eight climate-vegetation-soil zones of Macedonia (Fig. 22). The only missing zones are the sub-Mediterranean (modified Mediterranean) zones and Alpine zones. However, elements of these two zones can be found in the lowest parts of the Bregalnica River watershed and the highest peak of the Osogovo Mountains, especially the peak Ruen.

The lowest parts (Ovche Pole, Shtip Fields, Kochani Fields, Mangovica and the low parts of the valley of the Kriva Lakavica River) are under thermophile vegetation, where potentially *Querco-Carpinetum orientalis* forests could dominate and they represent the **continental-sub-Mediterranean area. The warm continental area** covers a wide belt of the Osogovo Mountains, Maleshevo Mountains, Golak, Obozna, Plachkovica the higher parts of the valley of the Kriva Lakavica River, etc. The dominant forest community of this region are the *Quercettum frainetto-cerris* forests. **The cold continental areas** are most noticeable at Plachkovica, Maleshevski Mountains, Golak, Obozna, western parts of the Osogovo Mountains. Above these regions and in regular belts there is an interchange of sub-mountainous and mountainous continental areas and subalpine areas. The **Sub-mountainous continental areas** are represented by a narrower belt at Plachkovica, Maleshevo, Osogovo, Ograzhden and Golak. Above this area on the same mountains is the **mountainous-continental area** represented by Beech forests from the *Calamintho grandiflorae-Fagetum* community but also at different communities with coniferous species. The **Subalpine mountainous area** can be found at the highest part of Osogovo, Plachkovica and Maleshevo.

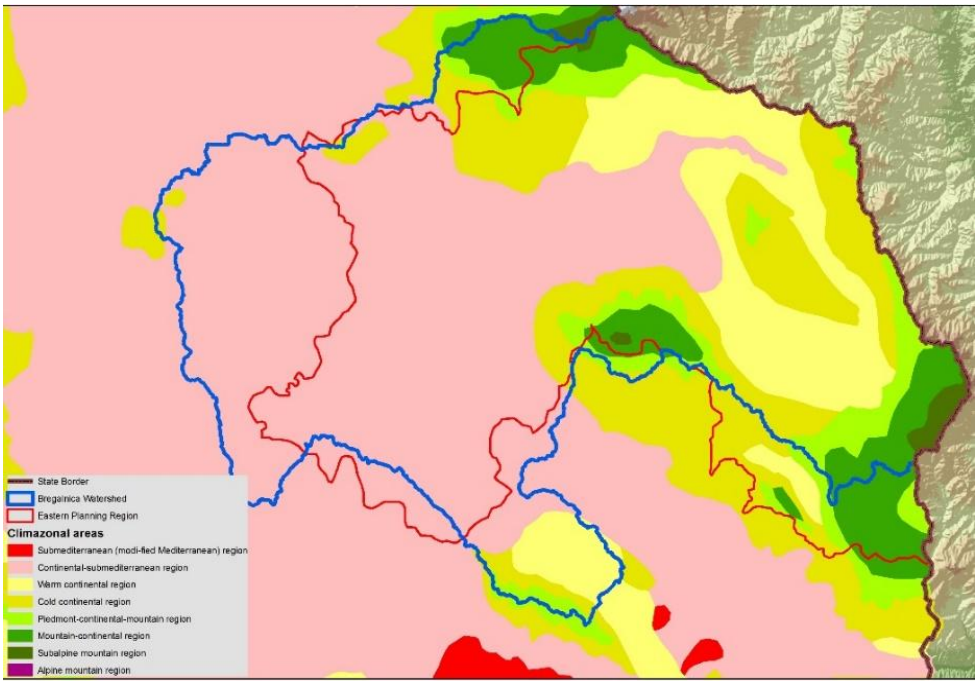


Fig. 22. Climate – vegetation – soil zones in the Bregalnica watershed and the East Planning Region

9 Agrobiodiversity

9.1 Plant Agrobiological Diversity

Plant agrobiodiversity in the Bregalnica river basin consists of registered crop varieties and hybrids that are commercially grown on large areas, and old landraces grown on small areas, meant for personal use of the local population. In every village there is a tradition of maintaining crop landraces. One household keeps different landraces of some crops, for ex. 2-3 different landraces of peppers, corn or beans. Agricultural practices are performed manually in a traditional way, with the exception of cereals where all operations are mechanized. Most of the residents who have landraces are between 50 and 75 years of age. Younger residents are leaving villages or focus on commercial agriculture based on modern varieties. This process is supported by subsidies from the government since they are only valid for certified seeds. In rare cases, these varieties are intended for the local markets. Thus, some varieties (cotton, flax and hemp) have been lost several decades ago, while some of the varieties that are still grown the diversity of landraces are being lost.

In the framework of this project, initial inventory of the Bregalnica region old landraces was made, but still the results cannot give the full figure of the plant agrobiodiversity in the region, since further examination needs to be done (experimental trials with the collected samples, description and comparison of the characteristics etc.). After the completion of this assessment, the full information should be distributed to the relevant institutions, and furthermore used for planning for agrobiodiversity conservation.

The greatest diversity of landraces is among the beans, which are also the oldest and are kept in families for decades. This crop has several subspecies with varieties that have different forms, colours, patterns and sizes of seeds. It is similar with green beans, while other legumes (broad beans, lentils, peas and cowpeas) are very limited and their varieties are almost completely lost. Cereal landraces are only maintained for corn which has several subspecies (white, yellow and popcorn) with different varieties regarding form, colour and size of cobs and seeds. Other cereals are rarely kept and most of them date from seven decades ago, while wheat and barley are replaced with old or new commercial varieties. Vegetable crops have the biggest variety among peppers with two subspecies and the most common is the “embroidered” pepper. Tomatoes and squashes are also very common but have a smaller number of varieties. Watermelons and melons are rarely grown but old winter landraces can still be found. Onions, garlic and leek are grown by almost every household with 2-3 different varieties, while other cultures are only commercially grown. Industrial crops have the highest loss of diversity and old landraces of opium poppy and sunflowers can rarely be found, aniseed can be found only in a few municipalities. Forage crops have a limited number of landraces as well only for the alfalfa and the sweet pea. Bitter vetch is very rarely grown as a medicine and other cultures are only present as commercial varieties.

During field research in populated areas in the Bregalnica watershed we registered the following:

9.1.1 Cereals

Cereals are mostly represented by corn, wheat, oat and broomcorn (Fig. 23).

Corn (*Zea mays*) - 335 samples of corn were collected. By the number of collected samples, this crop comes in the fourth place. Mainly there are 3 types of corn, represented by a number of different landraces, which are not in danger of extinction, with the exception of few popcorn landraces, that have coloured cobs.

Wheat (*Triticum aestivum*) **and Barley** (*Hordeum vulgare*) - 108 samples of wheat and 94 samples of barley were collected, out of which, some are older than 20-30 years. The diversity of wheat is disappearing. The oldest landraces of both crops have already been lost, and for the rest, that are maintained for 20-30 years, urgent measures for conservation have to be undertaken.

Oat (*Avena sativa*) **and Rye** (*Secale cereale*) - 63 samples of oat and 28 samples of rye were collected. From all cereals grown on larger areas, only older landraces from oats and rye can be found, since the farmers rarely buy certified seed from these crops.

Broomcorn (*Sorghum vulgare*) **and Millet** (*Panicum miliaceum*) - 9 samples of millet and 29 of broomcorn were collected. Both species are disappearing from the fields, so it is necessary to undertake urgent measures for conservation of the remaining landraces.

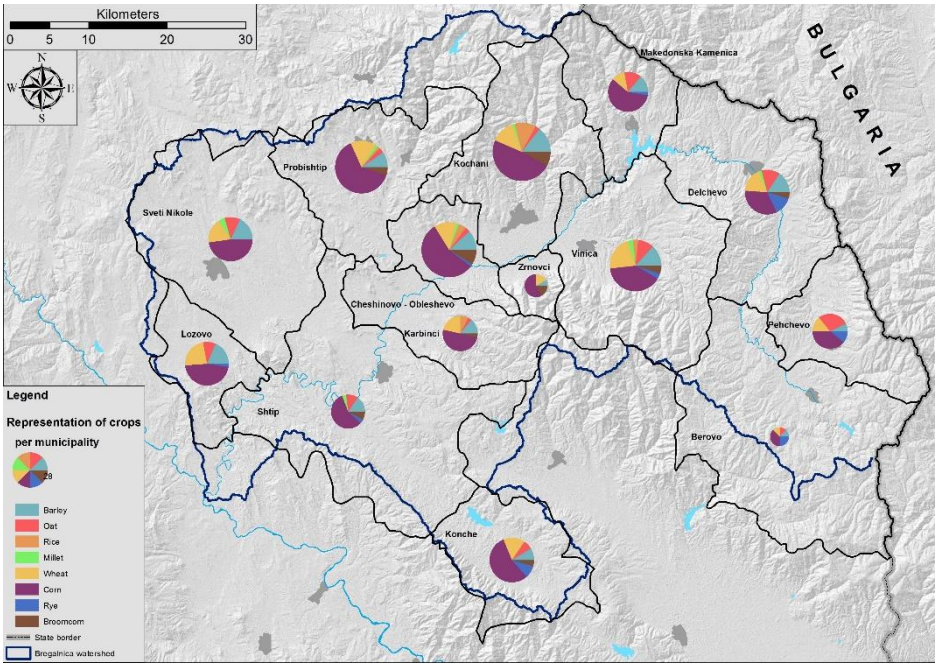


Fig. 23. Distribution of cereals per municipality

9.1.2 Legumes

Most common legumes in this region are beans, green beans, broad beans, lentils, peas and chickpeas. (Fig. 24)

Bean (*Phaseolus* sp.) - 680 samples of beans were collected. It is the predominant crop, with the most diverse landraces. It is not endangered, but still, there are few landraces with coloured seeds, that can be rarely found. Only *Phaseolus multiflorus* bean landraces, that are most prevalent in Maleshevo, are facing extinction and urgently need to be conserved.

Green beans (*Phaseolus vulgaris*) - 132 samples were collected. It is not in danger to be extinct in the near future.

Broad beans (*Vicia faba*) - Only 3 samples were registered in the Municipality of Konche. Since this crop facesextinction, urgent measures for its protection should be undertaken.

Cowpeas (*Vigna unguiculata*) - Only 12 samples were registered. Due to its low distribution, this crop is endangered to be extinct.

Lentils (*Lens culinaris*) - 19 samples were registered, but only few are old. The locals rarely cultivate it, mostly they are buying lentil for cooking. Measures for conservation of the old landraces are needed.

Beans – different types of landraces from the Bregalnica region

Peas (*Pisum sativum*) - 25 samples of pea were collected. People increasingly buy peas for cooking, so the old landraces of this crop will disappear soon. Only one old landrace of pea was found in the village Karbinci, while the others are newer.

Chickpeas (*Cicer arietinum*) - 57 samples were registered. It is endangered to be extinct in near future, because of the rapid spreading of the new varieties introduced from Turkey, India or the Arab countries.

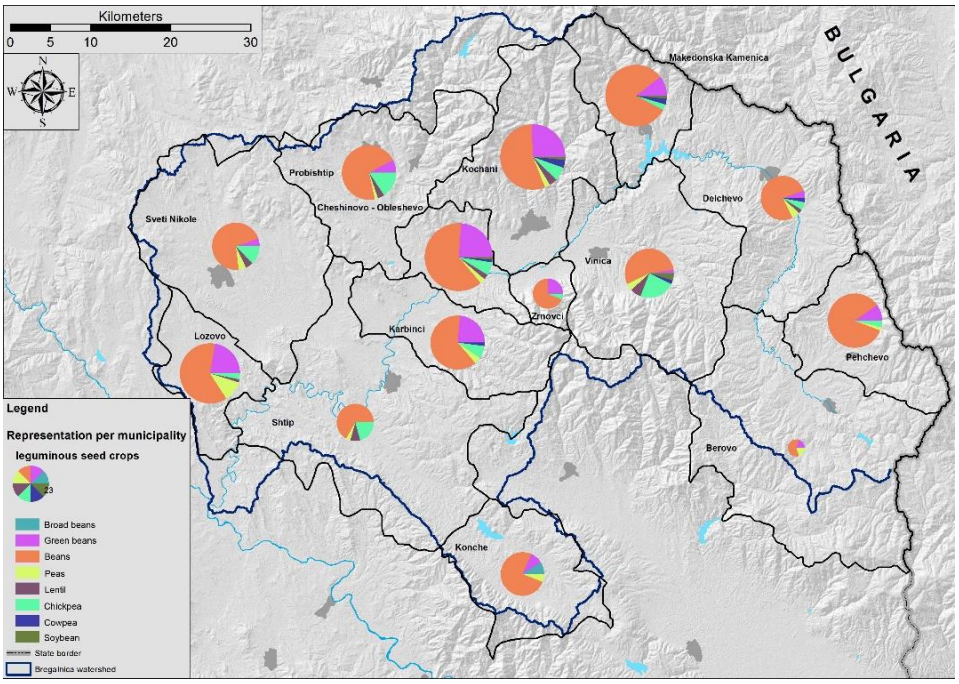


Fig. 24. Distribution of legumes distribution per municipality

9.1.3 Vegetable crops

The most commonly grown vegetables are: squashes, calabash, muskmelons, watermelons, peppers, tomatoes, cucumbers, eggplants, cabbage, lettuce, leek and onion (Fig. 25, 26 and 27).

Squashes (*Cucurbita* sp.) - 405 samples of winter squash and 37 of summer squash were registered. Almost every household keeps squashes. The locals don't buy commercial seed, and considering the popularity of health food consumption, its diversity is not threatened. The summer squashes are less represented, and more rarely maintained.

Calabash (*Lagenaria siceraria*) - 35 samples were registered. The diversity of this crop, which is not grown for consumption, it is not threatened in near future, but since the new generations will have no reasons for growing it, its disappearing is inevitable.

Peppers – crops from different landraces from one household in Tarinci.

Muskmelon (*Cucumis melo*) - 114 samples were collected. Since a lot of households keep at least one landrace of muskmelon for their own need, this crop is not endangered in the moment. But, it is mainly grown by the older population, so measures for its conservation should be undertaken on time, especially for the winter landraces.

Watermelon (*Citrullus lanatus*) - 88 samples were registered, mainly summer landraces. The winter landraces and the landraces for processing (making sweet/jam) are endangered to be extinct.

Pepper (*Capsicum annuum*) - 460 samples were registered, mainly “embroidered pepper”. The locals rarely buy commercial seed for this crop, and almost every household keeps at least 1-2 different landraces.

Tomato (*Licopersicon esculentum*) - 248 samples were registered. It is grown in every garden, but the locals often buy commercial seed or seedlings. The diversity of this crop is not threatened yet, because many families still keep old landraces.

Cucumber (*Cucumis sativus*) - 46 samples were collected. Locals often buy seeds, but still, part of the population keeps its own local landraces. Some of them are older than 30 years, and they should be conserved.

Eggplant (*Solanum melongena*) and **Okra** (*Abelmoschus esculentus*) - 13 samples of eggplant and 9 samples of okra were registered. These crops weren't traditionally grown in this region, and therefore there is no need for their protection.

Cabbage (*Brassica oleracea*) and **Spinach** (*Spinacia oleracea*) - 17 samples of cabbage and 18 of spinach were registered. These crops weren't traditionally grown in this area, and there is no need for their protection.

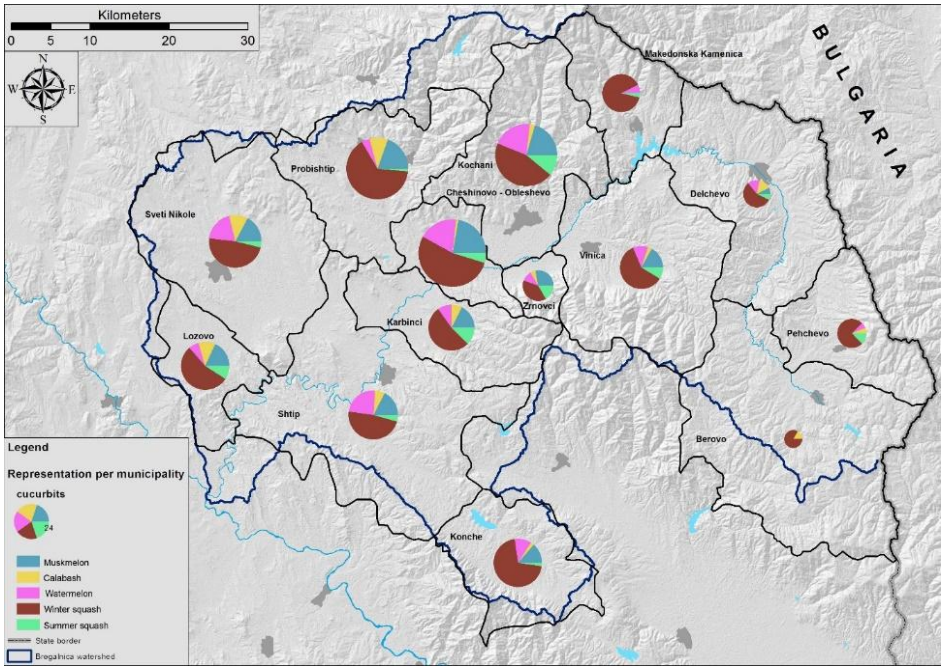


Fig. 25. Production of squashes and melons per municipality

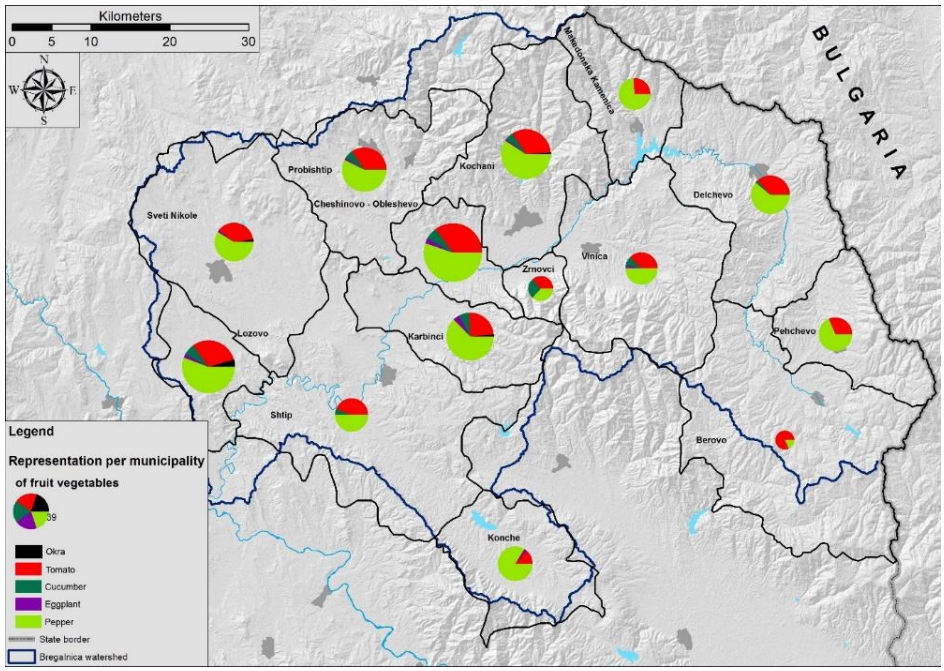


Fig. 26. Other vegetables per municipality

Lettuce (*Lactuca sativa*) and **Parsley** (*Petroselinum crispum*) - 21 samples of lettuce and 20 samples of parsnip were collected. People often buy commercial seed, but they are not threatened from extinction.

Other leafy vegetables (**Spinach beet, Orache and Patience dock**) can be sporadically found, but the people rarely keep seeds from them, since they grow spontaneously in their gardens.

Leek (*Allium ampeloprasum*)- 82 samples were collected. The landrace Zrnovski leek is most famous and grown for market sell, so its status is not endangered, but the other landraces can disappear in near future.

Onion (*Allium cepa*) and **Garlic** (*Allium sativum*) - 74 data for onion and 307 for garlic were registered (only few samples were collected, since they are grown from bulbs). Both crops are widely grown, and the people prefer their own landraces, so they are not endangered to be extinct in near future.

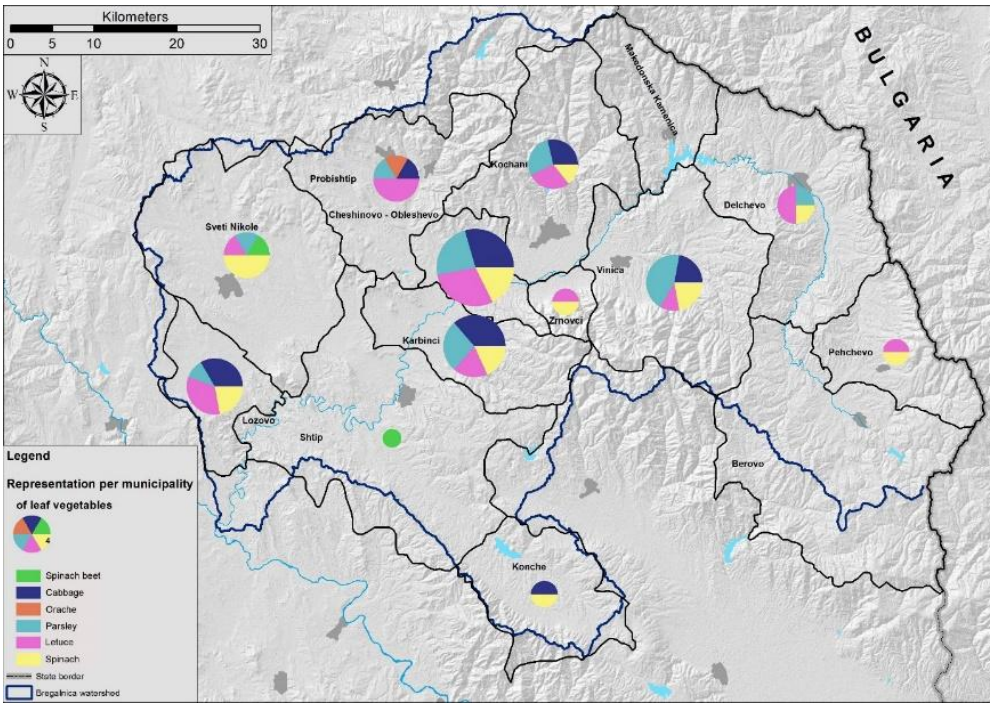


Fig. 27. Leafy vegetables per municipality

9.1.4 Industrial crops

The most common industrial crops are sunflowers, opium poppy, tobacco and aniseed.

Sunflower (*Helianthus annuus*) - 38 samples were registered. The diversity of the old landraces has almost disappeared, consequently urgent measures are needed for its protection.

Opium poppy (*Papaver somniferum*) 47 samples were registered, dating from the '40s, but some of these are not sowed more than 15 years. Because its growing is regulated by Low, the small farmers are avoiding its production and the local landraces are already disappearing. Urgent measures for their protection should be undertaken.

Tobacco (*Nicotiana tabacum*) - 11 samples were registered (old commercial varieties from the '50s). The old local landraces have already disappeared because the farmers buy seeds for its production on large areas.

Aniseed (*Pimpinella anisum*), **Peanut** (*Arachis hypogaea*), **Castor Bean** (*Ricinus communis*) and **Rapeseed** (*Brassica napus*) - Industrial crops such as hemp, cotton, castor bean , sesame and flax, that were grown on large areas in the '60s, today are difficult to find. The anise, which is used for preparation of traditional drink mastika is grown by a small number of farmers, on a small areas, for selling on the green markets. There were registered only 3 samples of peanuts that the farmers grow for personal use. Flax and sesame slowly returned to the fields on small areas, for producing cold pressed oils, but only with commercial varieties. Hemp is completely lost, the cotton as well. Rapeseed has always been cultivated only with commercial varieties.

9.1.5 Forage crops

Most common forage crops are Bitter Vetch and Sweet Pea.

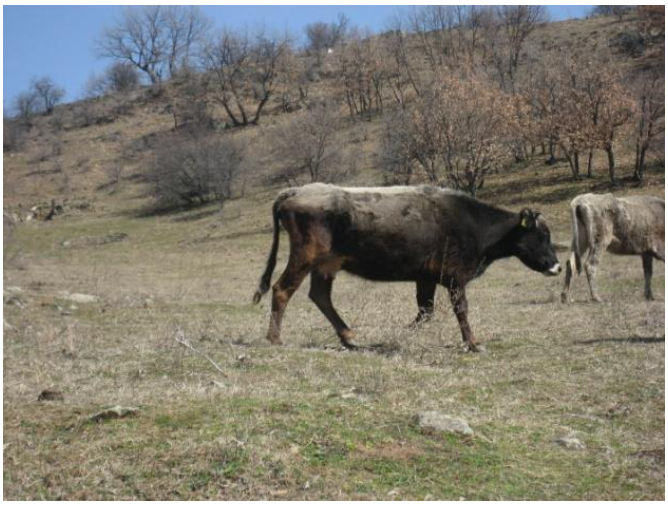
Bitter vetch (*Vicia ervilia*) - 15 samples were registered. In the past, it was largely grown as high energy livestock feed, but today it is disappearing. It is grown rarely for medicine purposes. The collected samples are old landraces, since there is no commercial seed for this crop.

Sweet peas (*Lathyrus cicera*), **Alfalfa** (*Medicago sativa*), **Sainfoin** (*Onobrychis sativa*), **Clover** (*Trifolium* sp.) and **Pea** (*Pisum sativum*) - 9 samples of sweet pea, 1 of sainfoin, 6 of alfalfa and 5 of clover were collected. All crops were largely grown in the past as livestock feed. They are faced with extinction and should be urgently preserved. The farmers that grow alfalfa are interested for the Debarska landrace, so it is necessary to conserve this landrace. The situation with the sweet peas and the clover is similar, because the farmers that grow these crops on larger areas, buy commercial seeds. The old local landraces are already lost.

9.2 Biological Diversity in Domesticated Animals

According to literature data, in the Eastern Planning Region, in which the river Bregalnica basin is the largest region, there is a notable presence of a variety of local species of domestic animals. One part of them is indigenous to the Republic of Macedonia (Ovcepolska sheep, the Macedonian bee) while another part is also spread through the neighbouring countries (the Busha cattle, the domestic Balkan goat, the Karakachan sheep, and the Sharplaninec dog).

The **Busha cattle** is a short horned “brachicern type” is widespread throughout the Balkans as well as Asia and the Middle East. The breed is characterized by a monochromatic colour in different variables (black, grey, blue, red, yellow and white) which is a distinct trait of all cattle belonging to the “brachicern type”. The adults have a small withers height (90-115cm.). The bodyweight varies between 150-300 kg. In favourable conditions the average live weight of cows is 280-320 kg, while the bulls reach up to 429 kg. According to locations identified via the livestock Identification and registration system, the greatest number of Busha in the Eastern region is in Karabinci, Kochani, Lozovo, while the usual number of heads per herd is 1-5 (Fig. 28). A conclusion drawn on the base of phenotypic characterization indicates that the types of Busha described above can still be found in the region in their indigenous form, albeit in smaller herds and often in the form of mixed breeds of Busha with other cattle breed.



Busha from the Bregalnica region

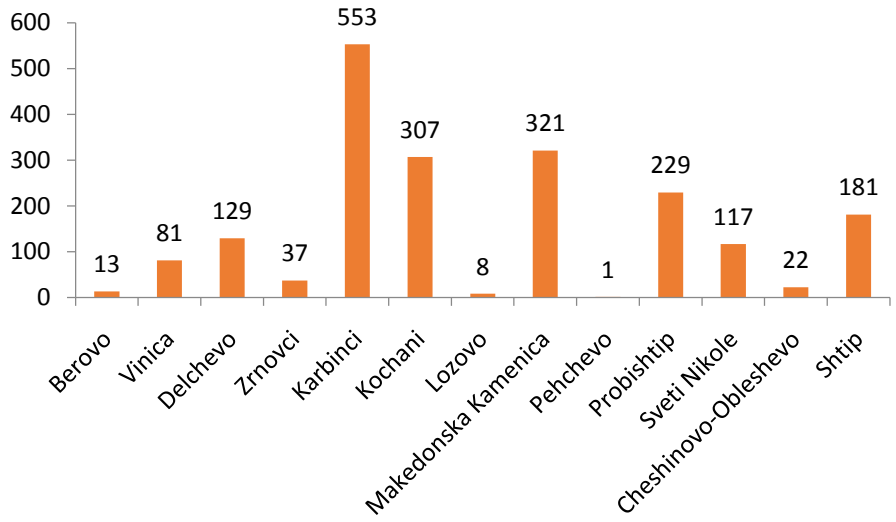


Fig. 28. Distribution of the Busha cattle in the regions of the Bregalnica watershed (Source: FVA)

From the local **sheep breeds** the regions is widely populated by the Pramenka breed which is represented in 3 types: Ovchepolka, Sharplaninka and Karakachanka. The name Pramenka describes a primitive type of sheep which can survive in poor conditions concerning food and care. It is a low-production breed with triple production traits: meet wool and milk. The breed is highly resistant and easily adjustable to different breeding conditions. The breed used to be widespread across Europe and was known as Zackel in Central Europe, as Tzurtsana in Poland and Romania, as Vlahian in Greece and as Pramenka (represented by 20 types) on the territory of the Former Federal Republic of Yugoslavia. The morphological and physiological characteristics are dependent on the geo – ecological conditions in the regain where the sheep are located. A curious characteristic is that the types of Pramenka often have great variability between themselves in both morphological (size, height, wool colour, tail length) and productive traits. The Ovchepolka is of great importance since it is the only true Macedonian pramenka, with a parent breeding region in the Bregalnica watershed.

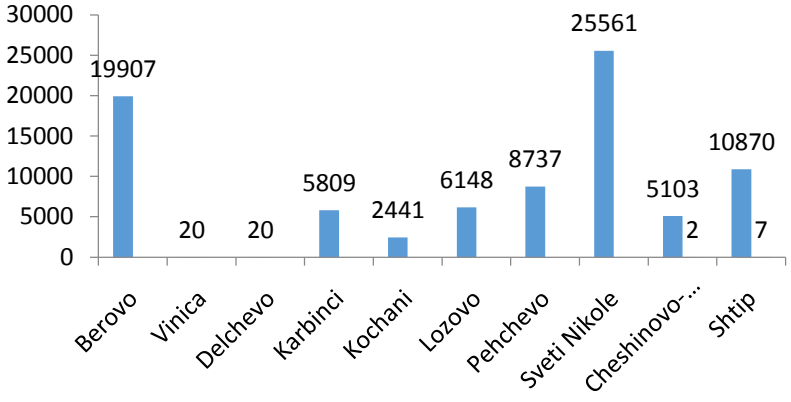


Fig. 29. Numbers for domestic animals of pramenka sheep according to regions (Source: Data processed from FVA database)

Compared to other Pramenka types, trunk size puts the Ovchepolka in the category of middle sized Pramenkas. The live weight of the adult animals is 45 kg (34-58) / 36 kg (25-48) with a withers height of 64.5/61 cm. A typical characteristic is the partial or complete black pigmentation of the head. Dark regions are loiscated at both sides of the head ranging from the ears and the base of

the horns to the mouth so that an irregularly shaped and sized white line, called “lisa” is formed on the frontal part of the head. “Karabashes” are often found, animals with a completely black or dark coloured head. The horns are well developed in rams although there are examples that are hornless, while the ewes are mostly hornless with exceptions having a developed pair of horns.

Ovhce Pole Pramenka

Shar Planina Pramenka

Karakachanski variety

Results gathered from the indicative location of the geographical distribution of the Ovchepolka sheep in the region of the Bregalnica river basin, indicate that the greatest population of the breed is in the Sveti Nikole region (Fig. 29). Interviews that were conducted on farms via a questionnaire for phenotypic characterization confirm the data gathered from literature. The phonotypical characteristics of the breed are present in the shape of “karabasha”, “lisa” or other form of dark pigmentation of the head. Although there is great variability within the breed, the most widespread type is sheep with irregular dark coloured regions. The variability in the milk production of the Ovchepolka in the controlled farms in the region is also high (ranging from 35.81 – 67.03l).

The **domestic Balkan goat** was the most common breed in the mountain regions of the Balkan Peninsula up until the World War II. The basic characteristic is a long, thick and shiny coat which can be white, black, chocolate or multi coloured. The goats are mostly horned, although there are exceptions. The goats are really manoeuvrable and can be found in difficult terrain. The live weight is small ranging from 30-40 kg, with one offspring per year being the average, although better herds can average 1.5 offspring per goat. Milk productivity is low ranging from 100-300 l during the lactation period of 7 months. Vinica, Delchevo and Kochani are the spots in the region where the goats are mostly distributed (Fig. 30).

Domestic Balkan Goat

Data from inventoried farms, gained through characterization of 15 morphological traits of the goats point towards variations in the colour with black being the least represented in both rams and ewes (48%/59.18%). Variations have been found in the profile line of the head, with the greatest dominance of a straight profile line. The largest part of inventoried animals representing both sexes, have coloured ears that are horizontally oriented. Most of the goats are horned (85.63 % of rams and 79.04 % of ewes) with looped horns. Both sexes have a dominantly long coat and dark skin pigmentation, while a special characteristic is the presence of “earrings” (70%).

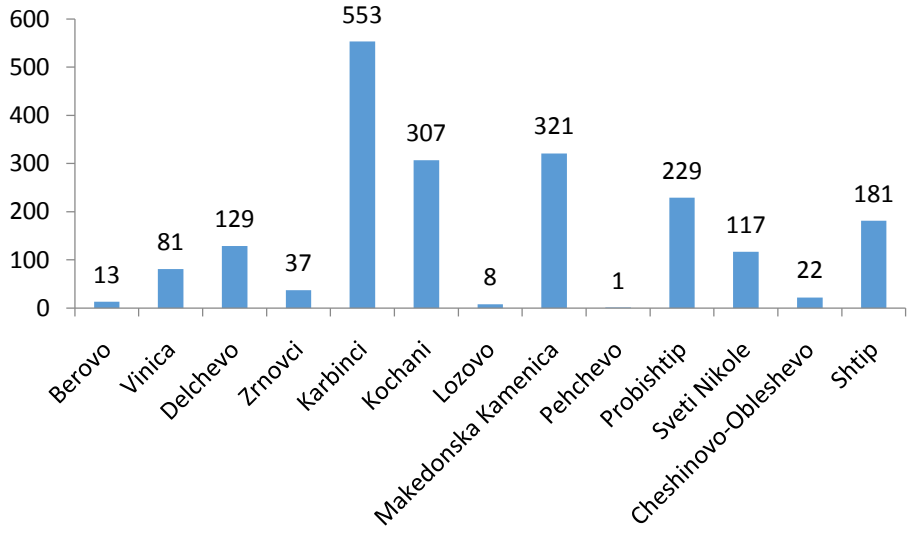
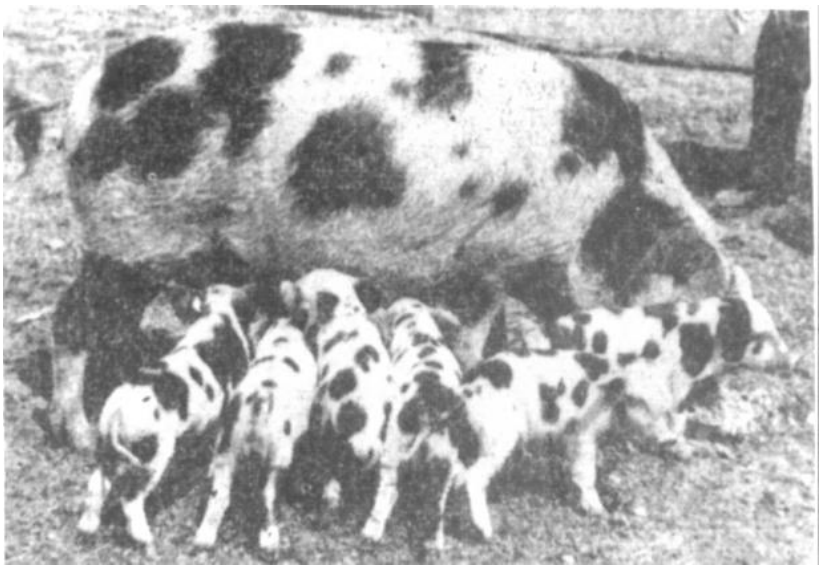


Fig. 30. Numbers of the domestic goat in the East Region (Data from FVA)

The **buffalo** population in the republic of Macedonia has been marked as critical/extinct, so this type of domestic animal has been brought down to 50 heads in 2013 (the previous count in 1939 being 39.500 heads). In the river Bregalnica basin region the buffalos are present at only 3 locations, represented by only 21 animals, which indicates the animals small significance in the total biodiversity of livestock.

Domesticated buffalo

The losses in the biological diversity in the domestic animals in the region (and further) is clearly evident and is not just a result of the lack of interest for the protection of indigenous species but also of the long lasting process of land reclamation and assimilation followed by permanent depopulating of the rural areas. The disappearance of the domestic primitive pig, the Karakachanka and Sharplaninaka sheep and the buffalos are great examples of that. The intensification of livestock breeding has completely suppressed the local Busha cattle, which is still present only in the mountain regions and in extensive production conditions.



Macedonian primitive pig

Protection of the biodiversity in domestic animals is a planned, coordinated and long term activity, contained and described in the Program for the protection of the biological diversity in livestock, and it is essential that it is properly implemented.

10 Biological Diversity of Species

The area of interest is characterized by a high biological diversity which represents a mixture of elements characteristic for several biogeographical provinces (consult: Chapter 8.1. Biomes). Even though there is a continuity in the changes between the lowest (arid and thermophilic) and the highest (mesophilic) habitats, there is still a noticeable contrast between the steppe-like habitats and the thermophilic (degraded) forests of the lower course of the Bregalnica River, mainly in the forested areas and the mountains in the middle and upper course of the river. The total number for species and habitats is represented in table 6. This overview has a good coverage of the vascular plants and vertebrates (353 species).

Regarding invertebrates, it should be taken into consideration that the research has covered only several systematic groups with only 760 familiar species. It can be expected that the real number of invertebrate species in the area of interest can be several tens of thousands.

The progress made in knowing the biological diversity with the implementation of the project activity is undoubtedly high. This is especially true of fungi, aquatic macroinvertebrates, diatomic algae and habitats (Fig. 31)

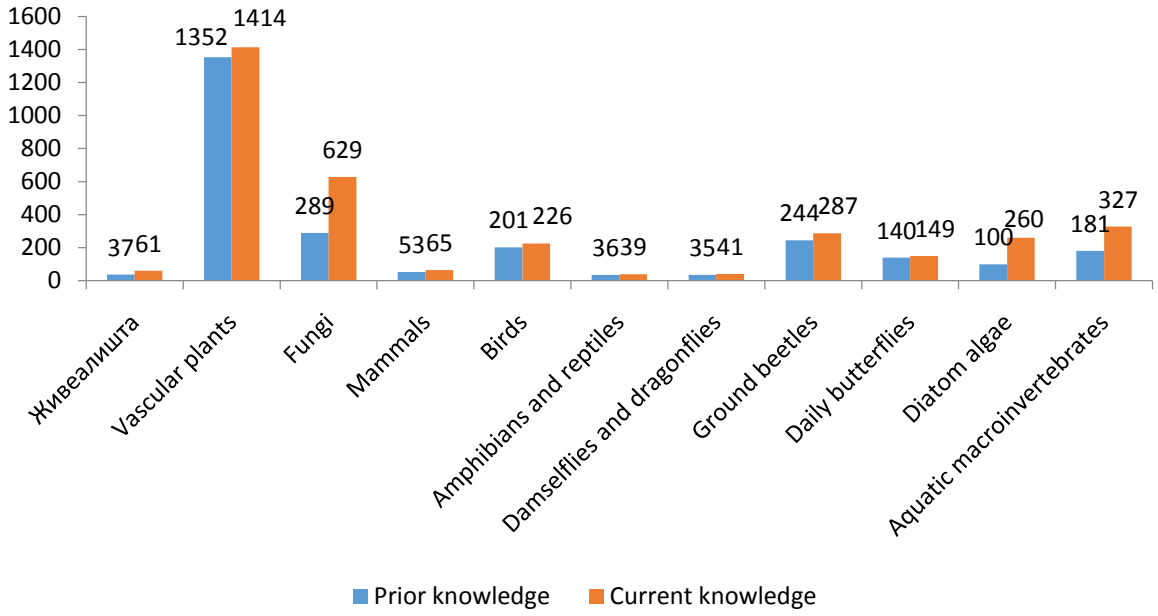


Fig. 31. Progress in knowing the biological diversity of analysed systematic groups

The Bregalnica River watershed has 35 registered endangered species according to the Global Red List of IUCN (the exact status of separate species is provided in the appropriate expert reports). The European Red List has 60 species, but it should be taken into consideration that it does not include all groups.

The Habitats Directive and the Birds Directive of the European Union are represented with 41 habitats and 135 species. The lists of the Bern Convention include 45 habitats and 255 species.

According to the Law on Nature Protection i.e. the National Lists of Protected and Strictly Protected species, there are 145 protected or strictly protected species in the Bregalnica watershed.

Endemic species can be found mainly in the groups of invertebrates and plants. The exact number of endemics is hard to assess, but at this moment we can say that the Bregalnica watershed has 9 steno-endemic plants but there is a large number of Balkan endemics; ground beetles have 2 local endemics, 2 steno-endemic and 16 Balkan endemics; two butterflies are Balkan endemics,

around 10 diatomic algae are steno-endemic; in the group of aquatic macroinvertebrates there are two Balkan and two steno-endemic species.

According to expert assessments the area has 297 rare species within the analysed groups.

Table 6. Overview of biological diversity in the Bregalnica River watershed according to available literature data

Biological Diversity Component	Number of species/habitats	Global Red Lis	European Red List	Habitats/Birds Directive	Bern Convention	Law on Nature Protection	Endemics	Rare species
Habitats	*61*			*41*	*45*			
Vascular flora	*1414 taxa*	*3*			*2*	*11*	*9*	*56*
Fungi	*629 species*		*26*			*12*		*100*
Mammals	*65 species*	*7*		*25*	*44*	*8*		
Birds	*226 species*	*17*	*17*	*68*	*165*	*78*		
Amphibians and reptiles	*39 species*	*1*		*28*	*37*	*26*		*13*
Fish	*26 species*	*1-3*				*4*		
Dragonflies and damselflies	*41 species*		*3*	*4*				
Ground Beetles	*287 species*	*1*				*2*	*20*	*42*
Butterflies	*149 species*	*3*	*12*	*7*	*5*	*4*	*2*	*10*
Diatomic algae	*> 260 species*						*~10*	*>25*
Aquatic macroinvertebrates	*327 species*	*1*	*2*	*3*	*2*		*4*	*51*
Total		***~35***	***~60***	**176**	**300**	**145**	**45**	**297**

10.1 Plant Diversity

The Republic of Macedonia from a floristic aspect is one of the richest and the most diverse areas in the Balkan Peninsula and in Europe. The research of the flora of the Republic of Macedonia started 170 years ago and occurred with different intensity. Today it is represented with 3200-3300 species.

Eastern parts of the Republic of Macedonia with its orographic, geological and botanical values were less attractive in the past, thus, there is less data for this area. The data on the flora of the investigated area is encountered especially in the edition of Flora of the Republic of Macedonia (Micevski, 1985 to 2005; Matevski, 2010) and some separate floristic and phytosociological articles for some parts of the watershed area of the river Bregalnica. More extensive research was conducted on the territory of Malesh and Pijanec (Micevski, 1978; Dzhekov and Rizovski, 1978), for Ovche Pole (Micevski, 1965), as well as for the Macedonian steppe (Micevski, 1972, Matevski et al., 2008).

The flora of the Bregalnica watershed has over 1400 taxa. The Osogovo Mountains alone account for 1000 species. The lowland flora is especially interesting since it has the largest number of rare and endemic species. The locality of Judovi Livadi and several others in the Maleshevo Mountains and Bukovnik are the only locations with the insectivorous plant *Drosera rotundifolia*.

The diversity of plants is most noticeable in the plains. West of Shtip there are locations which have rare and endemic species of plants (*Hedysarum macedonicum, Onobrychis megalophylla, Ferulago macedonica, Salvia jurisicii*), halophytes (*Artemisia maritima, Eurotia ceratoides, Camphorosma monspeliaca, Camphorosma annua*) and steppe plant species (*Astragalus parnassi, Morina persica, Convolvulus holosericeus*). Some of these species can be found on the slopes of Osogovo Mountains.

***Drosera rotundifolia*, Pehchevska River**

The easternmost part of the area has several significant plant species in the mountainous parts, viz: *Drosera rotundifolia, Picea abies, Verbascum lesnovoensis, Genista fukarekiana, Lycopodium clavatum, Dryopteris borreri, Festuca thracica* subsp. *violaceo-sordida* var. *osogovoense, Viola orbelica* etc.

Salvia jurisicii at the cemetary of Vrsakovo (Ovche Pole)

Thymus macedonicus

Thymus balcanus

Centaurea finazzerii

Chrosophora tinctoria

During the valorisation of different conventions, lists of important species with international or local significance were used (IUCN Red List, 1998, Bern Convention, CORINE, endemic and rare species).

The Global Red List of IUCN (1998) includes just one species: *Hedysarum macedonicum,* distributed along the locations on the villages Gradsko, Ulanci, Eneshevo; Sv. Nikole, Delisinci and Gladno Pole.

The Global Red List IUCN (2013) includes three species: *Marsilea quadrifolia* (Kochani, Shtip), *Salvinia natans* (Shtip, Kochani) and *Ranunculus fontanus* (only in the vicinity of Pehchevo). Two of these species are included in the Annex I (strictly protected species) of the Bern Convention: *Marsilea quadrifolia* and *Salvinia natans*. The species of *Ranunculus fontanus* and *Drosera rotundifolia* are included in the Corine list.

Hedysarum macedonicum

Especially interesting are the endemic species of the Bregalnica River watershed. Five species of those have a very limited distribution, practically in the area of interest and the steppe regions of Central and Southern Macedonia, and two species are endemic for the Osogovo Mountains:

1. *Alyssum bargalense* (Sv. Nikole- Delsinci, Kjoselari, Bogoslovec, Shtip-gorge of Breglanica);
2. *Potentilla tridentula* (Ovche Pole - Delsinci; Shtip; Nogaevci, Eneshevo, Slan Dol, Krivolak);
3. *Hedysarum macedonicum* (Gradsko, Ulanci, Eneshevo, Sv. Nikole- Delsinci, Shtip, Gladno Pole);
4. *Onobrychis hypargyrea* (Gradsko, Ulanci, Eneshevo, Sv. Nikole- Delsinci, Ovche Pole railway station, vicinity of Shtip);
5. *Ferulago macedonica* (Ovche Pole – Sudich, Vrsakovo);
6. *Salvia jurisicii* (Ovche Pole – Sudich, Vrsakovo);
7. *Thesium macedonicum* (Nogaevci, Ulanci, Eneshevo, Sv. Nikole – Ovche Pole railway station, Bogoslovec, Delsinci, Shtip);
8. *Verbascum lesnovoense* (Probishtip-Lesnovo)
9. *Genista fukarekiana* (Osgovo – Sultan Tepe Peak)

Hypericum cerastoides

The area of interest has a large number of rare species i.e. species that are only present on a small number of territories in Macedonia (<5): *Huperzia selago* (Osogovo - Sultan Tepe); *Lycopodium clavatum* (Osogovo - Sasa); *Selaginella helvetica* (Plachkovica); *Dryopteris borreri* (Osogovo -"Sasa"); *Dryopteris carthusiana* (Osogovo-"Sasa"); *Dryopteris x tavelii* (Osogovo - "Sasa"); *Gymnocarpium dryopteris* (Osogovo, Plachkovica, Golak); *Blechnum spicant* (Pehchevo-Pehchevska River); *Picea abies* (Maleshevo Mountains: Murite); *Ranunculus pseudomontanus* (Osogovo, Ruen, Sultan Tepe и Gushterica); *Silene pusilla* (Osogovo; Maleshevo Mt..-Chengino Kale); *Dianthus microlepis* (Osogovo, Ruen and Sultan Tepe); *Dianthus superbus* subsp. *speciosus* (Osogovo - Carev Vrv; Maleshevo Mt.:Chengino Kale); *Kraschenninnikovia ceratoides* (Ovche Pole: Delisinci; Veles - Ulanci, Eneshevo); *Camphorosma monspeliaca* (Ovche Pole-Erdzelija, Mustafino, Azambegovo и Delisinci; Veles - Eneshevo, Ulanci); *Camphorosma annua* (Ovche Pole: between Mustafino and Erdzelija); *Suaeda maritima* (Ovche Pole); *Limonium gmelinii* (Ovche Pole, Delisinci, Shtip); *Hypericum hirsutum (Osogovo – Sultan Tepe); Hypericum cerastoides (Plachkovica, Lomska River; Maleshevski Mt.-Cironska River, Suvi Laki; Berovo lake, Vinica: v. Laki, Kartal); Hypericum annulatum (Shtip-Isar; Kochani - v. Zrnovci; pl.Plachkovica - v.Blatec); Viola biflora (Osogovo - Sultan Tepe); Viola dacica (Kadijica, Gushterica); Arabis procurrens (Plachkovica - Blatechka River, Osogovo – Sultan Tepe); Arctostaphylos uva-ursi (Osogovo - Sultan Tepe); Vaccinium vitis-idaea (Ograzden - Suvi Laki); Pyrola minor (Bukovich, Pehchevo); Moneses uniflora (Osogovo - Sultan Tepe); Androsace elongata (Shtip - Vancho Prke); Chrozophora tinctoria (Ovche Pole); Geum rivale (Osogovo - Sultan Tepe); Sedum erythraeum (Osogovo - Sultan Tepe, Kitka); Sedum tuberiferum (Probishtip - v.Zletovo, Zletovska River); Drosera rotundifolia (Pehchevo, Pehchevska River, Judovi Livadi); Biserrula pelecinus (Sv.Nikole - v. Delisisnci); Trifolium strictum (Delchevo- v. Lukovica, v. Makedonska Kamenica; Pehchevo, Berovo-Obozna); Ammannia baccifera (Shtip - v. Krupishte); Impatiens noli-tangere (Osogovo - Sultan tepe, Makedonska Kamenica - Sasa; Pehchevo - Bregalnica; Plachkovica - v. Blatec; Chengino Kale); Impatiens balfourii (Pehchevo – Bregalnica river); Coriandrum sativum (Sveti Nikole - v. Delisinci); Centaurium spicatum (Sveti Nikole – Ovche Pole, Bogoslovec); Convolvulus holosericeus (Gradsko, v. Ulanci, v. Mushanci, Solen Dol v. Dzumajlija; Ovche Pole - Bogoslovec, Stip-Gladno Pole); Pulmonaria rubra (Osogovo - Ponikva; Kochani-v. Zrnovci-Zrnovska River; Vinica-Ramno Brdo, Osojnica river, v. Laki-Kartal, Plachkovica: v. Blatec; Berovo: Berovsko river); Nonea echioides (Ovche Pole - v. Delisinci, v. Vrsakovo, v. Sudich,; Shtip - Isar); Anchusa italica (Gradsko - v. Ulanci, Ovche Pole-v. Vrsakovo, v. Sudich, Bregalnica, v. Krupishte, Kochani, Shtip); Anchusa macedonica f. gracilis (Ovche Pole - v. Vrsakovo, v. Sudich, Bogoslovec; Shtip - Isar); Anchusa macedonica f. elatior (v. Mushanci, Solen Dol, v. Eneshevo); Ajuga pyramidalis (Osogovo-Sultan Tepe); Ballota hirsuta. (Kochani-v. Istibanja, Ballota acuta (Mch.) Briq.); Stachys milani (Shtip-Ovche Pole); Adoxa moschatelina (Malesh – Kitka, Debel Rid); Morina persica (Ovche Pole:Vrsakovo, Shtip: Gladno Pole, Penush, Plachkovica- v. Zrnovci); Pinguicula balcanica (Osogovo-Sultan Tepe); Veronica montana (Vinica: v. Laki, Kartal); Zacyntha verrucosa (Shtip: v. Penush); Astragalus paranassi (Ovche Pole:Vrsakovo,v. Sudich, Shtip: Gladno Pole, v. Penush)*

Suaeda maritima

As a result from this research there are finding of two new species for the Macedonian flora: *Nepeta parviflora* (Ovche Pole: Vrsakovo, Sudich) and *Hieracium olympicum* (Kamenica).

Especially important habitats are the following:

Ovche Pole (+ Gladno Pole): area with unique halophytic flora and vegetation. Important halophytic species: *Camphorosma monspeliaca, Hordeum geniculatum, Camphorosma annua, Puccinelia convoluta, Pholiurus pannonicus, Stachys milani, Plantago tenuifolia, Plantago coronopus, Anchusa macedonica, Anchusa italica, Centaurium spicatum, Chrozophora tinctoria, Limonium gmelinii, Suaeda maritima, Krascheninnikovia ceratoides, Nonea echioides, Centaurea finazzeri, Ferulago macedonica, Capparis sicula, Picnomon acarna, Artemisaia maritima*. Important halophytic communities: *Camphorosmetum monspeliacae, Hordeo-Trifolietum parviflori, Suaedetum maritimae, Puccinelietum convolutae* and *Camphorosmetum annuae*. More of them are devastated or fragmented.

Bogoslovec: area with nicely preserved stands of steppelike vegetation and Locus classicus of several endemic species (*Alyssum bargalense*, *Potentilla tridentula, Onobrychis hypargyrea, Hedysarum macedonicum, Ferulago macedonica, Salvia jurisicii*, *Morina persica, Astragalus parnassi, Thesium macedonicum, Convolvulus holosericeus, Zacyntha verrucosa, Anchusa macedonica, Centaurium spicatum, Coriandrum sativum, Biserrula pelecinus, Limonium gmelinii, Nonea echioides, Echinophora sibhorpiana, Phlomis herba-barona susbp. pungens, Thymus pseudo-atticus*).

Osogovo: Ruen, Sultan Tepe, silicate flora: *Genista fukarekiana, Lycopodium clavatum, Dryopteris borreri, Geum rivale, Ajuga pyramidalis, Sedum erythraeum, Moneses uniflora, Arabis procurrens, Viola biflora, Huperzia selago, Lycopodium clavatum, Dryopteris x tavelii, Gymnocarpium dryopteris, Ranunculus pseudomontanus, Silene pusilla, Bruckenthalia spiculifolia,Fritillaria gussichiae, Dianthus microlepis, Dryopteris carthusiana, Viola dacica, Potentilla haynaldiana, Thymus balcanus, Crepis conyzifolia, Aquilegia aurea, Senecio carpatica, Veronica bellidioides*

Osogovo-Zletovo, Ratkova Skala: *Verbascum lesnovoense, Juglans regia, Ostrya carpinifolia, Tilia tomentosa, Tilia platyphyllos, Corylus colurna, Acer hyrcanum* subsp. *intemedium, Malus florentina, Marsilea quadrifolia, Geranium macrorrhizum, Asplenium adianthum-nigrum*

Judovi Livadi, peat bog: *Drosera rotundifolia*, *Sphagnum* sp., *Cetunculus minimus, Juncus capitatus, Juncus tanageia, Blechnum spicant, Dianthus quadrangulus, and Ranunculus fontanus*

Pehchevska River, peat bog: Blechnum *spicant, Drosera rotundifolia, Sphagnum sp. , Monotropa hypopitys*

Plachkovica Mt.-Zrnovska River, dry grasslands: *Morina persica, Astragalus parnassi, Thumus comptus, Thymus macedonicus, Paronychia macedonica, Jurinea consaguinea subsp. Arachnoidea, Festuca callieri, Ficus carica, Ostrya carinifolia, Teucrium capitatum*

Plachkovica Mt.-Kartal, beech forest: *Hypericum cerastoides, Veronica montana, Angelica pancicii, Pulmonaria rubra, Polypodium interjectum*, *Neottia nidus-avis, Achillea macrophylla, Asarum europaeum, Circaea lutetiana, Pinus sylvestris, Crocus palasii.*

Maleshevo Mountains-Murite: *Picea excelsa, Abies borisii-regis, Lamium galeobdolon, Pulmonaria rubra.*

Maleshevo Mountains-Trebomirska River: *Pulmonaria rubra, Ranunculus ophioglossifolius, Atropis distans, Secale montanum, Orthilia secunda, Pinus sylvestris.*

Maleshevo Mountains-Chengino Kale: *Dianthus superbus* subsp. *speciosus, Geum coccineum, Succisa pratensis, Sphagnum* sp., *Bruckenthalia spiculifolia, Ranunculus ophioglossifolius, Centaurea stoebe, Thymus macedonicus.*

10.2 Fungi Diversity

The Republic of Macedonia is mycological relatively well studied. Since 2000 the studying of fungi diversity in Macedonia has become more systematic and intense. Previous studies on fungi diversity that are available were focused on separate regions in Macedonia (Pelister, Jakupica, Galichica, Golem Grad Island, Kozhuf, Shar Planina, Juzhno Povardarie, etc.) and with special emphasis of lignicolous fungi. But, the past 15 years of mycological research has given a more clear figure of mycobiota in certain regions of the country (Vodno, Bistra, Dobra Voda, Jablanica, Mavrovo, Osogovski Mountains, Ograzhden, etc.) or separate taxonomic categories (mainly macromycetes, such as: *Amanita, Ganoderma, Hymenochaete, Hyphoderma, Peniophora, Phellinus*, Boletaceae, gasteroid, hypogeous and hallucinogenic fungi, morels, etc.). Based on research to date, approximately 2,000 macromycetes species have been recorded in the Republic of Macedonia.

Previous systematic mycological researches in the area of interest (Bregalnica region) were related to Osogovo, while for the other localities (mountains: Ograzhden, Plachkovica, Maleshevski Mountains, Golak, as well as the vicinity of towns of Berovo, Shtip, Delchevo, Sveti Nikole) there are only single data in separate papers (Karadelev 1999; Karadelev 2000; Karadelev & al. 2002, 2004,

2006, 2007, 2008a, b, c, d, 2009, 2013; Karadelev & Spasikova 2004a, 2004b; Karadelev & Rusevska 2004-2005; Bauer-Petrovska et al. 2008; Karadelev 2008; Karadelev & Spasikova 2009; Kajevska et al. 2013; Rusevska et al. 2014). A total of 289 fungi species were known for the area of interest.

Amanita caesarea

The goal of the fungi diversity research in the Bregalnica watershed was to create a clearer and more complete understanding of the region's micodiversity. Field work was especially focused on older forests, riparian communities as well as forest habitats in protected or proposed protected areas.

Given that in the area of the Bregalnica watershed detailed and continuous mycological research has not been conducted (except on Osogovo) most of the identified data gaps were related to field studies. Field research and laboratory analysis conducted in the frame of this project provided 1200 additional data on fungi which creates a much more realistic picture for the fungi diversity in Bregalnica watershed. Some of this data was related to species that are new for Macedonia, species rare and endangered species as well as data for the Red List of Macedonia Fungi, The Biodiversity Strategy and other important documents. This research has also augmented the national fungi collection (Macedonian Collection of Fungi, MCF) and the national fungi database (MAK FUNGI).

Xylaria longipes

Based on previous data and with the new results from the research done in the scope of this project the Bregalnica watershed now has 629 fungi species.

Most of the species belong to stem fungi (Basidiomycota), 29 of them are gasteroid, followed by (Ascomycota) with 64 species, 10 of them are lichens and then (Myxomycota) with 11 species (Fig. 32). Three hundred and one species of the fungi are lignicole, 291 are tericole (2 of

those are underground species), while the rest grow on rocks, mosses, decaying leaves, faeces and other fungi (Fig. 33).

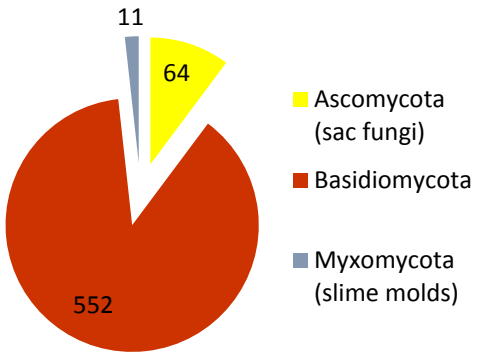


Fig. 32. Representation of the species in the main fungi phyla

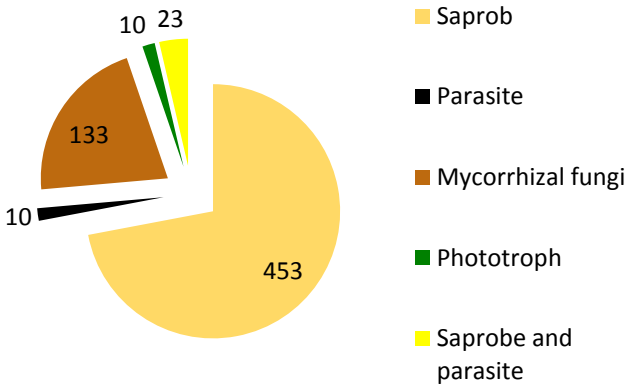


Fig. 33. Number of species according to their substrates

Valorisation has been made in accordance with a few internationally recognized criteria, such as: unofficial Red List of Macedonian Fungi, MRL (Karadelev & Rusevska, 2013), European Red List of Fungi, ERL (Ing, 1993), ECCF – European council for Conservation of Fungi (33 threatened fungi in Europe, August, 2003), rare/very rare species (according to previous research, as well as information provided in the mycology data base), protected areas and species proposed for priority protection. A total of 161 species were selected for the valorisation.

Based on the results there are 23 fungi from the National Fungi Red List, six of them are endangered and as many are vulnerable, seven are near threatened and three are least concerned. (Fig. 34).

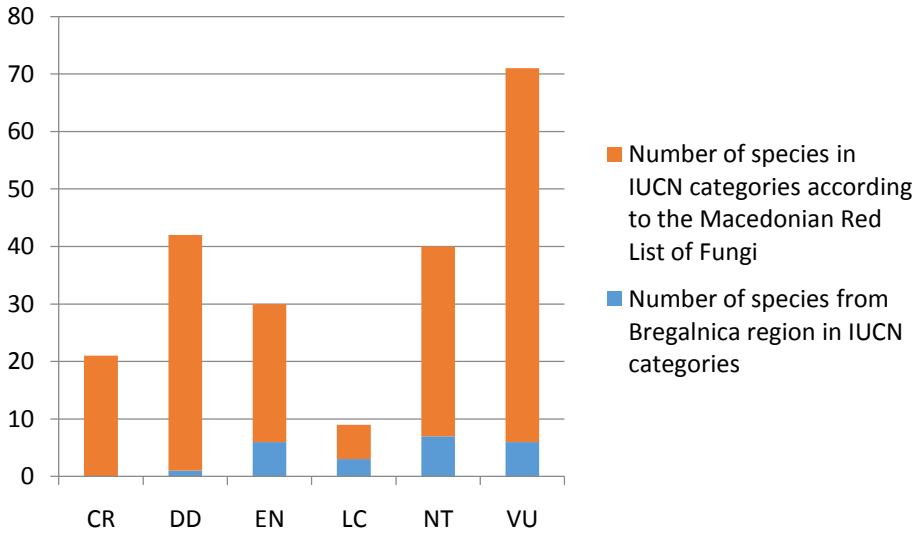


Fig. 34. Comparative figure of the IUCN categories of the total species number in Macedonian Red List of Fungi and Bregalnica region

The number of species that belong to the four groups of the European Red List (A, B, C and D) is 26. There are two species in group A and D, five in group B while the rest (17) belong to group C (Fig. 35).

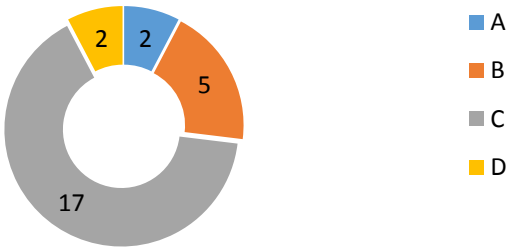


Fig. 35. Number of species from Bregalnica region which are part of the European Red List of Fungi

There are 44 rare species and 56 very rare.

In the group of protected species according to the Law on Nature Protection, there are 12 species. Nine of them are edible (three of those are commercial), one is poisonous and the other two lignicole species are not used in the human diet (Table 7).

Table 7. Fungi species protected with the Law on Nature Protection

Protected species
1. ***Agaricus macrosporus***
2. ***Amanita caesarea***
3. ***Auricularia auricula-judae***
4. ***Boletus aereus***
5. ***Boletus fechtneri***
6. ***Boletus rhodoxanthus***
7. ***Boletus satanas***
8. ***Craterellus cornucopioides***
9. ***Lopharia spadicea***
10. ***Macrolepiota procera***
11. ***Phellinus robustus***
12. ***Tremella foliacea***

The criteria for selection of these species was that they belong to at least one category, i.e. group, from the National or European Red List, or are included in the group of very rare/rare species. The researched area is the only place where some of these species can be found.

Out of the total number of species, 115 can be used as food (Fig. 36) and 36 of those are economically important while 16 are commercial species (Caesar's mushroom, Chanterelle, Horn of Plenty, Dark Cep, Summer Cep, Penny Bun, Common and Black Morels, etc.). There are 15 medicinal species, the most important being: Reishi Mushroom, Lion's Mane and Birch Bracket.

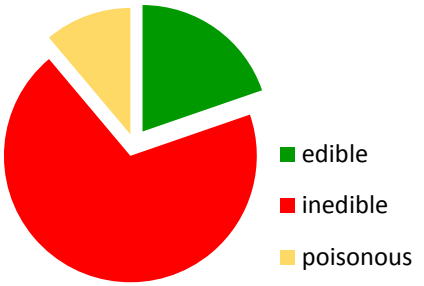


Fig. 36. Numbers of fungi according to their inclusion in human diet

Regarding habitats (Fig. 37), the richest habitats are beech forests (295 species) and azonal vegetation (168), while lower diversity is noted in oak forests (76), as well as in pine belts (46) or pine forests (48). A few species are recorded form meadows (13), pastures (6) or ruderal grassy habitats (6).

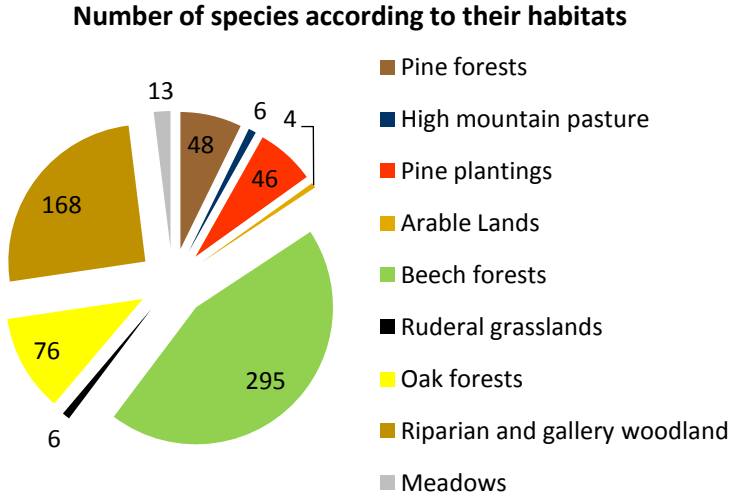


Fig. 37. Distribution according to habitats

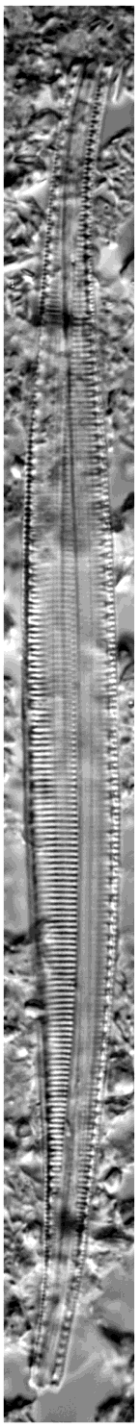
In relation to the relatively large number of localities and different habitats in the Bregalnica region, it is important to highlight the localities which provide first data for the Macedonian mycobiota for 38 species (Table 8). In this context, localities with old and well developed forest associations are especially important, such as the rivers: Trebomirska, Ramna, Pehchevska and Zletovska (vicinity of Knezhevo dam), Kartal and Pesok, habitats with riparian forests – poplar belts (vicinity of Ubogo village), and azonal vegetation (the gorges of Blateshnichka, Gradeshka and Zrnovska River).

***Sparassis crispa* at Trebomirska River**

Table 8 . Fungi Species which can only be found on a single location in Macedonia i.e. in the Bregalnica watershed

Species	Location	
1. *Amanita porphyria*	Valina Mountain	Road Pehchevo-Delchevo
2. *Barlaea constellatio*	Plachkovica	Blateshnika River gorge (over Blatec)
3. *Ceratobasidium cornigerum*	Veles-Gradsko	Vicinity of Ubogo
4. *Cortinarius (Phlegmacium) ophiopus*	Plachkovica	Gradehska River (over Gradec)
5. *Cortinarius cinnabarinus*	Plachkovica	Kartal (Over Laki, Selska River)
6. *Cortinarius sinapizans*	Maleshevo Mountain	Pesok (Berovo Lake, vicinity of Klepalo)
7. *Diatrype bullata*	Plachkovica	Lakavica River (Under Baltalija)
8. *Dichostereum effuscatum*	Veles-Gradsko	Vicinity of Ubogo
9. *Encoelia fascicularis*	Smrdesh	
10. *Glyphium elatum*	Slan Dol	Vicinity of Ubogo
11. *Hebeloma birrus*	Plachkovica	Gradeshka River (over Gradec)
12. *Hohenbuehelia myxotricha*	Plachkovica	Zrnovska River
13. *Hygrophorus barbatulus*	Valina Mountain	Pehchevska River
14. *Hyphoderma medioburiense*	Plachkovica	Zrnovska River
15. *Inocybe (Inocybulum) bongardii*	Osogovo Mountain	Vicinity of Knezhevo Dam
16. *Inocybe (Inocybulum) cincinnata*	Plachkovica	Gradeshka River (Gradec)
17. *Inocybe (Inocybulum) fraudans*	Plachkovica	Kartal(Laki, Selska River)
18. *Inocybe (Inocybulum) lacera var. helobia*	Maleshevo Mountains	Piponova Chuka
19. *Leucopaxillus tricolor*	Osogovo Mountains	Vicinity of Knezhino Dam
20. *Lyophyllum* cf. *tylicolor*	Plachkovica	Blateshka River Gorge (Blatec)
21. *Mycena bulbosa*	Plachkovica	Gradeshka River (Gradec)
22. *Mycena corynephora*	Smrdesh / Plachkovica	
23. *Mycena hiemalis*	Maleshevo Mountains	Piponova Chuka
24. *Mycena pseudoinclinata*	Golak	Stara Kula
25. *Pholiota flammans*	Maleshevo Mountains	Ramna River
26. *Pluteus luctuosus*	Maleshevo Mountains	Ramna River
27. *Psathyrella conopilus*	Osogovo Mountains	Vicinity of Knezhino Dam
28. *Psathyrella pseudogracilis*	Slan Dol	Ubogo
29. *Ramaria bataillei*	Vlaina Mountain	Pehchevska River
30. *Ramaria spinulosa*	Plachkovica	Gradeshka River (Gradec)
31. *Rickenella mellea*	Vlaina Mountain	Pehchevska River
32. *Russula acetolens*	Plachkovica	Zrnovska River
33. *Russula anthracina*	Vlaina Mountain	Pehchevska River
34. *Sparassis crispa*	Maleshevo Mountains	Terbomirska River
35. *Spinellus fusiger*	Maleshevo Mountains	Ramna River
36. *Stemonitis pallida*	Plachkovica	Zrnovska River
37. *Tephrocybe boudieri*	Plachkovica	Blateshka River Gorge (Blatec) (Блатец)
38. *Tricholoma inamoenum*	Vlaina Mountain	Pehchevska River

10.3 Diatom Algae Diversity



New species for science (genus *Nitzchia)*

Diatoms (silicate algae) are unicellular, photosynthetic, eukaryotic organisms inhabiting various water and wet habitats. They can be found in various habitats like springs, streams, rivers, ponds, wetlands, lakes as well as in costal and marine environments. There are several estimations about the diversity of the diatoms, but in general it is considered that there are around 100.000 species (extant and fossil). So far in Macedonia around 1600 species have been recorded. Based on their relatively narrow ecological preferences, diatoms can be used as a tool in various studies like biomonitoring, biogeography, ecology and paleoecology.

By far only a few papers in regard to the silicate algae have been published on the Bregalnica watershed. Some of them are related to biomonitoring, or deal with the flora of extreme habitats. More recently, the taxonomic studies of diatoms have been intensified resulting with description of several new species from the genera *Luticola*, *Achnanthes* and *Eunotia*.

However, the data on diatom composition for the major part of the habitats in the river Bregalnica watershed are missing. That is especially evident for extreme habitats as salty soils, thermo-mineral springs, peat-bogs and wet rocks. These habitats are discontinued, specific and characterized by species well adapted to low moisture or high temperature and mineral content. For that purpose a detail study on these habitats has been performed.

The detailed observations of samples from the river water bodies revealed 248 species. The diatom composition in the river was consisted mainly of cosmopolitan (widely spread) species that are tolerant to highly tolerant to eutrophication and pollution. More diverse flora has been recorded in the source area of the rivers where several rare and endangered species as *Eunotia macedonica, Eunotia atomus, Eunotia tetraodon* were recorded. More important were finding of the extreme habitats.

Peat-bogs are characterized with dystrophic conditions, low pH values and low concentration of nutrients and mineral content (conductivity). In such environments the number of diatoms species is low, but the species are very specific and have limited distribution in Macedonia as well as in Europe. In some habitats (for instance peat-bogs near Judovi Livadi, Pehchevo) due to the low pH and low nutrient concentration the number of species is very low, but all observed species are considered as rare in the flora of Macedonia. Such species are *Eunotia atomus, Eunotia fabaeformis*, *Pinnularia ivaloensis*, *Pinnularia rabenhorstii*, *Pinnularia submicrostauron.*

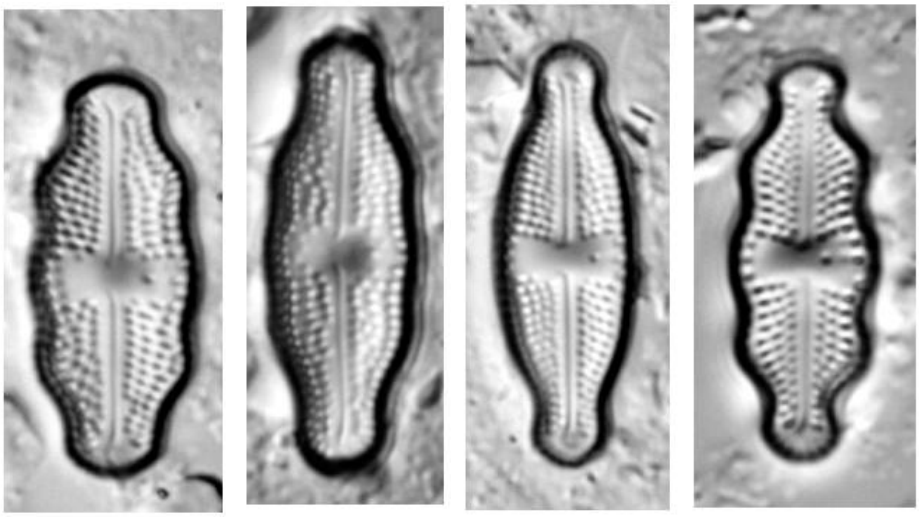
Wet rocks are also considered as extreme habitats that are inhabited with aerophytic species, or species that are tolerant to longer period of desiccation. Similarly as with previous habitat, the number of the diatom species is low, but the distribution of such species is highly limited. Several interesting species have been recorded on the mosses or blue-green mats like

Luticola quinquenodis, *Achnanthes prominula*, *Achnanthes pseudocoarctata*, *Cymbopleura hercynica*, *Stauroneis microbtusa* and other.

However, most interesting species were observed in the thermo-mineral springs and wet salty soils. These habitats are inhabited by very limited number of species which are adapted to high mineral content and higher temperature. Such species are *Achnanthes secretitaeniata*, *Cylindrotheca gracilis*, *Denticula subtilis*, *Entomonies paludosa* and *Scoliopleura peisonis*It. It should be noted that in a decade of diatem research, this study provides the first record in Macedonia for the genera *Cylindrotheca, Entomonies* and *Scoliopleura*. The genus that has large species diversity in such habitats is *Nitzschia sensu lato*.

During the observations of saline habitats and mineral springs 47 different species have been recorded. This number of species represents almost 2/3 of the total number of *Nitzschia* species so far observed in Macedonia. The analyses of the samples from these habitats reveal presence of several interesting species which are recorded for the first time in diatom flora of Macedonia, such as *Navicula bergeri, Navicula lundii*, *Pinnularia ivaloensis*, *Pinnularia minutiformis*, *Pinnularia submicrostauron*.

One of the main results of the observations is record of 34 taxa in total which have unclear taxonomical status. It is also worth mentioning that six taxa of *Halamphora* and *Luticola* (labelled with sp. 1-3) could not been further identified.



New species for science from the genus *Luticola* found at Gladno Pole

According to the current observations, the most important localities are the saline soils on Gladno Pole. On this locality three new genera and several new species for flora of Macedonia were recorded, and also more important several (at least six) new species for science were observed.

Beside this locality, important localities characterized by high diversity or presence of rare or endemic species are the soarce area of Kamenichka Reka, wet rocks on Osogovo Mountain (especially in the vicinity of Star Grad), peat-bogs on Bukovic, Pehchevo (Judovi Livadi). Several new species from the genera *Achnanthes, Eunotia* and *Luticola* have been described from these localities. New or rare species from the genus *Eunotia* have been determined from the peat-bogs around the source of Kamenichka Reka.

10.4 Mammal Diversity

According to the available literature data, (Kryštufek & Petkovski, 1989, 1990, 2003; Kryštufek et al., 1992; Kryštufek et al., 1998; Petkovski, 1997; Petrov, 1992; Polednik et al., 2008; Purger & Kryštufek, 1991, Stojanov et al. 2009, Stojanov et al. 2010, Micevski et al. 2014), there are 59 mammalian species found in the area of Bregalnica River Watershed. Although the number of registered species in the area is high, these data are still incomplete in regard to the existing or proposed protected areas in Bregalnica River Watershed. There are certain data for a very few important areas (Osogovo Mts., Zletovska River, Berovsko Lake) etc., while for the most of the localities there are almost no data for mammal presence.

The main goals of the research of mammalian fauna in Bregalnica River watershed were: to register the presence of mammalian species in the area, to compare the ground data with the available literature data, as well as to identify the most important species and areas for protection. During the research of the mammalian fauna, special focus was put on the existing protected areas, as well as on the proposed or newly identified areas for protection. Several methods were used to confirm the presence of certain species: camera-traps (Fig. 38), tracking surveys along transects, cave visits, echolocation and snap traps.

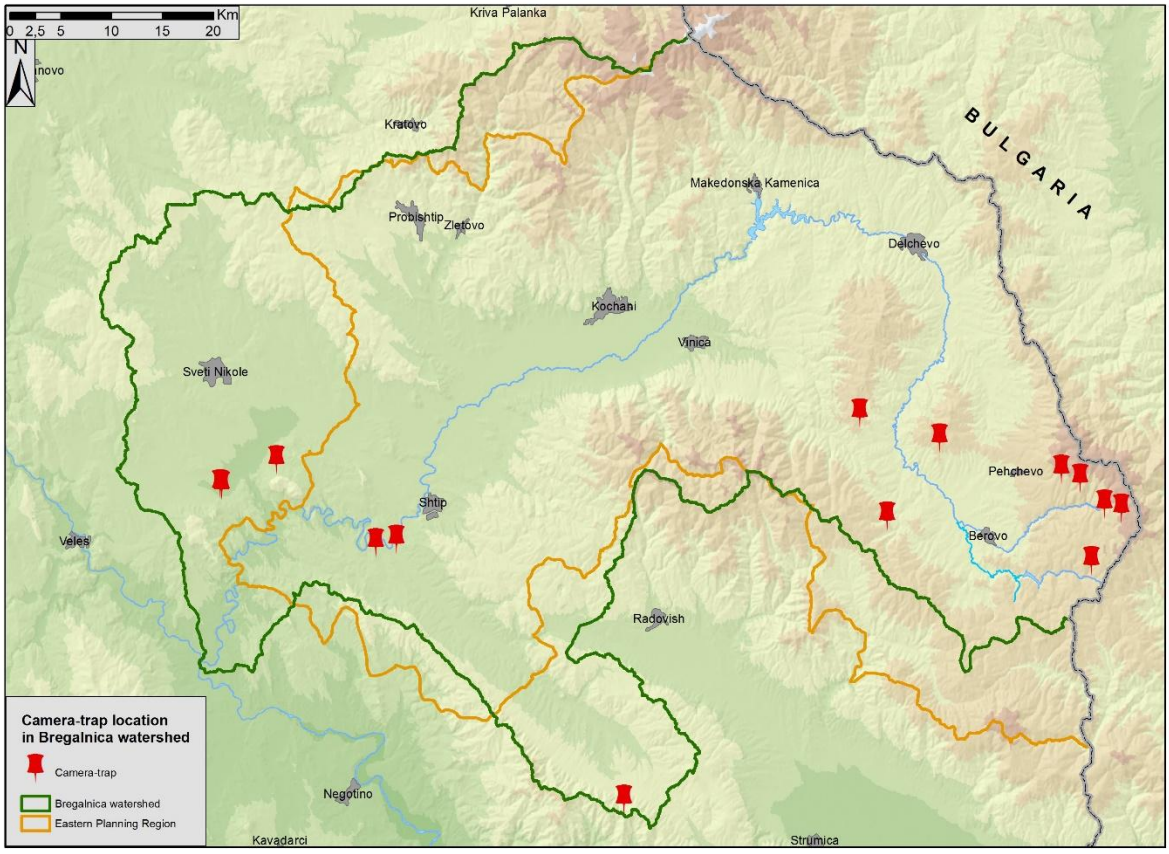


Fig. 38. Camera-traps placed during the Bregalnica watershed research

Thirty-eight to forty different mammalian species were registered during the field research. The number of species varies due to the fact that identification of certain bat species to a species level is not possible with analysis of the echolocation data only. This is the case with the specimens from the genus *Myotis sp.* and *Pipistrellus sp*. Six of the registered species are not mentioned in the literature and they are new for the area of interest: *Muscardinus avellanarius, Apodemus agrarius,*

Suncus etruscus, Barbastella barbastellus, Nyctalus lasiopterus and *Myotis emarginatus.* During the investigations, we got the first hard fact for presence of the species *Nyctalus lasiopterus* in the Republic of Macedonia.

Roe at Ljutaci, Pehchevo

Wild cat at Gjavol Dol, Berovo

Wolves at Ljutaci, Pehchevo

Wild boar at Kamenica, Berovo

Otter tracks on Bregalnica, near Stramer

Bear tracks at Zemunicija, Pehchevo

Geoffroy's bat at Konjska Dupka

Pygmy Shrew at Blatishte, Maleshevo

Considering both, the literature and the ground data, the total number of registered mammalian species in the area of Bregalnica River Watershed is 65, which represents around 76% of the mammalian fauna of Macedonia. Their spatial distribution is presented on Fig. 39. Two species are categorized as Vulnerable (VU) and 5 species are categorized as Near Threatened (NT) according to the European Red list of endangered species. Twenty-two species are included in Appendix II and 22 species are included in Appendix III of the Bern Convention. Nine species are listed in Annex II & IV, 15 species are listed in annex IV and 1 species is listed in annex V of the EU Species and Habitat Directive. Nineteen species are listed in Appendix II of the Bonn Convention, while 10 are identified as Emerald species. According to the provisions of the Law on Hunting of RM, 7 species are strictly protected and 6 species have seasonal protection. The Law on Nature Protection of RM defines 3 species as strictly protected and 5 additional as protected species.

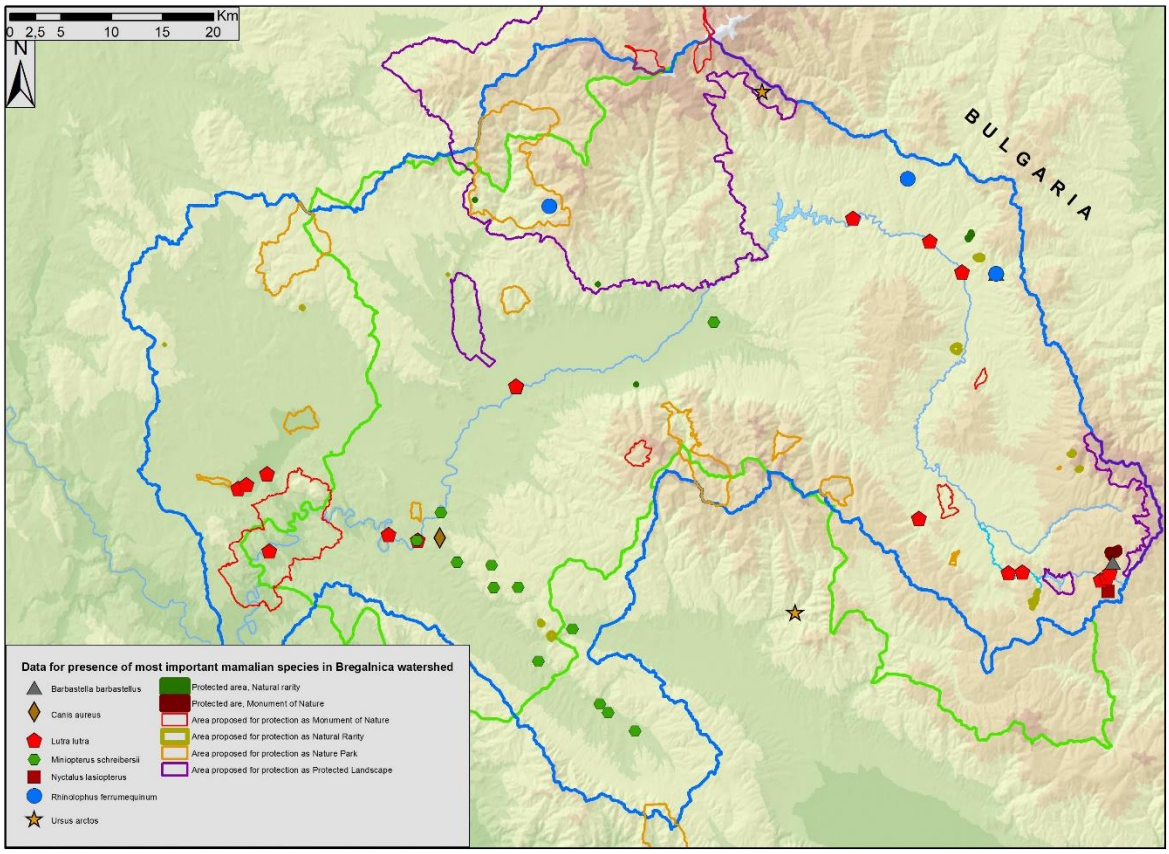


Fig. 39. Distribution of significant mammal species in the Bregalnica watershed

Most important mammalian species for the area of Bregalnica River Watershed are: Brown Bear (*Ursus arctos*), which is strictly protected by the Law on Hunting and Law on Nature Protection of RM and listed in several international convention and agreements; Otter (*Lutra lutra*), categorized as Near threatened (NT) according to the European Red list of endangered species; Marbled Polecat (*Vormela peregusna*), categorized as Vulnerable (VU) according to the European Red list of endangered species; Golden Jackal (*Canis aureus*), protected species according to the Law on Hunting of RM; Barbastelle (*Barbastella barbastellus*), categorized as Vulnerable (VU) according to the European Red list of endangered species; Schreibers' Bent-winged Bat (*Miniopterus schreibersii*), categorized as Near threatened (NT) according to the European Red list of endangered species; Greater Horseshoe Bat (*Rhinolophus ferrumequinum*), categorized as Near threatened (NT) according to the European Red list of endangered species; and Giant Noctule (*Nyctalus lasiopterus*), found only in Bregalnica River Watershed, close to the locality Klepalo.

The following protected or proposed areas for protection are identified as important for the conservation of the priority mammalian species in the area of Bregalnica River Watershed: Monument of Nature Murite, Natural rarity Kiselica Cave, Nature park Zletovska River-Ratkova Skala, Protected landscape Chengino Kale, Protected landscape Osogovo Mountains, Protected landscape Dolna Zletovica, Nature park Vulkanski Bombi, Nature park Ovche Pole, Protected Area Mangovica, Protected Area Gorni Livadi, Protected Area Kuri Dere and Monument of nature Lower Bregalnica (Consult **Report on the Status of Protected Areas in the Bregalnica River Watershed**).

10.5 Bird Diversity

A total of 226 birds have been recorded in the Bregalnica watershed. They belong to 147 genera, 57 families and 17 orders. Ninety-eight of them are resident breeding species or probable resident breeding species, 74 are migratory breeding species or probable migratory breeding species, 17 are wintering visitors, 30 only present during migration, 5 are vagrants and 2 (Little Bustard and Black Vulture) are considered extinct (Fig. 40). The Black Vulture regularly appears in the Kresna gorge in the Republic of Bulgaria, attracted by the reintroduced Griffon Vultures (Peshev et al. 2015). Since a flock of these birds has been observed from the Maleshevo Mountains, it can be expected that a Black Vulture can also be recorded there.

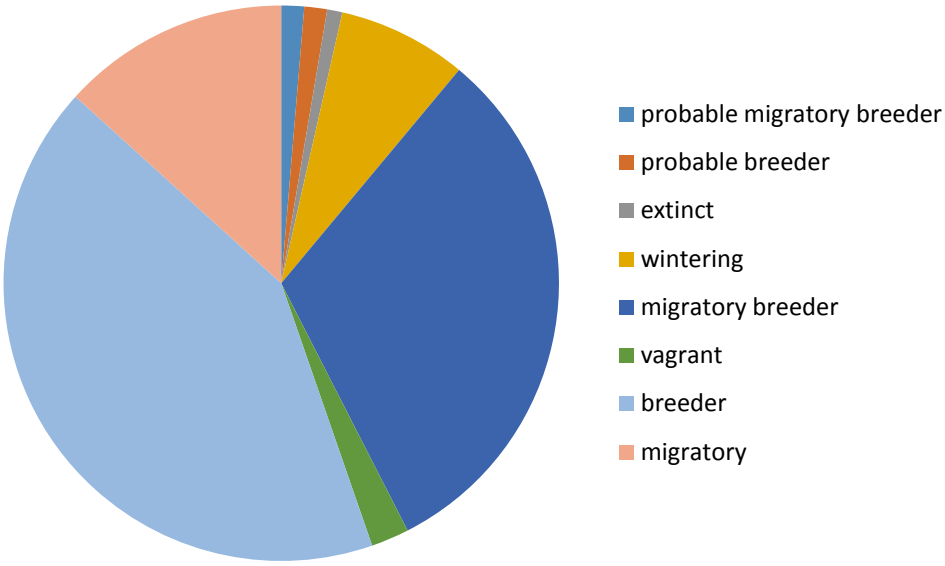


Fig. 40. Numbers of birds according to their seasonal status

Two of the registered species (Egyptian Vulture *Neophron percnopterus* and Saker Falcon *Falco cherrug)* are globally threatened, five (Imperial Eagle *Aquila heliaca*, Turtle Dove *Streptopelia turtur*, Common Pochard *Aythya ferina*, Dalmatian Pelican *Pelecanus crispus* and the Great Bustard *Otis tarda*) and vulnerable, while 10 other species are near-threatened.

According to the European Red List of Birds two species (Egyptian Vulture and Lanner Falcon *Falco biarmicus)* are threatened, nine species (Lapwing *Vanellus vanellus,* Kingfisher *Alcedo atthis,* Turtle Dove, Eurasian Curlew *Numenius arquata,* Great Grey Shrike *Lanius excubitor,* Common Pochard, Saker Falcon, Little Bustard *Tetrax tetrax,* Eurasian Oystercatcher *Haematopus ostralegus*) are vulnerable. Six species are near threatened.

Masked Shrike (*Lanius nubicus*)

As many as 68 species (Forty-six out of which are breeding or probably breeding) are included in Annex 1 of the European Union Birds Directive i.e. they are trigger species for protected areas in the framework of the Natura2000 network. A total of 165 species are included in Appendix 2 of the Bern Convention as Strictly Protected Fauna Species, and seven species are included in the Appendix 1 of the Bonn Convention on the Conservation of Migratory Species of Wild Animals as Threatened Migratory Species (Table 9).

Grey Heron Colony (*Ardea cinerea*) At Ularci

Lesser Kestrel (*Falco naumanni*) at Mustafino

Greater short-toed lark (*Calandrella brachydactyla*)

Roller (*Corracias garrulus*)

According to national legislation 60 species are strictly protected and 18 species are protected with the Lists for determining protected and strictly protected wild species in accordance with the Law on nature protection. According to the Law on Hunting, 61 species are permanently banned for hunting and 18 are protected with closed seasons.

Table 9. Numbers of species according to habitat and status

Numbers of species according to habitat and status	Total	Global Red List				European Red List				Annexes of Bird Directive								Annexes of Bern Directive			Annexes of Bonn Convention			Law on Nature Protection			Law on Hunting			
		EN	VU	NT	LC	EN	VU	NT	LC	I	I: II/A	I- II/R	II/A	II/B	II/A; III/A	II/A; III/B	N/A	II	III	N/A	I; II	II	N/A	Strictly protected	protected	unprotected	banned	Closed seasons	No protection	N/A
High-altitudes	**27**				**27**				**27**	**4**				**4**	**1**		**18**	**21**	**5**	**1**		**12**	**15**	**5**	**2**	**20**	**5**	**2**	**1**	**19**
breeding	2				2				2						1		1	1	1			1	1		1	1		1		1
migratory breeding	17				17				17	3				2			12	14	3			7	10	3	1	13	3	1		13
migratory	1				1				1								1	1				1				1				1
foraging	7				7				7	1				2			4	5	1	1		3	4	2		5	2		1	4
Coniferous Forests	**42**				**42**				**42**	**5**		**1**		**4**	**1**		**31**	**33**	**7**	**2**		**16**	**26**	**6**	**2**	**34**	**6**	**2**	**1**	**33**
breeding	32				32				32	2		1		4	1		24	24	6	2		10	22	4	2	26	4	2	1	25
possible breeding	1				1				1								1	1				1				1				1
migratory breeding	8				8				8	2							6	7	1			4	4	1		7	1			7
migratory	1				1				1	1								1				1		1			1			
Beech Forests	**46**				**46**				**46**	**9**		**1**		**6**	**1**	**1**	**28**	**34**	**10**	**2**		**17**	**29**	**6**	**4**	**36**	**6**	**4**		**36**
breeding	32				32				32	5		1		4	1		21	24	6	2		7	25	5	2	25	5	2		25
migratory breeding	11				11				11	3				1			7	9	2			7	4	1	1	9	1	1		9
possible migratory breeding	1				1				1	1								1				1				1				1
wintering	2				2				2					1		1			2			2			1	1		1		1
Oak forests and scrubland	**74**		**2**		**72**		**1**		**73**	**15**				**8**	**1**		**50**	**58**	**12**	**4**	**1**	**29**	**44**	**15**	**3**	**56**	**15**	**3**	**3**	**53**
breeding	41		1		40				41	7				6	1		27	30	7	4	1	10	30	10	1	30	10	1	3	27
migratory breeding	26		1		25		1		25	7				2			17	22	4			15	11	4	2	20	4	2		20
wintering	4				4				4								4	3	1			1	3			4				4
migratory	3				3				3	1							2	3				3		1		2	1			2
Hilly pastures with scrubland	**61**	**2**	**2**	**4**	**53**	**2**	**4**	**3**	**52**	**24**	**1**			**5**	**1**		**30**	**47**	**12**	**2**	**3**	**24**	**34**	**17**	**4**	**40**	**16**	**4**		**41**
breeding	21		1	1	19			1	20	3	1			3	1		13	11	8	2	1	3	17	5	2	14	5	2		14
possible breeding	1	1					1			1								1				1		1						1
migratory breeding	28		1		27	1	1		26	13				2			13	25	3		1	13	14	6	2	20	6	2		20
wintering	4				4		1	1	2	2							2	3	1			2	2	1		3	1			3
migratory	3			1	2			1	2	1							2	3				3				3				3
foraging	2	1			1	1			1	2								2			1	1		2			2			
extinct	2			2			1		1	2								2				1	1	2			2			
Rocks and ravines	**24**	**1**		**1**	**22**	**2**		**1**	**21**	**8**	**1**						**15**	**22**	**2**		**1**	**12**	**11**	**11**	**1**	**12**	**11**	**1**		**12**
breeding	11			1	10			1	10	4	1						6	9	2			5	6	7	1	3	7	1		3
migratory breeding	11	1			10	2			9	3							8	11			1	6	4	3		8	3			8
wintering	1				1				1								1	1					1			1				1
foraging	1				1				1	1								1				1		1			1			
Riparian Forests	**52**		**2**		**50**		**1**		**51**	**12**				**7**	**1**		**32**	**39**	**9**	**4**	**2**	**21**	**29**	**14**	**2**	**36**	**15**	**2**	**3**	**32**
breeding	34		1		33				34	5				6	1		22	24	6	4	1	11	22	8	1	25	9	1	3	21
migratory breeding	13		1		12		1		12	4				1			8	11	2			7	6	4	1	8	4	1		8
possible migratory breeding	1				1				1	1								1				1		1			1			
wintering	1				1				1								1		1				1			1				1
migratory	3				3				3	2							1	3			1	2		1		2	1			2
Rivers and river banks	**16**			**1**	**15**		**2**		**14**	**4**				**2**	**1**		**9**	**11**	**5**			**7**	**9**	**4**	**1**	**11**	**5**	**1**	**1**	**9**

Numbers of species according to habitat and status	Total	Global Red List				European Red List				Annexes of Bird Directive								Annexes of Bern Directive			Annexes of Bonn Convention			Law on Nature Protection			Law on Hunting			
		EN	VU	NT	LC	EN	VU	NT	LC	I	I: II/A	I- II/R	II/A	II/B	II/A; III/A	II/A; III/B	N/A	II	III	N/A	I; II	II	N/A	Strictly protected	protected	unprotected	banned	Closed seasons	No protection	N/A
breeding	6				6		1		5	1				1	1		3	4	2			1	5	1	1	4	1	1		4
migratory breeding	3				3				3								3	3				2	1			3				3
migratory	2				2				2								2	1	1			1	1			2			1	1
foraging	4				4				4	3							1	3	1			2	2	3		1	4			
vagrant	1			1			1							1					1			1				1				1
Accumulations and other waters	**52**		**2**	**1**	**49**		**2**	**1**	**49**	**17**		**1**	**2**	**5**	**1**	**6**	**20**	**32**	**20**		**2**	**34**	**16**	**19**	**7**	**26**	**21**	**7**	**1**	**23**
breeding	9				9		1	1	7	2				2	1	1	3	5	4			4	5	4	2	3	4	2			3
migratory breeding	5				5				5								5	4	1			4	1			5				5
possible migratory breeding	1				1				1	1								1				1				1				1
wintering	8				8				8					1		1	6	5	3			4	4	2		6	2	1		5
migratory	24		1	1	22		1		23	10		1	2	2		4	5	13	11		1	18	5	9	5	10	10	4	1	9
foraging	4				4				4	3							1	3	1			3	1	3		1	4			
vagrant	1		1						1	1								1			1			1			1			
Rice Fields	**53**			**3**	**50**		**2**	**2**	**49**	**13**		**1**	**1**	**11**		**1**	**26**	**34**	**14**	**5**		**27**	**26**	**13**	**1**	**39**	**14**	**2**	**4**	**33**
breeding	12			1	11		1		11	1				5			6	3	7	2		4	8	4		8	4		1	7
migratory breeding	6				6				6	2							4	6				4	2	1		5	1			5
possible migratory breeding	1				1				1	1								1				1				1				1
wintering	7				7			1	6	1				1		1	4	5	2			4	3	1		6	1	1		5
migratory	11			1	10			1	10	3		1		1			6	9	2			9	2	2		9	2			9
foraging	14				14				14	4			1	3			6	9	2	3		3	11	5	1	8	6	1	3	4
vagrant	2			1	1		1		1	1				1				1	1			2				2				2
Arable land	**69**	**1**	**3**	**6**	**59**		**5**	**4**	**60**	**21**			**1**	**11**	**3**		**33**	**47**	**16**	**6**	**3**	**23**	**43**	**22**	**8**	**39**	**21**	**8**	**3**	**37**
breeding	28		1	1	26		1		27	3				7	3		15	13	9	6	1	4	23	8	4	16	8	4	3	13
possible breeding	1	1					1			1								1				1		1						1
migratory breeding	20		1		19		1		19	6				2			12	17	3			7	13	4	2	14	4	2		14
wintering	7			1	6		1	2	4	3				1			3	5	2			4	3	2		5	2			5
migratory	5			2	3			2	3	3							2	5				5		1		4	1			4
foraging	5				5				5	2			1	1			1	3	2		1	1	3	3	2		3	2			
vagrant	1		1						1	1								1			1			1			1			
extinct	2			2			1		1	2								2				1	1	2			2			
Orchards, vineyards and other multiyear cultures	**60**		**2**		**58**		**2**		**58**	**6**			**1**	**9**	**1**		**43**	**41**	**13**	**6**	**1**	**22**	**37**	**10**	**4**	**46**	**10**	**4**	**4**	**42**
breeding	28				28				28	1				5	1		21	17	6	5		6	22	4	1	23	4	1	2	21
migratory breeding	17		1		16		1		16	4				1			12	14	3			7	10	2	1	14	2	1		14
wintering	1				1		1										1	1					1			1				1
migratory	5				5				5								5	5				5				5				5
foraging	9		1		8				9	1			1	3			4	4	4	1	1	4	4	4	2	3	4	2	2	1
Settlements	**47**				**47**				**47**	**4**			**1**	**7**			**35**	**31**	**10**	**6**	**1**	**12**	**34**	**8**	**2**	**37**	**9**	**2**	**5**	**31**
breeding	26				26				26	1			1	7			17	11	9	6		3	23	4	2	20	5	2	5	14
migratory breeding	18				18				18	3							15	17	1		1	7	10	4		14	4			14
wintering	2				2				2								2	2				1	1			2				2
migratory	1				1				1								1	1				1				1				1

These numbers are indicative for a relatively high national and international ornithological value of the area, which is a justification for initiatives for implementation of more intensive conservation measures.

Oak forests and scrubland in the researched area are most abundant with species (74 species with 67 breeding species), second most abundant are arable areas with 69 species (with 49 breeding species), followed by hilly pastures (61 species with 45 breeding species). Other types of forests are less abundant with species, the most interesting being riparian poplar and willow forests (52 registered species, with 47 breeding species), followed by beech forests (46 species, 43 breeding species) and coniferous forests (42 species, 41 breeding species). High altitude areas have 27 species of birds and only 19 of those are breeding species. Accumulations and other open waters have 53 species and rice-fields have 52 species. The importance of these habitats is primarily for migratory and wintering birds, but also for foraging of a large number of species which nest in neighboring habitats. Rocky areas and cliffs, as well as river banks support 24 and 16 bird species accordingly.

Priority species from the World Red List are linked to hilly pastures and arable lands; followed by oak forests and riparian forests. In relation to European importance (European Red List and Bird Directive), hilly pastures are again the most important habitats, followed by arable lands. Similar findings are reached when applying other valorisation criteria as well (Bern and Bonn Conventions, national nature protection and hunting legislation).

The importance of rocky areas is disproportionally higher in forests belts, which are relatively localized, but provide breeding conditions for more bird species, above all for raptors. Freshwater habitats are mainly artificial and as such support a relatively small number for individuals, even though there is an abundance of species. They play a slightly more important role during waterfowl migration. Special types of anthropogenic freshwater habitats are the rice-fields along the Bregalnica River and the Zletovska River which support many different species of birds but a small number of individuals. Frequent disturbance makes this habitat undesirable for nesting. However, the rice-fields support several heronries and provide trophic conditions for the densest population of storks in Macedonia.

Stork nest

There are 20 locations identified as important for birds, most of them are core areas in the already identified Macedonian Important Bird Areas (consult: **Report on Status of Protected Areas in the Bregalnica River Watershed**).

10.6 Herpetofauna Diversity

Lack of systematic research and scarcity of fauna data for Amphibians and Reptiles in the Bregalnica River basin was the starting point of the research within this project. Besides imbalanced geographical coverage of the data, quantitative data for two analysed group of vertebrates were also unequally presented. In the available literature database for Amphibians and Reptiles, as well as their habitats, conservation threats and protection measure were almost completely absent, or were given for only few regions proposed for future legal protection. Hence, the main goal of this project was to collect basic fauna data for all Amphibian and Reptile species that occur in the Bregalnica River basin, as well as to present their valorisation according to several national and international lists and conventions. Comprehensive knowledge about distribution of species, as well as their valorisation should be the basis for defining of important batrachological and herpetological regions in the Bregalnica River basin.

Typhlops vermicularis

Regarding batrachological and herpetological records, Bregalnica River basin is not adequately covered by research, regardless the numerous data provided in the literature, i.e. nine researched papers and two reports published between 1928 and 2014. During field research in 2015, we collected 1100 records in total, i.e. 469 for Amphibians and 631 for Reptiles. This result is a significant contribution for batrachofauna and herpetofauna distribution in the Bregalnica River watershed. The total number of amphibians is 11, and 28 species of reptiles.

The most common habitats for amphibians in the Bregalnica watershed are: ponds, meadows, degraded mesophilic oak forests, wet meadows, fast-flowing rivers (narrower than 5m), fields and agricultural land, rural settlements, degraded xerophilic and thermophilic oak forests, beech forests, mountain springs and temporary springs (Fig. 41). The most important habitats for reptiles are: hilly pastures with scrub, fields and agricultural land, meadows, rural settlements, degraded xerophilic and thermophilic oak forests, hilly pastures, mesophilic oak forests, hilly marlstone pastures, riparian forests and tree belts, wet meadows, beech forests and rice fields (Fig. 42).

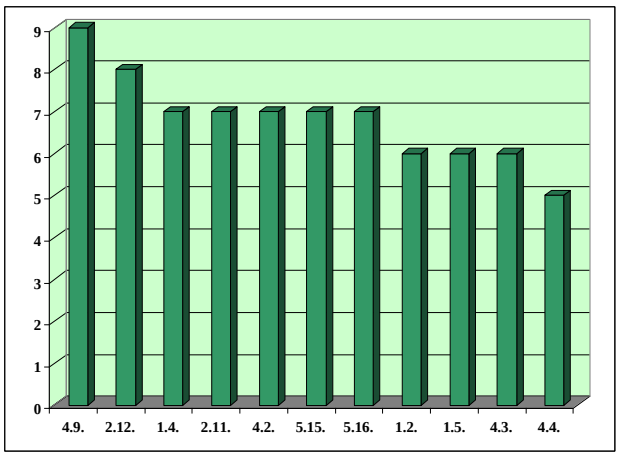


Fig. 41. Most common amphibian habitats.

Abbreviations: 4.9. ponds, 2.12. meadows, 1.4. degraded mesophilic oak forests, 2.11. wet meadows, 4.2. fast-flowing rivers (narrower than 5m), 5.15.), fields and agricultural land, 5.16. rural settlements, 1.2. degraded xerophilic and thermophilic oak forests, 1.5. beech forests, 4.3. mountain springs, 4.4. temporary springs.

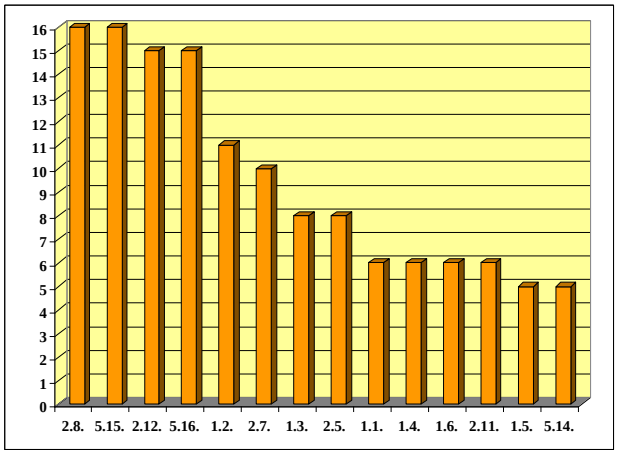


Fig. 42. Most common reptile habitats.

2.8. hilly pastures with scrub, 5.15.), fields and agricultural land, 2.12. meadows, 5.16. . rural settlements, 1.2. degraded xerophilic and thermophilic oak forests, 2.7. hilly pastures, 1.3. mesophilic oak forests, 2.5. hilly marlstone pastures, 1.1. xerophilic and thermophilic oak forests, 1.4. degraded mesophilic oak forests, 1.6. riparian forests and tree belts, 2.11. wet meadows, 1.5. beech forests, 5.14. rice fields.

For both groups of vertebrates, we analysed centres of diversity. For Amphibians, centres of diversity were recorded in the following UTM 10 x 10 km squares: EM71 and FM03 with nine species and EM72, EM95, FM32, FM43, FM44 with eight species (Fig. 43). Centres of diversity for reptiles are found in the following UTM 10 x 10 km squares: EM70 with 19 species, EM80 and FM03 with 18 species, FM24 with 17 species, as well as EM81 and EM82 with 15 to 16 species (Fig. 44).

Zamenis situla

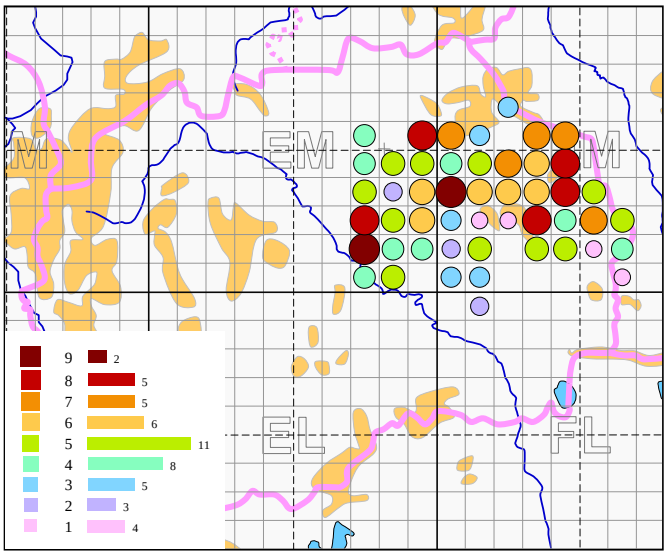


Fig. 43. Centeres of amphibian diversity (10 x 10 km UTM network) in the Bregalnica watershed

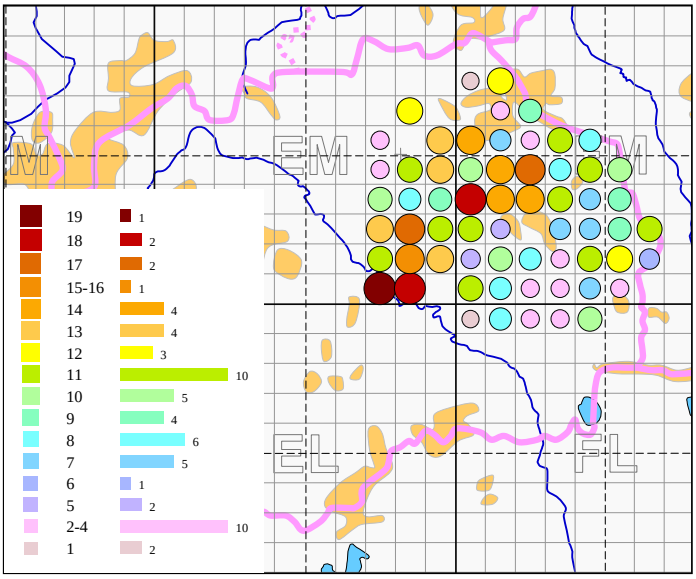


Fig. 44. Centres of reptile diversity (10 x 10 km UTM network) in the Bregalnica watershed

Valorisation of amphibian species was done according to national and international legislation. All species of amphibians were included in the Bern Convention. Six amphibian species were included in the Habitats Directive and National List of Protected Wild Species in Macedonia. Also, results of our study confirmed that the rarest species in the Bregalnica River basin were as follows: *Rana temporaria* (recorded at 2 localities), *Lissotriton vulgaris* (recorded at 5 localities) and *Pelobates syriacus* (found at 6 localities). These three species, as well as their habitats, should be regarded as priorities for protection in the region of concern. Valorisation of reptile species was also done according to national and international legislation. All species of reptiles were included in the Bern Convention. Twenty-two reptile species are included in the Habitats Directive, while 20 species are on the National List of Protected Wild Species in Macedonia. Three species of reptiles are included in the CITES list. Also, results of our study confirmed that the rarest species in the Bregalnica River basin were as follows: *Mauremys rivulata* (recorded at 1 locality only), *Cyrtopodion kotschyi* (found at 3 localities), *Eryx jaculus* (found at 3 localities), *Zootoca vivipara* (found at 4

localities), *Telescopus fallax* (found at 4 localities), *Emys orbicularis* (recorded at 5 localities), *Lacerta agilis* (recorded at 7 localities), *Ablepharus kitaibelii* (recorded at 7 localities), *Zamenis situla* (recorded at 7 localities) and *Vipera berus* (recorded at 7 localities). All above-mentioned reptile species, as well as their habitats, must be treated as top priorities for legal protection in Bregalnica River watershed.

Mauremys rivulata

Testudo graeca

10.7 Ichthyofauna Diversity

The ichthyofauna of the Bregalnica River and its tributaries has been researched by Dimovski (1971), Kostov et al. (2010), as well as during the research of Osogovo (MES, 2012).

Known species for the Bregalnica River include a species of lamprey (*Eudontomyzon mariae* (Berg, 1931)) and 25 fish species (Kostov et al. 2010):, *Gobio bulgaricus* Drensky, 1926, *Romanogobio elimeius* (Kattoulas, Stephanidis & Economidis, 1973), *Barbus balcanicus* Kotlik, Tsigenopoulos, Rab. & Berrebi, 2002, *Barbus peloponnesius* (Valenciennes, 1844), *Alburnoides bipunctatus* (Bloch, 1782), *Chondrostoma vardarense* Karaman, 1928, *Pachychilon macedonicum* (Steindachner, 1892), *Squalius vardarensis* Karaman, 1928, *Vimba melanops* (Heckel, 1837), *Rhodeus meridionalis* Karaman 1924, *Pseudorasbora parva* (Temmincj & Schlegel, 1846), *Alburnus macedonicus* Karaman, 1928, *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* (Linnaeus, 1758)**,** *Rutilus rutilus* (Linnaeus, 1758), *Rutilus macedonicus* Steind., *Cobitis vardarensis* Karaman, 1928, *Sabanejewia balcanica* (Karaman, 1928), *Barbatula barbatula* (Linnaeus, 1758), *Oxynoemacheilus bureschi* (Drensky, 1928), *Salmo macedonicus* Karaman 1924, *Oncorhynchus mykiss* (Walbaum, 1927), *Lepomis gibbosus* (Linnaeus, 1758), *Silurus glanis* Linnaeus, 1758, *Anguilla anguilla* Linnaeus, 1758, *Gambusia affinis* (Baird & Girard, 1853). Four of these species are introduced: *Gambusia affinis, Pseudorasbora parva, Oncorhynchus mykiss и Oxynoemacheilus bureschi*.

***Barbus peloponnesius* in Orizarska River**

Fourteen fish species were registered in the rivers of the southern slopes of the Osogovo Mountains (right tributaries of Bregalnica) during the research conducted in 2007 (MES, 2012).

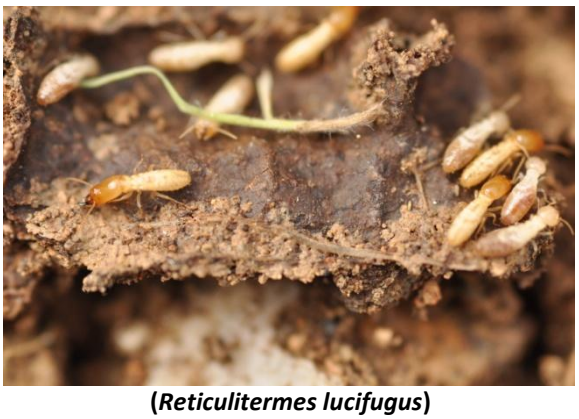
From a conservation stand point the most important fish is the carp (*Cyprinus carpio*), considered vulnerable according to IUCN. Potentially important are also *Anguilla anguilla* and *Alburnus macedonicus,* but their presence in Bregalnica is not confirmed. These species are critically endangered.

Four species are included in the National List of Protected and Strictly Protected Species; two of them are strictly protected (*Anguilla anguilla, Alburnus macedonicus*) and two are protected (*Romanogobio elimeius, Cyprinus carpio*).

Unfortunately, pollution of Bregalnica River with inorganic and organic pollutants affects the fish diversity in the river. Rebok (2013) determined numerous pathological findings in *Barbus peloponnesius* from Bregalnica. The river also has xenoestrogens which can cause long-term negative impact on fish reproduction.

10.8 Diversity of Select Groups of Invertebrates

The fauna of the terrestrial invertebrates in the Bregalnica watershed is exceptionally rich and diverse. The area has several types of Mediterranean ecosystems in the lower parts, mountainous ecosystems with alpine elements on the peaks of the higher mountains (Osogovo Mt. and Plachkovica). The steppe-like areas of the lower course of Bregalnica are habitats for the most specific animal species such as *Galeodes elegans*, *Mesobuthus gibbosus, Latrodectus tredecimguttatus, Reticulitermes lucifugus* and many other species, especially insects.



(*Reticulitermes lucifugus*)

(*Galeodes elegans*)

(*Latrodectus tredecimguttatus*)

(*Mesobuthus gibbosus*)

10.8.1 Ground Beetles (Coleoptera, Carabidae)

The ground beetles are well known group of insects found across almost everywhere in the world. According their preferences they can be ubiquitous (found everywhere) or specialists (found at certain localities and habitats). Ground beetles are used today as indicators for classification of habitats, following the consequences from the degradation and fragmentation of the habitats, the impact of the insecticides etc.

Literature review revealed 50 different species of ground beetles for Bregalnica river watershed, and for most of them habitat and locality are not recorded. Latest research of Osogovo Mts. discovered 216 species for the Bregalnica watershed area. Biggest diversity is found in riparian habitats followed by fens and bogs, while the lowest diversity is detected in silviculture, barren lands (rocks) and urban areas.

The terrestrial invertebrate fauna in the Bregalnica watershed is exceptionally diverse. The area of interest has 287 species. The area has species which are typical for Mediterranean ecosystems in the lower parts and mountainous ecosystem with alpine elements on the peaks of the higher mountains (Osogovo Mt. and Plachkovica.). The steppe-like area in the lower course of Bregalnica support the most specific animal species, such as: *Harpalus metallinus, H. triseriatus, Ophonus brevicollis, Dixus spp., Pachycarus cyaneus*, *Brachinus brevicollis*, *Ditomus clypeatus*, *Poecilus anatolicus, P. puncticollis,* etc. Riparian habitats (sandpits, poplar belts, rice fields etc.) support species such as *Carabus granulatus interstitialis*, *Elaphrus* spp., *Bembidion* spp., *Paratachys* spp., *Dyschirius* spp., etc. Saline soils support some halophytic insects such as *Cephalota turcica* and *Acupalpus elegans.* Forest ecosystems have many species and several endemics: *Molops piceus osogovensis, Molops rufipes denteletus, Tapinopterus balcanicus belasicensis, Myas chalybaeus, Aptinus merditanus*, etc. Besides endemic species, forests also support species of outstanding conservation importance as well as indicators for well-preserved forest ecosystems: *Carabus intricatus, C. convexus dilatatus, Calosoma sycophanta, Morimus funereus, Rosalia alpina*, etc. Peat bogs and other mountainous aquatic habitats support rare species such as: *Amara morio nivium, Loricera pilicornis, and Pterostichus apfelbecki*. The highest parts of the Osogovo Mountains support some mountain or even alpine species such as *Amara nigricornis, A. erratica, A. messae, Trechus priapus medius*, but also some endogeic species such as *Duvalius beshkovi*.

Out of the total number of species only one is on the Global Red List of IUCN *Carabus intricatus* in the category Low Risk/Near Threatened. Two species are on the CORINE list: *Carabus convexus dilatatus* and *Calosoma sycophanta*. The area of interest has a total of 22 endemics (Fig. 45), two of those are local endemics which can only be found at the Osogovo Mountains (*Molops piceus osogovensis* and *Duvalius beshkovi*), while four are stenoendemics i.e. species which can be found on the mountains of East Macedonia and West Bulgaria (*Platynus scrobiculatus bulgaricus*, *Aptinus merditanus orientalis*, *Molops rufipes denteletus* and *Xenion ignitum*). The remaining 16

endemic species are widely distributed on the Balkans. Two species can be considered as glacial relicts: *Nebria jockischi jockischi*, *Amara nigricornis*, while 45 species are considered rare.

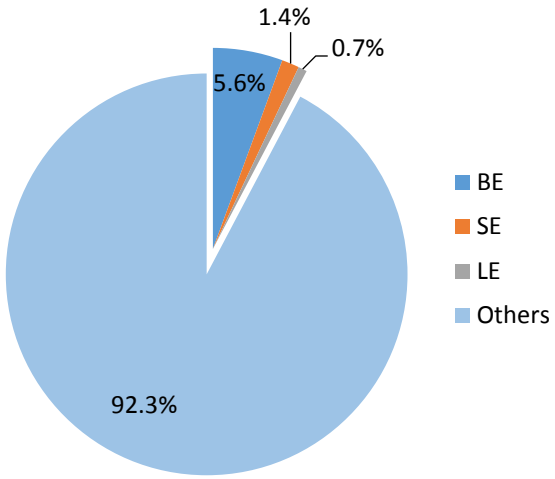


Fig. 45. Percentages of endemic species among Coleoptera and Carabidae (BE - Balkan endemic, SE - stenoendemic, LE - local endemic)

According the number of sp., appearance of endemics and relict species, we can select and emphasize the following habitats: high-altitude pastures and high mountain rocky areas, found only at the highest parts of Osogovo Mts. from Carev Vrv to Ruen including parts from the ridge Kalin Kamen; Peat bogs mainly found on Osogovo Mts; Beech forests from which as most important are the most preserved one in the belt of mountainous beech forest; Riparian forests in the lowlands; Halophytic habitats or the salty soils where we discovered *Cephalota turcica* known only for the seaside of Greece and Turkey; Lowland meadows in the lower flow of Bregalnica river where some new sp. for Macedonian ground beetle fauna are found; Hill pastures of marl characterised with steppe vegetation in the lower parts of Bregalnica.

***Cephalota turcica* at Gladno Pole**

When we speak of high biological diversity illustrated by the large numbers of endemics, relicts, rarities and species important for conservation we have to mention the Osogovo Mountains. The area of Slan Dol and Lower Bregalnica i.e. the steppe-like areas are an exclusive habitat for the Bregalnica River watershed regarding ground beetles fauna. Integral parts of this area are the poplar riparian forests and belts which support a large number for species. Some of the smaller localities that are worth mentioning are: Ruen with Carev Vrv, Slana Bara and Kalin Kamen; Ovche Pole;

Gladno Pole; Gjuzumliska River (Dorfulija and Kjoselari); Judovi Livadi and the caves at Turtel (consult: **Report on the State of Protected Areas in the Bregalnica River Watershed**).

***Carabus granulatus* in poplar belts along Bregalnica River**

10.8.2 Daily Butterflies

The daily butterflies (Lepidoptera: Papilionoidea) are a group of insects that are globally well studied. This is mostly due to their relatively large conservation interest. This knowledge is especially pronounced on in Europe where detailed information on their habitats, localities and ecology can be found. In the territory of Macedonia, the butterfly research began a century ago. Newest estimates count 205 species for Macedonia which represents 42% of the European butterfly fauna. Relative to its size and the fact that Macedonia is a land-lock country, this number is impressive. Part of the reason for such high butterfly diversity is the climate, suitable geographic location and the diversity of habitats. From the conservation viewpoint almost all the European species are assessed following the standards of the International Union for Nature Conservation (IUCN). Moreover, many European countries designated Prime Butterfly Areas (PBAs) that aim at highlighting the most suitable localities for protection of targeted species. Although many butterfly populations are in decline globally and in Europe, identification of their conservation status is a first step in their protection and recovery.

Taking into account its size of over 4000 km^2, the Bregalnica watershed offers big diversity of habitats, wide vertical gradient (from 100 to 2252 m asl), which provides for an impressive number of species.

***Lycaena dispar* – Species important for conservation and first registered in the research area at Istibanja**

***Apatura ilia* – Registered for the first time in the research area over Istibanja**

***Zerynthia polyxena* – Species important for conservation. Registered at Zelengradska and Lomija River on Plachkovica**

Riparian vegetation in the upper course of Bregalnica

During these two research seasons we managed to list a total of 103 butterfly species. Eight out of those were for the first time recorded for the researched area. If we merge this number of species to the 141 species that were already registered (and most of them published) in the previous periods of research, the total number of butterflies that can be found in the region is 149, which is 72 % of the total fauna of Macedonia. Conservation-wise, most important species from this list are the following: *Anthocharis gruneri, Boloria dia, Carcharodus flocciferus, Carcharodus lavatherae, Chazara briseis, Coenonympha glycerion, Colias caucasica balcanica, Erebia aethiops, Erebia pronoe, Euphydryas aurinia, Hipparchia fagi, Hipparchia statilinus, Iolana iolas, Lycaena dispar, Minois dryas, Neptis sappho, Parnassius apollo, Parnassius mnemosyne, Phengaris arion, Pieris balcana, Plebejus sephirus, Polyommatus eros, Pseudophilotes vicrama* and *Zerynthia cerisyi.* These butterflies earned their status by being present in certain directives and conventions for protection; they are identified as near threatened or are in one of the threatened categories according to the global or European IUCN red list; they have status of rare species in Europe; they are endemic for the Balkan Peninsula; and/or are protected with our legislation. The distribution of the important species is illustrated in Fig.46.

The butterflies have a wide range of habitats that they use. Certainly their survival depends on the specific plant species on which they or their larvae feed, but their life cycle cover wide area of habitats where they can be found. During our research we identified the following habitats to be the most important for butterflies: riparian habitats along Bregalnica River and its tributaries, open habitats in beech and mixed forests, ruderal and rural habitats, and meadows. In each of the listed habitats we managed to record 40 and more species. Although particularly important for many species, high-mountain pastures were not analysed because of the fact that Osogovo Mts. were not part of our study. The valorisation of the overall results did indeed include this habitat into account. The high-elevation parts of Plachkovica and Maleshevo Mts. do not cover large-enough areas with pastures and typical mountain flora in order for them to host typical mountain butterfly species.

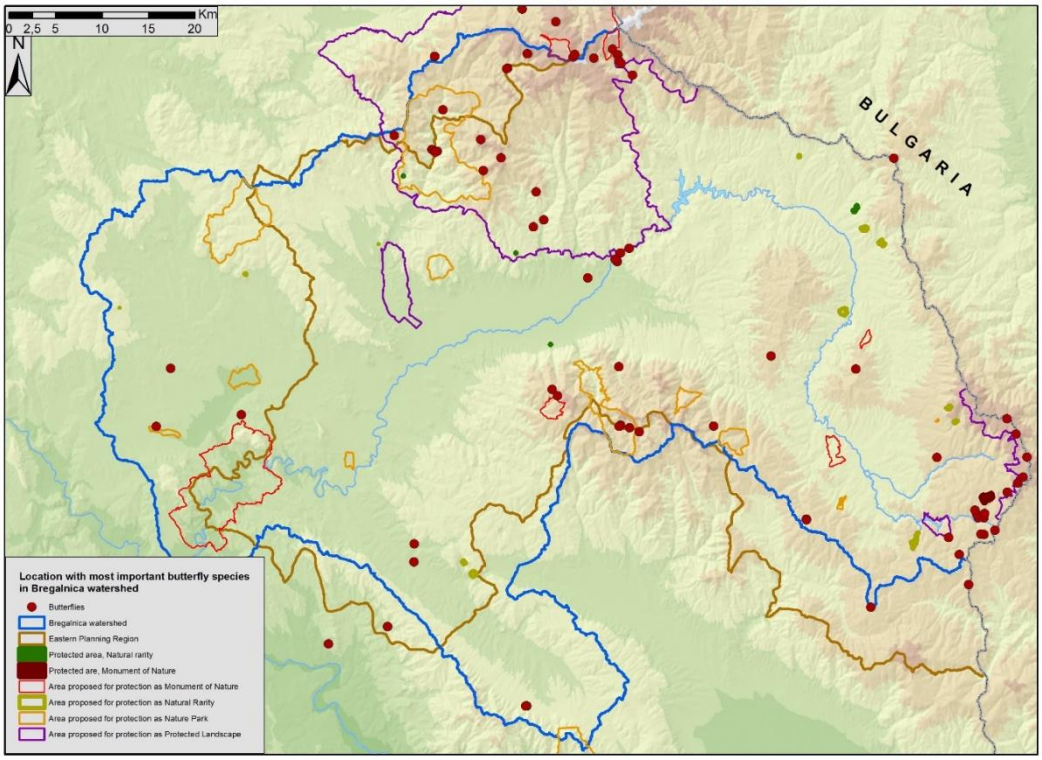


Fig. 46. Presence of important butterflies in the research area and protected and proposed protected areas

From the localities important for butterfly protection, we propose (consult: **Report on the State of Protected Areas in the Bregalnica River Watershed**):

1. Slan Dol and the lower parts of Bregalnica: steppe areas in this region are of interest for many different animal species. They represent one-of-the-kind habitats in Macedonia where butterflies such as *Gonepteryx farinosa, Melitaea telona, Pseudphilothes vicrama, Tarucus balkanica, Iolana iolas* and many more can be found.
2. Osogovo: the whole massive with certain localities that are more important for butterflies like Sultan Tepe and Ruen, the surroundings of Sasa mine, Kalin Kamen, the rivers of Zletovska, Zelengradska, Orizarska, Modra and Emirachka, Jastrebnik and Gradche dam. Here one can record: *Coenonympha glycerion, Minois dryas, Erebia aethiops, Parnassius apollo, Phengaris arion, Plebejus sephirus, Euphydryas aurinia* etc.
3. Upper parts of Maleshevo Mts. on the border range with Bulgaria: Klepalo, Golo Brdo, Nebojsha, Charshija, Dzami Tepe and Bregalnica springs, Ajduchki Rid, Kadiica, as well as Dabovec (with Murite). *Phengaris arion, Zerynthia cerisy, Zerynthia polyxena, Colias caucasica balcana, Pieris balcana, Parnassiums mnemosyne* are part of the many residents here.
4. The village of Istibanja: we recommend protection of parts of Bregalnica flow from the village (where the water grip is) until the Kalimanci Lake. Here one can find: *Lycaena dispar, Apatura ilia*, *Carcharodus flocciferus, Pieris balcana, Plebejus sephirus, Iolana iolas* etc.
5. Lower parts of Zletovica River, from the village of Chiflik to the town of Zletovo. Species: *Zerynthia cerisy, Carcharodus lavatherae* and more.
6. Lomija River on Plachkovica Mt. *Zerynthia polyxena, Phengaris arion* and more

Beside these newly identified areas, in 2003 a publication for identification of Prime Butterfly Areas in Europe was published. Eight such areas were identified in Macedonia and one of them is within the borders of the East Planning Region (consult: **Report on the State of Protected Areas in the Bregalnica River Watershed**). It stretches from the region of Ilovica village up until the Ograzhden summit (1745 m a.s.l.) and covers an area of 3916 hectares. PBA "Ograzhden" is designated based on the presence of two target species *Phengaris arion* and *Parnassius apollo*. Other interesting species in terms of rarity and conservation importance that dwell here are: *Carcharodus orientalis, Erynnis marloyi, Tarucus balkanicus, Libythea celtis* and *Thecla betulae*.

The Bregalnica watershed has species of special conservation importance such as: *Lycaena dispar* and *Euphydryas aurinia* which are trigger species for Prime Butterfly Areas. Parts of the mouth of Bregalnica definitely require this status.

10.8.3 Aquatic Inverterbrata Diversity

The number for known aquatic macroinvertebrates in the Bregalnica watershed is high (327 species). The Bregalnica watershed is the only known location for the taxa *Hydrochus* and the species *Hydrobius fuscipes* and *Agabus didymus* in Macedonia. Most of the coleopteran species (10 species) live in salty marshes in Ovche Pole, Slan Dol, Kochani Valley and the lakes close to Kriva Lakavica along the Mantovo accumulation while *Limnius volckmari* and *Pomatinus substriatus* are reophylic representataives noted on the rivers Brbushnica, Pehchevska and Zrnovska.

The faunistic overview enables the determination of invertebrates of international and European importance for conservation (Fig. 47). Certain locations (along Breglanica, Zletovska Rover, Dolni Balvan and the mouth of Bregalnica) have a registered presence of empty shells of *Unio crassus* (IUCN Red List Endangered species), which is why its presence is expected while viable populations are not confirmed. *U. crassus* is protected according to Annex II/IV from the Habitats Directive, which outlines the need for active conservation of the species and its habitat. The habitats directive provides strict protection of another two species (according to Annex IV): *Austropotamobius torrentium* and *Gomphus flavipes. A. torrentium* can be found in the upper course of Bregalnica, Zrnovska Reka, Pehchevska Reka and Osojnica (all tributaries to Bregalnica) as well as in the waters of the Osogovo (rivers Eshterec, Zlenegradska and Mala above the Kochani Lake). The spring crab is included in the Annex II of the list and is of special interest to the EU and its protection requires special protected areas. The List of important species for conservation also has some Balkan endemites *Paraleptophlebia lacustris* (Kochanska River, above Kochansko Lake and Orizaraska River, after the merger of Crna and Bela) and *Chaetopteryx stankovici* (Eshterec River) and the sub-endemites *Odontocerum hellenicum* and *Rhyacophila armeniaca* (source of Bregalnica River).

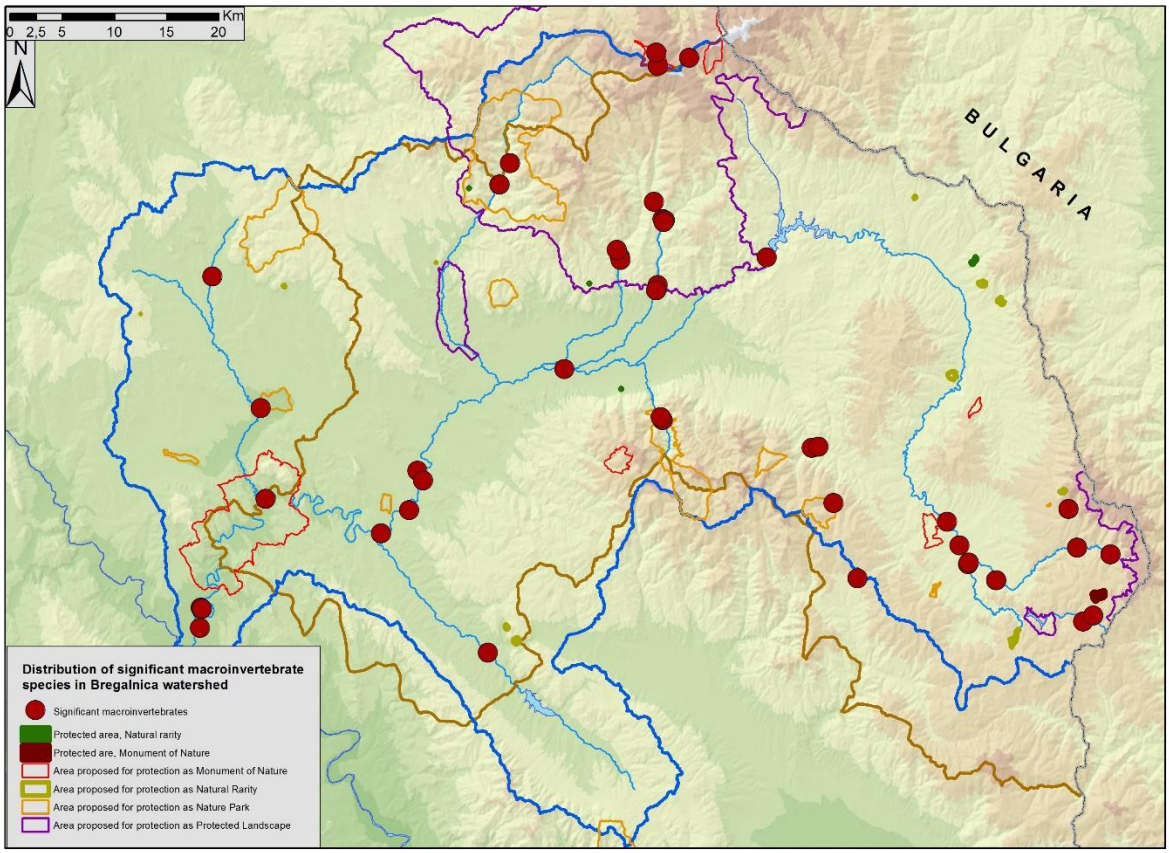


Fig. 47. Map of distribution of important macroinvertebrate for protection and priority protected areas

The most important localities for conservation and protection of the priority macroinvertebrate species were also selected (consult: **Report on the State of Protected Areas in the Bregalnica River Watershed):** "Kartal","Zrnovska Reka - Lisec", "Ovche Pole", "Lower Bregalnica", "Osogovo Mountains", "Ratkova Skala – Zletovska Reka", "pehcevska Reka", "Chengino Kale" as well as "Gladno Pole" which can contribute to the preparation of map of priority conservation areas.

Austropotamobius torrentium

Unio crassus

10.8.3.1 Dragonflies and Damselflies (Odonata)

The dragonflies (Odonata) are relatively small, but well known group of insects. The Mediterranean and the Southern Balkan as well, is home of large concentration of endangered species of dragonflies, that are listed in the Red list of IUCN (Riservato *et al.* 2009). The dragonfly's larvae are very sensitive to water quality, the changes of the water bodies' morphology and the effects of the chemical pollution in the water ecosystems (Matagi 1996). The adults are closely related to the habitats structure and therefore are excellent indicators for their disturbance (Samways 1993). The dragonflies are predators in every stage of their life and play important role in the food chain. As predators, they have important potential in the biological control of mosquitos (Norman W. Moore 1997).

The Critical List of published data in Macedonia lists 64 species of dragonflies and damselflies (Hristovski et al. 2015). The position, climate and relief with diverse habitats in Macedonia allows for the presence of Euro-Siberian and Mediterranean group. Research in Macedonia was mainly focused on still waters, especially lakes and a small number of published data refers to fast-flowing waters, and even less data is focused on East Macedonia.

The reference data analysis, that covers only few localities in the Bregalnica basin, shows small number of species (27 published) at only a few locations. If we add to the analysis some of the unpublished data for dragonflies and damselflies from the author of the book on the Osogovo Mountains and Kochani Field we can add another nine new species for the Bregalnica watershed, and data on another three species is especially important, that are *Cordulegaster heros, Caliaeschna microstigma* and *Ophiogomphus Cecilia.* Contribution to the reophylic fauna of dragonflies in the River Bregalnica are given by Kitanova et al. (2008) – 13 registered species and detail data for two important species *(Gomphus flavipes и Coenagrion ornatum).*

There is a lack of data for the larger part of the region. Therefore, the research was targeted towards gathering data for the source area of river Bregalnica, above Pehchevo and the basin of Bregalnica that is imminent to the Mountain of Golak, Plachkovica and Maleshevski Planini, Vlaina, Bejaz Tepe and Kriva Lakavica basin. Also, Dolna Bregalnica was target area during the research.

During the research we recorded a total of 41 species in the Bregalnica watershed which is 64% of the Macedonian fauna. Besides literature data we added 14 new species from the researcg and five of the registered species are important for conservation. *Coenagrion ornatum, Caliaeschna microstigma, Ophiogomphus cecilia* and *Cordulegaster heros* are near endangered species in the European Red List of dragonflies. *Coenagrion ornatum* is listed in the Annex II list in the Habitat Directive, *Ophiogomphus cecilia* and *Cordulegaster heros* in the Annex II and IV, and *Gomphus flavipes* in the Annex IV. Distribution of important species is represented in Fig. 48.

Still, the existence of flowing waters in the region increases the diversity of species, even though most of them are widely distributed. The bogs and swamps are habitats with greatest diversity of species, where 27 species were registered. These are characteristic habitats for the genus *Lestes, Erythromma, Coenagrion, Anax, Aeshna, Sympetrum* and others. During the research, some new species for the area were registered (*Anax parthenope, Aeshna mixta, Cordulia aenea, Lestes parvidens и Coenagrion pulchelum)*. Especially interesting finding is the registered *Lestes parvidens* that was found in small swamp formed by a stream near village Ubogo, near the estuary of Bregalnica in Vardar. There is little known for this species in the Balkans, and in Macedonia this species is found only near Skopje (Jović & Mihajlova 2009).

Gomphus flavipes

Lestes parvidens

Caliaeschna microstigma

Ophiogomphus cecila

Most of the species characteristic for the still waters are common inhabitants of salt swamps, which shows that they easily inhabit this specific habitat if there is well developed aquatic vegetation. The small artificial lakes and fishponds, that form nearly natural ecosystem, are also suitable for development of dragonflies. Here 20 species were registered. Near the accumulations small number of widely distributed dragonflies that easily colonize such ecosystems were registered (*Libellula depressa, Crocothemis erythraea, Orthetrum cancellatum, Onychogomphus forcipatus* and *Calopteryx splendens)*. This clearly shows the influence of the accumulation on the autochthonous odonatan fauna. Typical reophile represenatives of the species *Cordulegaster* and *Gomphus* are absent from this artificial ecosystem. The rice fields are especially suitable habitat for species that reproduce in temporal – periodical waters, but still, the registered species didn't showed rich diversity (14 species). Here predominantly present were populations from the genus *Sympetrum.*

Bregalnica has a well-developed hydrographic network. Its source area represents a river ecosystem with fast mountain streams, which form naturally larger riverbed with fast or medium fast flow, and in the lowland the river forms riverbed with slow water flow. This enables conditions for development of specific and divers flora and fauna, and so to the diversity of dragonflies as well.

The flowing waters in the mountain parts are characterized by specific microhabitats, especially important for the larvae. Small number of species (5-10) are found here, but some of them are very rare and endangered species. The presence of *Caliaeschna microstigma* and *Ophiogomphus cecilia* is indicator for well-preserved riparian habitats along Bregalnica River. These species together with *Cordulegaster heros* are found in rivers were there is little or no disruption of the natural conditions in the rivers and nearby. Their presence was recorded in the tributary rivers that come from the southern slopes of the Osogovo Mountains (Shtalkovichka River, Golema and

Mala River). Important findings are the larvae and adults of *Caliaeschna microstigma* and *Cordulegaster heros* found on the site Mokra Livada, above village Nov Istevnik. This confirms that *Caliaeschna microstigma* successfully reproduce in the upper parts of the river Bregalnica basin, i.e. above the Kalimanci Lake.

Characteristic important species for slowly flowing waters is *Gomphus flavipes*. Its presence was registered in the lowland parts of the river Bregalnica, where the river is wider and has meandering alluvial deposits. From the number of species closely related with clean water in mountain parts, only *Ophiogomphus cecilia* was registered for Dolna Bregalnica.

Coenagrion ornatum is an important species found in Dolna Zletovica, on places with well-developed aquatic vegetation (Kitanova et al. 2008). But during this research this species was not registered, also no part with well-developed hydrophyte aquatic vegetation neither along Bregalnica, nor in its major tributaries were registered.

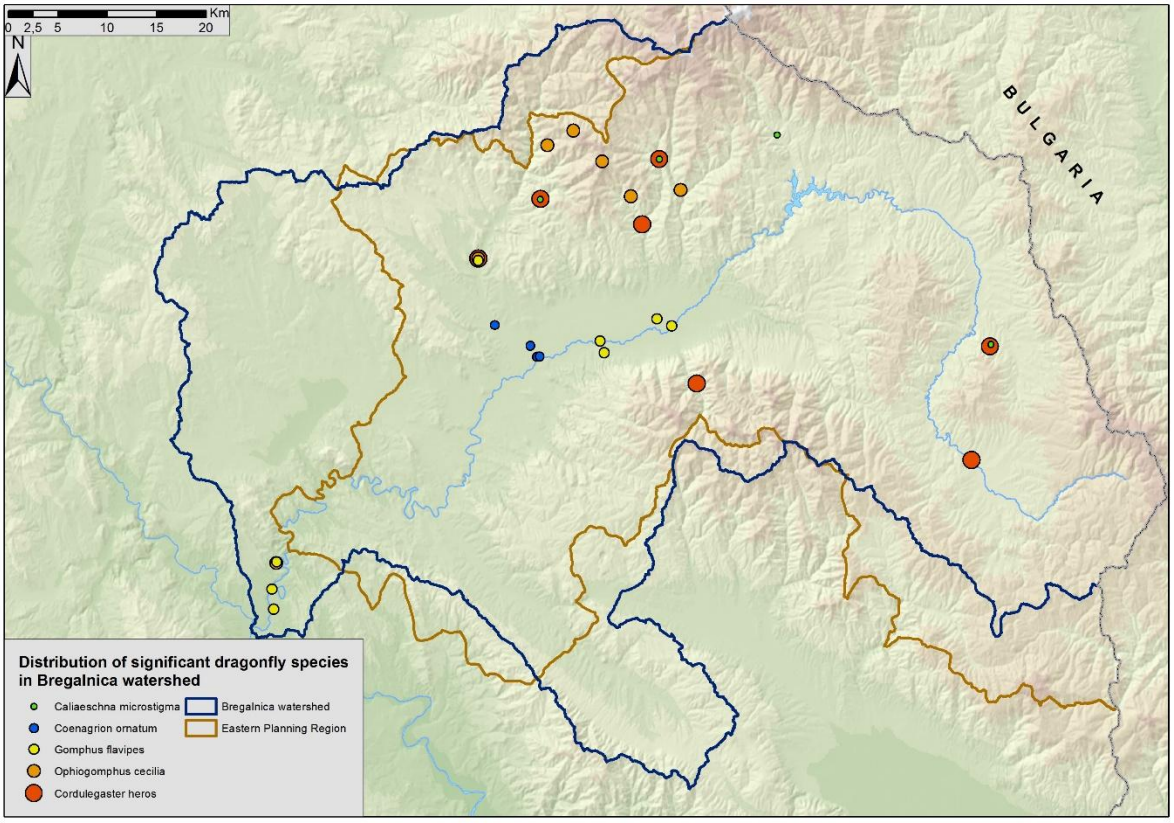


Fig. 48. Distribution of important species of dragonflies and damselflies in the Bregalnica River watershed

10.9 Habitats

A habitat is a part of environment with specific physical (primary) and biotic (secondary) features, in which individuals from a particular community, or a particular species normally that are adapted to its conditions normally live and occur. EUNIS Habitat classification is an integral part of the European Nature Information System, and is considered to be a prevailing classification system of habitats in Europe, which relies on the Annex I of the EU Habitats Directive and Resolution 4 from the Bern Convention. Under this system, habitats in Europe are allocated to 11 first order habitat types, followed by lower classification levels, forming a hierarchical network which covers most of the European habitats.

According to the EUNIS classification in Republic of Macedonia all habitat types from first order are presented, with exception of the marine habitat types (A and B), and they include: Inland surface waters (C), Mires, bogs and fens (D), Grasslands and lands dominated by forbs, mosses or lichens (E) Heathland, scrub and tundra (F), Woodland, forest and other wooded land (G), Inland non-vegetated or sparsely vegetated habitats (H), Regularly or recently cultivated agricultural, horticultural and domestic habitats (I), Constructed, industrial and other artificial habitats (J) and Habitat complexes (X).

River Bregalnica in vicinity of village Penush with poplar belts and river sand pit

For the research area there are several sources of data on the state of habitats: two scientific and applicative projects (Matevski et al., 2008; Melovski et al., 2010) and a report from the Osogovo project. These surveys roughly cover most of the area of the Bregalnica river watershed and cover almost all major habitats.

Still, there was a need of complete registration of all habitats in the areas previously studied, registration of other habitats elsewhere in the region and a further clarification on their status. Habitat group C (Surface standing waters; surface running waters and littoral zone of inland surface waterbodies) and the habitats of riparian vegetation (to a certain extent), were still not studied in details; there were ambiguities in phytoecological character of the riparian vegetation, as well as the habitat affiliation of marsh vegetation.

Research period covered two years - 2014 and 2015, in an effort to visit and register as many different types of habitats. Full or provisional phytosociological reviews were made for almost every habitat, which cover all or most important species in the habitat. Also, for the majority of the habitats herbaria material was collected and properly analysed, processed and deposited in herbarium of Faculty of Natural Sciences (MKNH). Research was conducted mainly in the period of March to November.

Peat Bog on Pehchevska River

In the basin of Bregalnica River, within the Eastern Region, the 61 habitats were registered: C - 20, D – 5, E - 14, F - 5, G - 12, H - 1, I - 2 and J – 2. The research confirmed presence of most of the habitats, identified from previous research in this area (Matevski et al., 2008; Melovski et al., 2010, and from the Osogovo project). In addition, there were habitats discovered and listed for the first time in the research area. It primarily refers to the habitats related to water bodies (C), which were not covered in the previous/existing research. Unfortunately, some habitats are defined with insufficient precision and determination of other habitats remains unresolved, or poorly resolved. The main reason is the lack of knowledge on the vegetation of the region, especially riparian, aquatic and marsh vegetation.

From all habitats identified, a total of 50 are included in the annexes of the Habitat Directive and the Bern Convention. Out of the 50, 41 habitats are on the Annex I of the Habitat Directive, and 45 are on the Resolution 4 from the Bern Convention. According to the Habitat Directive, 10 habitats are listed priority, and according to the Bern Convention – there are a total of 9 priority habitats (Table 10-14).

Habitat E1.21: Greek-Balkan steppes with Winter Savoury (*Satureja montana*) has no priority value, but it should be considered priority because it is an important habitat for orchids.

Steppe-like vegetation with *Eurotia ceratoides* at Kjoseleri

Part of the protected areas which are proposed in this project, include some of the habitats which have priority status according to the Habitat Directive. Thus, E1.332 Helleno-Balcanic short grass and therophyte is covered by protected areas Osogovo and Zletovska River; E6.2153: Pelago-Vardarian *Camphorosma monspeliaca* flats communities in areas Ovche Pole and Eneshovo; E6.2154: Central Paeonian salt steppes with Eneshevo, while habitat G3.5211 Moeso-Hellenic montane [*Pinus nigra*] forests is included in Kukuljeto, Berovsko Lake, Ramna River, Daboski Andak (Maleshevski Mt.) and Parkach (village Smojmirovo) (consult: **Report on the State of Protected Areas in the Bregalnica River Watershed)**.

Halophytic community consisting of *Camphorosmetum monspeliacae*, Gladno Pole

Habitat D2.3I: Balkan quaking bogs, although is not part of any of the lists, has particular importance because of its limited distribution in Macedonia (only two sites near Pehchevo), as well as for the presence of the species *Drosera rotundifolia*.

Heatland with *Chamaecytisus* sp. On Chengino Kale

Pastures and cliffs on Ruen

Endangered habitats in the investigated region are specific in character, and in terms of the degree of danger.

Table 10. Habitat list from the Inland surface waters group present on the habitat Directive and Bern Convention annexes. [*in brackets is the classification given in Revised Annex I of Resolution 4 (1996) of the Bern Convention on endangered natural habitats types using the EUNIS habitat classification (year of revision 2010)]

EUNIS	HABITAT DIRECTIVE	BERN CONVENTION
	C : Inland surface waters	
C2.33 : Mesotrophic vegetation of slow-flowing rivers	3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	C2.33 Mesotrophic vegetation of slow-flowing rivers
C2.34 : Eutrophic vegetation of slow-flowing rivers	3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	C2.34 Eutrophic vegetation of slow-flowing rivers
C2.5 : Temporary running waters	3290 Intermittently flowing Mediterranean rivers of the Paspalo-Agrostidion	
C3.5131 : Toad-rush swards	3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoeto-Nanojuncetea	C3.51 Euro-Siberian dwarf annual amphibious swards
C3.5132 : Swards of small *Cyperus* species	3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoeto-Nanojuncetea	C3.51 Euro-Siberian dwarf annual amphibious swards
C3.53 : Euro-Siberian annual river mud communities	3270 Rivers with muddy banks with Chenopodion rubri pp and Bidention pp vegetation	
C3.55 : Sparsely vegetated river gravel banks		C3.55 : Sparsely vegetated river gravel banks
C3.61 : Unvegetated river sand banks		C3.62 : Unvegetated river gravel banks
D : Mires, bogs and fens		
D2.3I: Balkanic quaking bogs.	7140 Transition mires and quaking bogs	D2.3 Transition mires and quaking bogs

Table 11. Habitat list from the Grasslands and lands dominated by forbs, mosses or lichens group present on the habitat Directive and Bern Convention annexes. [Consult: Table 10]

E : Grasslands and lands dominated by forbs, mosses or lichens		
E1.21 : Helleno-Balkanic Satureja montana steppes	6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	! E1.2 Perennial calcareous grassland and basic steppes
E1.332 : Helleno-Balkanic short grass and therophyte communities	*6220 Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	! E1.3 Mediterranean xeric grassland
E1.72 : *Agrostis – Festuca* grassland	6230 Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	
E1.73 : *Deschampsia flexuosa* grassland	6230 Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	
E1.833 : Balkanic montane *Nardus stricta* swards		! E1.83 Mediterraneo-montane [Nardus stricta] swards
E1.91 : Dwarf annual siliceous grassland	2330 Inland dunes with open Corynephorus and Agrostis grasslands	
E2.238 : Southwestern Moesian submontane hay meadows	6270 Fennoscandian lowland species-rich dry to mesic grasslands	E2.2 Low and medium altitude hay meadows
E2.33 : Balkan mountain hay meadows	6520 Mountain hay meadows	E2.3 Mountain hay meadows
E3.31 : Helleno-Moesian riverine and humid *Trifolium* meadows		E3.3 Sub-mediterranean humid meadows
E4.391 : Oro-Moesian *Festuca paniculata* grasslands,	62D0 Oro-Moesian acidophilous grasslands	E4.3 Acid alpine and subalpine grassland
E4.3921 : Oro-Moesian *Festuca valida* grasslands,	62D0 Oro-Moesian acidophilous grasslands	E4.3 Acid alpine and subalpine grassland
E4.393 : Oro-Moesian *Poa violacaea* grasslands,	62D0 Oro-Moesian acidophilous grasslands	E4.3 Acid alpine and subalpine grassland
E4.3941 : Oro-Moesian crooked sedge grasslands,	62D0 Oro-Moesian acidophilous grasslands	E4.3 Acid alpine and subalpine grassland
E4.3943 : Oro-Moesian *Festuca airoides* grasslands	62D0 Oro-Moesian acidophilous grasslands	E4.3 Acid alpine and subalpine grassland
E4.3945 : Oro-Moesian *Agrostis rupestris* grasslands	62D0 Oro-Moesian acidophilous grasslands	E4.3 Acid alpine and subalpine grassland
E5.42 : Tall-herb communities of humid meadows	6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	E5.4 Moist or wet tall-herb and fern fringes and meadows
E5.5721 : Moesian Balkan thistle tall herb communities,	6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	E5.5 Subalpine moist or wet tall-herb and fern stands
E5.5722 : Moesian butterbur tall herb communities	6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	E5.5 Subalpine moist or wet tall-herb and fern stands
E5.5723 : Moesian hogweed tall herb communities	6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	E5.5 Subalpine moist or wet tall-herb and fern stands
E5.5724 : Moesian scarlet avens tall herb communities	6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	E5.5 Subalpine moist or wet tall-herb and fern stands

E5.5B : Alpine and subalpine fern stands	6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	E5.5 Subalpine moist or wet tall-herb and fern stands
E6.2151 : Pelago-Vardarian saline meadows,	*1530 Pannonic salt steppes and salt marshes	! E6.2 Continental inland salt steppes (E6.2 Continental inland salt steppes)
E6.2152 : Pelago-Vardarian solonetz hollows,	*1530 Pannonic salt steppes and salt marshes	! E6.2 Continental inland salt steppes (E6.2 Continental inland salt steppes)
E6.2153 : Pelago-Vardarian *Camphorosma monspeliaca* flats.	*1530 Pannonic salt steppes and salt marshes	! E6.2 Continental inland salt steppes (E6.2 Continental inland salt steppes)
E6.2154 : Central Paeonian salt steppes.	*1530 Pannonic salt steppes and salt marshes	! E6.2 Continental inland salt steppes (E6.2 Continental inland salt steppes)

Table 12. Habitat list from the Heathland, scrub and tundra group present on the habitat Directive and Bern Convention annexes. [Consult: Table 10]

F : Heathland, scrub and tundra		
F2.26 : Bruckenthalia heaths	4060 Alpine and Boreal heaths	! F2.26 [Bruckenthalia] heaths
F3.164 : Sub-Mediterranean common juniper thickets	5130 Juniperus communis formations on heaths or calcareous grasslands	F3.16 Juniperus communis scrub
F9.123 : Balkan riverine willow scrub		F9.1 Riverine scrub

Table 13. Habitat list from the Woodland, forest and other wooded land group present on the habitat Directive and Bern Convention annexes. [Consult: Table 10]

G : Woodland, forest and other wooded land		
G1.11212 : Eumediterranean white and crack willow galleries		! G1.11 Riverine [Salix] woodland
G1.3156 : Paeonian poplar galleries	92A0 Salix alba and Populus alba galleries	G1.3 Mediterranean riparian woodland
G1.691 : Southwestern Moesian beech forests	91W0 Moesian Beech Forests	! G1.6 [Fagus] woodland
G1.733 : Hellenic Quercus pubescens woods	*91AA Eastern white oak woods	! G1.7 Thermophilous deciduous woodland
G1.762 : Helleno-Moesian *Quercus frainetto* forests	*91AA Eastern white oak woods	! G1.7 Thermophilous deciduous woodland
G1.7C1 – *Ostrya carpinifolia* woods	*91AA Eastern white oak woods	! G1.7 Thermophilous deciduous woodland
G1.7C221 : Helleno-Moesian oriental hornbeam forests	*91AA Eastern white oak woods	! G1.7 Thermophilous deciduous woodland
G1.8A : Continental sessile oak forests		! G1.8 Acidophilous [Quercus]-dominated woodland
G3.1E13 : Moeso-Macedonian spruce forests		! G3.1E4 Pelagonide [Picea abies] forests
G3.5211 : Moeso-Hellenic montane *Pinus nigra* forests	*9530 (Sub-) Mediterranean pine forests with endemic black pines	G3.5 [Pinus nigra] woodland

Table 14. Habitat list from the Inland non-vegetated or sparsely vegetated habitats group present on the habitat Directive and Bern Convention annexes. [Consult: Table 10]

H : Inland unvegetated or sparsely vegetated habitats		
H1 : Terrestrial underground caves, cave systems, passages and waterbodies		H1 Terrestrial underground caves, cave systems, passages and waterbodies
H2.33 : Southeast European mountain siliceous screes	8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	H2.3 Temperate-montane acid siliceous screes
H3.152 : Carpatho-Balkano-Rhodopide campion siliceous cliffs	8220 Siliceous rocky slopes with chasmophytic vegetation	H3.1 Acid siliceous inland cliffs

11 Biodiversity Threats Identified in the Bregalnica Watershed

Bregalnica river watershed underwent several land use changes in the last decades. Such changes are potential threats because of their impact to the natural appearance of the region, its natural values and its biodiversity. The threats detected in the research region are more or less specific and related to different biodiversity components. There are threats with negative influence to all species, their populations, habitats and ecosystems. Threats detected in the Bregalnica river watershed are predominantly human induced and are mostly related to habitat alteration, intensification of agricultural practices, unsustainable use of natural resources, water pollution etc.

Habitat alteration. This threat appears to be most wide-ranging of them all, since it includes conversion of hilly pastures into arable land, enlargement of the arable plots, drying out of wet meadows, forest spacing and clear-cuts, forest fires, habitat fragmentation due to infrastructure development, unplanned construction outside of urban areas etc.

Certain practices such as illegal logging, clear-cuts, unplanned and intensive construction in vicinity of or near forest ecosystems contribute towards jeopardizing the natural values, erosion and similar disruptions in the forest ecosystems.

River banks and riparian habitats destruction are another serious threat in the region. Human activities such as sand and gravel extraction, various construction work, partitioning of rivers and dam construction, fishponds, release of untreated wastewater etc., contribute to massive destruction of the natural river habitat. The rivers are a stronghold for a wide range of animal and plant species diversity, whose life cycle is closely connected to them (Otter and small mammals, riparian vegetation, insects, birds etc.).

Land conversion is a frequent practice in the region. There are examples where hilly and lowland-wavy pastures are converted into forest with forestation, and even more frequent are the examples where wet meadows are converted to arable land.

Elensko Blato after its destruction in 2015

Intensive agriculture. Intensive agricultural practices cause partial habitat destruction, but also affect the watershed water quality which is a direct threat to the biodiversity. Use of uncontrolled quantities of pesticides and artificial fertilizers in the agricultural production contributes to significant pollution and eutrophication of Bregalnica River. Besides, part of the agrochemical components used are highly toxic and their excessive use can contribute to decrease of the species diversity in the water ecosystems located in vicinity of the arable lands. Invertebrates (especially dragonflies, damselflies and butterflies), amphibians and birds are most vulnerable to these agricultural practices.

Industrial and communal waste pollution. As a direct result of the urbanization, Bregalnica River is strongly influenced by different range of pollution sources: mining (Zletovo, Sasa and Buchim mines), industrial facilities (food, textile and cellulose industries), and wastewater from urban settlements, livestock, pigs and poultry farms in the region. Majority of populated places, as well as the farms don't have proper wastewater and sewage treatment facilities and are usually directly released into the rivers, without any treatment whatsoever. One of the biggest negative impacts to the water ecosystems id the release of wastewater from ore flotation without any treatment. These water have low pH and high concentrations of toxic heavy metals which cause mortality to the river species and their entire populations. These types of pollution are serious threat to the biodiversity, especially to the species that have rivers as their primary habitats (algae, plants, macroinvertebrates, insects, amphibians, fish and others).

Policy. Other serious biodiversity threats in the Bregalnica River watershed are related to the currently divergent development plans and inappropriately assigned land concessions. Therefore, it's increasingly eminent to have serious approach in consolidation of sustainable use policy with natural resources and habitats management policies. Their proper consolidation and implementation would assist the decrease of their negative influence to the biodiversity.

The lack of subsidy policy (except for the subsidies for certified plant seeds) also contributes to the slow decline in traditional agricultural practices and keeping of traditional plant/crop variety, on account to the prevailing commercial production.

Regional depopulation. Although regional depopulation at first glance might not seem related to biodiversity, still it presents and indirect threat and if situation doesn't change, it could cause serious changes in the regions'' natural appearance. Depopulation also impacts agrobiological diversity. Preservation of aboriginal plant/crop varieties and domestic animals is mostly dependent on the villages in the region, where these practices are being substituted for new, more commercial varieties. Depopulation also influences the great landscape diversity of the region. This is especially evident of the hilly rural and mountain landscapes, where village abandonment is already shaping the appearance of these landscapes. Abandoning of old agricultural practices, such as mowing contributes to the loss of several important semi-natural habitats, such as meadows and pastures.

12 Recommendations for Biodiversity Conservation

Given the size of the research area and variety of landscapes and habitats, in the previous chapter the main identified threats were described. Consequently, it is necessary to highlight some recommendations aimed at preserving certain habitats, localities or areas; measures or guidelines that will help the various sectors to improve the development plan of the region and contribute to better management of natural resources, habitats and ecosystems. According to the identified threats, the recommendations correlate to proposals that would contribute to their mitigation or complete eradication.

In any segment of the listed recommendations it should be stressed that the improvement of the status of species, their habitats and ecosystems will only be possible through cooperation with the local population and mutual cooperation among different institutions. This is actually the main road to successfully achievement of sustainable development within one region.

Establishing protected areas. Changes and negative impacts on landscapes and certain habitats and species due to human activities can be mitigated by declaring new protected areas in the region. In Bregalnica watershed there are seven designated protected areas (category Natural Monument) declared in the 60s and 80s of XX century which have not passed through the process of re-proclamation. During this project implementation a detailed analysis of the proposed areas for protection according to the Spatial Plan of the Republic of Macedonia and other strategic documents and reports was made. The recommendations of the expert team for establishment of new protected areas were also taken in to account. Therefore, a study was produced (consult: **Report on the State of Protected Areas in the Bregalnica River Watershed**) which proposes new conservation areas of different category (mainly lower categories of protection), which in the future should be taken into account in the processes such is drafting of plans for development. Particular attention should be paid to rare and endangered components of biodiversity (according to various international agreements and European legislation) where these species and habitats should be prioritized in taking measures for their protection. One such example is the area with halophytic vegetation, which can still be found in fragments within Ovche Pole area, then wetlands and some of the forest associations, such are for example the old beech forests or riparian forest belts.

Protecting species. Apart from establishing a network of protected areas in the Bregalnica watershed, preparation of action plans for protection of certain important species is also recommended. There is presence of species in Bregalnica watershed that are both nationally and internationally important. With their protection and effective enforcement of the proposed measures developed within the action plans not only one species is protected, but also its entire habitat and the rest of the biodiversity related to the certain specimen. Mammals and birds are particularly favourable for application of this type of protection, since they usually occur as a flagship species.

Eradication of pollution from industry, mining and utilities. One of the biggest problems that dramatically affect the ecological status of water bodies in the watershed is discharge of sewage water from urban areas. The basic prerequisite for improving the situation is constructions of municipal system that would include all major settlements in the watershed and will function properly. An additional problem is the water that run down from the debris from the mines. It is necessary to construct a system which will collect these waters and do chemical treatment at the same time in order to remove heavy metals from their composition. Regarding the use of agro-chemicals (pesticides and fertilizers), especially in the cultivation of rice in the Bregalnica watershed, it is necessary to conduct a detailed analysis of the need for application of proper pesticides as well as the amount of pesticides and fertilizers applied.

Sustainable use of resources. According to studies and surveys conducted by experts, within the research area there are parts where the need and use of natural resources exceeds the supply capacity of ecosystems to these resources, whereas there are parts where the situation is reversed. The greatest attention for proposing recommendations for sustainable use of the natural resources is directed to the ones supplied by the forest ecosystems. Incompatible policies lead to a number of problems to the use of resources produced by forests, thus follow certain threats to these natural ecosystems. One of the primary actions that can influence the trend of loss of forests with high natural values is by changing the way of operating and managing forest resources, implementation of criteria for sustainable forest management and application of appropriate protection by declaring protected areas or protected forest habitats. In this setting it is important to continue research on forest resources and to register and protect important forest ecosystems. In the territories where there are endangered, endemic or species in extinction appropriate forest practices and activities needs to be planned and performed. In certain parts of forests that have special ecological significance all kinds of activities must be eliminated in order to preserve the natural look. Measures of sustainability and protection should be consistent with the purpose, value and functions of natural resources. So they move from strict protection in the forests that are designated as virgin, old or threatened to quite flexible measures for management to meet the social needs of the population. As for the natural resources supplied from other ecosystems, much scarcer data exist in comparison with those supplied by forests which results with difficulty to specify other recommendations except start with thorough research to assess the ecosystems capacity for supply of natural resources.

Monitoring, research and preparation of studies on the proposed areas for protection. To protect certain species or area, systematic research and monitoring of the environment in general and biodiversity is required. In that regard, Bregalnica watershed is not sufficiently explored. The exception to this is the Osogovo Mountains, where through implemented projects with duration of several years good data was gained which reflects the state of biodiversity. Almost no research is done on the effects on nature and environment by pollution from various sources. For example, given that agriculture is one of the most common activities in this region, we recommend starting a study that will calculate the effects of the use of chemicals, insecticides (spraying against mosquitos), the effects of the debris from the mines and other similar activities. Continuous monitoring of the populations and affected and rare species of plants, fungi and animals and their habitats is highly recommended.

Preparation of plans for urbanization with prior conduction of EIA and SEA. It is recommendable to prepare studies for environmental impact assessment even in the planning stages for construction of some infrastructure facilities such as roads, power plants, industrial facilities and other. Additionally, during the construction of infrastructure facilities the instructions of experts from the relevant fields should followed in order to minimize the negative impacts on biodiversity and environment. For example, in the process of construction of new roads, it is recommended to make crossings for small mammals and reptiles in order to reduce the mortality rate of these species on roads. In any case, whit such human activities, it is recommended to keep the balance between economic development and environmental protection as much as possible, as it is required by national and international laws and conventions. In cases where the research has proved that planned infrastructure facility would have a strong negative impact on certain species and habitats, an alternative needs to be find such as changing the location of infrastructure facility where its negative impacts on the nature and environment would be milder.

Subsidies for organic production. Existing programs for support in agriculture slowly but surely exceeds the traditional and lead to intensification in agricultural production. Bigger support should be directed toward encouraging the farmers to switch to organic production as well as

application of introduced agro environmental measures. Given that this region is second in Macedonia by the size of the poverty rate, motivating the farmers by increasing subsidies is highly recommended. This will lead to reduced pollution from agrochemicals, reduced depopulation from the villages, and at the same time indigenous plant varieties and breeds of domestic animals will be preserved.

Education among target groups. Education can significantly improve the status of biodiversity in the area. It can take place at several levels: public institution's employees (those who participate in the policy development and decision making primarily in the field of agriculture and forestry, and those who make decisions related to environment and agriculture), farmers, local population and the youngest population. We suggest starting an educational campaign for a thorough introduction to the benefits from IPARD program designed for farmers especially for the ones from Ovche Pole and Kochani Field. In this way, the farmers will get more familiar to the advantages of organic production. Looking long term, these mechanisms can positively impact on biodiversity in these valleys.

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13.3 Separate Studies from the Valorization Study for the Proposal of Establishing a Protected Area "Osogovo Mountains"

- Климата и метеоролошките услови во регионот на Осоговските Планини и североисточните делови од Република Македонија (сепаратна студија, П. Ристевски, 2007);
- Геоморфологија, геоморфолошки локалитети и хидрологија на Осоговските Планини (сепаратна студија, И. Милевски, 2007);
- Шуми и шумарство (сепаратна студија, Т. Јованов, 2007);
- Предели на Осогово (сепаратна студија, Љ. Меловски, 2007);
- Истражување на живеалиштата на Осоговските Планини (сепаратна студија, В. Матевски, 2009);
- Хидробиологија (алги и водни бентосни без'рбетници) на Осогово (сепаратна студија, В.Славевска-Стаменковиќ и З. Левков, 2009);
- Флората на Осоговските Планини (сепаратна студија, М. Костадиновски, 2009);
- Валоризација на разновидноста на габите на Осоговските Планини (сепаратна студија, М. Караделев, 2008);
- Без'рбетници:
    - Мекотели на Осоговските Планини (сепаратна студија, И. Дедов, 2008);
    - Пајаци на Осогово (сепаратна студија, М. Комненов, 2008);
    - Прелиминарни резултати за вилинските коњчиња на Осогово (сепаратна студија, Д. Китанова, 2007);
    - Лебарки, богомолки и правокрилци на Осогово (сепаратна студија, Д. Чобанов, 2009);
    - Разновидноста на тркачите (Carabidae, Coleoptera) на Осоговските Планини (сепаратна студија, С. Христовски, 2009);
    - Прелиминарни резултати за дневните пеперутки на Осогово (сепаратна студија, Д. Меловски, 2007);
- Резултати од квалитативните истражувања на ихтиофауната во реките и езерата на осоговскиот регион (сепаратна студија, Ј. Милошевски, 2007);
- Херпетофауната на Осоговските Планини (сепаратна студија, Б. Стеријовски, 2009);
- Прелиминарна анализа на орнитофауната на Осогово (сепаратна студија, М. Велевски, 2009);
- Цицачи на Осогово (сепаратна студија, А. Стојанов, Ѓ. Иванов, Д. Меловски, 2009);
- Студија за влијание на фрагментацијата на живеалиштата врз карабидите (тркачи) на Осоговските Планини (сепаратна студија, С. Христовски, А. Цветковска-Ѓорѓиевска, Т. Митев, М. Комненов, 2009);
- Студија за ерозивноста на Осоговските Планини (сепаратна студија, А. Трендафилов, 2010);
- Социо–економски истражувања (сепаратна студија, Ј. Гиновска - P&P Нова, 2007);
- Проценка на производството на боровинката Осогово и препораки за нивно одржливо користење (сепаратна студија, Љ. Меловски, С. Христовски, Ѓ. Стефков, 2008);
- Сточарството во осоговскиот регион (сепаратна студија, В. Џабирски, 2008);
- Социо–географски и економско–географски одлики на просторот на планинскиот масив Осогово (сепаратна студија, Б. Марковски 2009);
- Валоризација на културните вредности на Осогово (сепаратна студија, М. Мирчевска, 2012);

- Студија со предлог модел за управување со предлог-заштитеното подрачје „Осоговски Планини“ (сепаратна студија, Т. Белев, Д. Петрова, 2012);
- Студија за финансиските импликации на управувачкото тело за предлог –заштитеното подрачје „Осоговските Планини“ - економско-финансиска анализа (сепаратна студија, П. Недановски, А. Наумовски, 2012);
- Развивање на стратегија за комуникација со јавноста (сепаратна студија, И. Андреевска, 2008);
- Добра земјоделска пракса на Осогово (сепаратна студија, Г. Попсимонова В. Џабирски, 2010);
- Студија за одредување на погодноста на живеалиштата за присутност на крупни sверови (сепаратна студија, В. Авукатов, Г. Иванов, 2010);
- Студија за одредување на погодноста на живеалиштата во дабовиот појас согласно селективни видови од херпетофауната (сепаратна студија, В. Авукатов, Б, Стеријовски, 2010);
- Студија за определување на НАТУРА 2000 подрачја на Осоговските Планини (сепаратна студија, Љ. Меловски, М. Влелевски, С. Христовски, 2012);
- Заштитени подрачја - Во контекст на системот на заштитени подрачја во Македонија и можностите за видови на заштитени подрачја на Осоговските Планини (сепаратна студија, Љ. Меловски 2008);