Project Report

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

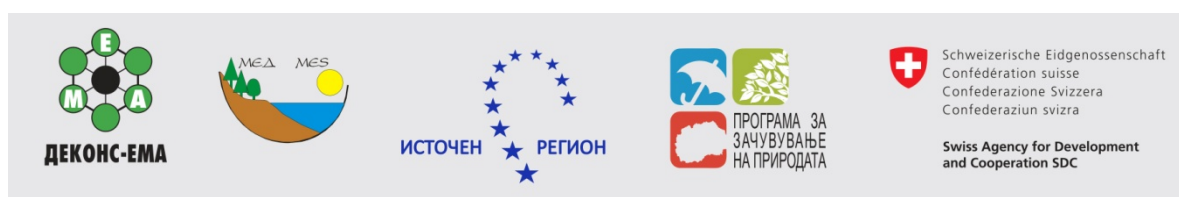### Dekons-Ema and Macedonian Ecological Society

Book 3

Landscape diversity in Bregalnica watershed

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1 Introduction

Landscapes are a mosaic of anthropogenic and natural ecosystems shaped as a result of long lasting interaction between humans and nature. This human-ecosystem interaction has been creating structures that have been changing in space and time and resulting in spatial and temporal heterogeneity. Dynamics of ecosystems which are certainly interacting is under the influence of that spatial and temporal heterogeneity. Humans have had a dominant bearing on landscape patterns (structural characteristics of landscapes, spatial heterogeneity) and therefore man is an important part of the definition of a landscape.

For centuries, people have played an important role in the shaping of natural ecosystems in the eastern part of Macedonia and have contributed to specific characterization of landscapes (landscape patterns). Preservation of harmonious coexistence of man and wild species within landscape(s) is of particular importance, as in most of Europe and world. Thus, the recognition of human activities as indispensible and integral part of ecosystems, globally, resulted in a shift of the conservation approach – from species and ecosystems protection to landscapes conservation.

According to Meeus et al. (1995), five major values and functions, can be attributed to landscapes:

1. role in sustainable use of natural resources,
2. **as wildlife habitats**,
3. providing economic benefits,
4. scenery and open spaces, and
5. possessing cultural heritage.

These overall values and functions of the landscapes explain why conservation of landscapes on European scale is so important[1]. In the context of the Project *"Ecological Data Gap Analysis and Ecological Sensitivity Map Development for the Bregalnica River Watershed"*, the second listed function of landscapes is of particular relevance.

Identification and characterization of landscape diversity in the region of Bregalnica watershed will therefore result in data that will complement existing understanding of natural resources and contribute significantly to integrated and sustainable conservation of natural values of the region. The analysis of anthropogenic induced changes on landscape level in recent history should be part of this Study to allow determining the capacity of ecosystems to support the preserved biodiversity, revitalization of degraded components and provision of the necessary ecosystem services. Structural analysis of landscapes should serve as a base for integrated spatial planning in the area of interest that would ensure sustainable development of communities in the region without serious impairment of natural ecosystems and overall biodiversity. Hence, recognizing the need for a detailed analysis of landscapes in Bregalnica region, this study includes typification of landscape types, while considering their structural features and their functionality in terms of biodiversity and ecosystem processes.

Importance of the landscapes for biodiversity is presently recognized in the worldwide biodiversity conservation efforts. The joined statement of the world's leading nature conservation organizations[2], in 1999 is an example:

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[1]See: Pan-European Biological and Landscape Diversity Strategy; Convention on Landscapes
[2]Conservation International, IUCN, The Nature Conservancy, The World Resource Institute and WWF

"It is crucial to implement integrated conservation and development plans and programs on a larger scale than those that have been attempted so far. Presently nature conservation focus is broadening to encompass landscape, working closely with the key stakeholders. This will help to address more effectively the broader social, economic, and policy factors that are critical to sustainable livelihoods and ecosystems".

Overall guiding principles in each case of broader scale nature conservation (landscape, eco-region, ecosystem based management, etc.) are essentially the same.

- Conservation – and where necessary restoring – **the full range of biodiversity**
- Planning of the conservation and development at **landscape or regional scales**
- Investing in "**good" science**
- National sovereignty and international **cooperation**
- **Long-term** commitment

1.1 Concept and basic terms in landscape ecology

The basis for landscapes study is found in Landscape Ecology, a new science derived from the science of ecosystems. For the purpose of easier understanding of the text in this Report, the box below presents the main definitions and terms of Landscape Ecology.

What is landscape and what is Landscape Ecology?

Landscape ecology is a science discipline that emerged from ecology of ecosystems (Burel and Baudry 2003). It was introduced to account for the human role in the biosphere and was used to evaluate impacts on ecosystems. In order to do it, it is necessary to:

- Explicitly take the **spatial dimension** into consideration,
- recognize **man as integral part** of ecological system, and
- recognize **spatial and temporal heterogeneity** of environments studied.

Although the landscape is originally geographical term, it is now considered as ecological system of higher level than ecosystem. Generally landscape was defined as a portion of land seen in a single view. However, ecology excludes view, i.e. landscape exists independently of perception (it is heterogeneous and dynamic level of organization of ecological systems).

Landscape is composed of several categories of **landscape elements**:

- **Matrix** is predominant all-encompassing element (e.g. croplands in agricultural landscapes)
- **Patches** are distributed within the matrix (e.g. woodlands, settlements)
  - o   Mosaic – set of patches
- **Corridors** – linear elements (e.g. tree lines along the hedge-rows between croplands)
  - o   Network – set of corridors
  - ➢   Edges – can be distinguished in the frames of patches and corridors – it has strong interaction with matrix
  - ➢   Interior – can be distinguished in the frames of patches and corridors– has weak or no interaction with matrix

Spatialarrangement of mosaic and matrix makes the **landscape pattern**. It can be useful in studyingthe differences or similarities between two landscapes from the **structural point of view**. The structure (elements) is a base for functional aspects of particular landscape.

Some important issues in landscape study are: **size of the patches** (quantity of available habitats); **fragmentation** (disjunction of the matrix or patches distance);**heterogeneity**(diversity of patches and corridors); as well as **spatial relationship between patches – connectedness and connectivity**.

Connectedness – two patches of the same type are in immediate proximity or merged in space.

Connectivity – individuals or propagules of species are able to move from one to another patch even if the latter are remote; the displacement capacity of individuals is an essential factor.

Quantitative presentation of heterogeneity and fragmentation is scale dependant (something that is connected at smaller scale could be fragmented at bigger scale).

In the course of the last two decades, landscape ecology has developed three main topics of research within general context of environmental studies and at international level.

1. Population dynamics in fragmented environment
2. **Maintenance of biodiversity** at landscape level (in both highly anthropogenous and more natural landscapes)
3. Control over the flow of water and nutrients in landscapes (usually in anthropogenic landscapes).

The above described terms and definitions clarify why landscape ecology is presently widely used in nature conservation. Studieson corridors and establishment of ecological networks are the main tools (e.g. EU Habitats Directive and NATURA 2000 network or PEEN Pan-European Ecological Network).

1.2   Existing knowledge of landscapes in Macedonia and Bregalnica watershed

By far there are practically no scientific data subjected to landscape types and characteristics in Macedonia. The only exceptions include:

- One elaborated doctoral thesis on part of the National Park "Mavrovo" – the area around Galichnik (Slavkovik 2011);
- Analysis of land-use/land cover changes during the last 70 years within "Galichica" National Park (Despodovska et al. 2013);

- Land cover succession as a result of changing land use practices in northeast Macedonia (Jovanovska & Melovski 2013);

Aside from the doctoral thesis of Slavkovikj of 2011, the other two scientific publications do not address typification of landscapes but focus on the change in the landscape structure relative to historical factors determining such changes

Prominent attempt towards typification of landscapes in Macedonia was made in the technical publication on natural values of Shar Planina (Melovski et al. 2010), though again on a limited area – Macedonian part of the territory of Shar Planina.

In relation to the area of interest to this project, there are also a number of technical papers and reports (unreviewed works).

- The most comprehensive data on landscapes typification together with methodology for identification are presented in Melovski (2010). The report identifies and spatially defines six landscape types on Osogovo Mountains. All identified landscapes are also specific to the part of Osogovo belonging to Bregalnica Watershed. These six basic landscapes are functionally intertwined and inter-related, especially in terms of carnivores migration, grazing patterns and influence of alpine region on the formation of surface waters and hydrology of forests. Corridors – rivers and streams running from high parts of the mountain most often belong to more than one landscape type.
- Analysis of land use change in the last six decades on part of Osogovo Mountains was made in the work of Redzovikj (2011). According to data presented in Redzovikj (2011), uncultivated areas are represented mainly by forests, followed by grasslands and barren land. Further on, Redzovikj has noted increase in the area under forests and shrubs during the last 60 years and decline in areas under pastures.
- Similarly, along the investigated corridor Kumanovo-Kriva Palanka, for the period 1995 to 2011, Jovanovska & Melovski (2013) noted the most prominent change in land cover with pastures, then agricultural areas and populated places and forests. As indicated by Jovanovska & Melovski (2013), the observed trend of abandoning of the areas under pastures, is followed by a successive scrubland and forest encroachment. This trend is considered to be an indirect reflection of the population migration and driven by abandonment of livestock breeding practices.

1.3   Goal of the project activity "Landscape diversity"

Bregalnica Watershed (watershed) occupies relatively large territory of 4302.6 km^2 (19 municipalities have smaller or larger parts in the basin, while most of the watershed overlaps the Eastern Planning Region – 3195.5km^2). It is characterized with great altitudinal difference (more than 2000 m) between Bregalnica river estuary and the highest peaks of Osogovo Mountains.

Numerous and in some cases intensive activities have been practiced in the region for centuries. This has left a strong human imprint on plains, mountains, landscapes and nature in general. On the other hand, heterogeneity in human practices has contributed and contributes to the current state of biodiversity. This means maintaining the existing landscape diversity and preservation of existing wildlife corridors is crucial to ensure comprehensive biodiversity conservation. It is obvious that provision of scientific data on landscapes in the Bregalnica watershed is vital for defining conservation measures while considering sustainable human activities. The ultimate goal would be development of effective management plan for the whole region (spatial plan), to include action

plans for preservation of the most important "flagship" species, ecosystems and habitats along with traditional and other human activities.

In the case of the project for identification of natural values of Bregalnica Watershed, the need for landscapes mapping and exploration of their structural and functional aspects is evident. Landscape ecology can play a great role in the definition of future research activities aimed at conservation of biological diversity in the area.

2 Applied methods

As mentioned above, Bregalnica Watershed is characterized with great diversity of habitats of different distribution and distinctive organization. Complexity increases with the accrual of geomorphological characteristics. Great elevation differences from the foothills to the highest peaks influence the distribution of vegetation types. However, setting up a study approach requires organization and systematization of the complexity.

In scientific literature, climate is the starting point in landscapes definition (Mucher et al. 2009), though variation of climate characteristics in the case of the area of interest to this project is insufficiently articulated considering relatively small area it occupies (climate changes along the gradient of geographical latitude at much bigger distances). On the other side, the region is featured with prominent gradient of altitude which in turn induces significant changes in climate influences at different altitudes. Hence, relief and differences in altitude were taken as starting point for identification of different landscape types. Their effect on climate and vegetation, and consequently on the manner of natural resources exploitation and thus resulting human life styles, is the main reason for different landscape types along elevation gradient.

Modern science identifies and delineates landscapes in a given area by use of computer tools (GIS software) and available cartographic layouts which determine landscape characteristics. This process includes mostly shapefiles on climate, geology and pedology of surveyed area, relief, land cover and land use. These are actually the only efficient tools for landscapes identification in very large areas (for example, at continental scale). This method also has substantial deficiencies, especially for the fact it neglects the visual aspect and specific features of certain spatial entirety. This concerns mainly the cultural aspect of the landscape (division in land plots, pattern of occupation, manners of cultivation and historical momentum – abandonment of cultivation). These matters cannot be included adequately in digital data processing (Mucher et al. 2009), which is not significant disadvantage when dealing with very small scales (on vast areas). Nevertheless, when identification of landscape types concerns smaller areas (like Bregalnica Watershed), we still have the possibility (in addition to initial delineation of basic landscape categories with GIS) to further determine landscape units based on field surveys, taking into account the basic cultural aspects of the area (Method of visual interpretation by use of composite multi-temporal images and precise digitalization of a given area (Lu et al. 2004). Application of this method has certain deficiencies: it takes time and involves a dose of subjectivity (results depend on the experience, expertise and field-specific knowledge of the expert). Yet, application of this method proved necessary in definition of some of the landscapes in Bregalnica Watershed.

Identification of landscape types in this Study was made through the following steps:

✓ The main elevation belts relative to which potentially defining landscape criteria were set in the matrix (column 1 in Table 1); belts were defined on the basis of distribution of potential vegetation in the area of interest, using the available data (Matvejev and Puncer 1989; Matvejev and Lopatin 1995; Filipovski et al. 1996)

✓ Eight criteria were selected to describe the main characteristics of the landscapes in Bregalnica Watershed (first line – columns 2-9 in Table 1):

- Relief - inclination (plains, mild slopes and hills, hills with steep or mild slopes, mountain ridges and peaks) has significant influence on land use and land cover; exposition (mainly northern

and southern exposition of slopes) has an influence on climate and land-cover or potential vegetation; altitude as relief category has been set as basis against which all other criteria are analyzed. Layouts used include: digital elevation model (ASTER GDEM) and topographic maps in 1:25000 scale (Agency for Real Estate Cadastre of the Republic of Macedonia).

- Present or potential vegetation – vegetation types at higher level dry grasslands, scrubs, forests, alpine pastures). Layouts used include: Google Earth Pro satellite images from 2012-2013 and CORINE Land Cover 2012; final classification and distribution of vegetation was determined on the basis of field specific data.

- Land use – this category comprises mainly the manners of agricultural practices (size and type of croplands, intensive versus extensive practices, presence of hedge-rows, the crop grown). Layouts used: land-use shapefiles (Agency for Real Estate Cadastre of the Republic of Macedonia); final digitalization was made on the basis of field specific data.

- Geology and soils – diversity of geological grounds (rock types) was simplified in a way that grounds with acid properties for pH were grouped in one type of "silicate rocks" (specific grounds, due to colour for instance, such as gneisses, were grouped separately), then rocks with base properties were grouped as "carbonate rocks"; the ground of marl was picked out as specific type of ground. Soil types were also generalized (saline, clay, alluvial, brown mountainous soils, etc.). Specifically digitalized shapefile based on Geological Map of Macedonia in 1:100000 scale (Federal Geological Institute, Belgrade) and shapefile of soil types (Soil Map of the Republic of Macedonia, Macedonian Soil Information System (MASIS), Ministry of Agriculture, Forestry and Water Economy of the Republic of Macedonia).

- Climate – vector data was not used, but data by Lazarevski (1993).

- Naturalness – natural, semi natural, degraded or strongly degraded stands of potential vegetation; the rate of naturalness of natural ecosystems was determined based on field-gathered information.

- Settlements and cultural characteristics – type and density of settlements in a given area; cultural characteristics refer to specific use of land and natural resources in certain parts of the basin.

- History – processes of changes in land use in recent and distant past (for example, abandonment or intensification of agricultural activities)

✓ All the above criteria were explained separately in the respective cell corresponding with a given criterion and given elevation belt (in matrix, Table 1); If an elevation belt is characterized by different characteristics of a criterion, then the cell is divided accordingly. This means that more than one landscape can occur in that elevation belt (partially subjective estimate!). For example, areas with different agricultural practices and different soils and geology were differentiated in lowland belt (see example in Table 1). This means that at least two landscape types exist in that elevation belt. It should be mentioned that application of this method of landscapes characterization and definition is conditioned by broader expert knowledge in the area of landscape ecology.
✓ Overlaps were analyzed and similar patterns in different elevation zones were identified;
✓ Geomorphology, existing predominant vegetation or land use pattern, naturalness and geological or soil grounds were used to name the identified types of landscapes, similarly as in Mucher et al. (2009).

The above described processes are summarized and presented in the enclosed Table 1.

Criterion of "general public perception" was not implemented, but specific features of certain regions (in wider national context) were used to name certain landscapes (subjectively, based on the perception of the authors of this Study).

At the end, upon identification of landscape types following the above elaborated methodological approach, the identified landscape types in the area of Bregalnica Watershed and Eastern planning region were spatially defined in ArcGIS. In reality, boundaries between landscapes are diffuse so that they often cross over each other so defining clear boundary between different landscape types is practically impossible, but necessary for further analysis of their characteristics. In this case, the boundaries were determined partially by manual digitalization (subjectively, mainly by observation of Google Earth images), and partially by tracing features of certain CLC classes.

Table 1 Matrix for identification and characterization of landscapes (urban and mining landscapes are not included)

	Relief (inclination exposition)	Potential vegetation (Land cover)	Geology and soils	Land use	Climate	Natural-ness	Settlements and cultural characteristics	History	Landscape type
1. Low-lands, to 400 m	Flatland	Lacking or narrow corridors of flooding forests	Alluvium; Clay soils	Intensive–rice fields	Sub-mediterranean influence	Mainly artificial	Dispersed, not dense, of compact type	Continuous use	**Kochani landscape**
			Alluvium or marl; saline soils	Intensive - crops					**Ovche Pole flatland landscape**
2. Foots, to 600 m	Rolling; mild slopes	Lacking	Alluvium or marl; saline soils	Intensive - crops	Sub-mediterranean influence to warm continental	Mainly artificial	Dispersed, not dense, of compact type	Continuous use	**Rolling agricultural landscape**
								Continuous use with anthropogenic manipulation	**Rolling agricultural landscape with wind hedges**
		Almost lacking		Moderately intensive, diverse crops				Continuous use, signs of abandonment	**Rolling agricultural rural landscape**
		Small remains of oak woodlands	Alluvium or marl; terraces	Extensive agriculture		Strongly altered	Rather dense villages of compact type; small plots	Slight signs of abandonment	**Rolling rural landscape**
							Dense villages of compact type; small plots with hedge-rows		**Rolling rural landscape with hedges**
3. Low elevation belt (600-900-1000 m)	Flatland	Lacking	Sediments and deposits - silicate	Relatively intensive agriculture	Warm continental to continental	Mainly artificial	Villages of compact type and towns	Continuous use	**Maleshevo-Pijanec rural agricultural landscape**
	Hilly; steep and mild slopes, deep dales	Remains of oak woodlands	Silicate ground	Extensive agriculture	Warm continental with weak mediterranen influence	Strongly altered	Rather dense villages of compact type; small plots	Slight signs of abandonment	**Hilly rural landscape**
		Small remains of oak woodlands; shrubby stands	Silicate ground	Livestock breeding		Semi-natural	Sparse villages of compact type	Abandonment	**Dry grasslands on silicate ground landscape**
			Marl ground				Very sparse villages of compact type, abandoned		**Dry grasslands on marl ground landscape**
		Xero-thermophilous degraded oak forests	Silicate ground	Forestry			No settlements	Abandonment of use	**Landscape of thermophilous degraded forests**
4. Medium elevation belt (700-900-1400 m)	Hilly-mountain; and mild slopes, deep dales	Thermophilous and mesophilous oak forests; pine plantations		Forestry	Warm continental	Mainly artificial forests	No or very rare settlements	Active management and use	**Mixed forests with coniferous stands landscape**
		Thermophilous oak and mesophilous oak and beech forests		Very extensive agriculture, forestry		Altered forests - sparse	Dispersed – of broken type, high number of neighbourhoods	Abandonment	**Osogovo mountain rural landscape**
							Distinctive objects	Large areas of extensive agriculture	**Maleshevo mountain rural landscape**
5. High mountain belt (1400-1800 m)	Mountain; and mild slopes, deep dales	Beech and sessile oak forests	Silicate ground	Forestry	Continental to mountain	Semi-natural to natural	Lacking	Continuous use	**Mesophilous broadleaf forest landscape**
		Black pine, white pine and mixed forests							**Pine forest landscape**
6. Subalpine and alpine zone (>1800 m)	Mountain; mainly mild slopes and shallow dales	Subalpine pastures, heaths, peat bogs	Silicate ground	Livestock breeding, berry collection	Mountain	Semi-natural to naturalи	No settlements; rare sheepfolds	Continuous use with signs of abandonment	**Landscape of mountain grasslands on silicate ground**

During study elaboration, four main directions were followed with regard to landscapes identification and nomenclature:

1) Landscape typology by Meeus et al. (1990, 1995)
2) Biomes on Balkan Peninsula by Matvejev (1973) Matvejev and Puncer (1989) and Matvejev and Lopatin (1995)
3) Climate-vegetation-soil zones in Macedonia by Filipovski et al (1996)
4) Cultural landscape characteristics, agriculture and settlements – original contribution.

(1) ... was used to harmonize the landscape types' nomenclature with the European level to the extent possible was.

(2) ... was used to address the main biogeographical aspects of the area under consideration; biome division of Matvejev is appropriate since the author has landscape approach and uses the terms biome and landscape as synonyms. Matvejev and Jaksic and (2002) have put a lot of effort to explain the synonymy between these two terms - biome and landscape.

(3) ... was used to reveal the soil-climate and agricultural potential aspects of different regions in Macedonia. Potential vegetation distribution was also taken into account. The findings showed that these zones almost fully correspond to Matvejev's biome division of Macedonian territory.

(4) ... played crucial role in cultural landscapes definition.

Available attempts for classification divide landscapes into two main categories: natural (land cover by natural or potentially natural vegetation types) and cultural (natural land cover has been strongly altered and anthropogenic habitats dominate). In this context, the attention in the case of natural landscapes was targeted at activities for biodiversity conservation, while cultural landscapes were usually regarded a cultural heritage. Anyhow, in the case of Bregalnica Watershed (as in Europe), this division is inappropriate with regard to biodiversity conservation, i.e. natural landscapes are not able to secure efficient protection of wild flora and fauna and their habitats (most of biodiversity components cannot be preserved in the areas where they have sustained as such due to their small size and obvious fragmentation). On the other side, anthropogenic activities cannot be prevented entirely. Hence, a different approach is required to aim at provision of co-existence of ecosystems and people in the frames of rural cultural landscapes and provision of corridors sufficient in number and efficiency to connect the remained patches and core areas of biodiversity.

Landscape classification should be made (or used) in line with the goals of protection (Lindenmayer at all. 2008). The way in which local residents perceive landscape plays an important role in the landscape definition and nomenclature and has to be taken into consideration. During the last decades, particular attention was paid to local landscape perception (see, for example, ECOVAST 2002).

Connectivity of habitats in the frames of the landscapes was analyzed using "ArcGIS" and "Graphab" software, and the shapefiles used to define habitats originated from "CORINE LandCover" (CLC2012) data from 2012. "ArcGIS" was used to define the required input parameters for "Graphab", i.e. preparation of data on habitats within the surveyed area, in a raster format with 50x50m resolution. For this purpose, favorable habitat categories were defined (codes 311, 312 and 313 ofCLC2012, with description: broadleaf, coniferous and mixed forests) as core patches, and weighting factors were defined for all CLC2012 categories existing in the surveyed area, representing "resistance" of the environment to connectivity, with values in the range[0 – 100], where 0 denotes core patches, and 100 –area least favorable for connectivity (see table below). These weighting factors are taken into account in "cost-distance" analyses of core patches connectivity. Analyses of habitats connectivity were carried out with "Graphab", using the spatial statistical analysis "Fractions

of delta Probability of Connectivity" (DeltaPC). Numerical values were obtained as a result, in the range[0 - 1], for each of the core patches and corridors they connect, representing cumulative probability for connectivity loss of the habitats in the investigated area, in case of loss of each individual core patch. Then, "ArcGIS" was used for zonal analyses, more precisely to determine affiliation and area by which each core patch entered each individual landscape. Valuation of the role of landscapes in terms of habitats connectivity was calculated with spreadsheets, for each landscape, using the following equation:

$$VALj = \sum_{i=1}^{N} DELTA\_PC(CORE\_PATCHi) * Area(CORE\_PATCHij) \,/\, Area(LANDSCAPEj),$$

where DELTA_PC(CORE_PATCH$_i$)–increase of the probability for loss of connectivity in the investigated area in case of loss of the core patch CORE_PATCH$_i$;

Area(CORE_PATCH$_{ij}$) –area of the core patch CORE_PATCH$_i$, entering the landscape LANDSCAPE$_j$, expressed in m^2;

Area(LANDSCAPE$_j$) –area of the landscape LANDSCAPE$_j$, expressed inkm^2;

N –total number of core patches in the investigated area

Landscape categories were valued by summing up the valuations of individual landscapes belonging to the same category.

Values of weighting factors of connectivity by CLC2012 categories

Code	Name ofCLC2012category	Weighting factor
311	Broad-leaved forest	0
312	Coniferous forest	0
313	Mixed forest	0
112	Discontinuous urban fabric	95
121	Industrial or commercial units	95
131	Mineral extraction sites	95
132	Dump sites	95
133	Construction sites	95
211	Non-irrigated arable land	80
213	Rice fields	80
221	Vineyards	40
222	Fruit trees and berry plantations	40
231	Pastures	50
242	Complex cultivation patterns	70
243	Land principally occupied by agriculture, with significant areas of natural vegetation	30
244	Agro-forestry areas	20
321	Natural grasslands	40
323	Sclerophyllous vegetation	50
324	Transitional woodland-shrub	20
331	Beaches, dunes, sands	90
333	Sparsely vegetated areas	60
512	Water bodies	100

3 Identified landscapes and landscape types in Bregalnica Watershed

Based on research conducted so far in the area of interest – Bregalnica Watershed, as well as the whole Eastern planning region, seven basic groups of landscapes (landscape types) can be distinguished:

1. Urban landscape

2. Mining landscape

3. Agricultural landscapes

4. Rural landscapes

5. Landscapes of dry grasslands

6. Forest landscapes

7. Landscape of mountain grasslands

The text below presents brief description of the general features of landscape types and landscapes covered in the seven basic groups of landscapes. Natural landscape specific features (flora, fauna, habitats) have been only briefly indicated as these are elaborated in more detail in separate expert reports on the respective groups of organisms or habitats.

3.1 Urban landscape

3.1.1 Urban landscape

Bregalnica Watershed encompasses several major populated places – towns/cities: Berovo, Delchevo, Makedonska Kamenica, Vinica, Kochani, Zletovo, Probishtip, Shtip and Sveti Nikole. Nevertheless, most of the towns in Bregalnica Watershed cover insignificant surface and by number of population (from 8.110 to 20.000 inhabitants in the last census of population – State Statistical Office, 2002) belong to the group of small towns. In general, the region of Bregalnica is characterized with low natural increase, notable rural-urban migration and high rate of emigration (State Statistical Office2012a, 2012b).

The urban character is most evident in the towns of Kochani and Shtip, which visually, structurally and in terms of surface allows definition of an **urban landscape**(Figure 1 – Map of landscapes). The urban landscape in Bregalnica Watershed has discontinuous distribution. The town of Kochani is situated in the central part of Bregalnica Watershed, along the course of the river Kochanska Reka. According to the latest population census (State Statistical Office, 2002), the number of inhabitants living in the town is 38.092 (11.981 households). The town of Shtip is situated in the southwestern part of Bregalnica Watershed, along the course of the river Lipovdolska. According to the latest population census (State Statistical Office, 2002), the number of inhabitants living in the town is 47.796 (15.065 households). From among industries, textile and manufacturing industries are the most represented branches in bigger towns. Significant rural-urban migration has contributed to expansion of villages situated close to cities and their merging with cities. Such is the case of the village Orizari (Kochani) and village Novo Selo (Shtip) which have already attained urban characteristics and are practically merged with cities. In reality, without the area of these

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settlements attached to cities, there would be no justified ground to distinguish urban landscape in Bregalnica Watershed.

The basic structural characteristics of landscape are presented in Table 2. The nature of the landscape is determined by predominant share of CLC classes 'Discontinuous urban fabric' and 'Industrial or commercial units' (dark red in Table 2) which means that the matrix in urban landscape is represented by residential and other buildings. Except in central urban areas where one can find residential multi-storey buildings, the rest of the city is dominated by family houses. Corridors are represented mostly by asphalted roads and anthropogenic broadleaf tree belts. Patches of smaller size under vegetation can be found in central urban areas (parks) or peripheral urban areas where family houses have larger yards (gardens or natural vegetation. Riverbeds in urban landscape are strongly modified, while river courses are with strongly deteriorated structural and functional characteristics. Hence, the role of rivers and riparian vegetation as corridor is insignificant. Villages Novo Selo and Orizari are populated places with consecutively attained urban character and urbanization is less pronounced. Here, the presence of anthropogenic broadleaf tree belts and patches of natural vegetation is more prominent.

Besides typically urban characteristics, the landscape within its boundaries has certain rural characteristics as well, indicated by significant presence of CLC classes 'complex cultivation patterns'(tan in Table 2) and 'pastures' (light yellow). There are also smaller areas under natural and semi-natural vegetation (Table 2).

Table 2. Basic structural characteristics (land cover- CLC)of Urban landscape (colours correspond with those on the map of landscapes)

Урбан предел	Urban landscape	Area (ha)	Area (%)
Хетерогено земјоделство	Complex cultivation patterns	335	19.71
Иглолисна шума	Coniferous forest	8	0.44
Урбана површина	Discontinuous urban fabric	881	51.78
Овоштарници	Fruit trees and berry plantations	7	0.39
Индустриски и комерцијални центри	Industrial or commercial units	255	14.96
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	118	6.91
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	30	1.76
Суви брдски пасишта	Pastures	42	2.48
Оризишта	Rice fields	1	0.07
Пасишта со грмушки	Transitional woodland-scrub	25	1.48
Вкупно	**Total**	1701	

Legend

Landscape types in the study area

- Lowland rolling agricultural landscape
- Lowland flatland-rolling agricultural landscape with wind hedges
- Lowland rolling agricultural rural landscape
- Ovche Pole flatland landscape
- Maleshevo-Pijanec agricultural landscape
- Kochani landscape
- Rolling rural landscape
- Rolling rural landscape with hedges
- Hilly rural landscape
- Osogovo mountain rural landscape
- Mountain rural landscape
- Landscapes of dry grasslands on silicate ground
- Landscape of dry grasslands on marl ground
- Mixed broadleaf forest with black pine stands landscape
- Thermophilous degraded forests landscape
- Mesophilous broadleaf forest landscape
- Pine forest landscape
- Landscape of mountain grasslands on silicate ground
- Urban landscape
- Mining landscape
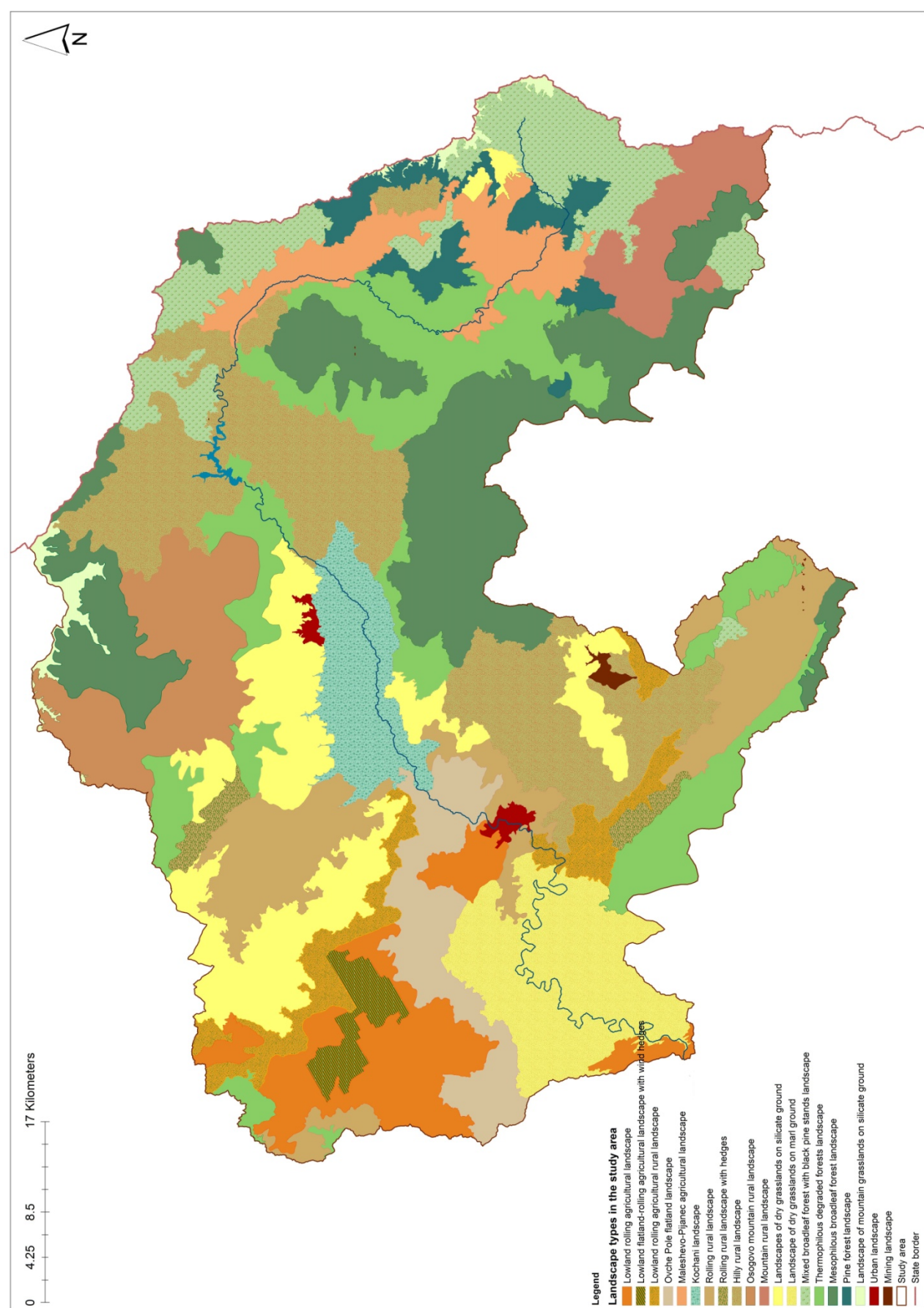- Study area
- State border

Figure 1 Map of landscapes in the investigated area

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3.2   Agricultural landscapes

Agricultural landscapes mainly span in the area of broad plains and floodplains along the valley of the river Svetinikolska Reka and central part of Bregalnica River mid-flow. Smaller agricultural areas with specific landscape features are found in Malesh and Pijanec (with rural characteristics), and along the course of the river Kriva Lakavica (Figure 1 – Map of landscapes). Owing to favorable natural and geographic characteristics (favorable geomorphology, favorable pedological and hydrographic features and favorable climate), the area of Ovche Pole and Kochani is dominated by vast areas under arable fields and croplands. Anthropogenic activities in this part of Bregalnica Watershed have been targeted at modification of natural vegetation towards agricultural expansion for centuries. Yet, fragmentation and alteration of areas under natural habitats (swamps, marshes, humid meadows and riparian woodlands) was the most intensive during the second half of the previous century. Presently, the main feature of this part of Bregalnica Watershed is the vast area of intensively cultivated agricultural land.

3.2.1   Agricultural flatland landscape on saline ground (Ovche Pole flatland landscape)

This landscape is characterized by a uniform flatland relief up to an altitude of about 350 m. Geological ground is represented by Quarter alluvial and proluvial sediments and deposits. Soils are represented by hydromorphic alluvial soils and alluvial skeletal soils (Filipovski at al. 1985; Zikov 1988). Peat-clay soils can be found near the village of Kjoseleri. However, the main characteristic of this landscape is the high rate of halomorphic soils – solonchak and solonetz which occur mainly in the area of Ovche Pole and to certain extent in the area of Shtip Pole (Zikov 1988). Climate is modified warm continental climate with Mediterranean influence (Lazarevski 1993; Zikov 1995; Filipovski at al. 1996) which is prevalent here in the frames of Bregalnica Watershed. Agricultural activities are intensive.

The main structural characteristics of the landscape are shown in Table 3. Agricultural nature of the landscape is provided by the share of CLC class 'non-irrigated arable land' (beige), while its specific feature (Ovche Pole!) is determined by greater presence of CLC classes 'complex cultivation patterns' (tan) and 'pastures' (light yellow)which is due to the presence of saline soils (Table 3). This means that the matrix is represented by arable land areas under intensive cultivation, big in size fields and croplands with crops of usually wheat, oats, barley and rye, and significant presence of vineyards (Table 3 – beige colour). The matrix of agricultural lands hosts populated places, mostly typical flatland villages of compact type, such as villages Dorfulija, Azambegovo, Erdzelija, Mustafino (Sveti Nikole area) and Vrsakovo, Sarchievo and Chardaklija (Shtip area). Corridors with tall shrubby/grass vegetation are almost absent, as are river corridors. They are mostly disjointed, though there are also well preserved landscapes with wind hedges in the northern part towards Sveti Nikole. Patches with natural vegetation are rare, because this part of Bregalnica Watershed is entirely altered by man. The most significant patches of natural vegetation (pastures) include smaller or larger areas where the well pronounced salinity of soil does not allow land cultivation (Table 3). There are also patches of small marshy areas and pine stands).

Visual features of this landscape are presented on Figure 2.

Table 3. Basic structural characteristics (land cover - CLC)of Agricultural flatland landscape on saline soils (Ovche Pole flatland landscape)(Colours correspond with those on the map of landscapes)

Овчеполски рамничарски предел	Ovche Pole flatland landscape	Area (ha)	Area (%)
Хетерогено земјоделство	Complex cultivation patterns	3476	19.03
Иглолисна шума	Coniferous forest	10	0.05
Урбана површина	Discontinuous urban fabric	432	2.36
Индустриски и комерцијални центри	Industrial or commercial units	30	0.16
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	473	2.59
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	12227	66.95
Суви брдски пасишта	Pastures	741	4.05
Оризишта	Rice fields	3	0.01
Ксерофитна вегетација	Sclerophyllous vegetation	53	0.29
Пасишта со грмушки	Transitional woodland-scrub	85	0.47
Лозја	Vineyards	735	4.02
Вкупно	**Total**	18264	

Within the frames of this landscape, additional landscape variance can be distinguished – **Ovchepole flatland agricultural landscape with wind hedges**(Figure 3). (In the Map of landscapes, Figure 1, this area is included in the group of *Lowland rolling agricultural landscape with wind hedges* for the sake of continuity of landscape).

Figure 2Ovche Pole agricultural flatland landscape(near the village of Kjoseleri)

Figure 3 Ovche Pole flatland landscape–variance with wind hedges (in the middle)

3.2.2 Lowland rolling agricultural landscape (Ovche Pole lowland rolling landscape)

This landscape is characterized by relief represented with wavy-hilly terrain with very mild slopes, found at an altitude up to 500 m. Pedological and climate characteristics of this landscape correspond with those of Ovche Pole flatland landscape. Here also soils are represented dominantly by hydromorphic alluvial soils and alluvial skeletal soils (Filipovski at al. 1985; Zikov 1988), while the main features are again attributed by the high rate of halomorphic soils – solonchak and solonetz (Zikov 1988). Climate is modified warm continental climate with Mediterranean influence (Lazarevski 1993; Zikov 1995; Filipovski at al. 1996). Agricultural activities in this area are also intensive.

Table 4. Basic structural characteristics (land cover - CLC)of Lowland rolling agricultural landscape (Ovche Pole lowland rolling landscape)(Colours correspond with those on the map of landscapes)

Низински бреговит земјоделски предел	Lowland rolling agricultural landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	89	0.36
Хетерогено земјоделство	Complex cultivation patterns	4222	17.27
Иглолисна шума	Coniferous forest	497	2.03
Урбана површина	Discontinuous urban fabric	170	0.70
Овоштарници	Fruit trees and berry plantations	39	0.16
Индустриски и комерцијални центри	Industrial or commercial units	2	0.01
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	1347	5.51
Пасишта со висока трева и планински пасишта	Natural grassland	5	0.02
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	15254	62.39
Суви пасишта	Pastures	1417	5.79
Површини со ретка вегетација	Sparsely vegetated areas	4	0.02
Пасишта со грмушки	Transitional woodland-scrub	662	2.71
Лозја	Vineyards	743	3.04
Вкупно		24450	

The main structural characteristics of the landscape are shown in Table 4. Agricultural nature of the landscape is provided by the share of CLC class 'non-irrigated arable land' (orange) (Table4) and thus the matrix is represented by large areas under arable land - fields and croplands with cereal crops. In addition to these, there are also large areas under vineyards, planted on heterogeneous,

smaller in size croplands and fields with significant representation (Table4 – beige colour). The matrix of agricultural lands hosts high number of villages of compact type. Patches with natural vegetation are more frequent compared to Ovche Pole flatland landscape and are represented mostly by small plots of pine stands, minor remains of Pubescent oak and hornbeam forests, xerothermic shrubs and grass vegetation (Table 4). There are also patches of small or larger marshy areas. Pastures are significant component of this landscape from biodiversity point of view, as they are represented mainly by communities of grasslands with *Morina persica* and *Astragalus parnassi* on marl ground. It is steppe vegetation specific for the central part of Macedonia where rare and endemic plant species can be found. Corridors are poorly represented, mainly by narrow belts of natural vegetation around streams which lack trees. Corridors of natural vegetation, often with shrubs and trees, can also be found along shallow dales and gullies. They account for 2.71 % of the entire landscape area (Table 4). Visual features of this landscape are presented on Figure 4.

Figure 4 Ovche Pole lowland rolling landscape(in the lower part of the photograph) and landscape with wind hedges (in the middle, somewhat left)

3.2.3 Lowland rolling agricultural landscape with wind hedges (Ovche Pole lowland rolling landscape with wind hedges)

Within the boundaries of Ovche Pole lowland rolling landscape (at smaller area, also in Ovche Pole flatland landscape), specific area can be distinguished in which visual effect is brought by wind hedges between fields. These areas occupy large spaces in Ovche Pole area and this allows for a special landscape unit to be distinguished with specific characteristics - **Ovche Pole lowland rolling landscape with wind hedges**(Figure 4)

Natural and geographic characteristics of this landscape are similar or identical with the previous one. Specific feature lies in the manner of land use. Here, the space is absolutely dominated by non-irrigated arable land with nearly 90 % of the overall area of the landscape (Table 5 – orange colour), though compared to Ovche Pole lowland rolling landscape, somewhat more extensive agriculture is significantly less represented. Besides, patches of other land cover classes are almost absent (except transitional woodland-scrub – Table5).

Corridors have regular "geometric" distribution in the landscape and are mostly represented by anthropogenic belts of broadleaf trees and tall shrubby/herbal vegetation and individual trees. They occupy minor area which is even not presented as separate CLC class (this means that they are almost meaningless from biodiversity point of view). Corridors are the most remarkable in eastern and southeastern parts of Sveti Nikole where they play the role of wind protection hedges.

Table 5. Basic structural characteristics (land cover - CLC)of Lowland rolling agricultural landscape with wind hedges (Colours correspond with those on the map of landscapes)

Бреговит земјоделски предел со полезаштитни појаси	Lowland rolling agricultural landscape with wind hedges	Area (ha)	Area (%)
Хетерогено земјоделство	Complex cultivation patterns	400	7.86
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	91	1.79
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	4494	88.40
Пасишта со грмушки	Transitional woodland-scrub	99	1.95
Вкупно	**Total**	5084	

3.2.4   Flatland ricefield agricultural landscape (Kochani landscape)

This landscape is characterized by uniform flatland relief on an altitude up to about 370 m. It is precisely the flatland remarkable character that distinguishes Kochani flatland landscape from the landscape variance with **terraced rice fields** of Vinnitsa along the river Osojnica (due to the small size of the area, it cannot be delineated as a separate landscape) and along the river Topolka near Chaska, where the terrain is slightly inclined.

Geological ground in the area of Kochani landscape is represented by Quarter alluvial terrace sediments. Soils are represented dominantly by alluvial and peat-clay soils. Climate is modified warm continental climate with Mediterranean influence (Lazarevski 1993; Zikov 1995; Filipovski at al. 1996). Kochani landscape is limited on the territory of Kochani Field, including also a stretch along the lower course of the river Zletovska Reka. The main characteristic of this landscape type is the rice fields, namely the way of rice cultivation into water.

Table 6. Basic structural characteristics (land cover - CLC)of Flatland rice field agricultural landscape (Kochani landscape) (Colours correspond with those on the map of landscapes)

Кочански предел (Рамничарски зем-јоделски предел на оризови полиња)	Kochani landscape (Flatland ricefield agricultural landscape)	Area (ha)	Area (%)
Шумски насади	Agro-forestry areas	96	0.59
Широколисни шуми	Broad-leaved forest	9	0.05
Хетерогено земјоделство	Complex cultivation patterns	3284	20.26
Иглолисна шума	Coniferous forest	1	0.01
Урбана површина	Discontinuous urban fabric	485	2.99
Овоштарници	Fruit trees and berry plantations	56	0.35
Индустриски и комерцијални центри	Industrial or commercial units	37	0.23
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	1965	12.12
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	3861	23.81
Суви брдски пасишта	Pastures	42	0.26
Оризишта	Rice fields	6216	38.34
Пасишта со грмушки	Transitional woodland-scrub	94	0.58
Лозја	Vineyards	67	0.41
Вкупно	**Total**	16214	

The main structural characteristics of the landscape are shown in Table 6. Agricultural nature of the landscape is provided by the share of CLC classes 'non-irrigated arable land' (orange) and 'rice fields' (blue-aqua) (Table 6), while its specific feature is determined precisely by rice fields. Although other agricultural land contributes higher percentage to the overall area of the landscape (Table 6), rice fields are distributed throughout the area and so they contribute at most towards the visual effect of the whole landscape, especially during vegetation period. Besides this, relief, soil type, proximity of the river Bregalnica and occasional flooding determine also the functional nature of the landscape, i.e. they make this area specific both by structure and functionality.

The matrix of agricultural areas (mainly rice fields, but there are also significant areas under other crops – 23.81 %, Table 6) accommodates high number of populated places – villages of compact type, among which villages Krupishte, Ularci, Cheshinovo, Obleshevo, Chiflik, Gorni and Dolni Polog, Mojanci, Pribichevo and some other are more prominent. Patches of natural vegetation are sparse, as this part of Bregalnica Watershed is entirely altered by man. Most of the former areas under wetlands in Bregalnica Watershed no longer exist. The ground water level is maintained artificially below the surface of the terrain by drainage network – amelioration system "Bregalnica" (Gashevski 1979; Zikov 1988). Hydro-ameliorative system "Bregalnica" is used for irrigation of agricultural area of 28.000 ha, primarily rice fields in Kochani Fields. Long lasting man's interventions in the area resulting in agricultural expansion have contributed to notable fragmentation of the riparian belt along the river course of Bregalnica – the most remarkable corridor in the landscape. Riparian corridor is represented mainly by belts of riparian woodlands of willows and poplars, areas under reed and reed-mace (especially visible in the vicinity of the village Grdovci) and higher representation of ruderal vegetation can be found at spots where alterations are more notable in the riparian belt. The plots of rice fields are mutually parted with narrow corridors of tall grass vegetation, reed and reed-mace. Agricultural and rural aspect of the landscape, as well as absence of significant industrial facilities and other infrastructure (long distance transmission lines, roads, etc.) makes the landscape of rice fields possessing significant aesthetic value.

Visual features of this landscape are presented on Figure 5.

Figure 5 Kochani landscape below the village of Grdovci

3.3   Rural landscapes

The main feature of rural areas in the region is given by humans that for centuries have locally shaped the natural ecosystems to adapt to their needs.. Rural landscape, as we perceive it visually today, reflects traditional practices of management, life styles, beliefs, traditions and values of people and is shaped continuously under their influence.

Topographic variations, profusion or scarcity of natural resources, ethnic and cultural diversity as well as socio-economic policies in the past and today have contributed towards formation of several types of rural landscapes in Bregalnica Watershed.

3.3.1   Lowland rolling agricultural rural landscape

This area is characterized by a monotonous relief, often represented by smaller plains and small hills with mild slopes that wavy rise to a height of 500 m a.s.l. on the southwest foothills of Plachkovica Mountain up to 400 m a.s.l. on the northwest foothills of Serta, mainly along the course of the river Kriva Lakavica and up to over 600 m a.s.l. on Mangovica. Agricultural land on mild slope terrains is represented by small or larger private plots almost always edged by boundary vegetation of fruit or wild tree species, while flatland part accommodates mostly wheat growing fields.

The ground is made of alluvial and dilluvial terrace sediments and deposits, and soils are entirely antrophogenized. Climate is moderate continental with Mediterranean influence. Natural vegetation is almost entirely lacking and where it occurs it consists of ruderal and weed plant communities.

The main structural characteristics of the landscape are shown in Table7. In structural terms, the landscape is entirely dominated by agricultural matrix around which settlements or other type objects are dispersed. Rural nature of the landscape is given by the share of the CLC classes 'Complex cultivation patterns', 'Land principally occupied by agriculture, with areas of natural vegetation' (tan) and 'Pastures' (light yellow) which dominate over the non-irrigated arable land (orange) (Table 7), which gives the agricultural nature of the landscape.

Table 7. Basic structural characteristics (land cover - CLC)of Lowland rolling agricultural rural landscape(Colours correspond with those on the map of landscapes)

Бреговит земјоделски рурален предел	Lowland rolling agricultural rural landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	76	0.53
Хетерогено земјоделство	Complex cultivation patterns	5013	35.34
Иглолисна шума	Coniferous forest	1	0.00
Овоштарници	Fruit trees and berry plantations	75	0.53
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	3139	22.13
Површински рудници	Mineral extraction sites	40	0.28
Пасишта со висока трева и планински пасишта	Natural grassland	3	0.02
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	4483	31.60
Суви брдски пасишта	Pastures	564	3.98
Пасишта со грмушки	Transitional woodland-scrub	697	4.91
Лозја	Vineyards	57	0.40
Водни тела	Water bodies	39	0.28
Вкупно	**Total**	14187	

Similarly as with rural landscapes, this landscape is characterized by lack of corridors and prominent patches (both in terms of number and size). Hence, the landscape does not have particular significance for biodiversity.

Visual features of this landscape are presented on Figure 6.

Figure 6 Lowland rolling agricultural rural landscape(Gradishtanska Planina Mt.)

3.3.2   Maleshevo-Pijanec rural agricultural landscape

Maleshevo-Pijanec landscape has the character of lowland rolling landscapes, but its specific is that it extends to much higher altitudes (from about 600 m a.s.l. in Pijanec to over 900 m a.s.l. in Malesh area). Another specific feature of this landscape relative to lowland rolling agricultural rural landscape is related to the climate characteristics, which are here more continental. Cold and long winters, as well as relatively more humid summers in Malesh and Pijanec enables growing of other crops here as well (e.g. potato and beans) on the account of cereal crops that dominate lowland rolling agricultural landscapes.

Table 8. Basic structural characteristics (land cover - CLC)of Maleshevo-Pijanec rural agricultural landscape(Colours correspond with those on the map of landscapes)

Малешевско-пијанечки земјоделски предел	Maleshevo-Pijanec agricultural landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	299	1.79
Хетерогено земјоделство	Complex cultivation patterns	5475	32.76
Иглолисна шума	Coniferous forest	219	1.31
Урбана површина	Discontinuous urban fabric	679	4.06
Овоштарници	Fruit trees and berry plantations	638	3.81
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	6738	40.32
Широколисно-иглолисна шума	Mixed forest	36	0.22
Пасишта со висока трева и планински пасишта	Natural grassland	5	0.03
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	1740	10.41
Суви брдски пасишта	Pastures	623	3.73
Пасишта со грмушки	Transitional woodland-scrub	233	1.40
Лозја	Vineyards	26	0.16
Вкупно	**Total**	16711	

The main structural characteristics of the landscape are presented in Table 8. Rural nature of the landscape is attributed by the share of the CLC classes 'Complex cultivation patterns', 'Land principally occupied by agriculture, with areas of natural vegetation' (tan) and 'Pastures' (light yellow), while agricultural nature is given by the CLC class 'Non-irrigated arable land' (orange) (Table 8). The specific appearance of the landscape is given by its flatland-lowland rolling relief and relatively large 'discontinuous urban fabric' (dark red).It is also specific that a number of forest

patches are dispersed around agricultural matrix making slightly above 3 % of the overall landscape area (Table 8). Patches are not well connected by corridors. Their better connection may be an important conservation activity in future, as this landscape is surrounded by forest landscapes at all sides. The role of those forest landscapes as core areas for carnivore animals could prove much more efficient if they are mutually connected.

Hence, Maleshevo-Pijanec rural agricultural landscape has potentially great importance for biodiversity.

Figure 7 Maleshevo-Pijanec rural agricultural landscape (Pijanec – village of Trabotivishte)

3.3.3   Rolling rural landscape

This landscape is characterized by a similar relief as lowland rolling agricultural landscapes - these are mostly lowlands and lowland wavy-hilly terrains distributed at altitudes up to 600 m in the northwestern part of Serta, to 800 m in southwestern part of Plachkovica and up to about 750 m on northern part of Plachkovica. In geological terms, this landscape type in southwestern part of the foothill of Plachkovica is characterized by different, mainly silicate gneisses and green shales, while the northern part of Plachkovica and foothill of Serta are dominated by Quarter alluvial, dilluvial and proluvial terrace sediments. Climate on southwestern slopes (modified submediterranean) differs from the climate on northern slopes (warm continental).

The main structural characteristics of the landscape are presented in Table 9. Rural nature of the landscape is attributed by the share of the CLC classes 'Complex cultivation patterns', 'Land principally occupied by agriculture, with areas of natural vegetation' (tan), 'Pastures' and 'Transitional woodland-scrub' (light yellow), as well as relatively large area under 'Broadleaf forest' (lime) which dominate over CLC class 'Non-irrigated arable land' (orange) (Table 9).

This landscape is characterized by matrix composed of arable land areas – croplands and fields with settlements scattered around. Arable land areas are represented by relatively small plots, but land use is intensive and therefore hedge-rows around small plots of land have not been sustained, though the landscape has preserved its rural appearance. Hedge-rows are often made of shrubs and low trees of natural vegetation, but also fruit trees, elms, poplars, etc. Settlements are of compact type. Patches are commonly made of submediterranean pubescent oak and hornbeam forest plots. Corridors are narrow and disjointed.

The landscape is not vital for biodiversity, especially for carnivores.

Visual features of this landscape are presented on Figure8.

Table 9. Basic structural characteristics (land cover - CLC)of the Rolling rural landscape (Colours correspond with those on the map of landscapes)

Брегови рурален предел	Rolling rural landscape	Area (ha)	Area (%)
Песокливи површини	Beaches, dunes, sands	35	0.10
Широколисни шуми	Broad-leaved forest	1506	4.38
Хетерогено земјоделство	Complex cultivation patterns	10485	30.52
Иглолисна шума	Coniferous forest	129	0.38
Урбана површина	Discontinuous urban fabric	376	1.10
Одлагалишта	Dump sites	66	0.19
Овоштарници	Fruit trees and berry plantations	41	0.12
Индустриски и комерцијални центри	Industrial or commercial units	33	0.10
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	6585	19.17
Широколисно-иглолисна шума	Mixed forest	155	0.45
Пасишта со висока трева и планински пасишта	Natural grassland	73	0.21
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	7817	22.76
Суви брдски пасишта	Pastures	2383	6.94
Оризишта	Rice fields	20	0.06
Ксерофитна вегетација	Sclerophyllous vegetation	126	0.37
Пасишта со грмушки	Transitional woodland-scrub	3991	11.62
Лозја	Vineyards	243	0.71
Водни тела	Water bodies	287	0.83
Вкупно	**Total**	34352	

Figure 8Lowland rolling rural landscape (in the vicinity of the village Knezhje)

3.3.4   Rolling rural landscape with hedges

Due to the relatively small footprint in Bregalnica Watershed, this landscape can be set aside as a variation of rolling rural landscape. The natural features of the rolling rural landscape with hedges are the same as in the previous type. Areas that can be characterized as rural landscape with hedges include the areas of the villages in the wavy foothill of the mountain Serta (villages Selce, Puhche, Leskovica, Suvo Grlo) and western part of Osogovo (villages Kundino, Marchevo, Drevenci, Tripatanci, Lepopelci and Vrbica). Agricultural activities with this landscape type are less intensive and thus hedge-rows of natural vegetation have persisted. Small areas with features of rural landscape with hedges can also be found in the foothill of the mountain Plachkovica (villages

Zrnovci, Morodvis, Vidovishte, etc.). Nevertheless, due to the small size, this part of Plachkovica foothill is included in lowland agricultural landscape (although it does have features of rolling rural landscape with hedges).

The main structural characteristics of the landscape are presented in Table 10. Rural nature of the landscape is provided by full domination of CLC classes 'Complex cultivation patterns', 'Land principally occupied by agriculture, with significant areas of natural vegetation'(tan), 'Pastures' and 'Transitional woodland-scrub' (light yellow), while specific features of the landscape compared to rolling rural landscape are attributed by hedge-rows of trees between small plots and small woodlands (lime) (Table 10). Another specific feature compared to rolling rural landscape is almost full absence of CLC class 'Non-irrigated arable land' which contributes 22.76 % to the overall area of the previous landscape type.

From structural point of view, this landscape is characterized by matrix composed of arable land – croplands and fields, around which settlements are scattered and patches are represented by submediterranean pubescent oak and hornbeam woodlands. Hedge vegetation within this type of landscape is usually represented by ruderal vegetation and planted broadleaf trees, as well as remains of natural vegetation and thus it has a function of corridor.

Table 10. Basic structural characteristics (land cover - CLC)of the Rolling rural landscape with hedges (Colours correspond with those on the map of landscapes)

Брeговит рурален предел со меѓи	Rolling rural landscape with hedges	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	113	2.92
Хетерогено земоделство	Complex cultivation patterns	1540	39.97
Урбана површина	Discontinuous urban fabric	73	1.90
Земоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	1242	32.24
Широколисно-иглолисна шума	Mixed forest	9	0.24
Пасишта со висока трева и планински пасишта	Natural grassland	74	1.92
Интензивно обработувано земоделско земјиште	Non-irrigated arable land	3	0.07
Суви брдски пасишта	Pastures	179	4.64
Површини со ретка вегетација	Sparsely vegetated areas	3	0.07
Пасишта со грмушки	Transitional woodland-scrub	617	16.02
Вкупно	**Total**	3853	

The landscape has especially high aesthetic value owing to the well preserved rural appearance. This is important landscape for development of certain alternative forms of tourism, like rural tourism. Presence of large areas under shrubs is a positive feature for biodiversity conservation (it enhances the connectivity of forest patches), but it indicates intensive process of agricultural activities abandonment, which may in turn disturb the rural character of the landscape.

The main visual features of this landscape are presented on Figure9.

Figure 9Rolling rural landscape with hedges in the foothill of Serta

3.3.5   Hilly rural landscape

Hilly rural landscape is characterized by wavy-hilly terrain and extends up to an altitude of 800-900 m on the southeast and southwest of Plachkovica. The hilly rural landscape also extends over southeastern (Kamenica part) and northwestern (Kratovo area) slopes of Osogovo (Figure1 – Map of landscapes).

Table 11. Basic structural characteristics (land cover - CLC)of Hilly rural landscape(Colours correspond with those on the map of landscapes)

Ридест рурален предел	Hilly rural landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	6777	10.80
Хетерогено земјоделство	Complex cultivation patterns	9174	14.62
Иглолисна шума	Coniferous forest	2064	3.29
Урбана површина	Discontinuous urban fabric	195	0.31
Одлагалишта	Dump sites	40	0.06
Овоштарници	Fruit trees and berry plantations	2	0.00
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	12390	19.75
Површински рудници	Mineral extraction sites	76	0.12
Широколисно-иглолисна шума	Mixed forest	1755	2.80
Пасишта со висока трева и планински пасишта	Natural grassland	1738	2.77
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	2267	3.61
Суви брдски пасишта	Pastures	10111	16.11
Оризишта	Rice fields	358	0.57
Ксерофитна вегетација	Sclerophyllous vegetation	32	0.05
Пасишта со грмушки	Transitional woodland-scrub	15389	24.52
Лозја	Vineyards	0	0.00
Водни тела	Water bodies	380	0.61
Вкупно	**Total**	62748	

In geological terms, the landscape is characterized by different, mainly silicate acid grounds (gneisses, amphibolites and amphibolites shales, mica schists and leptynolyhes, flysch sediments,

etc.) and small areas under sandstones. Among soil types, district cambisols dominate. As for vegetation, there is notable presence of grass plant communities of pastures in the landscape which grow on silicate ground up to around 1000 m above sea level. Yet, grasslands (pastures) are not dominant here, but mixed with anthropogenic habitats, arable lands and pastures.

The main structural characteristics of the landscape are presented in Table 11. Rural nature of the landscape is attributed by the share of CLC classes 'Complex cultivation patterns', 'Land principally occupied by agriculture, with significant areas of natural vegetation' (tan), then 'Pastures' and 'Transitional woodland-scrub' (light yellow), as well as significant area under 'Broad-leaved forest' (lime) (Table 11). There are also significant areas under coniferous or mixed forest stands (above 6 % of the overall area), as well as significant areas under non-irrigated arable land (Table 11), which is specific of agricultural landscapes.

Presence of settlements scattered throughout the landscape is an important feature of this landscape type. Besides settlements, there are a lot of agricultural areas represented by small croplands most often distributed discontinuously in the area. Villages situated in the southwestern and partially southeastern part of Plachkovica are especially impressive, where isolation and different life styles, traditions and culture of Turkish ethnic community contribute to a different visual perception of the landscape.

Visual features of this landscape are presented on Figure10.

Figure 10 Hilly rural landscape near the village of Kuchica

Hilly rural landscape occupies significant area of the investigated area (around 13.5 %) which means that it attributes prominent feature to the whole area. The large area it covers, along with its structural characteristics – significant areas under forests, degraded forests, shrubby stands and other natural vegetation – make this landscape important for biodiversity conservation. The hilly rural landscape is disjunctively distributed throughout the basin (except in northwestern part and extreme southeastern part) in a form of several smaller or larger areas on different mountains in the basin. Diverse natural and geographic features of the areas where this landscape is represented induce certain differences in the structure of the landscape units. Considering the importance of the landscape for biodiversity, analysis of the structure of different landscape units within this landscape was made. The analysis is presented in Table 12 and includes comparison of the share of certain specific CLC classes by individual landscape units. Corine classes of minor share are not shown (they are included in the summary table above – Table 11).For practical reasons, the cells of the column presenting proportional representation of individual CLC classes in individual landscape units of the Hilly rural landscape in Table 12 are colored. Colour of each Corine class corresponds with the colour

of the landscape type in the Map of landscapes (Figure 1) for which the relevant CLC class is the most specific.

Thus, for example, extensive agricultural practices are the most specific for each rural landscape. They are represented mainly by two CLC classes - 'Complex cultivation patterns' and 'Land principally occupied by agriculture, with significant areas of natural vegetation' (tan), which in this landscape occupy around 34.5 %at an average (Table 11). The state of this landscape differs in different landscape units: at Golak, areas under traditional farming account for 38.7 %, at Osogovo 43.7 %, at Jurukluk part of Plachkovica Mt. only 16.8 % (but, there is also 3.5 % non-irrigated arable land there as well - orange), at the northern part of Plachkovica and the area of the village of Kalimanci as much as 47.4 % (besides, there is also 8 % non-irrigated arable land there– orange), at Smrdesh only 13.5 %, and at Vlaina Planina Mt. 42.7 % (Table 12).

Compared to other rural landscapes, Hilly rural landscape is also characterized by significant areas under forest. Thus, forests at Golak (broadleaf, coniferous and mixed – lime, dark teal and light green) cover 22 %of the area of the landscape unit (with equal portions of broadleaf and coniferous forest stands), at Osogovo around18 % (with dominance of broadleaf forests), in the area of Jurukluk 20.2 % (broadleaf forests dominate entirely), at northern part of Plachkovica and Kalimanci 11.45 %, at Smrdesh 15.2 (but there are also 52.1 % transitional woodland-scrubs, scrubs and strongly degraded forests there – light yellow colour, which suggests intensive process of agricultural practices abandonment), and at Vlaina Planina– 26.8 % (here, coniferous and mixed forests dominate entirely) (Table 12).

Areas under grasslands (light yellow colour) in the Hilly rural landscape vary in different landscape units ranging from around 10 % to around 20 % (including also natural grasslands – light lime colour). Much greater differences between individual landscape units exist with regard to the share of CLC class 'Transitional woodland-scrubs' (also marked in light yellow colour in Table 12). This is a direct indication of the difference in the rate of abandonment of agricultural practices in individual regions driven by economic and some other reasons. This category of land cover contributes a great portion to other landscape units in this landscape as well – from 20 % to more than 36 % (Table 12), except in the areas of Kalimanci and Vlaina Planina. It is clear that this landscape undergoes gradual extinction in Macedonia and it is not excluded that the landscape unit on Smrdesh Mountain might extinguish in 2-3 decades or it might transform into Landscape of degraded thermophilous forests.

Table 12. Hilly rural landscape – similarities and differences between landscape units in different parts of the region according to the share of CLC classes

Landscape unit	CLC class	CLC класа	Area (ha)	Area (%)
Golak	Broad-leaved forest	Широколисни шуми	140	9.88
	Complex cultivation patterns	Хетерогено земјоделство	58	4.11
	Coniferous forest	Иглолисна шума	131	9.24
	Agricultural land with significant areas of natural vegetation	Земјод. земјиште со површини под природна вегетација	489	34.61
	Mixed forest	Широколисно-иглолисна шума	41	2.92
	Pastures	Суви брдски пасишта	147	10.36
	Transitional woodland-scrub	Пасишта со грмушки	393	27.80
Osogovo	Broad-leaved forest	Широколисни шуми	1560	9.19
	Complex cultivation patterns	Хетерогено земјоделство	4857	28.62
	Coniferous forest	Иглолисна шума	592	3.49
	Agricultural land with significant areas of natural vegetation	Земјод. земјиште со површини под природна вегетација	2558	15.07
	Mixed forest	Широколисно-иглолисна шума	904	5.32
	Pastures	Суви брдски пасишта	2200	12.96
	Transitional woodland-scrub	Пасишта со грмушки	3407	20.08
Plachkovica –southern part (**Jurukluk**)	Broad-leaved forest	Широколисни шуми	3819	18.71
	Complex cultivation patterns	Хетерогено земјоделство	1048	5.13
	Coniferous forest	Иглолисна шума	216	1.06
	Agricultural land with significant areas of natural vegetation	Земјод. земјиште со површини под природна вегетација	2388	11.70
	Mixed forest	Широколисно-иглолисна шума	88	0.43
	Non-irrigated arable land	Интен. обработ. земјо. земјиште	700	3.43
	Pastures	Суви брдски пасишта	4164	20.40
	Transitional woodland-scrub	Пасишта со грмушки	7401	36.26
Plachkovica –northern part and **Kalimanci**	Broad-leaved forest	Широколисни шуми	757	3.97
	Complex cultivation patterns	Хетерогено земјоделство	2889	15.14
	Coniferous forest	Иглолисна шума	906	4.74
	Agricultural land with significant areas of natural vegetation	Земјод. земјиште со површини под природна вегетација	6163	32.29
	Mixed forest	Широколисно-иглолисна шума	524	2.74
	Non-irrigated arable land	Интен. обработ. земјо. земјиште	1534	8.04
	Pastures	Суви брдски пасишта	3063	16.05
	Rice fields	Оризови полиња	358	1.88
	Transitional woodland-scrub	Пасишта со грмушки	2234	11.70
Smrdesh	Broad-leaved forest	Широколисни шуми	502	15.19
	Complex cultivation patterns	Хетерогено земјоделство	295	8.94
	Agricultural land with significant areas of natural vegetation	Земјод. земјиште со површини под природна вегетација	150	4.56
	Pastures	Суви брдски пасишта	472	14.28
	Transitional woodland-scrub	Пасишта со грмушки	1721	52.09
Vlaina	Complex cultivation patterns	Хетерогено земјоделство	27	1.70
	Coniferous forest	Иглолисна шума	220	14.07
	Agricultural land with significant areas of natural vegetation	Земјод. земјиште со површини под природна вегетација	641	41.04
	Mixed forest	Широколисно-иглолисна шума	199	12.73
	Natural grassland	Планински пасишта	176	11.30
	Pastures	Суви брдски пасишта	67	4.27
	Transitional woodland-scrub	Пасишта со грмушки	233	14.90

3.3.6   Osogovo mountain rural landscape

In Bregalnica Watershed, this landscape is typical for Osogovo Mountains and parts of Vlaina Mountain. The relief is rather uniform, represented by moderate to steep slopes, ravines and valleys. Brown forest soils predominate and there are frequent rocky spots, too. Geological ground is the same as in other landscapes on the mountain (mostly silicate rocks). Owing to higher altitudes of this landscape spread compared to the previous ones (1000-1400 m above sea level), climate is warm continental (south) and sub continental to continental (north). Italian and Turkey oak forests (and Sessile oak in the upper part of the belt) spread over southern expositions (oak forests of oriental hornbeam and pubescent oak can be also found in lower parts). Submontane beech forests occur in ravines. Beech ecosystems occur most often on northern expositions. Southern and western slopes are under strong anthropogenic pressure and are more or less altered, natural or semi-natural. Agriculture is extensive and livestock breeding is the main occupation of the local population. There are only small areas under potato fields and rye, although most of the former areas under these crops have been abandoned. The area is sparsely populated and settlements are of scattered type. It is actually the scattered formation of the settlements that gives the distinctive outlook of this landscape.

Rural nature of the landscape is attributed by the share of CLC classes - 'Land principally occupied by agriculture, with significant areas of natural vegetation' (tan), 'Pastures' and 'Transitional woodland-scrub' (light yellow), while domination of 'broadleaf forests' (dark teal) (Table13) gives specific feature to the landscape. The matrix is composed of broadleaf forest, mostly of oak forests of Turkey and Italian or Sessile oak, as well as beech forests. However, forests often lack fully closed arrangement and are rather sparse at spots, though visually they do not appear degraded. There are many patches of more or less abandoned populated places, meadows and minor fields.

Table 13. Basic structural characteristics (land cover - CLC)of Osogovo mountain rural landscape(Colours correspond with those on the map of landscapes)

Осоговски планински рурален предел	Osogovo mountain rural landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	16060	64.80
Хетерогено земјоделство	Complex cultivation patterns	328	1.33
Иглолисна шума	Coniferous forest	120	0.48
Градилишта	Construction sites	74	0.30
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	2395	9.66
Широколисно-иглолисна шума	Mixed forest	401	1.62
Пасишта со висока трева и планински пасишта	Natural grassland	517	2.09
Суви брдски пасишта	Pastures	1851	7.47
Пасишта со грмушки	Transitional woodland-scrub	3040	12.26
Вкупно	**Total**	24785	

From aesthetic point of view, this landscape possesses great value and therefore great potential for rural tourism development. Furthermore, the landscape bears great importance for biodiversity, although more precise definition of the form and potential of forest corridors connecting major forest areas is required for accurate establishment of the conservation significance of the landscape.

Visual features of this landscape are presented on Figure 11.

Figure 11 Osogovo rural landscape (a neighborhood of Jasterbnik village)

3.3.7   Mountain rural landscape (Maleshevo mountain rural landscape)

In Bregalnica Watershed, this landscape is typical of the central part of Maleshevo Mountain massif and part of it also spreads over northern slopes of Ograzhden. Relief is rather uniform with mountain and a hilly terrain at altitudes of 900-1300 m. Geological ground is composed mainly of silicate rocks. From among soil types, rankers and brown mountain soils are dominant with frequent presence of regosols and lithosols as well. Due to the high altitude over which this landscape spreads, climate is mainly continental, while mountain climate has significant influence at higher parts.

Similarly as in Osogovo mountain landscape, this mountain landscape has rural characteristics, too (Figure 1 – Map of landscapes). However, the structure of this area differs significantly from that of Osogovo. Forest does not dominate although it contributes almost 43 %. It is important that Maleshevo mountain rural landscape is featured with large areas of extensive agricultural practice (Table 14 – tan), compared to mountain rural landscape where such areas occupy only around 11 %. Probably the most prominent difference between these two landscapes relates to settlements, although it does not affect the structure directly. There is no significant number of settlements on Maleshevo Mountains (even broken type settlements) and isolated facilities for stay during vegetation season locally called "apartments" are typical here.

The main structural characteristics of the landscape are presented in Table 14.Rural nature of the landscape is given by the share of CLC classes 'Land principally occupied by agriculture, with significant areas of natural vegetation' and 'Complex cultivation patterns' (tan), as well as 'Pastures' and 'Transitional woodland-scrub' (light yellow), while mountain nature of the landscape is attained by domination of CLC classes 'broadleaf forests' (dark teal) and 'Natural grassland' (light lime) (Table 14). In this case, no matrix can be established to characterize the landscape, given the fact that agricultural land and forests have almost equal shares. Both CLC classes are arranged in a form of larger or smaller patches. Additionally, the non-forest nature of the landscape is determined by the presence of around 16 % of the land covered with pastures and scrubs (Table 14). The status of connectedness of forest patches should be assessed further for the purpose of more precise definition of the relevance of this landscape for biodiversity, especially carnivores.

Table 14. Basic structural characteristics (land cover - CLC)of Mountain rural landscape(Colours correspond with those on the map of landscapes)

Планински рурален предел	Mountain rural landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	5861	42.52
Хетерогено земјоделство	Complex cultivation patterns	750	5.44
Иглолисна шума	Coniferous forest	25	0.18
Одлагалишта	Dump sites	44	0.32
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	4813	34.92
Широколисно-иглолисна шума	Mixed forest	13	0.09
Пасишта со висока трева и планински пасишта	Natural grassland	575	4.17
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	26	0.19
Суви брдски пасишта	Pastures	830	6.02
Пасишта со грмушки	Transitional woodland-scrub	846	6.13
Вкупно	**Total**	13784	

Alike Osogovo mountain rural landscape, this one also possesses great aesthetic values along with values enabling conservation of biodiversity. Opposite to Osogovo landscape, this landscape does not show serious signs of abandonment and transformation of the main land cover classes.

3.4   Landscapes of dry grasslands

The structure and the character of dry grasslands are entirely preconditioned by anthropogenic factor. Pastures in the hilly part of Macedonia are secondary formation resulting from continued cattle breeding and grazing initiated thousands of years ago. However, the once strong anthropogenic pressure that has through years contributed to the shaping and formation of areas under pastures has lessened the intensity. Negative migration trend of the population (State Statistical Office 2012b), combined with significant neglect of cattle breading practices has lead to gradual abandonment of areas used as pasture and this in turn leads to successive overgrowth with shrubs and thus loss of the basic structural feature of the landscapes of dry grasslands – open pastures. Maintaining this type of landscape should be a challenge for future generations of socio-political and economic stakeholders.

3.4.1   Landscape of dry grasslands on silicate ground

The Landscapes of dry grasslands on silicate ground is characterized by predominantly hilly terrain with steep slopes in some parts. From geological point of view, silicate ground is dominant, represented by various mass rocks or shales, while limestones or other base grounds are exceptionally rare (e.g. above Kochani near the village of Beli). Erosion exists and eroded areas occur frequently. Climate is usually modified submediterranean, while modified continental climate is specific solely for the area of Maleshevo. The main vegetation characteristic of this landscapes the presence of grassland plant communities that develop on silicate substrate up to about 1000 m altitude. This vegetation is of secondary origin and can be maintained only by continuous grazing.

The area occupied by this landscape used to be important as support to agricultural activities (especially livestock breeding) of the population living in lowland parts (described in previous

landscape types). Thus, during the last centuries, these areas were under strong anthropogenic pressure which resulted in full degradation of natural habitats. As a result of the migration process (village-city) initiated in the second half of the last century, the area was abandoned and meadows and fields were converted into insufficiently grazed pastures. The landscape is most represented on southern and partially western slopes of Osogovo, western and southern slopes of Plachkovica and on Mangovica (Figure1 – Map of landscapes).

The main structural characteristics of the landscape are presented in Table 15. Grassland nature of the landscape is given by the dominant share of CLC classes 'Pastures' and 'Transitional woodland-scrub' (light yellow). However, this landscape has rural feature as well, which is determined by the presence of the CLC classes 'Land principally occupied by agriculture, with significant areas of natural vegetation' and 'Complex cultivation patterns' (tan), as well as presence of significant areas under CLC class 'broadleaf forests' (lime).

Matrix is composed of open and degraded land with specific vegetation of some of the classes of pastures. Patches are mainly represented by submediterranean pubescent oak-hornbeam forests. Corridors are situated mainly along rivers and streams, but they are disjunctive and there is practically no network of corridors.

Table 15. Basic structural characteristics (land cover - CLC) of the Landscapes of dry grasslands on silicate ground(Colours correspond with those on the map of landscapes)

Предел на брдски пасишта на силикат	Landscapes of dry grasslands on silicate ground	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	3669	9.29
Хетерогено земјоделство	Complex cultivation patterns	3380	8.55
Иглолисна шума	Coniferous forest	220	0.56
Урбана површина	Discontinuous urban fabric	69	0.18
Индустриски и комерцијални центри	Industrial or commercial units	2	0.01
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	2487	6.29
Површински рудници	Mineral extraction sites	97	0.24
Широколисно-иглолисна шума	Mixed forest	109	0.28
Пасишта со висока трева и планински пасишта	Natural grassland	733	1.85
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	554	1.40
Суви брдски пасишта	Pastures	12196	30.87
Оризишта	Rice fields	0	0.00
Површини со ретка вегетација	Sparsely vegetated areas	214	0.54
Пасишта со грмушки	Transitional woodland-scrub	15782	39.94
Вкупно	**Total**	39510	

Visual features of this landscape are presented on Figure 12.

Figure 12 Landscape of dry grasslands on silicate ground (Plachkovica Mt., above village Radanje)

Within this landscape type, a separate landscape variant can be set aside - **Landscape on dry grasslands on silicate ground with shrubs**.

Natural characteristics of this landscape are mainly the same as in the case of the previous one. The difference is that the dry grasslands here are overgrown with rare shrubs indicating decline in anthropogenic pressure and abandonment of livestock breading practices.

The matrix of shrubs and scrubs includes patches of pubescent oak-hornbeam forests. Corridors are situated mainly along rivers and streams.

Visual features of this landscape are presented on Figure 13.

Figure 13 Landscape of dry grasslands on silicate ground with Junipers oxycedrus shrubs

3.4.2   Landscape of dry grasslands on marl ground

This landscape in Bregalnica Watershed is mainly present in the areas of Kuchukol and Slan Dol, while smaller areas by surface can be found in the vicinity of the city of Shtip and on the western slopes of Plachkovica (Figure1 – Map of landscapes).

The landscape is characterized by wavy-hilly relief with occasional occurrence of steep slopes and rather deep dales. There are also frequent occurrences of bare rocks of considerable dimensions. The ground is marl - mainly marl rocks or different flysch sediments (flysch, sandstones, claystones and marlstones) and lake terraces, again with marl composition. Soils are mostly halomorphic with heavy structure. Submediteranean climate is predominant in the area of this landscape, or Mediterranean climate is rather strong. Summers are exceptionally warm and very dry (the area in the triangle Shtip-Veles-Krivolak is the driest part of Macedonia with semi-desert characteristics). Winds are with considerable precipitations (mostly rain) and mild.

Submediteranean climate and specific geological ground (along with centuries long anthropogenic activities) have enabled this area to retain many steppe elements in the flora and fauna, and dry grasslands with *Morina persica* and *Astragalus parnassii* are prevailing habitats and at certain spots occur as real "hedgehog" vegetation formations.

Potential vegetation (pubescent oak-hornbeam forests) was uprooted back in ancient times (for the purposes of the main settlements (Stobi, Bargala, Stene). Due to obviously dry climate and heavy marl ground on which saline soils develop, forest recovery has been and still is impossible up to present days. Intensive livestock breeding until the Second World War has significantly impaired the natural vegetation ability to recover. Huge sheepfolds that grazed the pastures of mountain Bistra in western Macedonia during the summer, were brought here during the winter period. Now, high number of the areas is returned to the heirs of the former cattle breeders. Major part of the area has yet remained under state ownership – these are the areas of the military training ground Krivolak (which in part enters Bregalnica Watershed). Restricted access in the area occupied by this military ground actually provides excellent conditions for unintended though very efficient conservation of the exceptionally valuable biodiversity in the area.

The main structural characteristics of the landscape are presented in Table 16. Grassland nature of the landscape is provided by the dominant share of CLC classes 'Pastures' and 'Transitional woodland-scrub' (light yellow), as well as relatively low share of the CLC class 'broadleaf forests' (lime), while specific feature of the landscape, besides marl ground, is attributed by relatively high proportion of eroded and rocky areas - CLC class 'Sparsely vegetated areas' (gold); rural nature of the landscape is presently poorly pronounced which is why the share of CLC classes 'Land principally occupied by agriculture, with significant areas of natural vegetation' and 'Complex cultivation patterns' (tan)is low (Tab. 16).

Matrix of the Landscape of dry grasslands on marl ground is composed of grass and scrub vegetation – pastures. Different patches of natural habitats are scattered around the matrix, such as small pubescent oak-hornbeam woodlands in stepper parts, smaller or larger areas grown over with shrubs mainly of *Paliurus spina-christi*, bare rocky grounds, eroded areas, steep rocks, etc. Corridors are not continuous and represented mainly by dales of permanent watercourses which are surrounded by marshy vegetation or remains of oak belts.

Table 16. Basic structural characteristics (land cover - CLC)of the Landscape of dry grasslands on marl ground(Colours correspond with those on the map of landscapes)

Предел на брдски пасишта на лапор	Landscape of dry grasslands on marl ground	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	1373	4.74
Хетерогено земјоделство	Complex cultivation patterns	1698	5.86
Иглолисна шума	Coniferous forest	541	1.87
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	1090	3.76
Пасишта со висока трева и планински пасишта	Natural grassland	4976	17.17
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	757	2.61
Суви брдски пасишта	Pastures	8456	29.18
Површини со ретка вегетација	Sparsely vegetated areas	973	3.36
Пасишта со грмушки	Transitional woodland-scrub	9114	31.44
Лозја	Vineyards	6	0.02
Вкупно	**Total**	28985	

The landscape is entirely or nearly entirely unpopulated. There are several villages that are completely abandoned and their former existence is testified only by wall remains (Jamularci,

Creshka, Ubogo, etc.). Few villages still have a few residents (Sofilari, Bekirlija, etc.), while other ones are active only during winter when sheep flocks arrive here from the mountains of western Macedonia (Penush, Eneshevo, etc).

The landscape bears exceptional conservation significance, especially for pray birds (vultures) and endemic plants and invertebrate animals. Therefore, the next phase of the project should pay particular attention to this landscape type.

Visual features of this landscape are presented on Figure 14.

Figure 14 Landscape of dry grasslands on marl ground (Slan Dol near village Penush)

The landscape possesses outstanding peysage values as well, especially because of the valleys of small rivers and streams. In this context, we should distinguish the river Bregalnica as it makes numerous meanders receded into marl ground as early as during Eocene. Meanders have also created larger recent river terraces of fertile land, on which flooding poplar forests dominate unless areas under riparian forests are converted into arable land.

3.5 Forest landscapes

Forest landscapes in Bregalnica Watershed have partially retained their natural features, especially those forest landscapes positioned in areas that are difficult to reach. Here, the anthropogenic influence is reflected primarily in the use of part of the areas under forests for livestock breeding and agriculture (meadows, forest clearings) and as firewood and construction material, and partly due to the extraction of minerals and mining. Anthropogenic influence is prevalent and therefore most visible in the belt of thermophilous oak forests.

3.5.1 Thermophilous degraded forests landscape

This landscape has quite a varied relief. It includes mild to moderately steep and steep slopes, then gorges, ravines and valleys. Cinnamon and brown forest soils (cambisols) are present on silicate ground; one can also find lithosols, regosols, as well as bare silicate rocks of various types. There is also eroded land there. As a result of higher altitude compared to previous landscape types (700-1000 m), climate is somewhat colder; in certain parts, it is warm continental, while strong Mediterranean influence can be felt on southern expositions. Vegetation in the area of degraded thermophilous forests is characterized by oak-hornbeam forests (*Phyllireo-Carpinetum orientalis* =*Querco-Carpinetum orientalis*), and there are also mixed forests of Turkey and Italian oak

(*Quercetum frainetto-cerris*) and Hop hornbeam forests (*Ostrya carpinifolia*). The vegetation is more or less modified and semi-natural. The main precondition for the development of this landscape type is the relief (steep slopes) and infertile soils. Therefore, there are no houses and other types of settlements. Nevertheless, proximity of populated places leads to strongly expressed pressure on natural vegetation (especially collection of firewood). Strong pressure has caused high degree of degradation in forests which are currently of low growth and poor quality (as construction wood or similar purposes). The overall process of abandonment of the households in hilly parts throughout the area has contributed to the decline of anthropogenic pressure as potential vegetation (mainly oak forests) starts to retrieve former positions. Tree canopies are closed and former features of forests are gradually regained.

Table 17 indicates that forest nature of the landscape is provided by the prominent share of the CLC class 'broadleaf forests' (lime), while its specific (degraded) feature is gained by the significant presence of CLC classes 'Transitional woodland-scrub', 'Pastures' and 'Natural grasslands' (light yellow). The landscape possesses certain rural feature as well, owing to the significant share of CLC classes 'Land principally occupied by agriculture, with significant areas of natural vegetation' and 'Complex cultivation patterns' (tan) (Table 17).

One may conclude that the matrix is composed of forest land only if we sum up the area under forest and area grown over by shrubs, strongly degraded woodlands and overgrown pastures thus obtaining 36 % (Table 17). Forests are dominated by forest plant communities of submediterranean pubescent oak-hornbeam forests and mixed Turkey and Italian oak forests. Patches are represented by numerous meadows, mostly abandoned.

Table 17. Basic structural characteristics (land cover - CLC) of Thermophilous degraded forests landscape(Colours correspond with those on the map of landscapes)

Предел на термофилни деградирани шуми	Thermophilous degraded forests landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	20111	37.91
Хетерогено земоделство	Complex cultivation patterns	1158	2.18
Иглолисна шума	Coniferous forest	714	1.35
Урбана површина	Discontinuous urban fabric	30	0.06
Земоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	4413	8.32
Површински рудници	Mineral extraction sites	39	0.07
Широколисно-иглолисна шума	Mixed forest	849	1.60
Пасишта со висока трева и планински пасишта	Natural grassland	1863	3.51
Интензивно обработувано земоделско земјиште	Non-irrigated arable land	159	0.30
Суви брдски пасишта	Pastures	4558	8.59
Површини со ретка вегетација	Sparsely vegetated areas	0	0.00
Оризишта	Rice fields	3	0.01
Пасишта со грмушки	Transitional woodland-scrub	19128	36.06
Водни тела	Water bodies	26	0.05
Вкупно	**Total**	53051	

Visual features of this landscape are presented on Figure 15.

Figure 15Pubescent oak-hornbeam forests (near the village Shashavarlija)

The landscape of thermophilous degraded forests is very important in terms of biodiversity conservation, because:

- it occupies around 11.4 % of the total study area (combined with the hilly rural landscape of the same belt, it accounts for ¼ of the entire investigated area);
- it is situated in the hilly belt, immediately below forest mountain landscapes;
- lack of settlements;
- relatively good coverage of forest vegetation.

The vast area it covers, along with its structural characteristics – domination of areas under forests, degraded forests, shrub stands and woodland scrubs, as well as connectedness and connectivity with upper forest landscapes – make this landscape important for biodiversity conservation. The landscape of thermophilous degraded forests is distributed in discontinuation throughout the basin (even in a more scattered way than the hilly rural landscape) in a form of several larger and smaller areas on different mountains within the basin. Diverse natural and geographic characteristics of areas over which this landscape spreads case certain differences in the structure of landscape units. Considering the importance of this landscape for biodiversity conservation, analysis of the structure of different landscape units composing this landscape was made. The analysis is presented in Table 18and includes comparison of the representation of certain specific CLC classes in individual landscape units. Less represented Corine classes are not shown (those are presented in the summary table above – Table 17). For better understanding, in Table18, the cells of the column showing proportional representation of individual CLC classes in individual landscape units of the Hilly rural landscape are colored. The colour of each Corine class corresponds with the colour of the landscape type on the map of landscapes (Figure 1) for which the sad CLC class is the most specific.

The most typical forest features of this landscape occur in the area of the mountain Gradishtanska Planina (63.1 % under forest) and Kalimanci (60.6 % under forest), as well as landscape units of this landscape on Smrdesh and Serta where forests are represented by equal proportions (42 %), but the percentage of shrub stands cover here is the highest compared to all other landscape units (around 50 %) (Table 18). Smrdesh and Serta are positioned very close to each other and this example of even representation of different CLC classes in two distinctive areas shows that representation of different categories of land cover is directly preconditioned by the pattern of land use and life styles of local population. This demonstrates clearly that the structure of a landscape is anthropogenically determined. It is interesting to note that these two landscape units completely lack land with extensive agriculture. In other landscape units, these CLC classes are represented by significant portions (from 3.2 % - Kalimanci to 58.5 % - Maleshevo) (Table 18).

The most intensive abandonment of traditional practices in this landscape is notable again in Serta and Smrdesh (around 50 % of the land is under shrub stands). Real pastures have almost not sustained at all. Table 18 indicates clearly that the most important areas under pastures are distributed on the hills of higher mountains where we can find significant portion of areas under mountain pastures.

The analysis presented in Table 18 indicates another interesting fact – the different rate of afforestation during the last decades of the previous century. Thus, considerable stands of black pine (coniferous forest – dark teal in the table and mixed stands -light green) exist only in extreme eastern parts of the study area (Golak and Bejaz Tepe). This is certainly not directly related to traditional practices in the areas, but rather to the activity of forest management companies. (The example of afforestation is based on coniferous, i.e. black pine stands because this tree species has been absolutely dominant in the last decades of afforestation in our country).

Table 18. Thermophilous degraded forests landscape– similarities and differences between landscape units in different part of the region based on the share of CLC classes

Landscape unit	CLC class	CLC класа	Area (ha)	Area (%)
Bejaz Tepe	Broad-leaved forest	Широколисни шуми	783	19.86
	Complex cultivation patterns	Хетерогено земјоделство	352	8.92
	Coniferous forest	Иглолисна шума	179	4.55
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	319	8.09
	Mixed forest	Широколисно-иглолисна шума	176	4.47
	Natural grassland	Планински пасишта	296	7.49
	Pastures	Суви брдски пасишта	528	13.39
	Transitional woodland-scrub	Пасишта со грмушки	1290	32.69
Golak	Broad-leaved forest	Широколисни шуми	3646	31.03
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	677	5.76
	Mixed forest	Широколисно-иглолисна шума	373	3.17
	Natural grassland	Планински пасишта	347	2.95
	Pastures	Суви брдски пасишта	1509	12.84
	Transitional woodland-scrub	Пасишта со грмушки	4783	40.70
Gradishtanska Planina	Broad-leaved forest	Широколисни шуми	1155	63.10
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	113	6.20
	Transitional woodland-scrub	Пасишта со грмушки	535	29.22
Kalimanci	Broad-leaved forest	Широколисни шуми	954	57.54
	Coniferous forest	Иглолисна шума	50	3.01
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	53	3.20
	Natural grassland	Пасишта со висока трева и планински пасишта	105	6.32
	Transitional woodland-scrub	Пасишта со грмушки	403	24.33
Maleshevo	Broad-leaved forest	Широколисни шуми	99	9.32
	Complex cultivation patterns	Хетерогено земјоделство	143	13.51
	Coniferous forest	Иглолисна шума	92	8.72
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	472	44.54
	Pastures	Суви брдски пасишта	229	21.58
Maleshevo	Broad-leaved forest	Широколисни шуми	505	28.96

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Landscape unit	CLC class	CLC класа	Area (ha)	Area (%)
Mountains	Complex cultivation patterns	Хетерогено земјоделство	163	9.32
	Coniferous forest	Иглолисна шума	189	10.81
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	610	34.97
	Pastures	Суви брдски пасишта	99	5.67
	Transitional woodland-scrub	Пасишта со грмушки	179	10.27
Osogovo Mounta8ins	Broad-leaved forest	Широколисни шуми	3409	34.44
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	852	8.60
	Natural grassland	Планински пасишта	361	3.64
	Pastures	Суви брдски пасишта	943	9.53
	Transitional woodland-scrub	Пасишта со грмушки	3946	39.87
Plachkovica	Broad-leaved forest	Широколисни шуми	4166	52.88
	Land princip. occupied by agriculture, with signif. areas of natural vegetation	Земјоделско земјиште со површини под природна вегетација	1099	13.94
	Pastures	Суви брдски пасишта	987	12.53
	Transitional woodland-scrub	Пасишта со грмушки	1398	17.75
Serta	Broad-leaved forest	Широколисни шуми	3961	42.01
	Natural grassland	Планински пасишта	737	7.81
	Transitional woodland-scrub	Пасишта со грмушки	4883	51.77
Smrdesh	Broad-leaved forest	Широколисни шуми	1432	42.05
	Pastures	Суви брдски пасишта	218	6.40
	Transitional woodland-scrub	Пасишта со грмушки	1667	48.96

3.5.2   Mesophilous broadleaf forest landscape

This landscape is mainly spread in the altitude zone ranging in between 1400 and 1800 m, though it can be also distinguished on much lower elevation depending on the ground exposition and inclination. Brown forest soils on silicate ground are the dominant soil type. Climate is continental to mountain. The main type of habitat is the mountainous beech ecosystem (represented by the ass. *Calamintho grandiflorae-Fagetum*) spread over all expositions, while mountain pastures growing on forest clearings are secondary habitats. Forests are natural to semi-natural. Sessile oak or even smaller areas under Italian-Turkey oak forests dominate at lower altitudes. Agriculture is very extensive and potato and rye are cultivated on forest clearings. Cattle and sheep breeding is also present. Many of these activities are in a process of abandonment or have been already abandoned. The landscape is not populated and there are only individual, nonpermanent sheepfolds or other similar structures playing the role of cottages. Many of those are also abandoned.

The main structural characteristics of the landscape are presented in Table 19. The table shows clearly that forest nature of the landscape is given by the absolute domination of CLC classes 'broadleaf forests' (dark teal) and 'mixed forests' (light green). CLC classes 'Transitional woodland-scrub' (light yellow) and 'Natural grasslands' (light lime) have significant shares, too.

Hence, the matrix is composed of forests, usually beech forests and oak forests. Patches or larger areas covered by coniferous tree species plantations (pine, fir, larch, etc.) are also found in this landscape. Forests are intensively managed and used mainly as firewood or construction wood. There are many patches of abandoned meadows, potato and rye fields and pastures (grasslands).

Table 19. Basic structural characteristics (land cover - CLC) of Mesophilous broadleaf forest landscape (Colours correspond with those on the map of landscapes)

Предел на мезофилни широколисни шуми	Mesophilous broadleaf forest landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	46014	74.24
Хетерогено земјоделство	Complex cultivation patterns	35	0.06
Иглолисна шума	Coniferous forest	509	0.82
Одлагалишта	Dump sites	0	0.00
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture with significant areas of natural vegetation	1218	1.97
Широколисно-иглолисна шума	Mixed forest	2262	3.65
Пасишта со висока трева и планински пасишта	Natural grassland	2589	4.18
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	62	0.10
Суви брдски пасишта	Pastures	1130	1.82
Пасишта со грмушки	Transitional woodland-scrub	8165	13.17
Вкупно	**Total**	61984	

This landscape compared to other landscapes in the investigated area is the most important in terms of carnivore conservation as it is characterized by insignificant fragmentation.

Visual features of this landscape are presented on Figure 16.

Figure 16 Beech forests on Osogovo (in the watershed of Crvena Reka)

3.5.3   Mixed broadleaf forest with black pine stands landscape

In some areas of Bregalnica Watershed (especially in Maleshevo-Pijanec region) there are larger forest plantations fully dominated by black pine. Because of the scatter character and the relatively small area of conifer plantations compared to degraded broadleaf forests, landscape of conifer forests cannot be clearly differentiated. However, the black pine plantations offer completely different visual aspect of the area, which is why a landscape with mixed broadleaf forest with black pine stands can be differentiated as a separate landscape type. Larger areas under pine plantations which dominate over the native oak vegetation occur only in the part leading to Delchevo (at the

point where Osogovo proceeds with the mountain of Vlaina). In the rest of the investigation area, this landscape type occurs only on a minor part of Smrdesh (Figure1 – Map of landscapes).

Physical, geographical and climate characteristics in the area of this landscape are the same as in the upper hilly and lower mountain belt, described for hilly and mountain rural landscape, as well as landscapes of broadleaf forests.

The main structural characteristics of the landscape are presented in Table 20. The forest character of the landscape is provided by the dominant forest land cover, while the presence of similar representation of CLC classes 'broadleaf forests' (lime), 'Mixed forest' (light lime) and 'Coniferous forest' (dark teal) gives the mixed nature of the forest landscape. The landscape also has certain rural features, which is indicated by the presence of CLC classes 'Land principally occupied by agriculture, with significant areas of natural vegetation' and 'Complex cultivation patterns' (tan) and 'Transitional woodland-scrub' and 'Pastures' (light yellow), as well as 'Natural grassland' (light lime) (Table 20).

Structurally, the landscape is dominated by coniferous forests of black pine, and there are also small areas under cypressand Thuja. Black pine stands are fragmented considerably and there is high number of patches of natural, mostly degraded vegetation of oak forests.

Table 20. Basic structural characteristics (land cover - CLC)of Mixed broadleaf forest with black pine stands landscape(Colours correspond with those on the map of landscapes)

Предел на мешани шуми со иглолисни насади	Mixed broadleaf forest with black pine stands landscape	Area (ha)	Area (%)
Песокливи површини	Beaches, dunes, sands	28	0.09
Широколисни шуми	Broad-leaved forest	9417	30.37
Хетерогено земјоделство	Complex cultivation patterns	1784	5.75
Иглолисна шума	Coniferous forest	4983	16.07
Урбана површина	Discontinuous urban fabric	24	0.08
Овоштарници	Fruit trees and berry plantations	1	0.00
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	2503	8.07
Широколисно-иглолисна шума	Mixed forest	3356	10.82
Пасишта со висока трева и планински пасишта	Natural grassland	1566	5.05
Интензивно обработувано земјоделско земјиште	Non-irrigated arable land	13	0.04
Суви брдски пасишта	Pastures	2820	9.09
Пасишта со грмушки	Transitional woodland-scrub	4510	14.55
Водни тела	Water bodies	1	0.00
Вкупно	**Total**	31006	

The Mixed broadleaf forest with black pine stands landscape does not have great importance for biodiversity conservation due to significant level of fragmentation of forest patches. On the other side, this landscape spreads along border mountains towards Bulgaria (which means not far away from the big mountain massifs Pirin and Rila) that connect the forested landscapes of the mountains Ograzhden, Maleshevo and Osogovo. This actually makes important corridor for big mammals identified in MAK-NEN (Brajanoska et al. 2009).Hence, the importance of this landscape for biodiversity conservation is great, and in time (with vegetation growth on forest clearings or through direct improvement of the landscape structure), it could become vital for the eastern part of Macedonia. Visual features of this landscape are presented on Figure 17.

Figure 17 Black pine stands on Vlaina Planina (village Vetren)

It is worth to note that this landscape includes areas where the black pine forests are natural. These are most of Maleshevo Mountains and part of the mountain Ograzhden, as well as minor part of Plachkovica – area which due to its size is not distinguished as separate Mixed broadleaf forest with black pine stands landscape. Areas where the black pine is introduced anthropogenically and areas where it occurs naturally have been identified as one single landscape due to similarities in the dominating vegetation. Otherwise, these two types of areas are significantly different visually because of their different structure – natural forests are insignificantly fragmented and most often occur along with beech, while planted pine forests most often occur in the oak belt and are still significantly fragmented. Apart from this, consistent arrangement of black pine trunks in the space is notable, which is immediate indication of anthropogenic origin of these forests.

Natural beech-black pine mixed forests has much greater importance from biodiversity point of view.

3.5.4   Pine forest landscape

Black pine forests on Maleshevski Planini Mt. and Maleshevo area are almost exclusively indigenous with significantly well preserved natural features. On some localities they occupy larger areas so that a special type of landscape can be set aside – Pine forest landscape (or Pine forests with black pine landscape). The extent of preservation of these forests in this region indicates long lasting appropriate management of forests in the area of Maleshevo, regardless of the intensity of exploitation and permanent threat to forests by fires.

Climate in this area has characteristics of continental climate as prevailing climate type throughout the country. This means that long, cold and rich in snow winters and fresh summers prevail. Higher areas of this landscape are characterized with well manifested mountainous influence on climate.

The main structural characteristics of the landscape are presented in Table 21. Forest nature of the landscape is attributed by predominant forest land cover, while its specific feature is attained by the domination of CLC classes 'Coniferous forest' (dark blue-lime) and 'Mixed forest' (light green) over the class 'broadleaf forests' (lime). The landscape also possesses certain rural characteristics which indicates some presence of CLC classes 'Land principally occupied by agriculture, with significant areas of natural vegetation' and 'Complex cultivation patterns' (tan), as well as 'Transitional woodland-scrub' and 'Pastures' (light yellow). The presence of the CLC class 'Natural

grassland' (light lime) with significant share reflects mountainous nature of the landscape in certain parts, too.

Table 21. Basic structural characteristics (land cover - CLC)of the Pine forest landscape (Colours correspond with those on the map of landscapes)

Предел на борови шуми	Pine forest landscape	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	750	6.82
Хетерогено земоделство	Complex cultivation patterns	313	2.84
Иглолисна шума	Coniferous forest	4515	41.03
Урбана површина	Discontinuous urban fabric	3	0.03
Овоштарници	Fruit trees and berry plantations	15	0.13
Земоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	1036	9.42
Широколисно-иглолисна шума	Mixed forest	1626	14.78
Пасишта со висока трева и планински пасишта	Natural grassland	440	4.00
Интензивно обработувано земоделско земјиште	Non-irrigated arable land	65	0.59
Суви брдски пасишта	Pastures	626	5.69
Пасишта со грмушки	Transitional woodland-scrub	1559	14.17
Водни тела	Water bodies	55	0.50
Вкупно	**Total**	11004	

The landscape possesses high aesthetic values and great importance for biodiversity conservation in the investigated area.

3.6 Landscape of mountain grasslands on silicate ground

The Landscape of mountain grasslands on silicate ground is typical for the highest areas of Osogovo Mt. (Kalin Kamen, Sultan Tepe and Ruen) Vlaina Planina Mt. (Kadiica) and Maleshevski Planini Mt. (Chengino Kale). (Figure1 – Map of landscapes). Mountain pastures have secondary origin. In this part of the Balkan Peninsula, the mountain pastures would have potentially been distributed over 2200 m a.s.l, but as a result of a long lasting tradition of grazing herds of numerous sheep and cattle, the line of the forest belt was artificially lowered by about 300-500 m. This allows differentiating Landscape of mountain grasslands which is particularly representative on Osogovo.

The area above forest belt is covered by grass vegetation. Bare grounds and rock sites are not represented with significant scale. Owing to the uniformity of the ground which is typically silicate (albite-chlorne shales, double mica strip/granular gneisses, granites, quartz, mica schists, etc.), only one type of mountain grasslands landscape (on silicate ground) can be identified in Bregalnica Watershed. Heaths develop on podzols, while pastures commonly develop on mountain humus soil. Histosols and mire organic soils cover considerable areas on the highest parts of the mountains. Climate is typically mountain.

Anthropogenic activities include sheep breeding during summer, less frequently cows and cattle grazing, as well as collection of wild fruits (bilberries) during summer. Abandonment of livestock breeding practices is evident, but it seems that other activities intensify. Mining is typical for the highest part of Osogovo - Ruen.

Table 22 shows clearly that grassland nature of the landscape is determined by the absolute domination of the CLC class 'Natural grassland' (light lime) and 'Pastures' (light yellow). The presence

of the CLC class 'broadleaf forests' (lime) is occasional. Matrix is composed of mountain grasslands and heaths. Patches are represented by mires and different tall herbs, broadleaf or coniferous woodlands, screes, etc. Visual features of this landscape are presented on Figure 18.

Table 22. Basic structural characteristics (land cover - CLC)of the Landscape of mountain grasslands on silicate ground(Colours correspond with those on the map of landscapes)

Предел на високопланински пасишта на силикат	Landscape of mountain grasslands on silicate ground	Area (ha)	Area (%)
Широколисни шуми	Broad-leaved forest	175	4.46
Иглолисна шума	Coniferous forest	8	0.21
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	0	0.00
Широколисно-иглолисна шума	Mixed forest	88	2.24
Пасишта со висока трева и планински пасишта	Natural grassland	3418	87.07
Суви брдски пасишта	Pastures	175	4.45
Пасишта со грмушки	Transitional woodland-scrub	61	1.56
Вкупно	**Total**	3926	

Figure 18Mountain grasslands on Osogovo Mt. (Ruen and Sultan Tepe)

The landscape of mountain grasslands has great importance for biodiversity conservation, especially flora diversity. In this context, fens and mires on Maleshevo Mountains which host the very rare mire based plant*Drosera rotundifolia*are the most important.

3.7   Mining landscape

3.7.1   Mining landscape

In the surveyed area– Bregalnica Watershed and Eastern planning region - two types of anthropogenic landscapes with fully modified structure can be identified. These are the cities of Shtip and Kochani (urban landscape) and the area of the mine "Buchim" with open pit. The mine

covers an area of around 7 km^2, which in respect of the entire area of interest is insignificant. However, the intensity of the activities and the extent to which the environment has changed due to their practicing has left a deep mark of the entire surrounding area (not only visual but also in terms of functional characteristics of the surrounding landscape) in which the mine is located. So, there are sufficient arguments for this area (despite the dimensions) to be identified as a separate landscape type. Furthermore, there a number of mines in the investigated area (mainly on Osogovo Mts.) which leave noticeable mark footmarks in the structure of the surrounding area. Yet, these are underground mines and anthropogenic structures on the surface are not of such dimensions to allow for identification of additional landscape units of the mining landscape.

Figure 19Mining landscape (Buchim mine)

The main structural characteristics of the landscape are presented in Table 23. The nature of the landscape is determined by the domination of CLC classes 'Mineral extraction sites' and 'Dump sites' (dark tan). Significant presence of the CLC class 'Pastures' (light yellow) reflects the nature of the landscape before the initiation of anthropogenic activities. So, the matrix of the landscape is composed of different modified areas – eroded slopes of quarries,new excavation sites, dump sites, industrial structures and alike. This predominant structure of the land incorporates pastures as well.

Table 23. Basic structural characteristics (land cover - CLC)of the Mining landscape(Colours correspond with those on the map of landscapes)

Руднички предел	Mining landscape	Area (ha)	Area (%)
Одлагалишта	Dump sites	150	21.69
Земјоделско земјиште со површини под природна вегетација	Land principally occupied by agriculture, with significant areas of natural vegetation	4	0.55
Површински рудници	Mineral extraction sites	330	47.63
Суви брдски пасишта	Pastures	209	30.13
Вкупно	**Total**	693	

The landscape obviously has "simple" structure if only three CLC classes and therefore has no importance whatsoever for biological diversity. Besides, visual effect is really bad.

4 Valorization

Valorization of landscapes can be defined as a process of "determining the importance of a given landscape or landscape feature by referring to a specified value criteria". Value criteria that are used in the process for landscape valorization may vary depending on the purpose for which landscape valorization is carried

Giving the purposes of this Study, the following value criteria were selected:

- Landscape character. It refers to the distinctive and recognizable pattern of features which makes one landscape type unique. This criterion is applied when comparing two landscape units of the same type, as assessment criteria are not applicable between landscapes of different types.
- Landscape condition. The criterion is related to landscape character and is the index of the integrity or intactness of the basic pattern of landscape features, which constitute the landscape character of that type. An appraisal of landscape condition allows the comparison of two landscapes of the same type, but also comparison of two landscapes of different types. This is because the criterion of 'intactness of landscape pattern' is applicable between landscapes of different types, even though those patterns are different.
- Landscape values. It refers to the aspects attributing importance to a given landscape type and the magnitude of the importance that we attribute. Landscapes can be characterized as worth for conservation due to the good status of preservation, possession of exceptional scenic values or possession of important environmental, cultural or historical features. An appraisal of landscape values allows the comparison of two landscapes of the same type, but also comparison of two landscapes of different types. Landscape sensitivity. It can be defined as capacity of the landscape to tolerate a change without undergoing significant alteration of the basic features that define the character of the landscape. This criterion is applied in comparison of two landscapes of the same type, but also comparison of two landscapes of different types.
- Connectivity of resource patches in the landscape. Connectivity denotes connectedness and connectivity of the resource patches in the landscape. It may also refer to connectivity of individual landscape units or individual landscapes within wider area. Landscape connectivity can be defined as the degree to which the landscape facilitates or impedes movement between resources patches (Taylor et al. 1993). Landscape connectedness plays an important role in dispersal of species, and consequently in biodiversity conservation (Tischendorf and Fahrig 2000). Connectivity can be also characterized as structural or functional. Structural connectivity (connectedness) facilitates interpretation of spatial links between patches of habitats, as for example distance between patches of the same type or availability of corridors. Functional connectedness (connectivity) determines the ability of organisms to move between patches in the landscape (Taylor et al. 2006). Two patches may be positioned at short distance and have high structural connectivity. However, functional connectivity of the two patches will depend on the nature of the distance and characteristics and ability of dispersion of the organism observed.

Observing the above explained criteria for valorization, several prominent landscape types can be identified in the surveyed area:

Flatland ricefield agricultural landscape (Kochani landscape). Agricultural rural aspect of the landscape, as well as absence of major industrial facilities and other infrastructure (long distance transmission lines, roads, etc.) attribute significant aesthetic value to the landscape of ricefields, especially for the fact that it is unique for Macedonia. The landscape also contributes to the enhancement of biodiversity (aquatic birds, aquatic and marsh plants and animals), considering that most of the marsh habitats in Macedonia have been converted into agricultural land. On the other side, ricefields at the same time threat to biodiversity because they offer possibility for introduction of many allochtonous species.

Maleshevo-Pijanec rural agricultural landscape. Specific feature of this landscape is higher number of forest patches scattered around agricultural matrix. Patches are not well connected with corridors. Their better connection may be an important conservation activity in future, given the fact that this landscape is surrounded by forests all around. The role of these forest landscapes as core areas for carnivores could be much more efficient if they are inter-connected. Hence, Maleshevo-Pijanec rural agricultural landscape has potentially great importance for biodiversity.

Rolling rural landscape with hedges. The landscape possesses especially high aesthetic value due to its well preserved rural appearance. It is important landscape for development of certain alternative forms of tourism, like rural tourism. Hedge vegetation in this landscape type is most often represented by ruderal vegetation and planted broadleaf trees, as well as remains of natural vegetation and has the function of corridor. Presence of large areas with scrubs is favorable feature from biodiversity conservation point of view (it increases the connectivity of forest patches), but it is a sign of intensive process of abandonment of agricultural activities (especially notable in the western part of Osogovo) which might cause degradation of the rural nature of the landscape.

Hilly rural landscape. Hilly rural landscape occupies significant area of the investigated region (around 13.5 %) and thus attributes prominent feature to the entire area. The large surface area it covers and its structural characteristics – significant areas under forests, degraded forests, scrub stands and other natural vegetation – makes this landscape important for biological diversity conservation. Villages situated in the southwestern and partially southeastern part of Plachkovica (Jurukluk) where isolation and different life styles, traditions and culture typical for Turkish ethnic community are especially impressive and contribute to a distinctive visual perception of the landscape.

Osogovo mountain rural landscape. From aesthetic point of view, this landscape type possesses very high value and thus carries great potential for rural tourism development. Besides, the landscape has great importance for biodiversity as well, through it is necessary to make more precise definition of the form and the potential of forest corridors that connect large forest areas in order to identify the conservation significance of the landscape accurately.

Mountain rural landscape (Maleshevo mountain rural landscape). Similarly as Osogovo mountain rural landscape, this one possesses very high aesthetic values along with values enabling biodiversity conservation. As opposed to Osogovo landscape, this landscape does not manifest serious signs of abandonment and conversion of the basic land cover classes.

Landscape of dry grasslands on marl ground. The landscape is of outstanding conservation importance, especially in terms of protection of birds of prey (vultures) and endemic plants and invertebrate animals. Therefore, the next phase of the project should pay greater attention to this landscape type. Areas Kuchukol and Slan Dol are especially typical for this landscape.

Mixed broadleaf forest with black pine stands landscape. The Mixed broadleaf forest with black pine stands landscape is not very important from biodiversity conservation point of view, owing to the extent of forest patches fragmentation. On the other side, this landscape spreads along

border mountains towards Bulgaria (which means not far away from the big mountain massifs Pirin and Rila) that connect the forested landscapes of the mountains Ograzhden, Maleshevo and Osogovo. This actually makes important corridor for big mammals identified in MAK-NEN (Brajanoska et al. 2009). Hence, the importance of this landscape for biodiversity conservation is great, and in time (with vegetation growth on forest clearings or through direct improvement of the landscape structure), it could become vital for the eastern part of Macedonia.

Pine forest landscape. Black pine forests on Maleshevski Planini Mt. and Maleshevo area are almost entirely autochthonous with significantly well preserved natural features. The landscape has high aesthetic values and great importance for biodiversity conservation in the investigated area.

Mesophilous broadleaf forest landscape. This landscape, compared to other landscapes in the investigated area, is the most important in terms of conservation of carnivores, as it characterized with insignificant degree of fragmentation. Landscapes mesophilous broadleaf forests on the mountains Plachkovica and Maleshevo, as well as mesophilous broadleaf forests on Osogovo possess especially high values as corridors.

*Landscape of mountain grasslands on silicate ground.*The Landscape of mountain grasslands has great importance for biodiversity conservation, especially for plant diversity. In this context, fens and mires on Maleshevo Mountains which host the very rare mire based plant *Drosera rotundifolia*are the most important. The largest and the most specific areas under mountain grasslands on silicate ground are found on Osogovo Mts.

In general, with regard to connectivity, the most important landscapes include certainly *forest landscapes,* then *mountain rural landscapes* (both Maleshevo and Osogovo), *hilly rural landscape* and at the end agricultural landscapes (Figure 20).

However, certain landscape units in the frames of the same landscape are not always characterized with equal or similar connectivity. Differences occur mostly due to differences in population density and different land use practices in different areas in Bregalnica Watershed and the Eastern planning region. Population density is conditioned by different historical changes determined by socio-economic and ethnic factors.
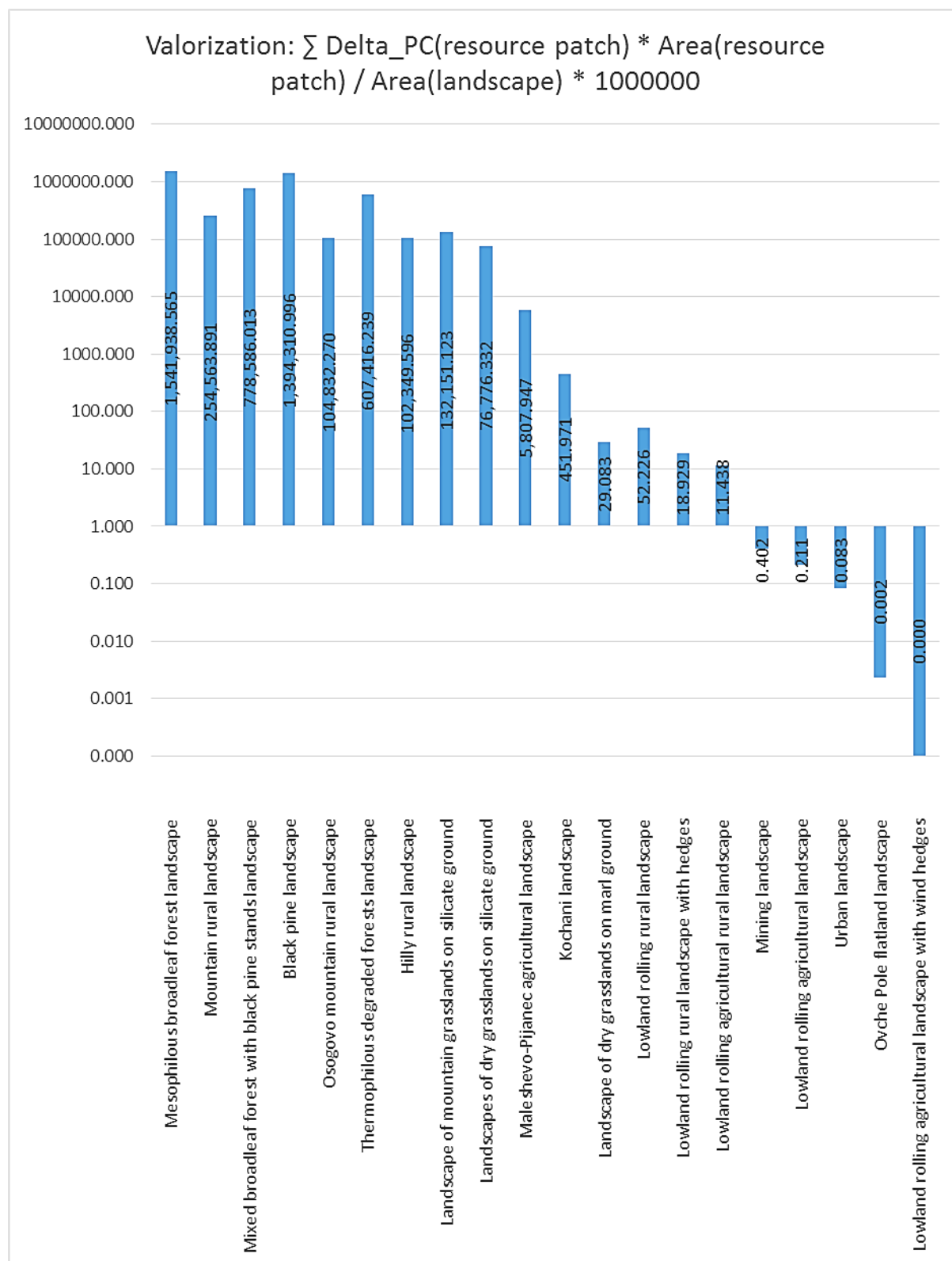
Figure 20 Cumulative valorization of landscape types (all landscape units together) against the criterion for connectivity (ordinate axis has logarithm values!)

Thus, for example, the Hilly rural landscape in southwestern part of Plachkovica (Jurukluk) populated mainly by Turkish population is characterized by high connectivity, as in the rank of the areas of thermophilous forests. As opposed to this, the Hilly rural landscape in the area of Kalimanci

and Makedonska Kamenica on Osogovo are characterized with significantly weaker connectivity (Figure 21).

Characteristics of other landscape units of all landscapes in the surveyed area are presented in the graphical overview on Figure 21. Identification numbers for each individual landscape unit (in the graphical overview) are shown on the map on Figure 22.
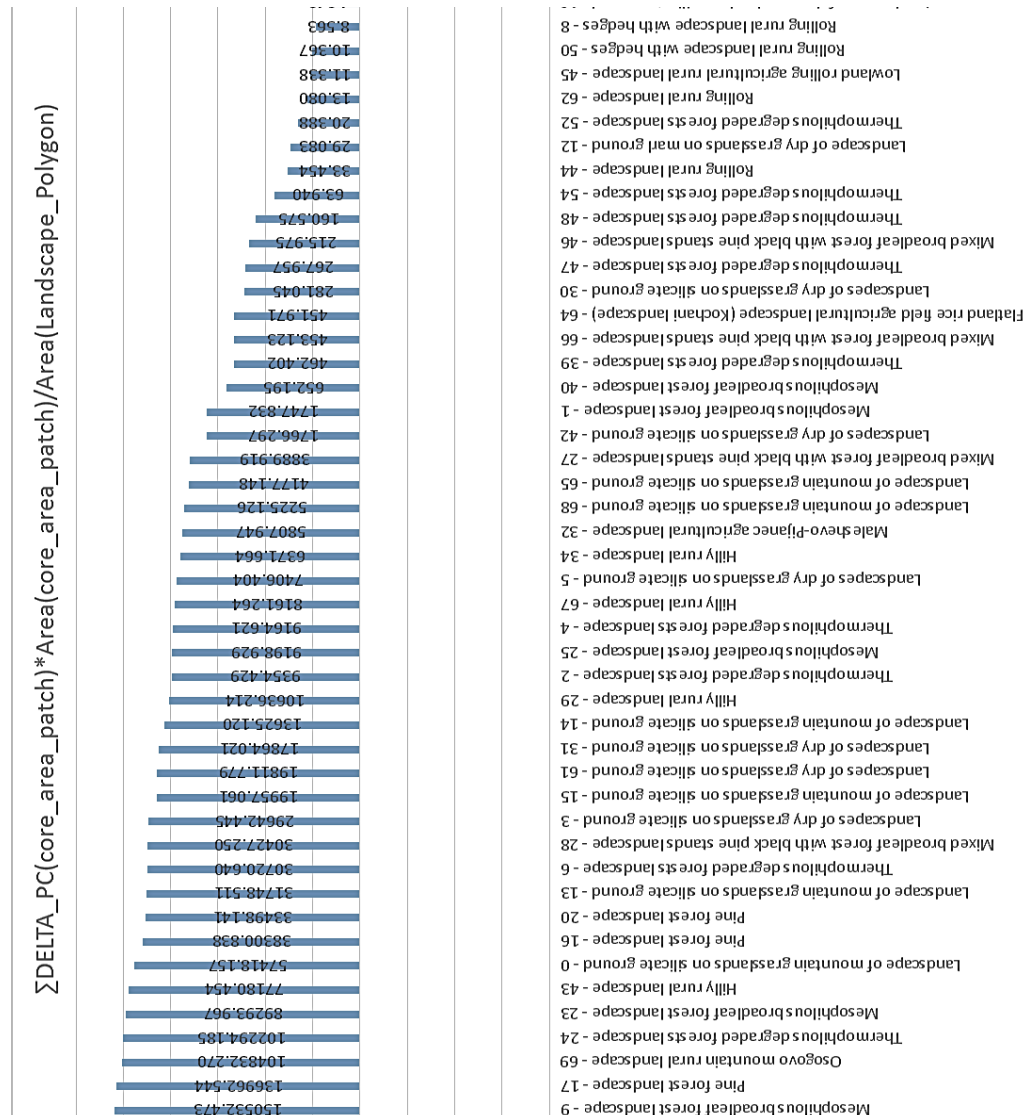
$\sum DELTA\_PC(core\_area\_patch)*Area(core\_area\_patch)/Area(Landscape\_Polygon)$

Value	Landscape unit
8,563	Rolling rural landscape with hedges - 8
10,367	Rolling rural landscape with hedges - 50
11,338	Lowland rolling agricultural rural landscape - 45
13,080	Rolling rural landscape - 62
20,388	Thermophilous degraded forests landscape - 52
29,083	Landscape of dry grasslands on marl ground - 12
33,454	Rolling rural landscape - 44
63,940	Thermophilous degraded forests landscape - 54
160,575	Thermophilous degraded forests landscape - 48
215,975	Mixed broadleaf forest with black pine stands landscape - 46
267,957	Thermophilous degraded forests landscape - 47
281,045	Landscapes of dry grasslands on silicate ground - 30
451,971	Flatland rice field agricultural landscape (Kochani landscape) - 64
453,123	Mixed broadleaf forest with black pine stands landscape - 66
462,402	Thermophilous degraded forests landscape - 39
652,195	Mesophilous broadleaf forest landscape - 40
1,747,832	Mesophilous broadleaf forest landscape - 1
1,766,297	Landscapes of dry grasslands on silicate ground - 42
3,889,919	Mixed broadleaf forest with black pine stands landscape - 27
4,177,448	Landscape of mountain grasslands on silicate ground - 65
5,225,126	Landscape of mountain grasslands on silicate ground - 68
5807,947	Maleshevo-Pijanec agricultural landscape - 32
637,664	Hilly rural landscape - 34
7406,404	Landscapes of dry grasslands on silicate ground - 5
8161,264	Hilly rural landscape - 67
9164,621	Thermophilous degraded forests landscape - 4
9166,929	Mesophilous broadleaf forest landscape - 25
9354,429	Thermophilous degraded forests landscape - 2
10,098,214	Hilly rural landscape - 29
13,625,120	Landscape of mountain grasslands on silicate ground - 14
17,864,021	Landscapes of dry grasslands on silicate ground - 31
19,811,779	Landscapes of dry grasslands on silicate ground - 61
19,957,061	Landscape of mountain grasslands on silicate ground - 15
29,642,445	Landscapes of dry grasslands on silicate ground - 3
30,427,250	Mixed broadleaf forest with black pine stands landscape - 28
30,720,640	Thermophilous degraded forests landscape - 6
31,748,511	Landscape of mountain grasslands on silicate ground - 13
33,498,141	Pine forest landscape - 20
38,300,838	Pine forest landscape - 16
57,418,157	Landscape of mountain grasslands on silicate ground - 0
77,180,454	Hilly rural landscape - 43
89,293,967	Mesophilous broadleaf forest landscape - 23
102,294,185	Thermophilous degraded forests landscape - 24
104,832,270	Osogovo mountain rural landscape - 69
186,962,544	Pine forest landscape - 17
150,532,473	Mesophilous broadleaf forest landscape - 9

Figure 21 Individual valorization of landscape units by criterion of connectivity (ordinate axis has logarithm values!)
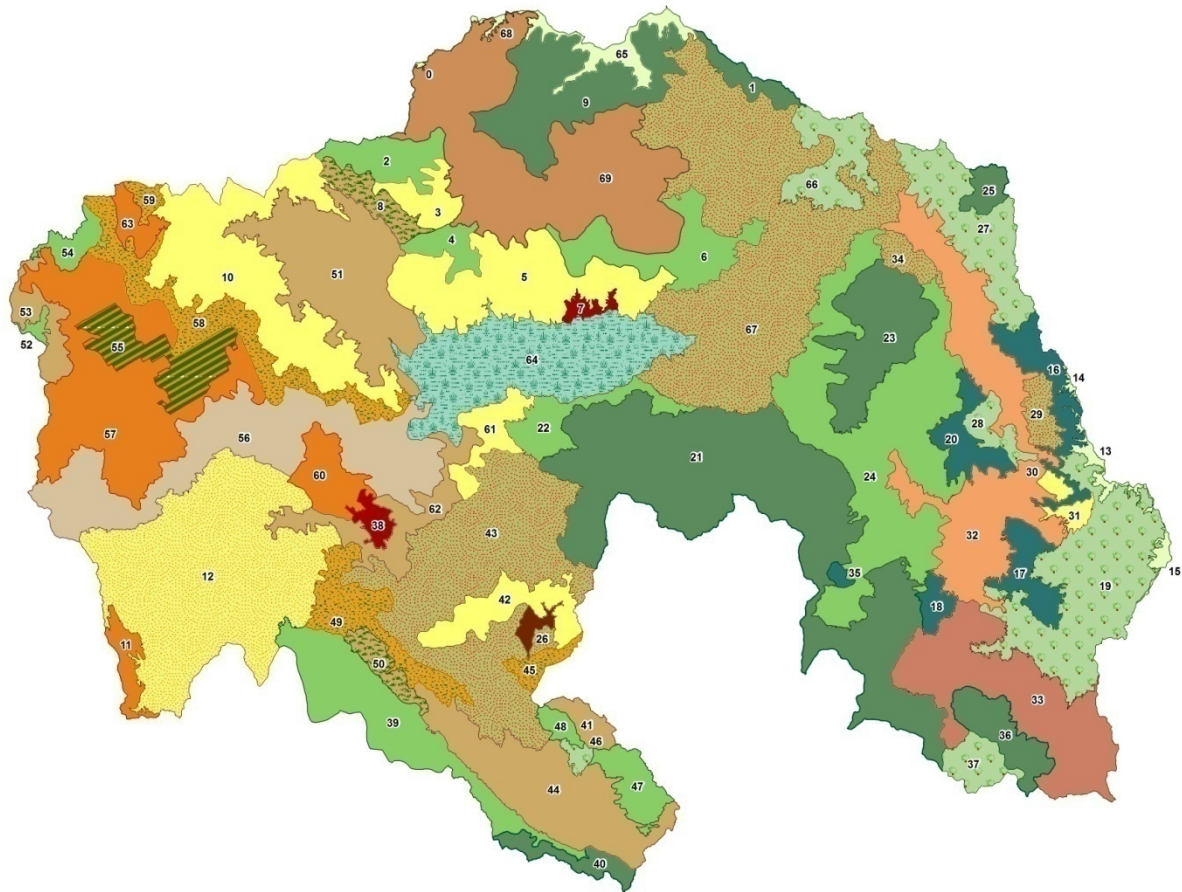
Figure 22 Individual valuation of landscape units by criterion of connectivity

5 Identified threats

Threats to landscapes are complex and brought up by socio-economic, political and development policies on local and national levels. Complexity is mirrored in the fact that each landscape is made of a number of ecosystems which are affected by series of ecosystem specific processes. On the other side, certain threats to landscape structure can be beneficial for biodiversity. Thus for example, overgrowth of rural landscapes consequent loss of visual effect, but creates larger patches of shrubby, followed by forest vegetation which has positive impact on carnivores in terms of possibilities for their unobstructed movement, hiding and hunting (especially with carnivores). In this way, the extent of fragmentation of favorable habitats is reduced as well. So, if we consider certain process from visual effect point of view, it can be a threat, and when we consider it from biodiversity point of view, that process can have positive effects. Yet, this is not entirely true either – simplification of the structure of the landscape (especially with rural landscapes) assumes loss of habitats, too (meadows, hedge-rows, pastures) which leads to extinction of high number of plant and invertebrate animal species.

Finally, one same process affects different landscape types in a different manner. For example, overgrowth of agricultural landscapes with vegetation means invigorating the complexity of the landscape structure which generates better visual effect and richer biodiversity. As demonstrated above, the situation with rural landscapes is entirely opposite.

In conclusion, several key threats can be identified for the landscapes in the area of Bregalnica Watershed and Eastern planning region.

- Overgrowth of rural landscape with vegetation due to abandonment of traditional agricultural practices which results in loss of visual values and degradation of certain biodiversity components – habitats, plant species and invertebrates;
- Overgrowth of hedge-rows in the Rolling rural landscape with hedge-rows with natural forest vegetation due to abandonment of agricultural practices (migration) which leads to loss of visual values (concerns the area of Lakavica - Serta);
- Overgrowth of meadows in Osogovo mountain rural landscape due to abandoned traditional practices – loss of visual values;
- Intensification of agricultural practices by consolidation of plots and loss of hedge-rows which leads to loss of visual values and loss of corridors for certain organisms (concerns only some parts of the region Probishtip-Zletovo area);
- Decline in surface of ricefields – areas under ricefields have varied considerably for the last several decades due to changes in market price of the rice;

6 Recommendations for conditions improvement

Landscapes management is immense and complex task corresponding with the complexity of factors that cause degradation of their values. Therefore, it is not easy to make recommendations for improvement of their condition. This would refer mainly to changes in current policies related to economy at state level. Yet, we can generally recommend that implementation of recommendations for sustainable development, especially sustainable agriculture, is of crucial importance for the maintenance of the favorable status of landscapes in the region.

Another general recommendation refers to elaboration of action plan for the implementation of the recommendations contained in the Plan for corridors developed for the purposes of MAK-NEN.

When designating protected areas in the project region, care should be paid to the values of the landscapes. Parts of landscapes or entire landscapes should be integrated in some protected areas in line with their values. Further on, protected areas should be designated along the main corridors of MAK-NEN to incorporate forest landscapes.

Specific recommendations:

- Bregalnica – avoid fragmentation of riparian poplar forests;
- Forest landscapes – prohibit bare cuts;
- Strengthen urban planning both in urban and rural settlements; elaborate detailed urban plan for the settlements and thus avoid illegal construction;
- Spatial planning should be founded on the principles of landscape ecology taking into account structures in the landscape and their role in biodiversity conservation;
- Rural landscapes – encourage development of alternative forms of tourism in rural areas; particular attention should be devoted to the preservation of traditional image of the settlements and conservation of the naturalness of these areas;
- Improvement of connectedness of core areas of the MAK-NEN in the area of Maleshevo via Maleshevo-Pijanec agricultural rural landscape;
- Elaboration of science based plan for utilization of the pastures in the Landscape of dry grasslands on marl ground;
- Elaboration of science based plans for utilization of natural resources in the Landscape of mountain grasslands on silicate ground, including pastures and blueberries.

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8 Summary

Landscapes are a mosaic of anthropogenic and natural ecosystems shaped as a result of long lasting interaction between human and nature. Human has historically had a dominant influence on landscape forms (structural characteristics of landscapes, spatial heterogeneity) and therefore is an important part of the definition of a landscape. Thus, the recognition of human activities as an integral part of ecosystems globally resulted in a shift of the conservation approach – from species to landscapes.

For centuries, the region of Bregalnica basin has been under continuous anthropogenic influence. This has left a strong human imprint of plains, mountains, landscapes and nature in general. On the other hand, heterogeneity in human practices contributed and contributes to the current state of biodiversity. That means maintaining the existing landscape diversity and preservation of existing wildlife corridors is crucial to ensure comprehensive biodiversity conservation. Therefore, the identification and characterization of landscape diversity in the region of Bregalnica basin will result in data that will complement the existing understanding of natural resources and contribute towards integrated and sustainable conservation of natural values in the region. The analysis of anthropogenic induced changes on landscape level in recent history, as part of this study, will allow determining the capacity of ecosystems to support biodiversity, revitalization of degraded components and providing the necessary ecosystem services. Structural analysis of the landscape should serve as a base for integrated spatial planning in the area of interest that would provide sustainable development of communities in the region without serious impairment of natural ecosystems and overall biodiversity. Hence, recognizing the need for a detailed analysis of the landscape of the Bregalnica region, this study includes a typification of landscape types, while considering their structural features and their functionality in terms of biodiversity and ecosystem processes.

As a starting point for identification of different landscapes, eight criteria that define the main characteristics of the landscapes were taken: relief, inclination, altitude, present or potential vegetation, land use, geology and soils, climate, naturalness, neighborhoods and cultural characteristics and history. Consequently the criteria that potentially identify the landscapes were set against relief and elevation in a matrix. It should be noted that when using this method of characterization and definition of landscapes, a wider knowledge of field-specific characteristics and expert knowledge in landscape ecology is substantial. Landscape types were depicted and defined using the specified methodology, after which a spatial delineation of landscape units was made. The final delineation of landscape types was carried in GIS software by overlaying vector files of above defined criteria (excluding climate, natural and cultural features and history). Corine Land Cover 2012 shapefile was used as most relevant for carrying the analyses of landscapes structural characteristics. Functional characteristics of some landscapes of interest (rural landscapes, landscapes of dry grasslands and forest landscapes) were also analyzed in order to define the most important corridors and to determine their relevance in biodiversity conservation and their capacity for supporting ecosystem processes. Calculations for connectivity were carried using Grabhab software.

The results have identified seven basic types of landscapes in the area of interest- river Bregalnica watershed and Eastern planning region (Figure 1 – Map of identified landscapes):

1. Urban landscape

2. Mining landscape

3. Agricultural landscapes

4. Rural landscapes

5. Landscapes of dry grasslands

6. Forest landscapes

7. Landscape of mountain grasslands

Urban landscape. The urban character is most evident in the cities of Kochani and Shtip, which visually, structurally and in terms of surface allows definition of an urban landscape. The urban landscape has discontinuous distribution in the surveyed area. The main structural characteristics of this landscape are shown in Table 2.

Agricultural landscapes. Agricultural landscapes mainly span in the area of broad plains and floodplains along the valley of Svetinikolska Reka river and in along the plain of river Bregalnica mid-flow. Smaller agricultural areas with specific landscape features are found in Males and Pijanec (with rural characteristics), and along the river Kriva Lakavica.

Agricultural flatland landscape on saline ground (Ovche Pole flatland landscape). This area is characterized by a uniform flatland relief up to an altitude of about 350 m. The main structural characteristics of the landscape are shown in Table 3. Within the frame of this landscape an additional landscape variance can be singled out – *Ovche Pole flatland agricultural landscape with wind hedges*.

Lowland rolling agricultural landscape (Ovche Pole lowland rolling landscape). This area is characterized by lowland wavy-hilly terrain with very gentle slopes, found at an altitude of 500 m. The main structural characteristics of the landscape are shown in Table 4.

Lowland rolling agricultural landscape with wind hedges (Ovche Pole lowland rolling landscape with wind hedges). Within the frame of Ovche Pole lowland rolling landscape, the visual effect of the landscape is strongly featured by the field protective zones. These areas cover a large area in Ovche Pole area and this allows for a special unit with specific landscape characteristics can be set aside - Ovche Pole lowland rolling landscape with wind hedges. The main structural characteristics of the landscape are shown in Table 5.

Flatland ricefield agricultural landscape (Kochani landscape). This landscape is characterized by uniform lowland relief on an altitude up to about 370 m. It is precisely the lowland remarkable character that distinguishes Kochani flatland landscape from the landscape variance with staggered rice fields of Vinnitsa along the river Osojnica (due to the small size the area this area cannot be delineated and singled out as a separate landscape) and along the river Topolka in Chaska, where the terrain is slightly inclinated. The main structural characteristics of the landscape are shown in Table 6.

Rural landscapes. The main feature of rural areas in the region is given by humans that for centuries have locally shaped the natural ecosystems to adapt to their needs. Topographic variations, profusion or scarcity of natural resources, ethnic and cultural diversity as well as socio-economic policies in the past and today have contributed towards formation of several types of rural landscapes in the area of interest.

Lowland rolling agricultural rural landscape. This area is characterized by a monotonous relief, often represented by smaller plains and small hills with gentle slopes that wavy rise to a height of 500 m a.s.l. on the southwest foothills of Plachkovica up to 400 m a.s.l. on the northwest foothills of

Serta (mainly along the river Kriva Lakavica) to over 600 m a.s.l. on Mangovica. The main structural characteristics of the landscape are shown in Table 7.

Maleshevo-Pijanec agricultural landscape. Maleshevo-Pijanec landscape has the character of lowland rolling landscapes, but here the specific is that it extends to much higher altitudes (from about 600 m a.s.l. in Pijanec to over 900 m a.s.l. in Malesh). The main structural characteristics of the landscape are presented in Table 8.

Rolling rural landscape. This landscape is characterized by a similar relief as lowland rolling agricultural landscapes - that are mostly lowlands and lowland wavy-hilly terrain at altitudes up to 600 m in the northwest of Serta, to 800 m in southwestern Plachkovica and up to about 750 m on north slopes of Plachkovica. The main structural characteristics of the landscape are presented in Table 9.

Rolling rural landscape with hedges. Due to the relatively small footprint in Bregalnica basin, this landscape can be set aside as a variation of lowland rolling rural landscape. The natural features of the lowland rolling rural landscape with hedges are the same as in the previous type. The main structural characteristics of the landscape are presented in Table 10.

Hilly rural landscape. Hilly rural landscape is characterized by wavy-hilly terrain and extends up to an altitude of 800-900 m on the southeast and southwest of Plachkovica. The main structural characteristics of the landscape are presented in Table 11.

Osogovo mountain rural landscape. This landscape is typical for Osogovo Mountains and parts of Vlaina Mountain. The relief is rather uniform, presented with moderate to steep slopes, ravines and valleys. The area is sparsely populated and settlements are of scattered type. It is actually the scattered formation of the settlement that gives the distinctive look of this landscape. The main structural characteristics of the landscape are presented in Table 13.

Mountain rural landscape (Maleshevo mountain rural landscape). This type of mountain rural landscape is found on the southern slopes of Maleshevski Planini Mt. It is very similar to that on Osogovo Mts. But in terms of structure, this landscape considerably differs from that on Osogovo. The visual effect of Maleshevo mountain rural landscape is strongly featured by the large coverage of small-scale extensively managed agricultural areas and the absence of scattered settlements. The main structural characteristics of the landscape are presented in Table 14.

Landscapes of dry grasslands. The structure and the character of dry grasslands in the area are anthropogenically preconditioned. Pastures in Macedonia are secondary formation resulting from continued cattle breeding and grazing initiated for thousands of years. However, due to the negative migration trend and significant abandonment of traditional cattle breading practices, large part of the area once used as pasture is now abandoned. This trend leads to successive overgrowth with shrubs and thus loss of the basic structural feature of the landscapes of dry grasslands – open pastures. Maintaining this type of landscape should be a challenge for future generations of socio-political and economic stakeholders.

Landscape of dry grasslands on silicate ground. This type of landscape is predominantly characterized by a hilly terrain with steep slopes in some parts. A main vegetation characteristic of this landscape type is the presence of grassland plant communities that develop on hilly open pastures on silicate substrate to about 1000 m altitude. This vegetation is of secondary origin and can be maintained only by continuous grazing. Within this landscape type, a separate landscape variant can be set aside - - landscape on dry grasslands on silicate ground with shrubs. Here the pastures are overgrown with rare shrubs resulting from abandonment of traditional cattle breading practices. The main structural characteristics of the landscape are presented in Table 15

Landscape of dry grasslands on marl ground. This landscape type is mainly present around Kuchukol and Slan Dol, while smaller areas by surface can be found around the city of Shtip and on the western slopes of Plachkovica. The landscape is characterized by wavy-hilly terrain on characteristic geological substrate – mainly marl flysch rocks or different flysch sediments and terraces, again with marl composition. The main structural characteristics of the landscape are presented in Table 16. This landscape type has a high conservational value, especially for the protection of birds (vultures) and endemic plants and invertebrates.

Forest landscapes. Forest landscapes in the study area have partially retain their natural features, especially those forest landscapes positioned in areas that are difficult to reach. Here, the anthropogenic influence is reflected primarily in the use of areas under forests for cattle breeding and agriculture (meadows, forest clearings) and as firewood and construction material, and partly due to the extraction of minerals and mining. Anthropogenic influence was most prevalent, and therefore is most visible in the forest belt of thermophilous oak forests.

Thermophilous degraded forests landscape. This landscape has quite a varied relief. It includes mild to moderately steep and steep slopes, then gorges, ravines and valleys. Vegetation in the area of degraded thermophilous forests is characterized by oak-hornbeam forests (Querco-Carpinetum orientalis), and there are also mixed forests of Turkey and Italian oak (Quercetum frainetto-cerris) and Hornbeam forests (*Ostrya carpinifolia*). The vegetation is more or less modified and semi-natural. The main structural characteristics of the landscape are presented in Table 17.

Mesophilous broadleaf forest landscape. This landscape is mainly spread in the altitude zone ranging in between 1400 and 1800 m a.s.l., but can be also distinguished on much lower elevation as its positioning depends on the exposure and the inclination of the terrain. The main type of habitat is the mountainous beech ecosystem (represented by the ass. Calamintho grandiflorae-Fagetum) present at all exposures, while mountain pastures are forest clearings are secondary habitats. Forests are natural to semi-natural. At lower altitudes the landscape is predominantly characterized by sessile oak or even by smaller areas under Italian-Turkish oak forests. The main structural characteristics of the landscape are presented in Table 19.

Mixed broadleaf forest with black pine stands landscape. In some areas of the study area (especially in Maleshevo-Pijanec region) there are larger by area forest plantations dominated by black pine. Because of the scatter character and the relatively small area of conifer plantations in terms of degraded broadleaf forests, landscape of conifer forests cannot be clearly differentiated. However, the black pine plantations provide completely different visual aspect of the area, which is why a landscape with mixed broadleaf forest with black pine stands can be differentiated as a separate landscape type. The main structural characteristics of the landscape are presented in Table 20.

Pine landscape. Black pine forests on Maleshevski Planini Mt. and Maleshevo are almost exclusively indigenous with significantly preserved natural features. On some localities they occupy larger areas so that a special type of landscape can be set aside – Black pine landscape (or Pine forests with black pine landscape). The main structural characteristics of the landscape are presented in Table 21.

Landscape of mountain grasslands on silicate ground. This landscape is characteristic for the highest parts of Osogovo (Kalin Kamen, Sultan Tepe and Ruen) Vlaina Planina Mt. (Kadiica) and Maleshevski Planini Mt. (Chengino Kale). Mountain pastures have secondary origin. In this part of the Balkan Peninsula the mountain pastures would have potentially been distributed over 2200 m a.s.l but as a result of a long lasting tradition of grazing herds of numerous sheep and cattle, the line of the forest belt was artificially lowered by about 300-500 m. This allows for areas under mountain

grasslands on silicate ground to be differentiated as a separate landscape type. This landscape type is particularly representative for Osogovo Mts. The main structural characteristics of the landscape are presented in Table 22.

Mining landscape. In the investigated area, two types of anthropogenic landscapes with fully modified structure can be identified. These are the cities of Shtip and Kochani (urban landscape) and the area of the mine "Buchim". The mine covers an area of 7 km^2, which in respect of the entire area of interest is insignificant. However, the intensity of the mining activities and the extent to which the environment has changed due to their practicing has left a mark of the surrounding area (not only visual but also in terms of functional characteristics of the surrounding landscape). So, there are enough arguments for this area (despite the dimensions) to be set aside as a separate landscape type. The main structural characteristics of the landscape are presented in Table 23.