Forest Bioenergy in the Protected Mediterranean Areas

Geographical identification and description of biomass districts in the protected areas

Workpackage 3 - Testing

Activity A.3.4 - Planning biomass based energy production at regional and sub-regional level in protected areas.

D3.4.1 Geographical identification and description of biomass districts in the protected areas

Partner in charge: LP – Sicily Region, Regional Department for the Rural and Territorial Development

June 2018

Deliverable 3.4.1

Geographical identification and description of biomass districts in the protected areas

Responsible Partner:

LP: Sicily Region - Regional Department for the Rural and Territorial Development

Contributing Partners:

PP1: Municipality of Petralia Sottana

PP2 – Enviland Ltd

PP3: Slovenian Forestry Institute

PP4: Regional Development Agency Green Karst Ltd

PP7 - Zadar County

PP8 - Public institution Nature Park Velebit

June 2018

Project Acronym:	ForBioEnergy
Project full title:	Forest Bioenergy in the Protected Mediterranean Areas
Grant agreement number	1MED15_2.2_M2_182
Project reference number:	621
Lead Partner:	Sicily Region - Regional Department for the Rural and Territorial Development
Deliverable:	D. 3.4.1 Geographical identification and description of biomass districts in the protected areas
Summary:	The document contains the identification and the description of the Biomass Districts (BDs) by each partner, following the methodology proposed aimed at allowing the utilization of forest biomass for energy purpose in a sub-regional planning context. The collected information will be used for the design of an open source decision support system (DSS) aimed at planning biomass supply chains for energy use in protected areas, ensuring ecological and socio-economic sustainability.
Authors methodology and Italian study area (LP, PP1 and PP2)	Emilio Badalamenti (Lp), Laura Cobello (Pp2), Vincenzo David (Pp1), Despoina Karniadaki (Pp2), Donato La Mela Veca (Lp), Fabrizio Miserendino (Lp), Gaetano G. La Placa (Pp1), Vittorio Li Puma (Pp1), Massimo Pizzuto Antinoro (Lp), Paolo Contrino (Lp), Claudia Rubino (Pp2), Carlo Simonetti (Pp2)
Authors Slovenian study area (PP3 and PP4)	Eva Harmel (PP3), Matjaž Harmen (PP3), Darja Kocjan (PP3), Darij Krajčič (PP3), Nike Krajnc (PP3), Dunja Mahne (PP4), Kristina Sever (PP3), Anica Simčič (PP3), Matevž Triplat (PP3)
Authors first Croatian study area (PP7)	Alen Berta, Tena Birov, Edin Lugić
Authors second Croatian stydy area (PP8)	Vedran Banaj, Robert Bogdanić, Nela Miličić, Inga Orešković, David Rukavina
Document ID:	ForBioEnergy-D3.4.1_ Geographical identification and description of biomass districts in the protected areas
Distribution	Public
Version:	Final

Table of contents

1. PREMISE

The main objective of the Activity A.3.4 is the planning of energy production based on the use of forest biomasses in protected areas, at regional and sub-regional planning context. To reach this goal, each partner has to identify and characterize, within the chosen pilot area, specific Administrative Units (named as “Biomass Districts” – hereafter BDs), with the aim to plan short biomass supply chains for energy use, capable of ensuring environmental sustainability, as well as promoting the territorial socio-economic development. The BDs should also represent the administrative units for the forest planning at the company level. One important goal is to identify BDs as much as homogeneous possible in terms of availability of agroforestry resources (potential biomass supply for energy use), the distribution of the road network, and local energy needs (energy demand). For this purpose, the ratio between the energy needs and the agro-forestry areas (Forests plus permanent crops according to the CLC classification) was particularly taken into account, along with the occurrence of different kind of restrictions (for biodiversity protection, landscape or hydrogeological) for forest biomasses utilization. To develop a technically efficient and economically valuable wood supply chain is necessary the presence of a sufficient number of specialized forest enterprises; hence, the surveys dedicated to find private companies operating in the biomass sector in each BD assumed great relevance. The collected information, through GIS (Geographic Information System) applications, will be used to develop a DSS (Decision Support System). Such a tool will be elaborated for Public Authorities, aimed at supporting the forest planning for bioenergy production within the pilot protected area.

2. METHODOLOGHY

2.1 Geographical identification and description of "Biomass Districts" within the protected area (Deliverable 3.4.1)

The aim of the activity is to define the methodology to be adopted for the identification of administrative units (the BDs), where to use the residual agroforestry biomass for bioenergy production, in a context of planning at a sub-regional and regional level.

2.1.1 Criteria to identify "Biomass Districts"

The BDs within the protected area will also represent the administrative units for the purposes of forest planning at the company level. They will be identified in consideration of their total area and that of the available agroforestry areas, aiming at obtaining districts as homogeneous as possible under these aspects.

The GIS elaborations to identify the BDs (a single municipality or more municipalities aggregated) will be carried out using the following thematic references of each municipality or other administrative unit falling within the pilot protected area:

- total area of the municipal territories, even if partially falling within the protected area;
- agroforestry area of each municipality, obtained from the land use map according to the Corine Land Cover legend, distinguished in forests (codes 311, 312, 313) and permanent crops (classes 221, 222, 223);
- characteristics and distribution of the main road network;
- localization of urban centers;
- energy needs of each municipality.

These data, and others, will be used for the identification of homogeneous administrative units constituting the BDs.

The previous area data will allow considering the unification of neighboring municipalities in order to establish BDs as homogeneous as possible, in terms of agroforestry areas present and energy needs, and well served by the road network.

The identified BDs will be characterized in terms of geomorphological, bioclimatic, land use type, and of other environmental factors. Moreover, the environmental, landscape and territorial restrictions in force will be considered, particularly those referring to the 92/43/CEE Habitat

Directive and related Special Protection Areas (SPAs) and Sites of Community Importance (SCIs) (then Special Areas of Conservation, SACs) (Natura 2000 sites).

In addition, the energy needs of each district must be indicated, resulting from the needs of the municipalities that are part of it (see Deliverable 3.2.1), as well as the active private companies involved in the biomass sector, in order to promote a synergistic development of short supply chains for the use of agroforestry biomass, also increasing the employment opportunities at the local level.

Finally, the current road system must be described and classified, distinguishing roads and forest tracks, suitable for biomass harvesting, from lorry roads, functional to transport biomass.

In summary, it is proposed that the following aspects will be considered to describe the BDs:

1. Territorial and administrative framework;
2. Geomorphological and bioclimatic aspects;
3. Land use according to the Corine Land Cover (CLC) classification;
4. Territorial, landscape and environmental restrictions;
5. Distribution and classification of the main road system;
6. Energy needs;
7. Private companies operating in the biomass sector.

Such preliminary investigations will be used to verify the agro-forestry areas potentially available for design sustainable short supply chains for bioenergy production.

The BD represents the reference administrative unit for forest planning at company scale. The ForBioEnergy project foresees, in the A3.7 activity of the WP3, the drafting of a forest management plan oriented to the production of biomass at the local level within protected areas.

2.1.2 GIS elaborations

This paragraph describes the procedure to be followed in the GIS environment for the delimitation and characterization of the BDs. Below is the list of the necessary steps:

1. Preliminary identification of the municipalities whose territories also partially fall within the protected area. Starting from the shapefile (.shp) of the municipal administrative limits, a "select layer by location" will be performed according to the shapefile of the protected area. Then the result will be exported to a new shapefile containing the municipalities falling within the protected area and which will represent our "study area"

within which to identify the BDs. This shapefile will be implemented with a field related to the total annual energy need of each municipality.

2. Using the shapefile of the "study area" just derived, some "*intersect*" will be performed with the shapefiles of the main road network and with the land use map from Corine Land Cover (CLC), in order to extrapolate only the tracks and the areas included in the "study area" and merge the information contained in the related attribute tables.
3. The shapefile of the CLC land use map thus derived will be subjected to a further "*intersect*" with the shapefile of the protected area in order to include the information contained in the related attribute tables and thus to discriminate the agro-forestry areas occurring within and outside the protected area.
4. Using the shapefile of the so obtained CLC land use map, a "*select layer by attribute*" should be performed to identify all the polygons with the CLC land use code "11": "*Residential urban areas*". The result will then be exported to a new shapefile identifying only the urban centers.

In all the themes obtained, an "area" or "length" field, according to the type of shapefile (polygon or line), will have to be created and its value calculated. Then, the statistical analysis on the obtained shapefiles will be carried out. Using the shapefile of the CLC land use map, as referred to the point 3, a "*summary statistics*" will be carried out to obtain for each municipality in order to obtain:

a. the area of each municipality falling within and outside the protected area;
b. the agro-forestry areas falling within and outside the protected area, classified according to the land use types (codes 311, 312, 313 for forest areas and codes 221, 222, 223 for permanent crops).

Identification of BDs:

A. Preliminary assessments based on the main road network linking the different urban centers present so as to consider all the possible merging of the municipalities adjacent to each other and directly connected through the current road network (the shapes of the urban centers, as referred to in point 4, and those of the main road network, as referred to in point 3, will be used). The result of this assessment will provide a first hypothesis of the delimitation of the BDs;

B. Verification of the areas covered by each district and by the agro-forestry areas available for biomass harvesting with the aim of obtaining BDs as much homogeneous as possible. The energy needs of each district will also be taken into account, with the aim at finding a ratio between the total annual energy needs and the availability of current agro-forestry biomass as much homogeneous as possible;
C. In the event that these requirements are not met, appropriate changes will be made to the merging of the different municipalities, always considering the territorial contiguity and the connection through the existing road network, in order to comply with the homogeneity requirements at point B.

3. GEOGRAPHICAL IDENTIFICATION AND DESCRIPTION OF BIOMASS DISTRICTS (BDs) WITHIN THE REGIONAL NATURAL PARK OF MADONIE (ITALY)

3.1 Identification of BDs

The results of the method described, as applied in the Regional Natural Park of Madonie, are shown in table 1. For each of the 15 municipalities falling within the protected area, the total municipal areas and those falling within the protected area have been calculated. From the CLC land use map, the agro-forestry areas present in each municipality were extrapolated and distinguished in different land use types. The total energy needs of each municipality have been obtained from the respective Sustainable Energy Action Plans (SEAP).

In total, 5 BDs have been identified after the merging of the municipalities (Table 2). The requirements of territorial contiguity, direct connection through the current road network and of homogeneity in terms of territorial extent and availability of agroforestry areas for biomass harvesting have been met. The ratio between the energy needs and the agro-forestry areas present was the most homogeneous possible, with the exception of district n. 4. In such district, this ratio was low due to the presence of the municipality of Petralia Soprana, characterized by a high energy need in relation to the effective availability of agro-forestry biomass (see Table 1). Even moving the municipality of Petralia Soprana to other districts the problem here emerged is not solved.

The figures 1 and 2 graphically represent what is shown in the tables. Figure 1 shows the administrative limits of the municipalities present in the Natural Park of Madonie, the current road network and the location of the main urban centers. Figure 2 shows the same information of Figure 1, with the addition of the identification of the 5 BDs. Figure 3 shows the territorial distribution of the agro-forestry biomass present in the different BDs.

Table 1 - Municipal territorial areas and agro-forestry areas in the municipalities of the Madonie Park

Municipality	*Municipal area*	*Municipal area within the park*	*CLC land use types in forest areas*								*CLC land use types in permanent crops*							
			Within the park				Outside the park				Within the park				Outside the park			
			311	312	313	Total	311	312	313	Total	221	222	223	Total	221	222	223	Total
			a	*b*	*c*	*d=a+b+c*	*e*	*f*	*g*	*h=e+f+g*	*i*	*l*	*m*	*n=i+l+m*	*o*	*p*	*q*	*r=o+p+q*
	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha
Caltavuturo	9.713	1.986	119,22	80,40	0,00	**199,62**	0,00	0,32	0,00	**0,32**	0,00	0,00	544,98	**544,98**	0,00	0,00	331,23	**331,23**
Castelbuono	6.090	2.563	776,16	109,26	0,00	**885,42**	84,93	89,38	0,00	**174,31**	0,00	0,00	919,95	**919,95**	0,00	0,00	2.742,07	**2.742,07**
Castellana Sicula	7.261	1.079	65,00	64,85	0,00	**129,85**	0,00	0,00	0,00	**0,00**	0,00	0,00	0,00	**0,00**	148,97	0,00	28,33	**177,30**
Cefalù	6.594	2.704	580,65	131,53	0,00	**712,18**	581,20	48,67	0,00	**629,87**	0,00	0,00	487,51	**487,51**	0,00	41,82	1.083,69	**1.125,51**
Collesano	10.771	4.226	728,46	22,80	0,00	**751,26**	33,23	0,00	0,00	**33,23**	0,00	0,00	472,64	**472,64**	0,00	235,54	1.416,66	**1.652,20**
Geraci Siculo	11.256	4.278	1.706,29	0,00	138,03	**1.844,32**	203,68	0,00	47,37	**251,05**	0,00	0,00	103,80	**103,80**	0,00	0,00	959,48	**959,48**
Gratteri	3.820	2.729	737,48	83,48	0,00	**820,96**	120,47	11,41	0,00	**131,88**	0,00	71,07	16,93	**88,00**	0,00	0,00	182,58	**182,58**
Isnello	5.047	4.484	1.942,28	218,51	0,00	**2.160,79**	0,00	0,00	0,00	**0,00**	0,00	0,00	139,83	**139,83**	0,00	0,00	433,54	**433,54**
Petralia Sottana	17.787	5.888	1.871,83	0,32	452,68	**2.324,83**	0,00	0,00	0,00	**0,00**	0,00	0,00	0,00	**0,00**	2,16	0,00	39,63	**41,79**
Petralia Soprana	5.717	1.845	0,00	0,00	280,85	**280,85**	0,00	4,72	0,00	**4,72**	0,00	0,00	0,00	**0,00**	0,00	0,00	0,21	**0,21**
Polizzi Generosa	13.426	4.218	503,02	113,80	81,37	**698,19**	0,00	0,00	0,60	**0,60**	0,00	0,00	716,75	**716,75**	0,00	0,00	103,01	**103,01**
Pollina	4.934	1.805	631,36	0,21	0,00	**631,57**	852,93	4,63	0,00	**857,56**	0,00	5,77	608,10	**613,87**	0,00	83,42	1.463,53	**1.546,95**
San Mauro Castelverde	11.406	219	90,07	0,00	0,00	**90,07**	2.606,17	46,45	1.047,32	**3.699,94**	0,00	0,00	119,36	**119,36**	0,00	0,00	1.514,37	**1.514,37**
Scillato	3.145	1.951	295,45	6,15	0,00	**301,60**	0,00	2,47	0,00	**2,47**	0,00	0,00	437,55	**437,55**	0,00	0,00	180,29	**180,29**
Sclafani Bagni	13.497	242	38,51	0,00	0,00	**38,51**	644,69	32,28	401,69	**1.078,66**	0,00	0,00	0,14	**0,14**	561,70	0,00	279,66	**841,36**
Total	**130.464**	**40.217**	**10.085,78**	**831,31**	**952,93**	**11.870,02**	**5.127,30**	**240,33**	**1.496,98**	**6.864,61**	**0,00**	**76,84**	**4.567,54**	**4.644,38**	**712,83**	**360,78**	**10.758,28**	**11.831,89**

**not available*

Table 2 - Overview of the area data of the municipalities and of agro-forestry resources, as well as energy needs used to identify the BDs within the Madonie Regional Natural Park.

District ID	Municipality	Municipal area	Municipal area within the park	Forests[1]			Permanent crops[2]			Total area (forests plus permanent crops)	Energy needs	Energy needs/agro-forestry areas ratio
				Within the park	Outside the park	Total	Within the park	Outside the park	Total			
				a	*b*	*c=a+b*	*d*	*e*	*f=d+e*	*g=c+f*	*h*	*i=g*100/h*
		ha	ha	ha	ha	ha	ha	ha	ha	ha	MWh	%
1	Cefalù Pollina San Mauro Castelverde	22.934	4.728	1.434	5.187	**6.621**	1.221	4.187	**5.408**	**12.029**	125.603	10
2	Collesano Gratteri Isnello	19.638	11.439	3.733	165	**3.898**	700	2.268	**2.969**	**6.867**	87.165	8
3	Castelbuono Geraci Siculo[3]	17.346	6.841	2.730	425	**3.155**	1.024	3.702	**4.725**	**7.880**	53.712	15
4	Castellana Sicula Petralia Soprana Petralia Sottana	30.765	8.812	2.736	5	**2.740**	0	219	**219**	**2.960**	161.886	2
5	Caltavuturo Polizzi Generosa Scillato[3] Sclafani Bagni	39.781	8.397	1.238	1.082	**2.320**	1.699	1.456	**3.155**	**5.475**	68.128	8
Totale		**130.464**	**40.217**	**11.870**	**6.865**	**18.735**	**4.644**	**11.832**	**16.476**	**35.211**	**496.494**	---

[1] *Corine Land Cover (classes 311, 312, 313)* [2] *Corine Land Cover (classes 221, 222, 223)* [3] *Energy needs not available*

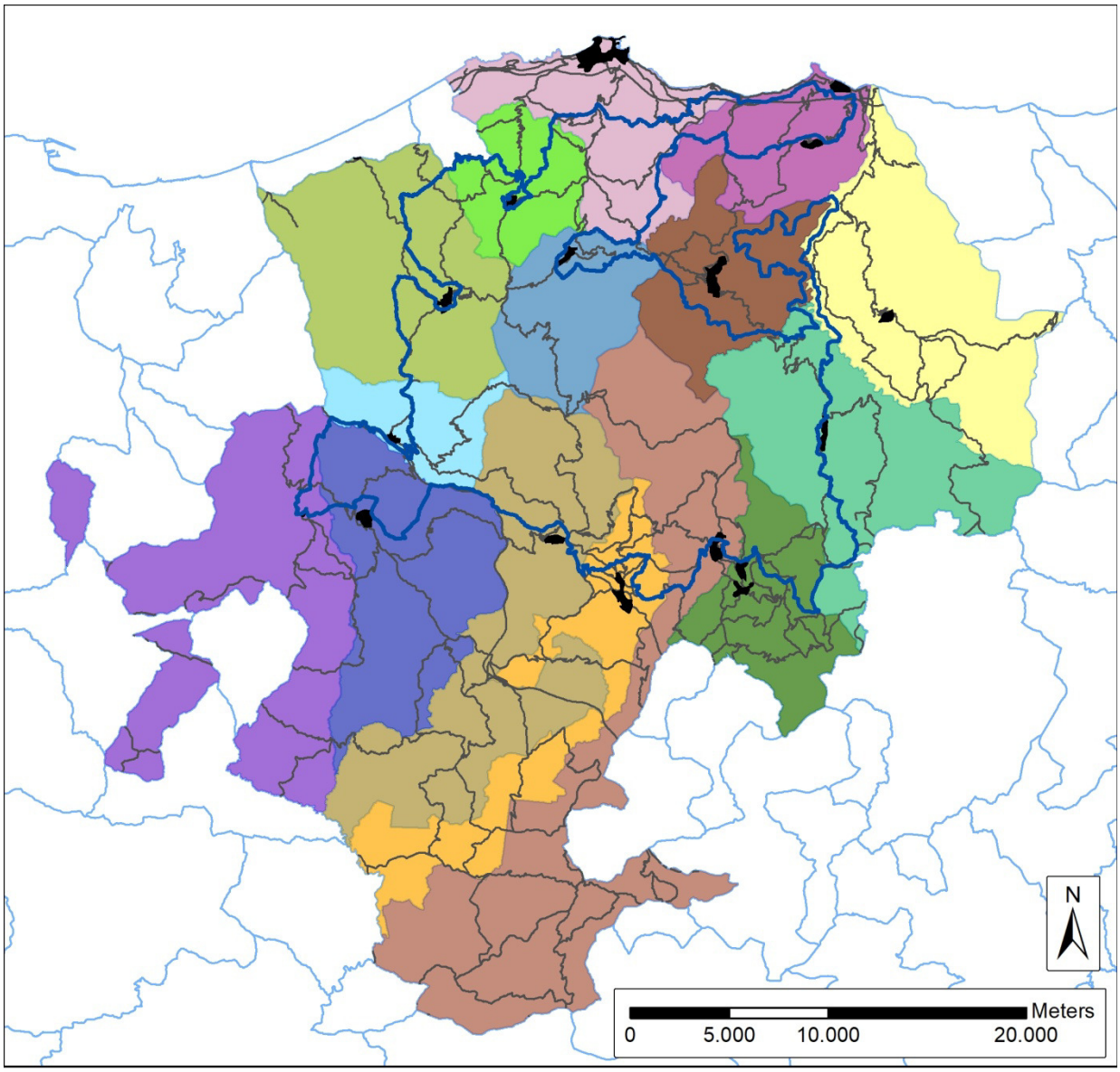


Figure 1 - GIS analysis for the identification of BDs, considering the municipal territories also partially falling within the park, the main road network and the inhabited centers.

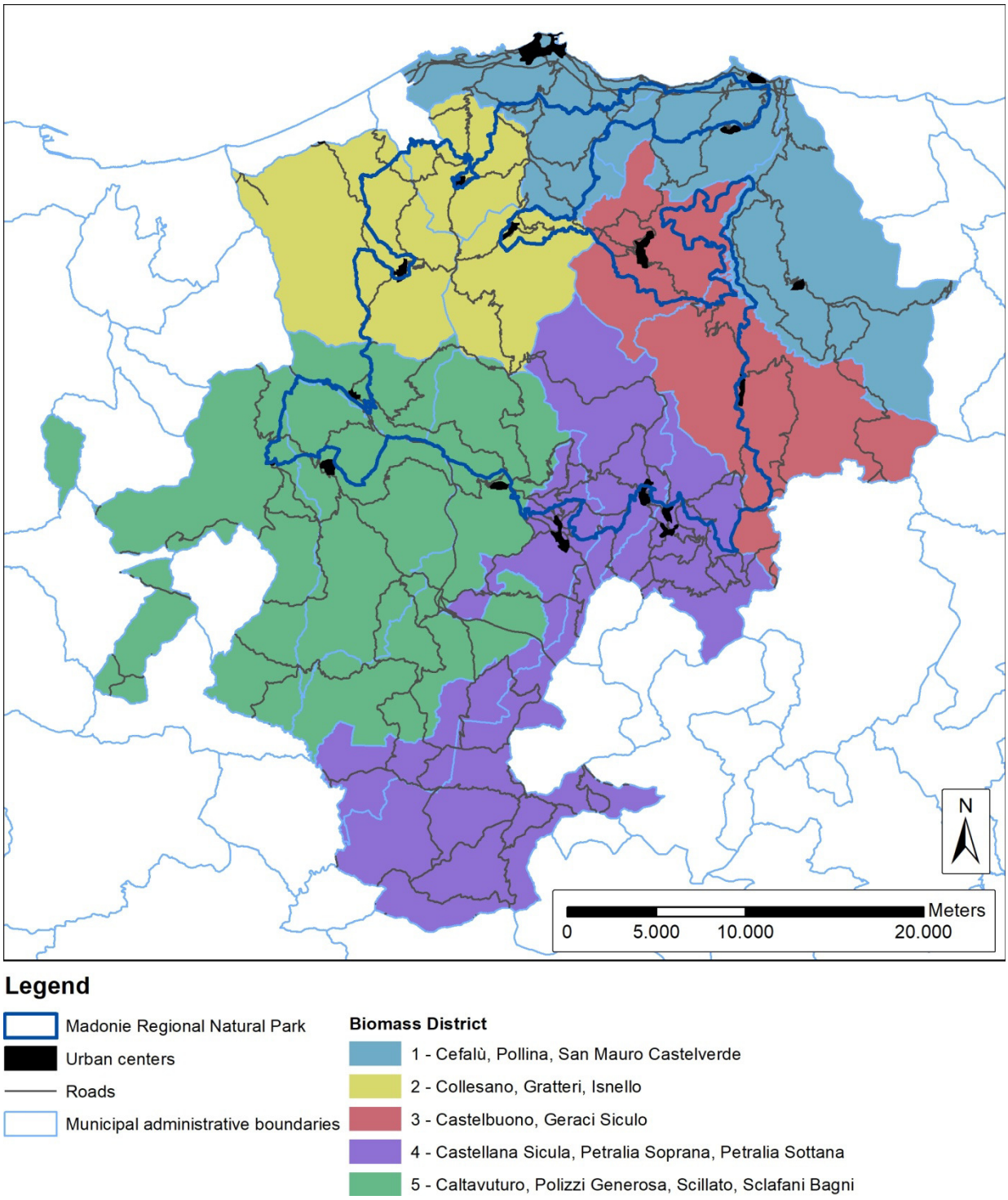


Figure 2 - Hypothesis of identification of the BDs in the park according to the main roads.

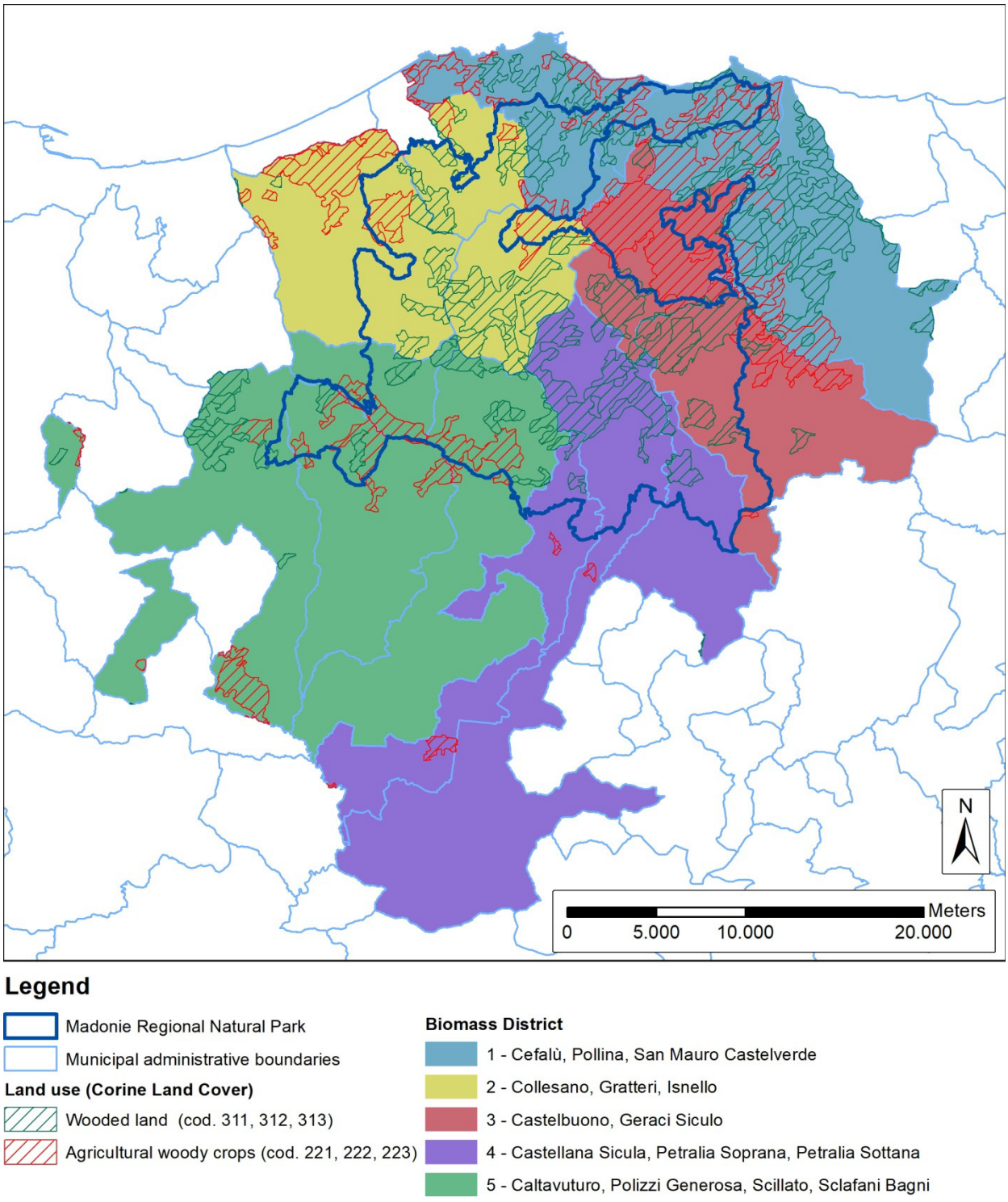


Figure 3 - Distribution of agro-forestry resources within each BD.

3.2 Description of BDs

3.2.1 *Geology and soils*

3.2.1.1 *Lithological characteristics*

The Regional Natural Park of Madonie is very diversified both from the lithological and pedoclimatic point of view is hence characterized by a number of different environments and ecosystems, hosting a significant animal and plant biodiversity, including many rare and endemic species. From a geo-lithological point of view, the Madonie mountain range is characterized by three main categories very different from each other: the central carbonate massif of Pizzo Carbonara, the surrounding silico-clastic reliefs, and the clayey slopes of the southern reliefs, which take the typical forms of the Sicilian interior hills. The main lithological complexes present in the identified Biomass Districts (BDs) are the following: arenaceous-clay, carbonatic, clay, clastic of continental deposition, sandy-calcarenitic, conglomeratic-arenaceous and evaporitic. The arenaceous-clay complex accounts for over 67% of the area of District 1 (Cefalù, Pollina, San Mauro C.), located in the northern sector of the protected area, 22% of District 2 (Collesano , Gratteri, Isnello), 28% of District 3 (Castelbuono and Geraci Siculo), whereas it is less representede (around 10%) in Districts 4 (Castellana S., Petralia Sottana and Petralia Soprana) and 5 (Caltavuturo, Sclafani Bagni, Polizzi G., Scillato), both located in the southern sector of the protected area. In the latter District, the conglomerate-arenaceous complex, compared to the other districts, is quite significant (almost 20%) (Figure 4). The evaporitic complex covers a limited area, only about 5% and almost all within District 4, which includes the territory of Petralia Soprana, where an important salt mine is located, as well as several rocky outcrops of the Gessoso Solfifera Series. The clay lithological complex is the more abundant in all the identified BDs, ranging from 20% (District 1) to 63% (District 4) of total area. The carbonate complex covers a significant area only in District 2, which is 28%, whils in the other BDs it does not exceed 10%; in the other districts, on the contrary, it is always less than 10%. Finally, the sandy-calcarenitic is the least significant complex in all the BDs (Figs 4, 5). The carbonate complex covers a significant area only in District 2, which is 28%, whilst in the other BDs it does not exceed 10%. In the other districts, on the contrary, it is always less than 10%. Finally, the sandy-calcarenitic is the least significant complex in all the BDs (Figs 4, 5).

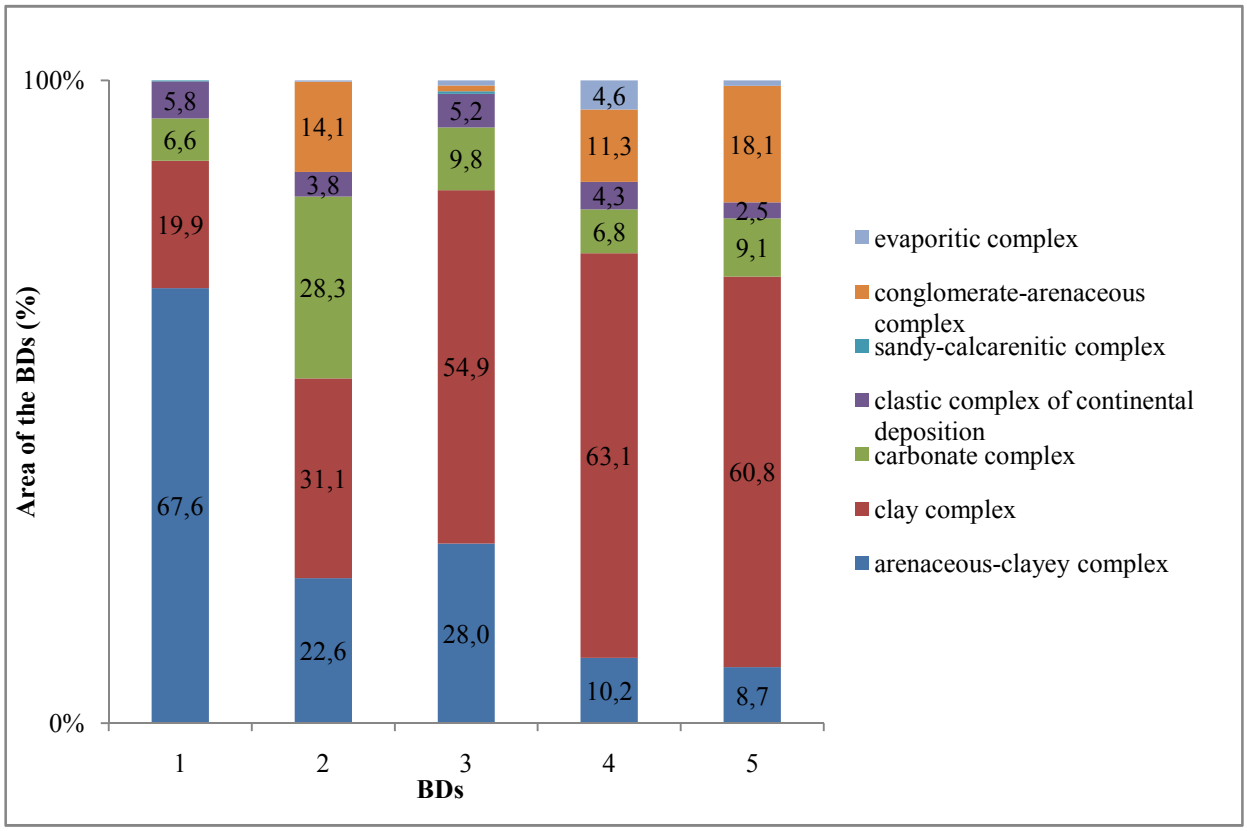


Figure 4 – Distribution of the lithological complexes present in the BDs. The percentage values lower than 1% are not reported in the graph.

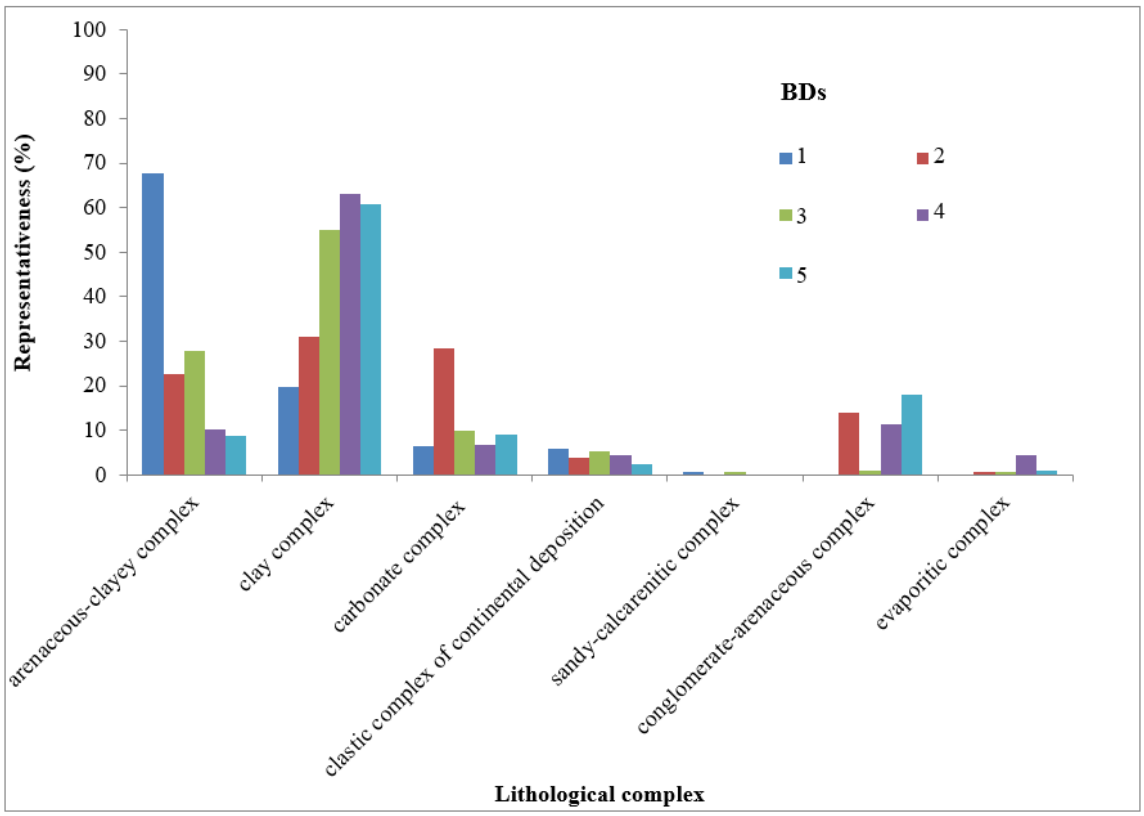


Figure 5 – Representativeness of the lithological complexes in the BDs.

3.2.1.2 *Pedological characteristics*

The diversity of lithological substrates, geomorphological aspects and the different climatic characteristics of the territory of the Madonie Mountains, have determined the formation and evolution of different soil types, and consequently the presence of numerous soil associations (Fierotti 1988). Half of the soil associations present in Sicily are found in the pilot protected area (Table 3). Three classification systems of soil associations were considere: U.S.D.A. (Soil Taxonomy), FAO-UNESCO and C.P.C.S. (France, modified).

Table 3 – Soil associations in the BDs.

Code	Soil Association		
	U.S.D.A. (Soil Taxonomy)	**FAO-UNESCO**	**C.P.C.S. (France) modified**
0	Urban areas	Urban areas	Urban areas
1	Rock outcrop - Lithic Xerorthents	Rock outcrop - Lithosols	Rock outcrop - Lithosols
4	Lithic Xerorthents - Rock outcrop - Lithic Haploxerolls	Lithosols - Rock outcrop - Eutric Regosols	Lithosols - Rock outcrop - Protorendzina
6	Lithic Xerorthents - Rock outcrop - Typic e/o Lithic Xerochrepts	Lithosols - Rock outcrop - Eutric Cambisols	Lithosols - Rock outcrop - Cambisols
7	Lithic Xerorthents - Rock outcrop - Typic e/o Lithic Rhodoxeralfs	Lithosols - Rock outcrop - Chromic Luvisols	Lithosols - Rock outcrop - Terra rossa
11	Typic Xerorthents - Lithic Xerorthents - Typic e/o Vertic Xerochrepts	Calcaric Regosols - Lithosols - Eutric e/o Vertic Cambisols	Regosols - Lithosols - Cambisols e/o Vertic Cambisols
12	Typic Xerorthents - Typic e/o Vertic Xerochrepts - Typic e/o VerticXerofluvents e/o Typic Haploxererts	Eutric Regosols - Eutric e/o Vertic Cambisols - Eutric Fluvisols e/o Chromic e/o Pellic Vertisols	Regosols - Cambisols - Fluvisols e/o Vertisols
13	Typic Xerorthents - Typic e/o Vertic Xerochrepts	Eutric Regosols - Eutric e/o Vertic Cambisols	Regosols - Cambisols e/o Vertic Cambisols
14	Typic Xerorthents - Typic e/o Vertic Xerofluvents e/o Typic Haploxererts	Eutric Regosols - Eutric Fluvisols e/o Chromic e/o Pellic Vertisols	Regosols - Fluvisols e/o Vertisols
16	Typic Xerorthents - Typic Xerochrepts - Typic Haploxeralfs	Eutric Regosols - Eutric Cambisols - Orthic Luvisols	Regosols - Cambisols - Leached Cambisols
17	Typic e/o Vertic Xerofluvents - Typic e/o Vertic Xerochrepts	Eutric Fluvisols - Eutric e/o Vertic Cambisols	Fluvisols
18	Typic e/o Vertic Xerofluvents - Typic Haploxererts	Eutric Fluvisols - Chromic e/o Pellic Vertisols	Fluvisols - Vertisols
20	Typic Xerochrepts - Calcixerollic Xerochrepts - Lithic Xerorthents	Eutric Cambisols - Calcic Cambisols - Lithosols	Cambisols - Calcic Cambisols - Litosuoli
25	Typic Xerochrepts - Typic Haploxeralfs - Typic e/o Lithic Xerorthents	Eutric Cambisols - Orthic Luvisols - Eutric Regosols e/o Lithosols	Cambisols - Leached Cambisols - Regosols e/o Lithosols

Code	Soil Association		
	U.S.D.A. (Soil Taxonomy)	FAO-UNESCO	C.P.C.S. (France) modified
31	Typic e/o Lithic Rhodoxeralfs - Calcixerollic Xerochrepts – Lithic Xerorthents	Chromic Luvisols - Calcic Cambisols - Lithosols	Terra rossa - Calcic Cambisols - Lithosols

The figure 6 shows the percentage contribution of each soil association within each BD in terms of covered area.

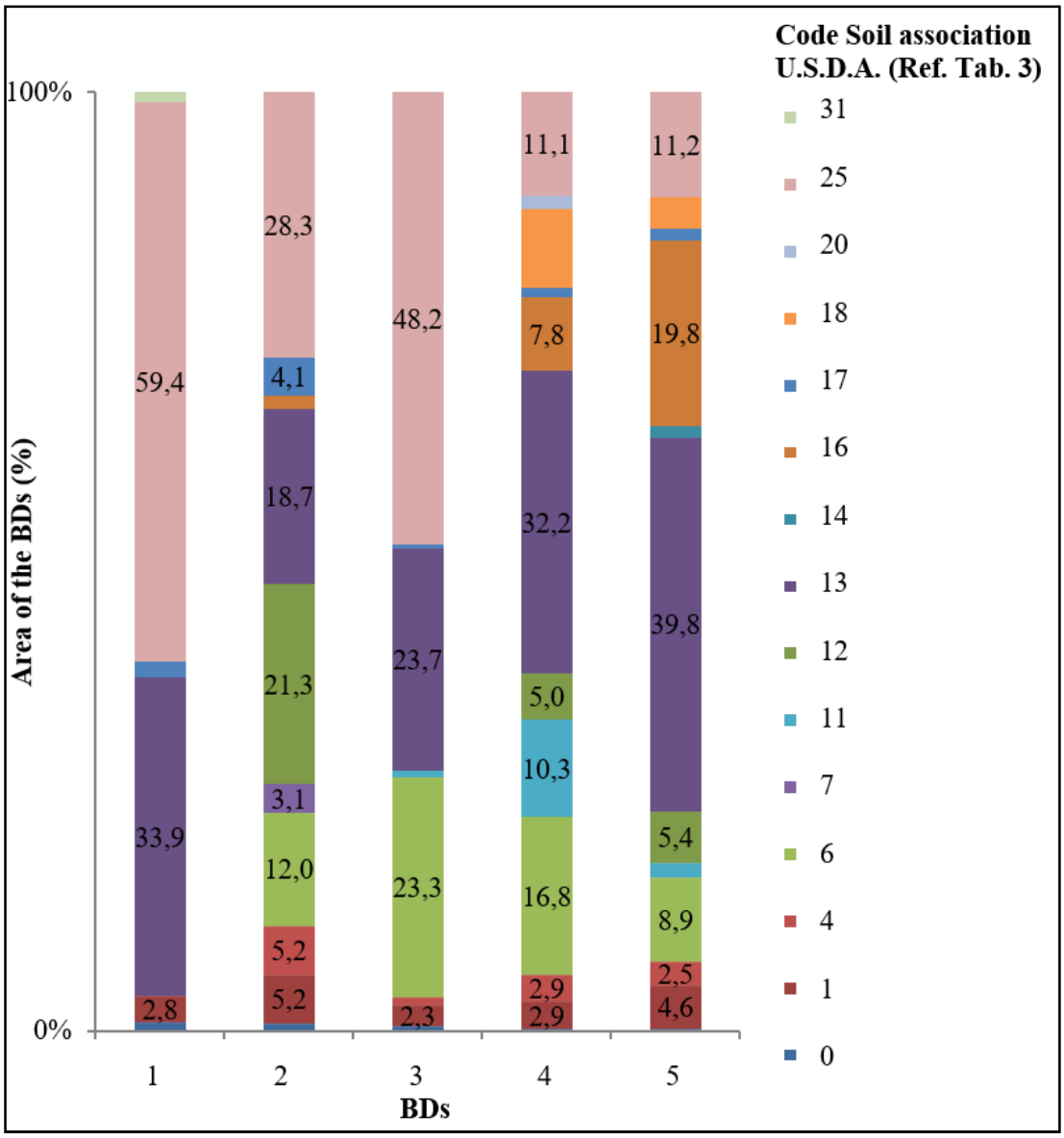


Figure 6 – Soil Association distribution in the BDs. The percentage values lower than 2% are not reported in the graph.

The Association n. 25 (*Brown soils - Leached brown soils - Regosols and/or Lithosols*) covers 59.4% of the area of District 1, 28.3% of District 2 and 48.2% of District 3, and about 11% of both Districts

4 and 5 (Figure 6). This association tends to prevail in mountain and/or hilly territories, with slopes from inclined to moderately steep, and have a good productive potential and fertility. The Association n. 13 (*Regosols - Cambisols and/or Vertic Cambisols*) is rather represented in all the BDs, too. In Districts 1, 4 and 5, it exceeds the 30% of their total area (33.9%, 32.2 % and 39.8%, respectively), whereas it reaches 18.7% and 23.7% in Districts 2 and 3, respectively. This association is the most widespread in Sicily, mainly occurring at altitudes between 500 and 900 m a.s.l., although it is also possible to find it close to the sea level and up to 1,500 m a.s.l. The agronomic potential and the fertility of these soils vary from discrete to good, so that their prevailing destination is cereal cultivation. The Association n. 12 (Regosols- Chromic soils-Fluvisols and/or Vertisols) occupies a significant area only in District 2 (over 20% of the total). The soils of this association, particularly the Typic Xerorthents, lack of a stable structure and are therefore particularly exposed to the erosion processes which may originate landslides and gullies, the most evident expression of the hydrogeological instability of clayey hill systems. The Association n. 6 (*Lithosols-Outcropping rock-Chromic soils*) is significantly spread in the BDs expect BD 1, with values ranging from 8.9% (District 5) to 23.3% (District 3). The absence in District 1 is explained by the fact that this association is linked to a characteristic landscape dominated by calcareous and dolomitic substrates, which are rare in District 1 (Fig. 5). Being mainly present on mountainous and submontane morphologies with steep slopes, the main land use of such soil association is pasture and sometimes forests; the agronomic potential of the association is, on the whole, low.

3.2.2 *Bioclimate*

The knowledge of the bioclimatic characteristics of a given territory is of prominent importance to understand vegetation richness and dynamics, including forest species. The bioclimatic belts occurring in the BDs (Rivas Martinez et al., 2011), including the temperature (Mean annual temperature) and pluviometric (Mean annual precipitation) ranges, are shown in Table 4.

Table 4 - Bioclimatic types in the BDs.

Bioclimate	Temperature Range	Pluviometric Range
Supramediterranean – upper humid	T = 8-13 °C	P = 1300 – 1600 mm
Supramediterranean – lower humid	T = 8-13 °C	P = 1000 – 1300 mm
Supramediterranean – upper subhumid	T = 8-13 °C	P = 800 – 1000 mm
Supramediterranean – lower subhumid	T = 8-13 °C	P = 600 – 800 mm
Mesomediterranean – upper humid	T = 13-16 °C	P = 1300 – 1600 mm

Bioclimate	Temperature Range	Pluviometric Range
Mesomediterranean – lower humid	T = 13-16 °C	P = 1000 – 1300 mm
Mesomediterranean – upper subhumid	T = 13-16 °C	P = 800 – 1000 mm
Mesomediterranean – lower subhumid	T = 13-16 °C	P = 600 – 800 mm
Mesomediterranean – upper dry	T = 13-16 °C	P = 450 – 600 mm
Mesomediterranean – lower dry	T = 13-16 °C	P = 350 – 450 mm
Thermomediterranean – lower humid	T = 16-18 °C	P = 1000 – 1300 mm
Thermomediterranean – upper subhumid	T = 16-18 °C	P = 800 – 1000 mm
Thermomediterranean – lower subhumid	T = 16-18 °C	P = 600 – 800 mm
Thermomediterranean – upper dry	T = 16-18 °C	P = 450 – 600 mm
Thermomediterranean – lower dry	T = 16-18 °C	P = 350 – 450 mm

Although almost all the bioclimatic types present in Sicily can be found in the pilot protected area, the most represented bioclimates in the BDs are the following: Thermomediterranean lower subhumid, Mesomediterranean upper dry, Mesomediterranean lower subhumid, Mesomediterranean upper subhumid, Supramediterranean lower humid (Figure 7). The thermomediterranean lower subhumid is very widespread in Districts 1 and 2, where it reaches values of 42.9% and 39.7%, respectively. The Mesomediterranean upper dry bioclimate is present in all the BDs but it exceeds 30% only in District 4 (37.4%) and in District 5 (31.3%), since their territories are pushing towards the interior of Sicily, typically drier than the northern mountain range. The Mesomediterranean lower subhumid is the most widespread bioclimatic type in all the BDs, reaching a cover (in % of the total area of the BDs) ranging from 13.9% in District 2 to 38.3% in District 3. The Mesomediterranean upper subhumid is less extensive, exceeding 20% only in District 3. Such district, including the municipalities of Castelbuono and Geraci Siculo, develops on the northern slopes of the Madonie mountain range and in areas located at higher altitudes, which benefit from the humid air coming from the Tyrrhenian Sea. Finally, the Supramediterranean lower humid reaches values close to 10% only in District 2 (10.2%) and District 4 (7.8%).

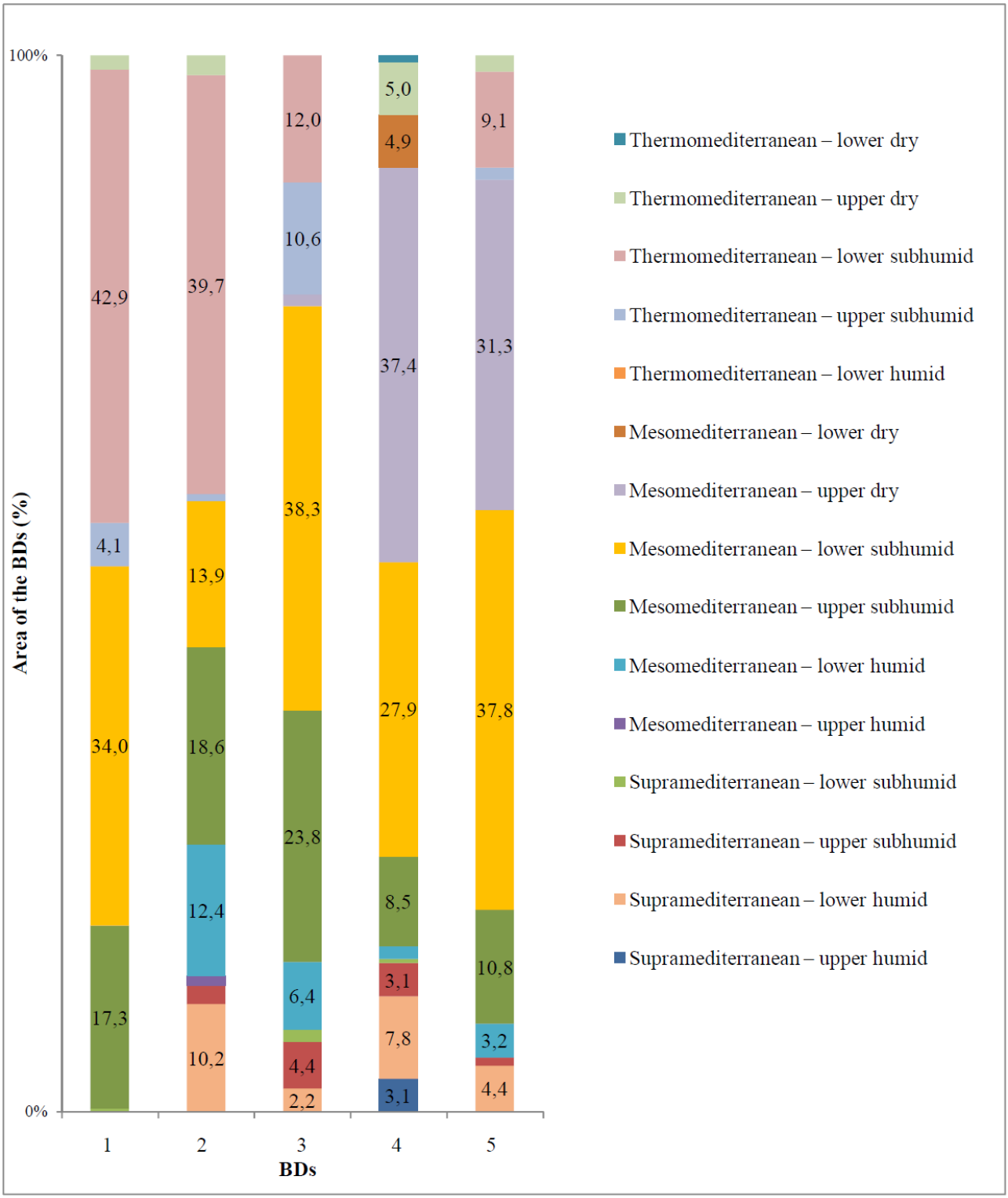


Figure 7 – Bioclimate distribution in the BDs. The percentage values lower than 2% are not reported in the graph.

3.2.3 *Land use*

Taking into account the objectives of the Project and the planning of bioenergy production by means of woody biomass, the analysis of land use is by sure one of the most important. As

previously said in the Guidelines, the Corine Land Cover land use map (Level IV) was used to identify the agro-forestry areas available for biomass harvesting, identifying *forests* (Codes 311, 312, 313) and *permanent crops* (Classes 221, 222, 223).

3.2.3.1 *Forests*

Forests (CLC classes 311, 312, 313), located both within and outside the Madonie Natural Park, are by far most represented within District 1, where they cover more than 6,500 ha, followed by District 2 (about 3,900 ha), 3 (about 3,100 ha), 4 (about 2,700 ha) and 5 (about 2,300 ha). It is found the same order if we consider the percentage of area covered by *forests* with respect to the total area of each BD (Figure 8). Forests occupy 29% of District 1 area, followed by 20% (District 2), 18% (District 3), and only 9% (District 4) and 6% (District 5).

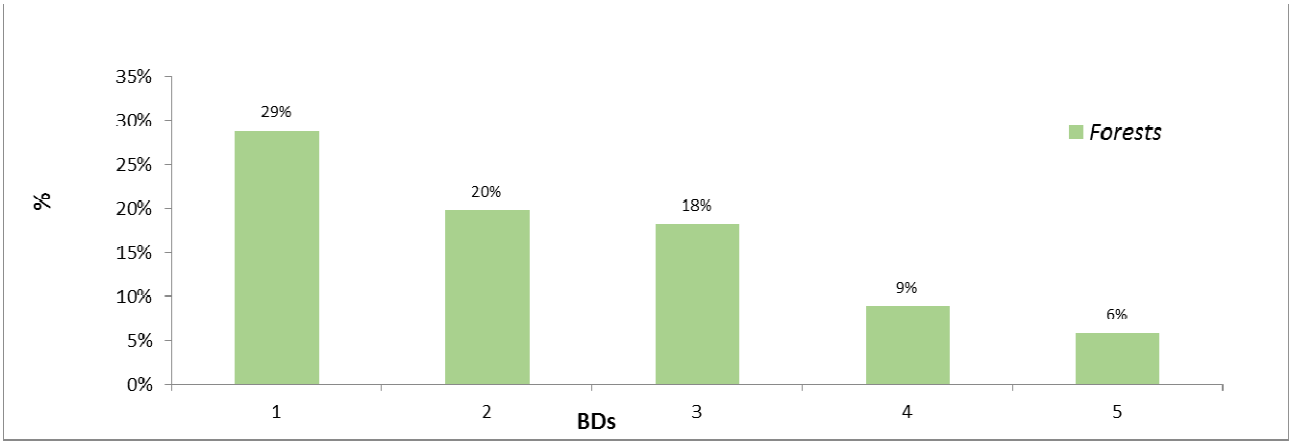


Figure 8 - Representativeness of *Forests* in the BDs.

For the purposes of this work, it is important to distinguish forests located within the Madonie Park from those located outside the protected area (Figure 9).

Within the BDs 2, 3 and 4, *forests* are largely located within the Madonie Park, with values ranging from more than 86% to more than 99%. Just over half of the area (about 53%) of District 5 is covered by *forests*, while, conversely, *forests* are largely located outside the Park in District 1 (more than 78%). This is mostly due to the presence of the municipality of San Mauro Castelverde, which is characterized by a very small area of *forests* inside the protected area (about 220 ha), as opposed to a considerable extension in the outside (about 3,700 ha).

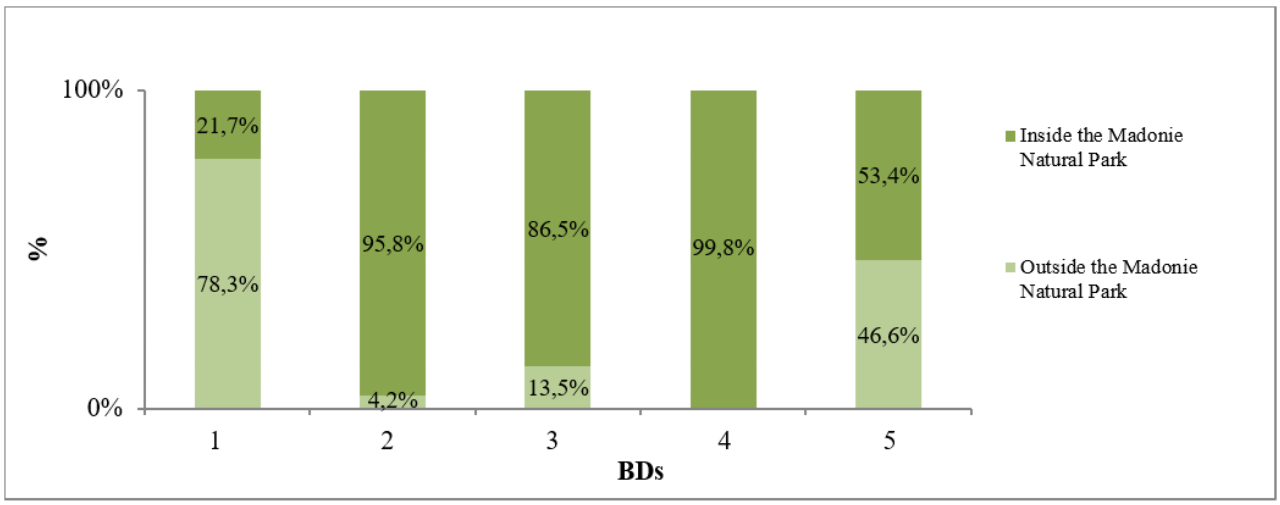


Figure 9 - Distribution of *Forests* per BD, inside and outside the Madonie Natural Park. The percentage values lower than 1% are not reported in the graph.

3.2.3.2 *Permanent crops*

Permanent crops (Classes 221, 222, 223), located both within and outside the Madonie Natural Park, are prevalent in District 1 (about 5,400 ha), followed by District 3 (more than 4,500 ha), District 5 (more than 3,100 ha), District 2 (approx. 3,000 ha), and finally District 4 (with just over 200 ha). *Permanent crops* occupy 27% of District 3 area, 24% and 15%, of Districts 1 and 2, respectively, and only 8% of District 5 and barely 1% of District 4 (Figure 10).

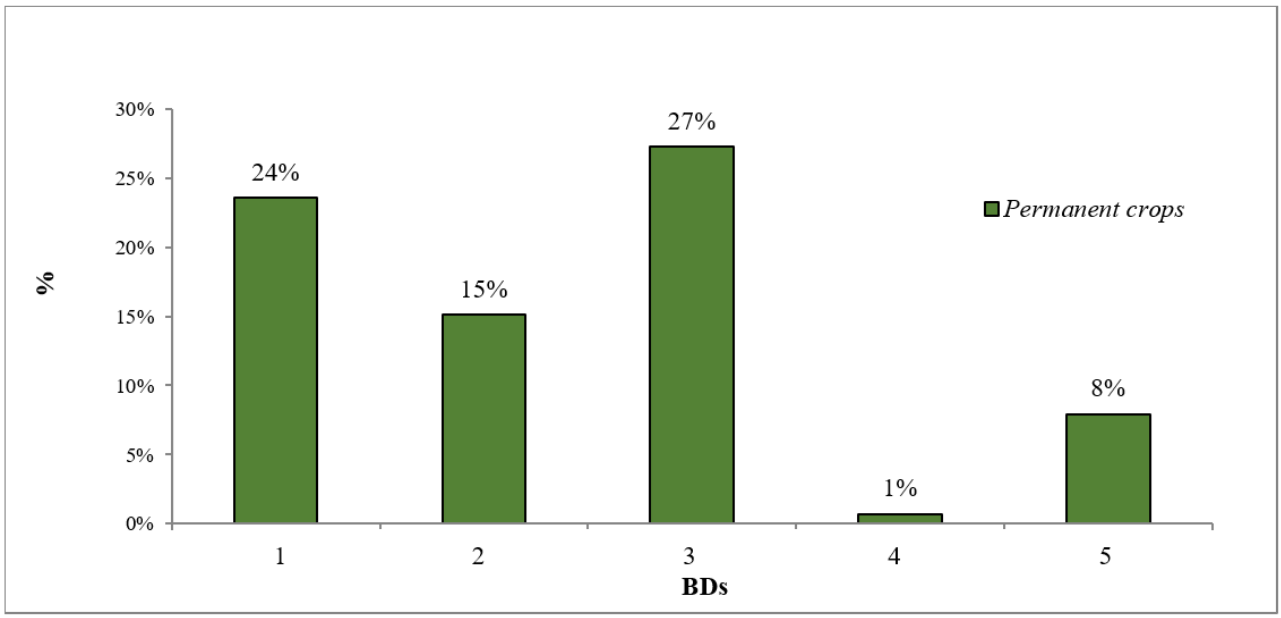


Figure 10 - Representativeness of *Permanent crops* in the BDs.

Differently from forests, *permanent crops* are mainly located outside the Madonie Natural Park in all the BDs, except for District 5, where their distribution is somewhat homogeneous (Figure 11).

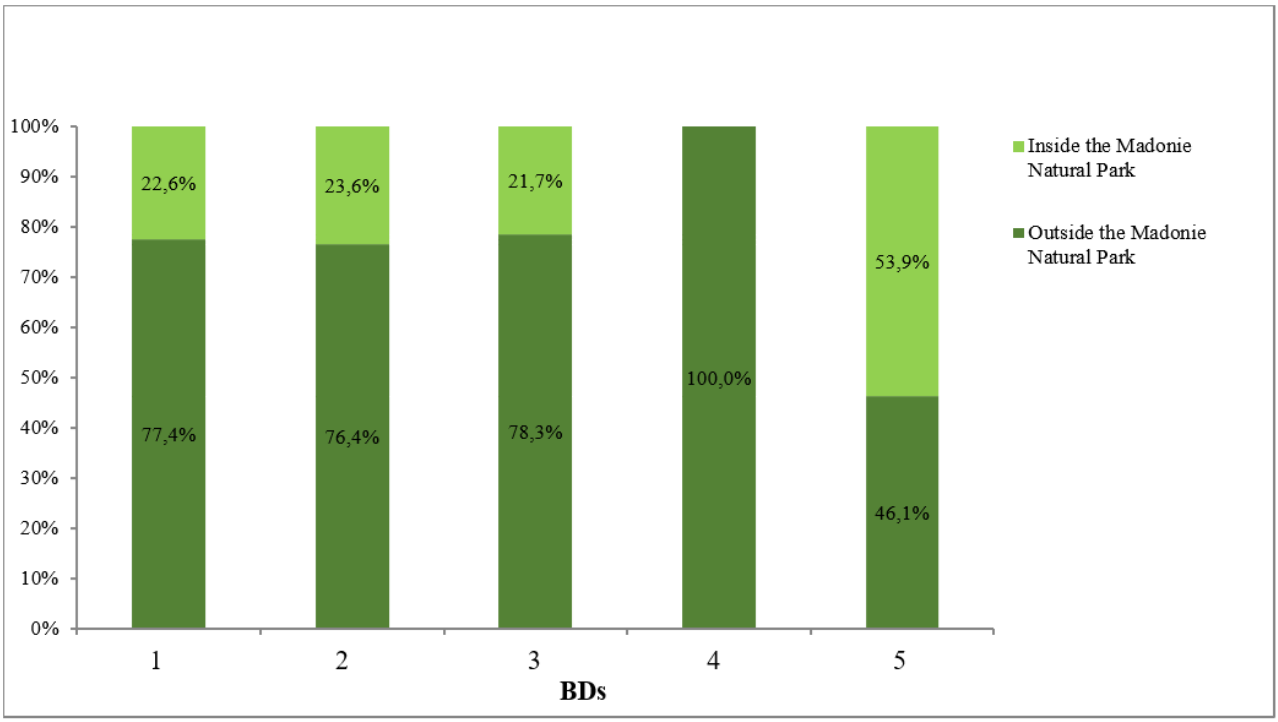


Figure 11 - Distribution of *Permanent crops* inside and outside the Madonie Natural Park for each BD.

3.2.3.3 *Agroforestry areas*

Overall, *Forests* (CLC Codes 311, 312, 313) and *Permanent crops* (CLC Codes 221, 222, 223) are prevalent within District 1, covering more than 12,000 ha, followed by District 3 (almost 8,000 ha), District 2 (almost 7,000 ha), District 5 (almost 5,500 ha), and finally District 4 (almost 3,000 ha). In terms of percentage of area with respect to the total area of each BD, the land use classes most useful for biomass harvesting (*forests* and *permanent crops*) are much more present in Districts 1, 2 and 3, where they cover 52%, 35% and 45% of total area, respectively (Figure 12). Conversely, they cover only 10% and 14% of District 4 and 5, respectively.

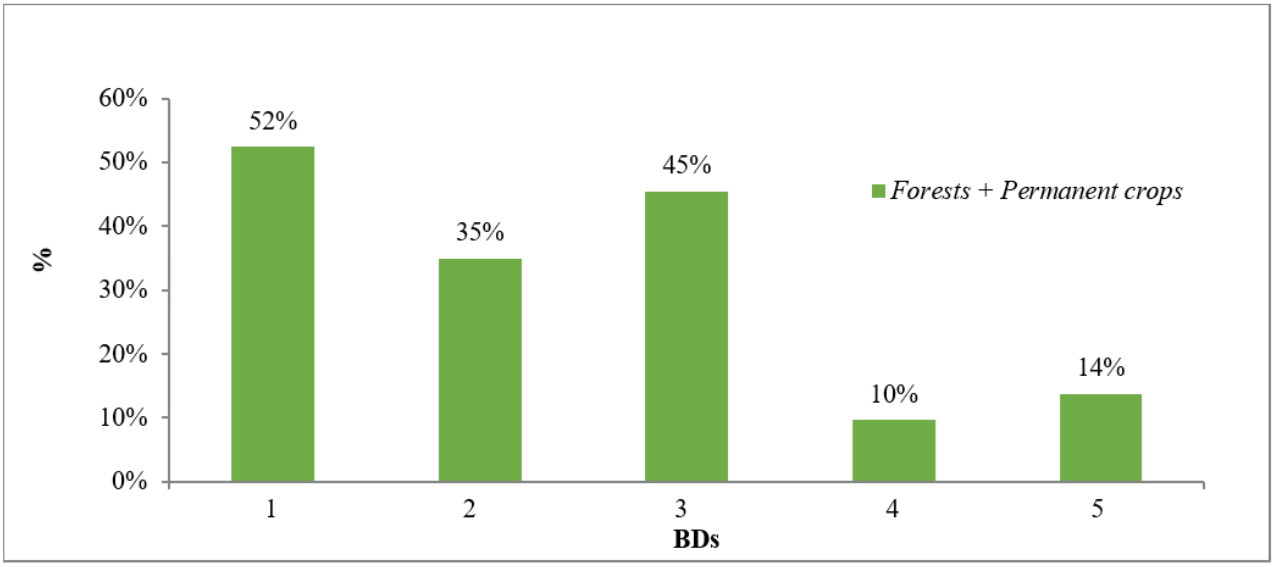


Figure 12 – Representativeness of *Forests* and *Permanent crops* in the BDs.

3.2.4 *Naturalistic, Environmental and Landscape restrictions*

In the pilot protected area, there are several types of restrictions that may limit forest utilization, including naturalistic, hydrogeological and landscape restrictions.

3.2.4.1 *Environmental restriction*

The main restriction to which the pilot area is subject to is the environmental restriction, especially deriving from the establishment of the Madonie Regional Park (it insists on all the BDs) and, to a lesser extent, from the "Bosco della Favara e Granza" Reserve, which only concerns District 5 (Figure 13).

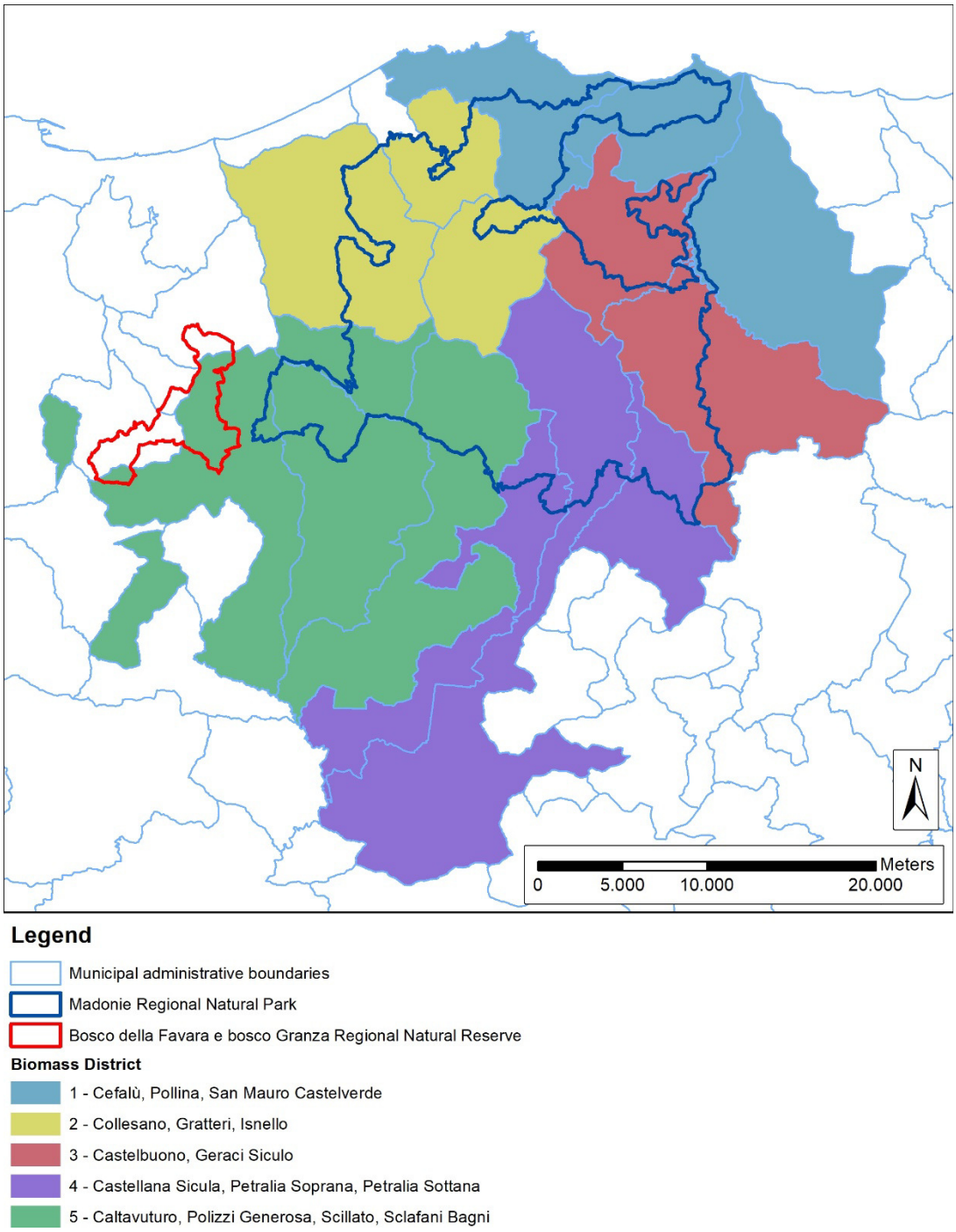


Figure 13 – Naturalistic restriction in the BDs.

Regional Natural Park of Madonie

The Regional Natural Park of Madonie was established in 1989, by a decree of "Assessorato Regionale Territorio e Ambiente" n.1489, which included a specific regulation. The Park covers a total of 39,679 hectares, and is divided into the following four zones:

- - Zone A (*integral reserve*, extended 5,733 ha) in which the natural environment is preserved in its integrity and which includes natural ecosystems of great naturalistic and landscape interest;
- - Zone B (*general reserve*, extended 16,535 ha) in which land transformation works are forbidden, whilst agro-forestry-pastoral activities are allowed;
- - Zone C (*of protection*, extended 427 ha) in which tourist-accommodation and cultural facilities are allowed;
- - Zone D (*control*, extended 16,984 ha) in which all activities compatible with the purposes of the Park are permitted.

The territories of the 5 BDs are differently conditioned by the presence of the Natural Park. Over 58% of the District 2 area falls within the boundaries of the Park, followed by District 3 with 39.8%, District 4 with 28.3%, District 5 with 20.9% and finally District 1 with 20.7% (Figure 14). Considering that the presence of the different zones has a strong influence on the possibility to carry out forest interventions, we report this information in detail for each BD (Figure 15). In District 1, as much as 70% of the area falling within the Park (about 20% of the total area of the District) is in Zone D and about 25% in Zone B (the area falling in Zone A is less than 1%). In District 4, almost 24% of the area of the district in the Park (about 28% of the total area) is in Zone A, 38.4% falls in Zone B and almost 37% in Zone D. District 2 has about 16% of the area falling in the Park in Zone A, 47% in Zone B and 35% in Zone D. In District 3, the area falling in Zone A is 6.3%, 30% is in Zone D and more than 60% in Zone B. Finally, in District 5, approximately 17% of the area is in Zone A, 29% in Zone B and almost 52% in Zone D.

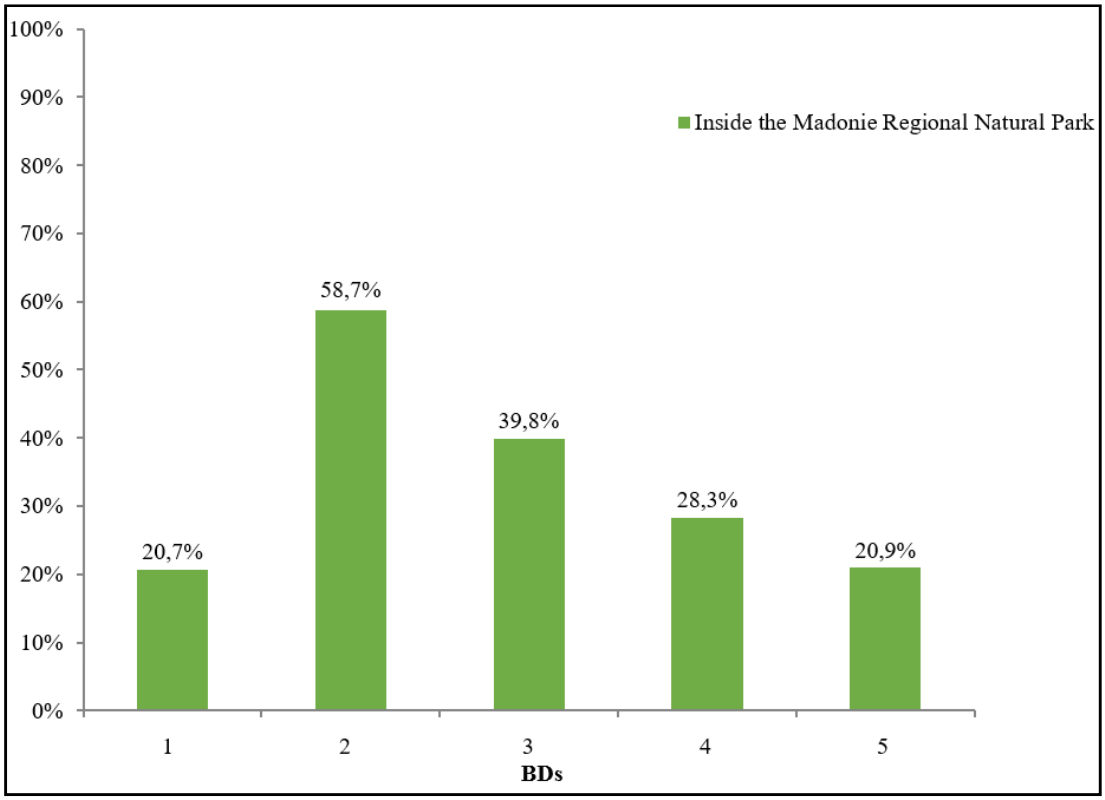


Figure 14 – BDs Area inside the Madonie Natural Park.

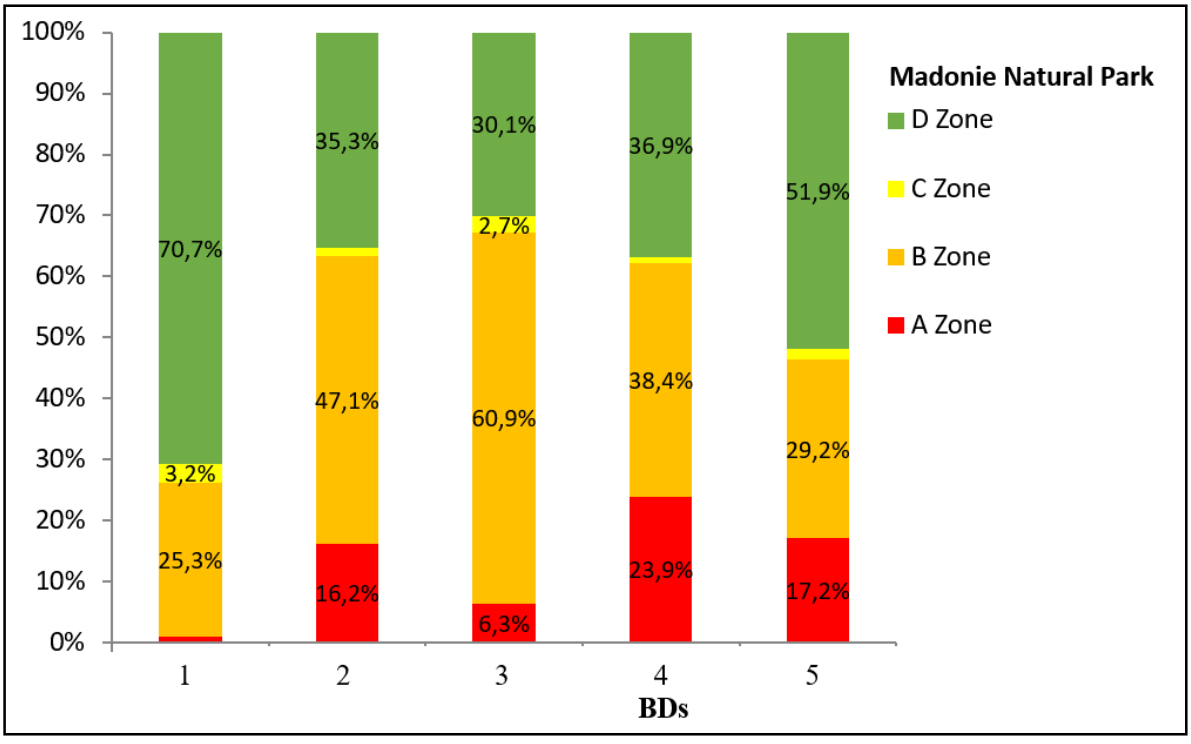


Figure 15 – BDs area distribution inside the different zones of Madonie Natural Park. The percentage values lower than 2% are not reported in the graph.

Nature Reserve "Bosco della Favara e Granza"

The “Bosco della Favara e Granza” Nature Reserve is located within District 5, where it occupies only 4% of the total area. It was established in 1997 because of its rich flora and native biodiversity, including cork oak, holm oak and downy oak woods, as well as many Mediterranean shrub species. The Reserve is found, for a small part, in the municipality of Sclafani Bagni (included in District 5). Overall, this Reserve occupies 1,580 ha in the District, of which 1,045 ha (66% of the total area) fall in Zone A and 536 ha (34% of the total area) in Zone B.

3.2.4.2 *Natura 2000 Network*

Many Special Areas of Conservation (SACs) are present in the pilot area of the project, including the BDs (Table 5). Particularly, SACs occupy a significant part of District 2, which is 58.5%. Then, SACs occupy 44.5% of District 1, 40.1% of District 3, 29.3% of District 4, and 23.9% of District 5 (Figure 16). Such high percentage values are in agreement with the extraordinary natural heritage of the protected pilot area. The localization of the Natura 2000 sites falling within the BDs is showed in figure 17.

Table 5 - Natura 2000 Sites in BDs area.

CODE	NAME
ITA020032	BOSCHI DI GRANZA
ITA020045	ROCCA DI SCIARA
ITA050009	RUPE DI MARIANOPOLI
ITA020001	ROCCA DI CEFALU'
ITA020018	FOCE DEL F. POLLINA E M. TARDARA
ITA020003	BOSCHI DI SAN MAURO CASTELVERDE
ITA020020	QUERCETI SEMPREVERDI DI GERACI SICULO E CASTELBUONO
ITA020004	M. S. SALVATORE, M. CATARINECI, V.NE MANDARINI, AMBIENTI UMIDI
ITA020016	M. QUACELLA, M.DEI CERVI, PIZZO CARBONARA, M. FERRO, PIZZO OTIERO
ITA020017	COMPLESSO PIZZO DIPILO E QUERCETI SU CALCARE
ITA020002	BOSCHI DI GIBILMANNA E CEFALU'
ITA020038	SUGHERETE DI CONTRADA SERRADAINO
ITA050005	LAGO SFONDATO
ITA020015	COMPLESSO CALANCHIVO DI CASTELLANA SICULA
ITA020051	BAIA SETTEFRATI E SPIAGGIA DI SALINELLE
ITA020050	MONTI MADONIE

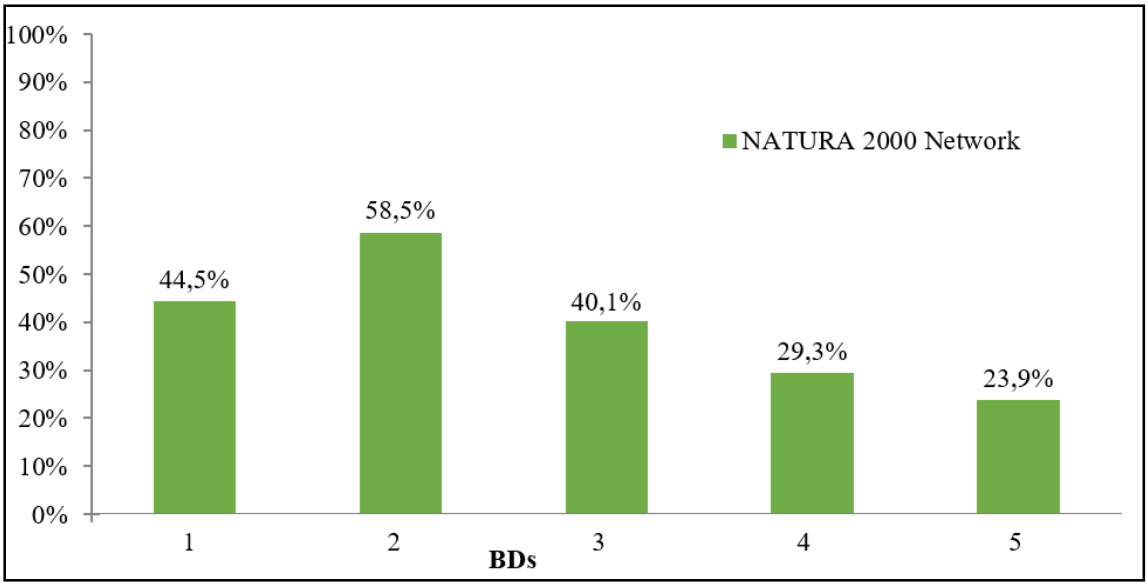


Figure 16 – BDs area (%) falling in Natura 2000 Network.

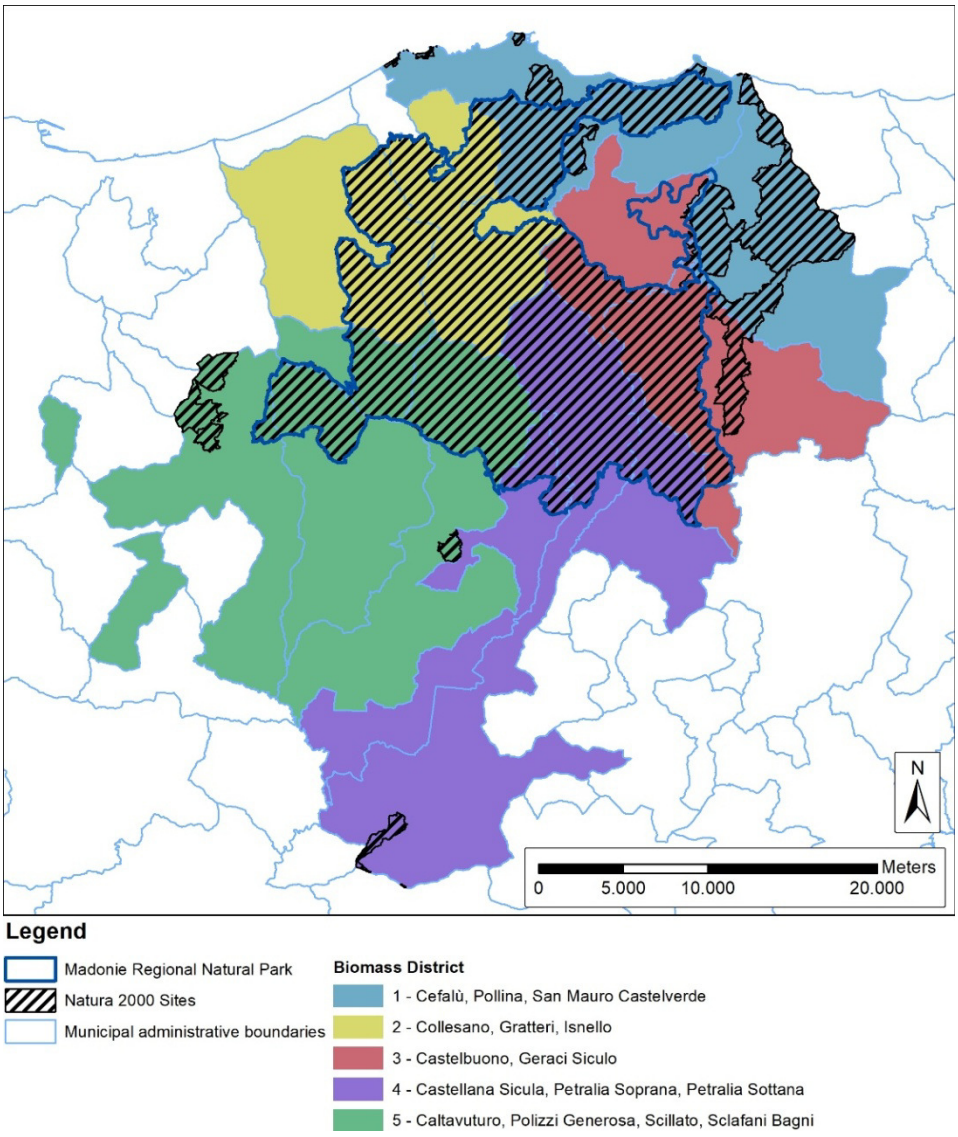


Figure 17 – Natura 2000 Sites in the BDs.

3.2.4.3 *Hydrogeological restriction*

The hydrogeological restriction applies to the great part of the territory of the BDs, which is 82% of District 1, 68% of District 2, 48% of District 3, 61% of District 4, and approx. 72% of District 5 (Figure 18). The localization of the areas subject to hydrogeological restriction and the BDs is showed in figure 19.

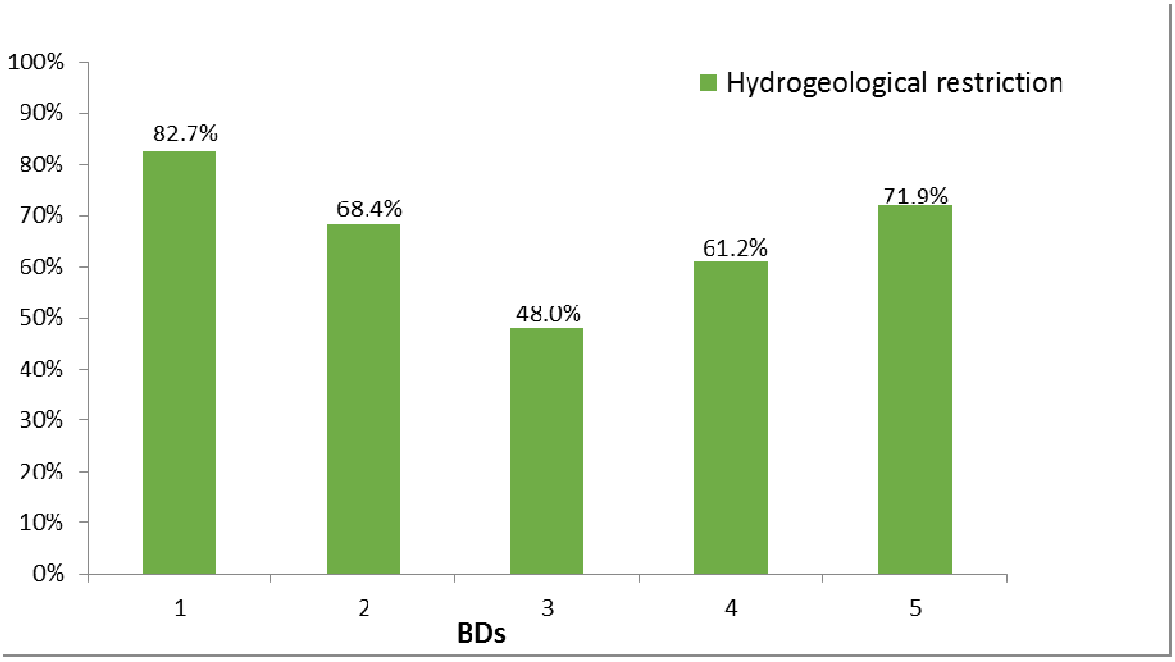


Figure 18 – Area of BDs (%) subject to hydrogeological restriction.

3.2.4.4 *Landscape restriction*

The landscape restriction applies to most of the territory of the BDs, due to the high naturalistic value and the richness of their ecosystems. Such restrictions apply to the whole territory of Districts 1 and 2, to 96.8% of District 3, to 43.2% of District 4, and to 66.2% of District 5 (Figure 20). The localization of the areas subject to landscape restriction and the BDs is showed in figure 21.

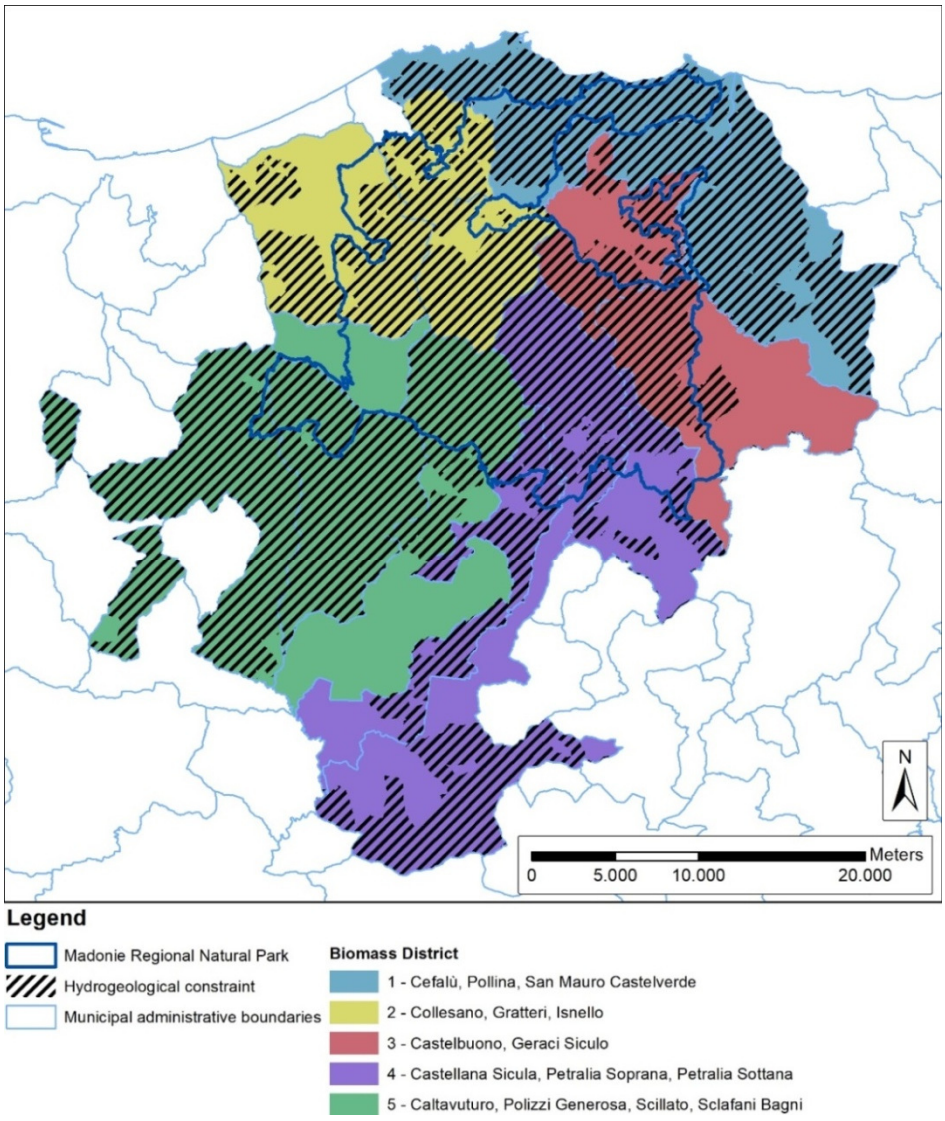


Figure 19 – Area of the BDs subject to hydrogeological restriction.

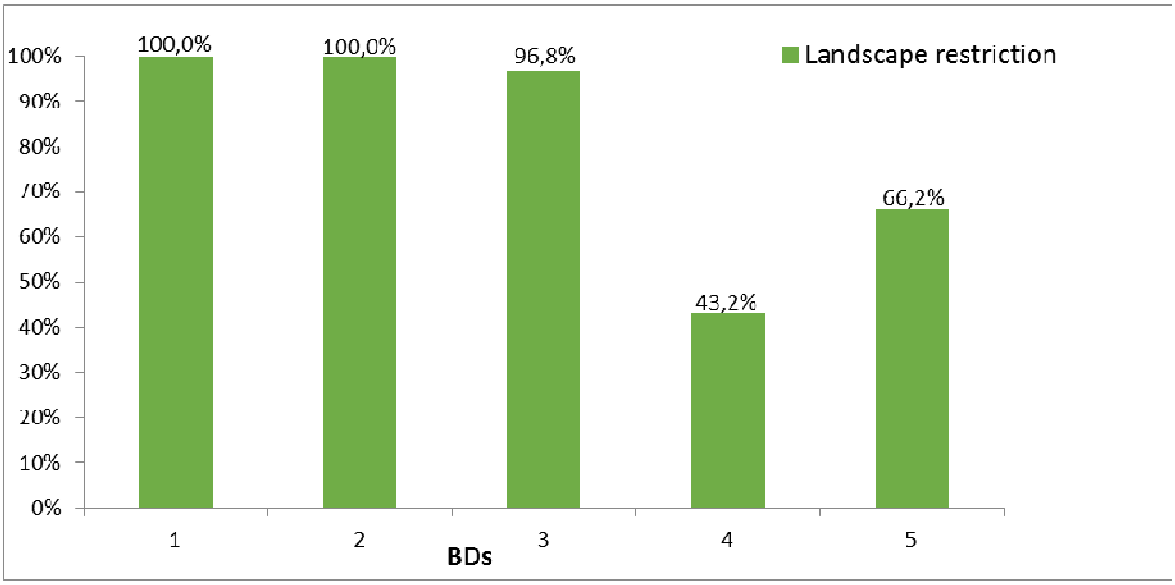


Figure 20 – Area of BDs (%) subject to landscape restriction.

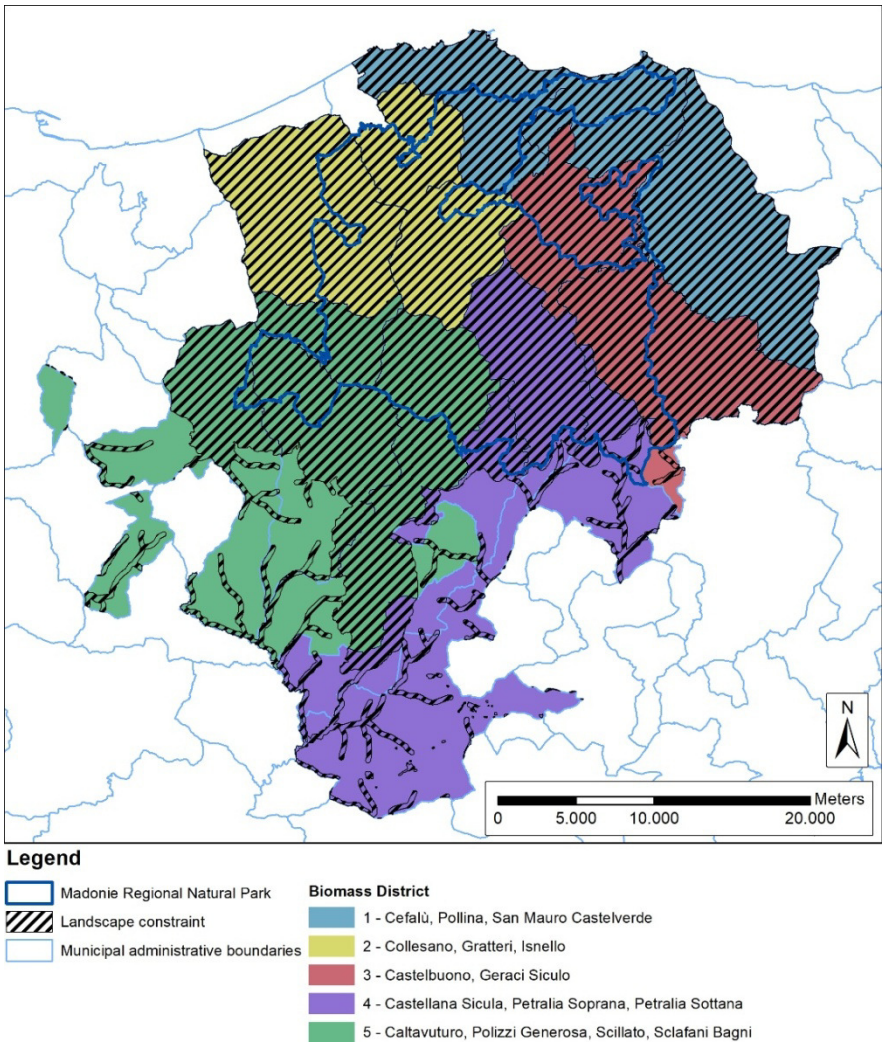


Figure 21 – Area of BDs subject to landscape restriction.

3.2.4.5 *Overall restricted area*

In this paragraph we analyze all the restrictions as a whole, assessing how much they may affect the biomass harvesting activity. Considering the area not subject to any restriction within each BD, notable differences were found (Figure 22). In District 1, only 0.05% of the area is free from any type of restriction, in District 3 the unconstrained area is 3.3% of the total area, in District 4 it is 26.4 % and finally in District 5 it is 8.8%. Conversely, in District 2, the entire area is subject to some type of restriction. Hence, only District 4 has a considerable non-constrained area (about 26% of the total area), whereas in the other BDs the percentage value of the area subject to restrictions is more than 90%. In order to plan the production of energy based on the use of forest biomass, it is very important to analyze and understand the types of restrictions that concurrently are in force in the area of interest. As seen in the previous paragraph, the main restrictions that persist in the

territory of the BDs derive from the presence of the Madonie Regional Park, the sites of the Natura 2000 Network, and the hydrogeological and the landscape restrictions. It is apparent that, in general, more restrictions insist simultaneously on the same area, the greater may be the limits imposed on the biomass harvesting.

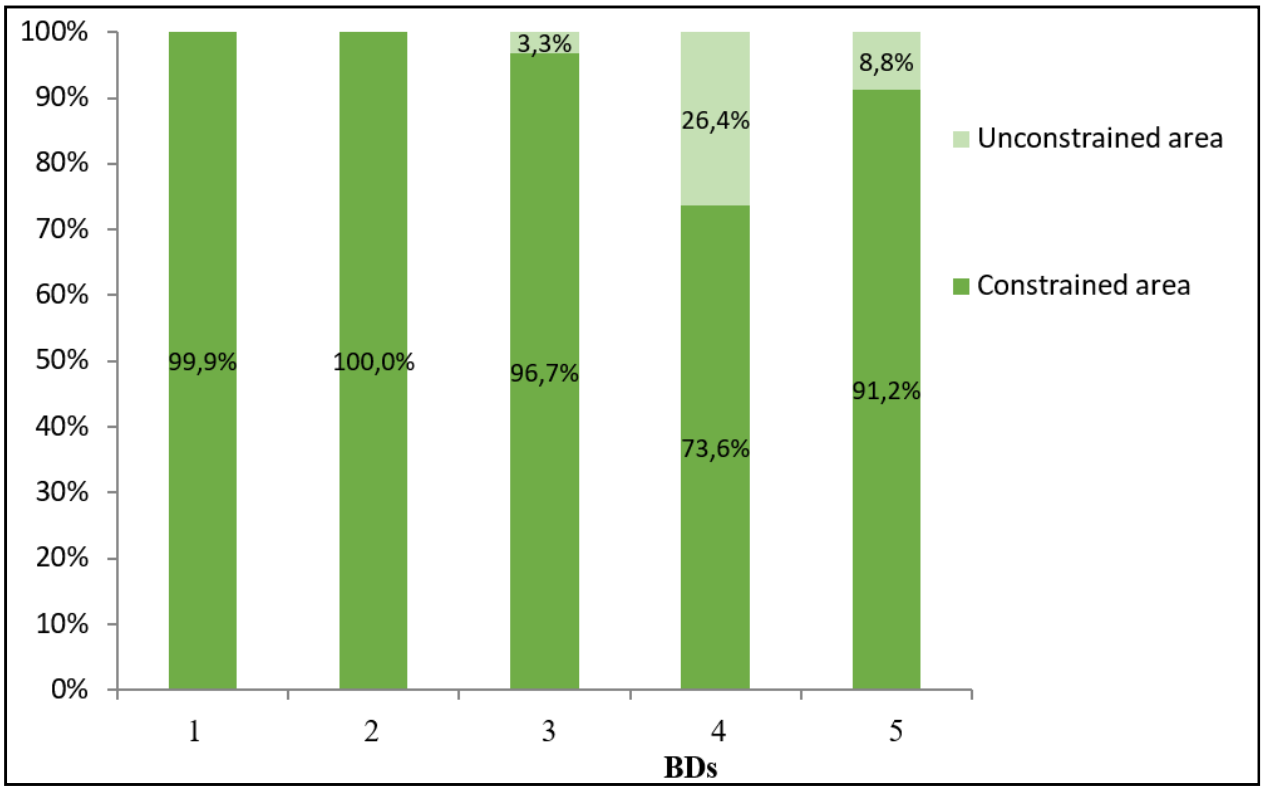


Figure 22 – Constrained and Unconstrained area (%) in the BDs. The percentage values lower than 3% are not reported in the graph.

Firstly, we considered the most extreme case, which is the occurrence of all the possible restrictions in the same area (Figure 23). In District 1 the area on which the four restrictions simultaneously are present is 17.2%, in District 2 it is even higher than 48%, in District 3 it is about 30%, in District 4 it is about 24% and in District 5 it is just over 16%. However, these high values are fully compatible with the environmental characteristics of the BDs, in consideration of the high naturalistic value of the protected pilot area.

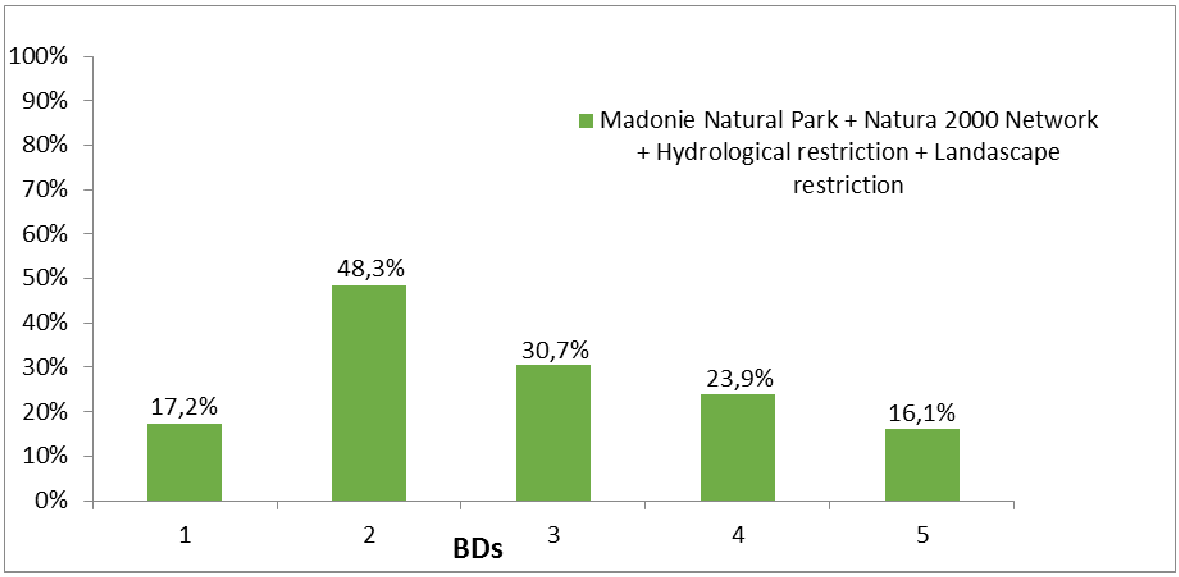


Figure 23 - Area (%) of the BDs subject to hydrogeological, landscape and naturalistic restriction (Madonie Natural Park and Natura 2000 Network).

Considering the areas included in the Natura 2000 network, simultaneously subject to hydrogeological and landscape restrictions, but falling outside the Madonie Park, the percentages of areas are significantly lower than in the previous case (Figure 24). In all the BDs, the representativeness values are almost irrelevant, being equal to 0.2% in District 2, 2.2% in District 3, 0.3% in District 4 and 0.8% in the District; an exception is District 1 in which the affected area is 21.5% of the total area.

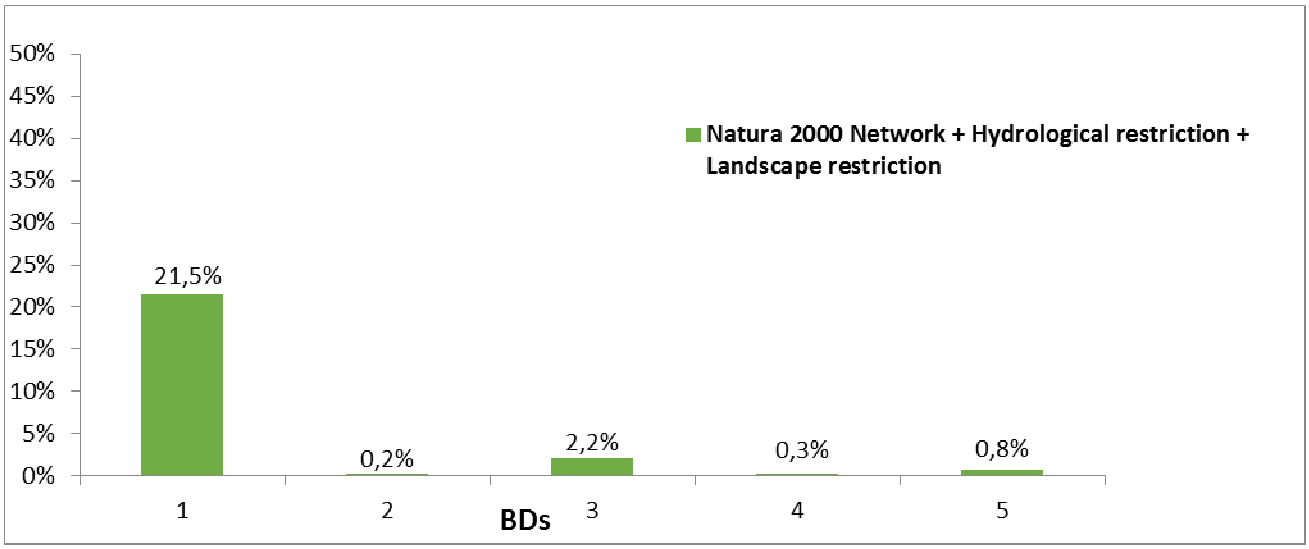


Figure 24 - Area (%) of the BDs subject to hydrogeological, landscape and naturalistic restriction (Natura 2000 Network).

The high naturalistic value of the pilot protected area, including the BDs, appears even more evident if we consider the areas subject only to hydrogeological and landscape restrictions (not

falling within the Natura 2000 network or within the Madonie Park) (Figure 25). The percentage of areas of the districts subject to the two restrictions are quite high, being equal to 43.3% in District 1, to 19.6% in District 2, 10.6% in District 3, 7.5% in District 4 and 26.5% in District 5.

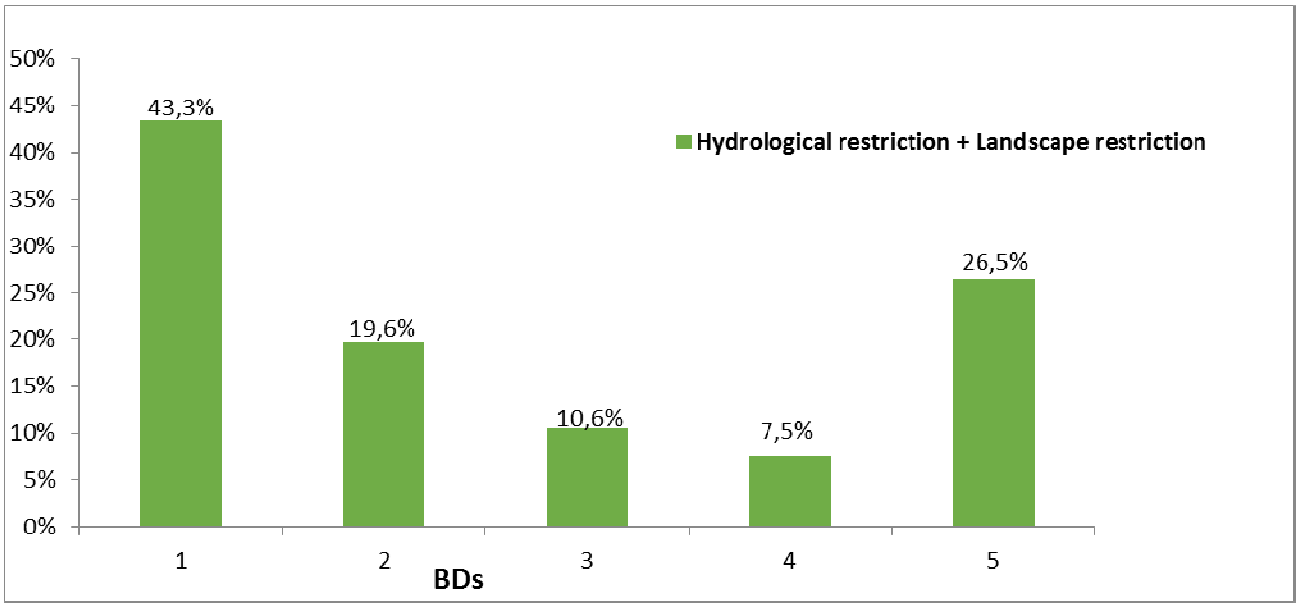


Figure 25 - Area (%) of the BDs subject to hydrogeological and landscape restriction.

3.2.5 *Slope*

In order to assess the ease of biomass harvesting in each BD, the range (grade) and the slope class of the territory were taken into account (Table 6).

Table 6 – Slope class.

Range (grade)	Slope class
0-10	flat/sub-flat
10-30	moderate
30-50	high
50-80	very high

As shown in figure 26, most of the territory of the BDs has a moderate slope. In District 1 the area with a gradient between 10 and 30 degrees is about 72% of the total, in District 2 it is about 60%, in District 3 it is 70%, in District 4 it is 57% and in District 5 it is over 56%. The percentage of area with slope between 0 and 10 degrees (Flat/sub-flat) is also quite high in all the BDs. In District 1 it occupies about 20% of the area of the district, in District 2 it occupies about 28%, in District 3 it covers 25%, in District 4 and in District 5 it occupies, in both cases, about 40% of the total area. Less extensive are the areas with a gradient between 30 and 50 degrees (high slope): only in

District 2 they cover 10% of the area, in District 1 they cover 7.4%, in District 3 about 6%, in District 4 about 3% and in District 5 about 4%. On the other hand, areas with a gradient between 50 and 80 degrees (very high slope) are not very common, assuming values of less than 1% of the total area in all the BDs.

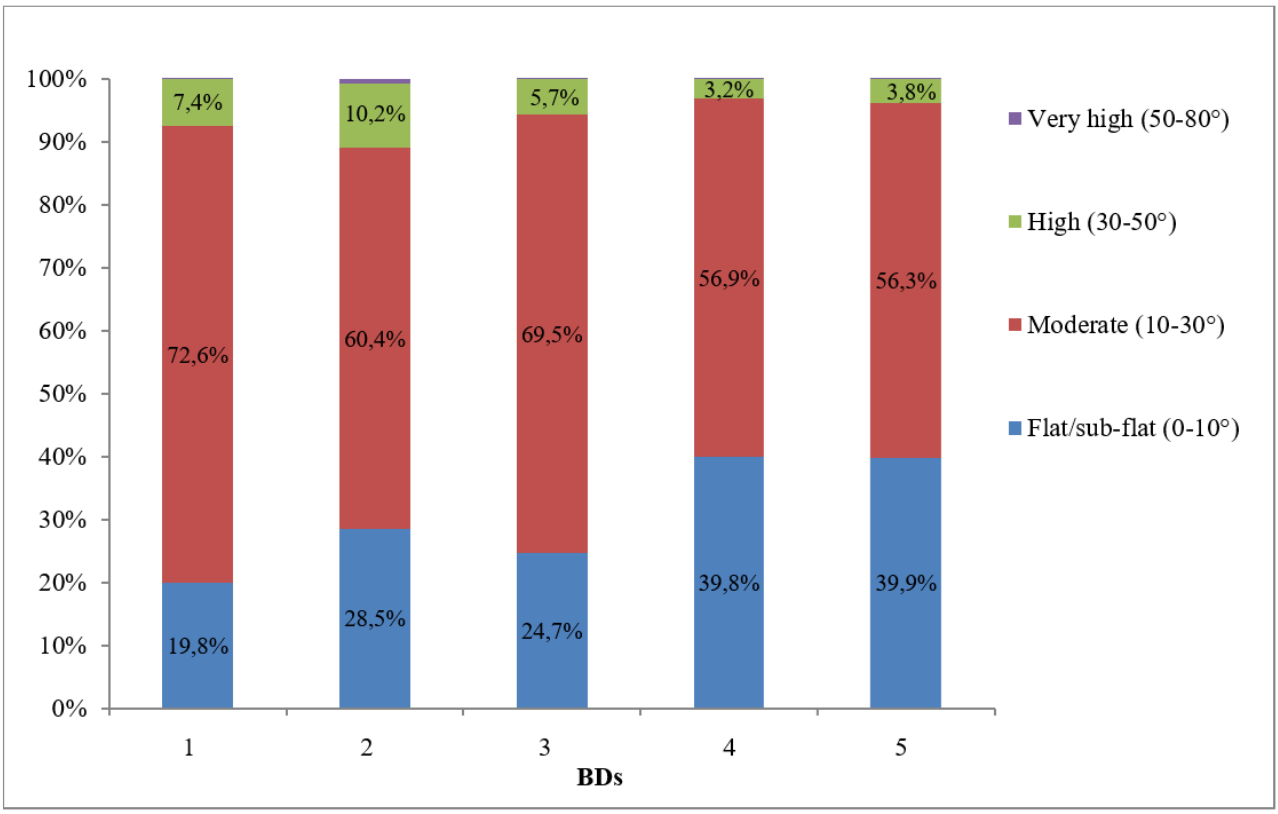


Figure 26 – BDs area distribution in Slope class. The percentage values lower than 3% are not reported in the graph.

3.2.6 *Distribution and classification of the main road network*

The ordinary road network is also a very important aspect to be considered in the planning of energy production based on the use of woody biomass, both in terms of road types and their distribution in the territory. After harvesting, the biomass must be easily transported to the plant. In the present work, the following 4 road types were taken into account: *motorways*, *national roads*, *provincial roads*, *other roads* (*municipal*, ecc.). For what concerns *motorways*, only District 1 and District 5 show significant values (over 20 Km) (Figure 27). For what concerns *national roads*, with the exception of District 2 where they are completely absent, in the other districts their value is quite similar and is around 40 km. For what concerns *provincial roads*, in Districts 1 and 2 their length is around 80 km, in Districts 4 and 5 it is around 60 km, while in District 3 their total length is less than 20 km. For what concerns *other roads*, in Districts 2 and 3 their length is close to 40

km, in Districts 1 and 5 such value is around 100 km, while in District 4 their length is more than 160 km. The localization of the ordinary road network in the BDs is showed in figure 28.

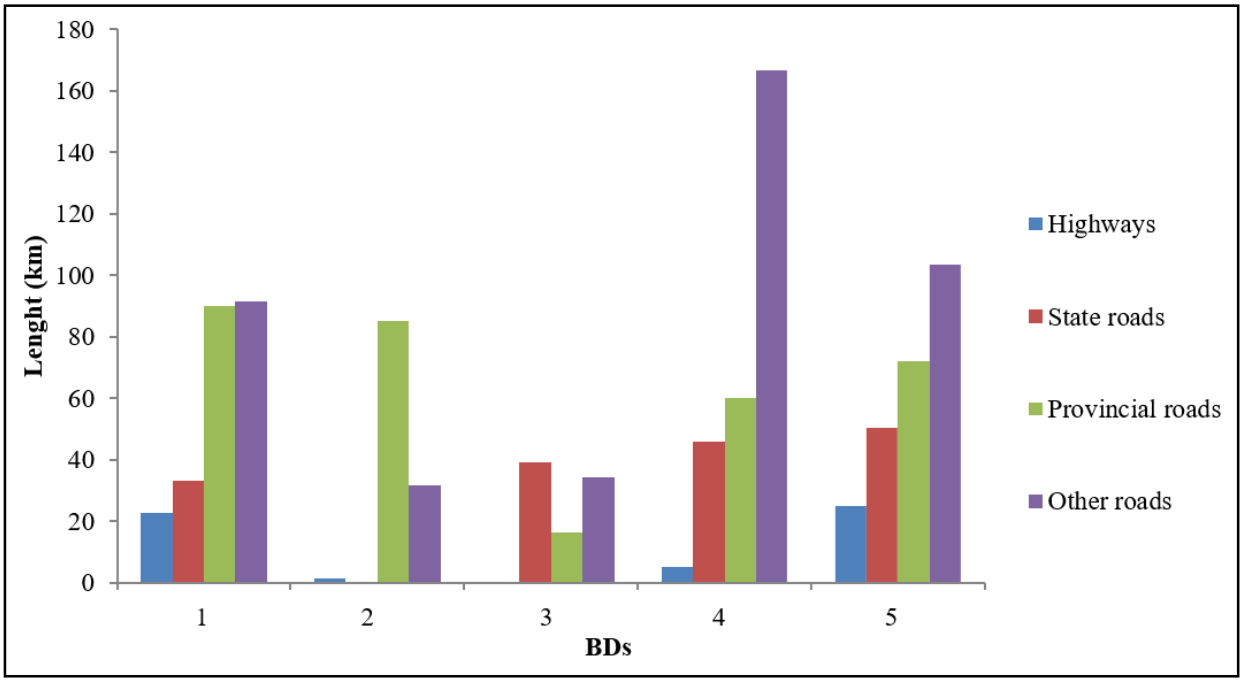


Figure 27 – Total lenght (km) of the ordinary road network in the BDs.

3.2.7 *Energy needs*

Assessing whether or not the harvesting biomass from a given territory can meet its energy needs is undoubtedly one of the crucial aspects of the bioenergy production planning based on the use of woody biomass. An evaluation error in this sense would result in the construction of an incorrectly sized system. The energy needs, expressed in MWh/year, per each BD are showed in figure 29.

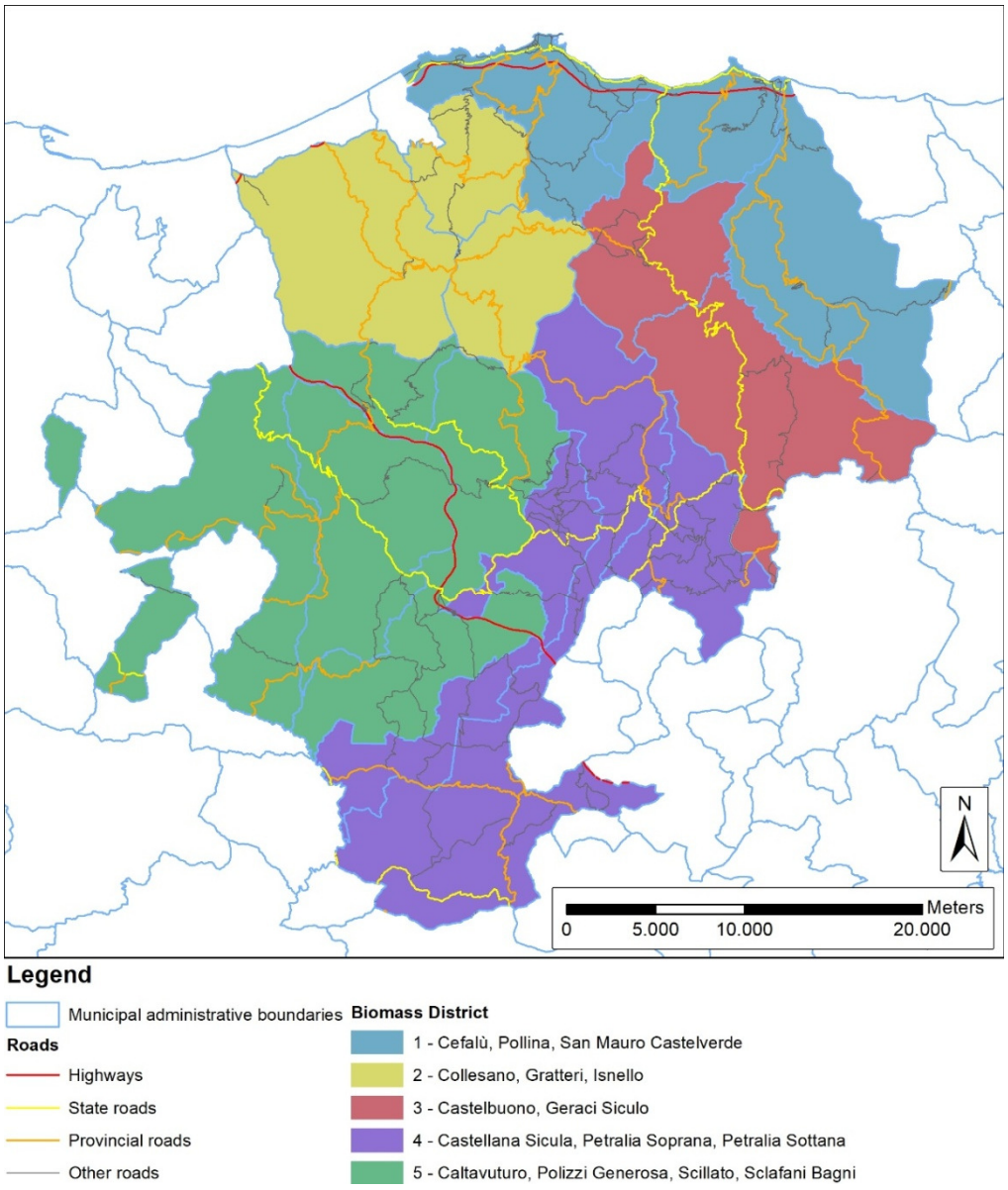


Figure 28 – Ordinary road network in the BDs.

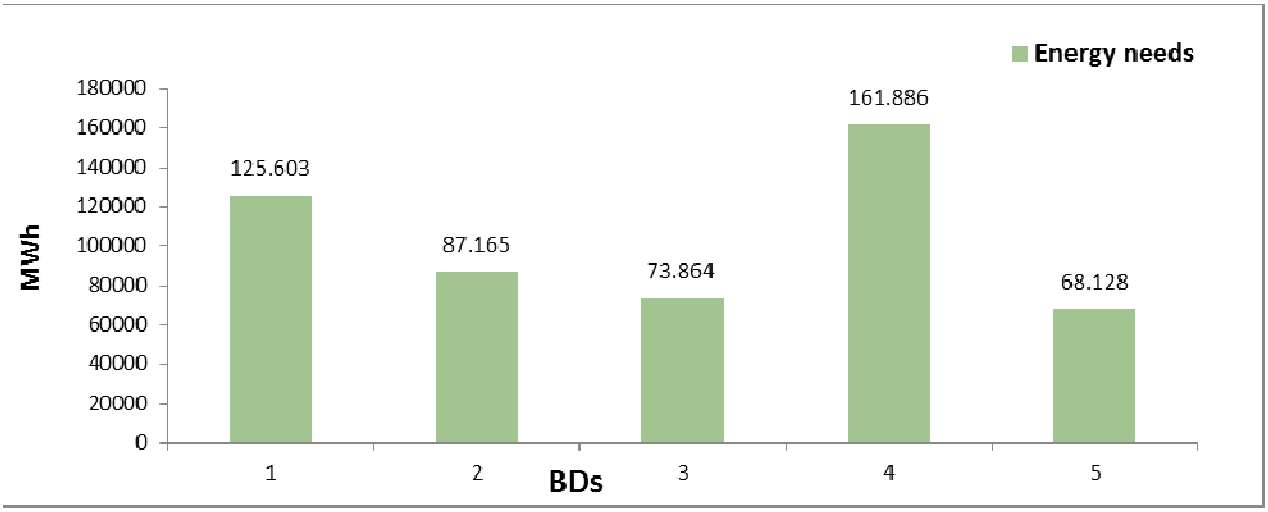


Figure 29 – Annual energy needs per BD.

As can be seen from figure 29, District 4 hold the higher value, with an annual energy need of 161,886 MWh, followed by District 1 with 125,603 MWh, District 2 with 87,165 MWh, District 3 with 73,864 MWh and finally District 5 with 68,128 MWh. A useful indicator for the correct evaluation during the planning phase is the ratio between the energy needs of the district and the agro-forestry areas effectively present in the district (Table 7). It must be highlighted that these areas have to be considered only proxies of the potential woody biomass occurring in each BD. In the pilot protected area, this ratio ranges from 8 to 11% for all districts, with the exception of District 4 where this ratio is only 2 because of the peculiarities of the municipality of Petralia Soprana, characterized from a particularly high energy need (86,672 MWh) as opposed to a very modest presence of agro-forestry available areas (285.78 ha).

Table 7 – Ratios between energy needs and potential woody biomass in each BD.

District ID	Energy needs (MWh)	Ratio between energy needs and available agro-forestry areas (%)
1	125.603	10
2	87.165	8
3	53.712	11
4	161.886	2
5	68.128	8

3.2.8 *Private companies operating in the biomass sector*

The presence on the territory of private companies operating in forestry and biomass sector is another very important factor to be taken into account during the planning of energy production based on the use of woody biomass. Unfortunately, in the territory of the identified BDs, the number of companies currently operating in the forest sector is rather limited. In recent decades, in fact, due to the changed socio-economic conditions of the area and the exodus towards large metropolitan areas, we have witnessed the abandonment of mountains, forests and the rural areas in general. As showed in figure 30, no forest company is registered in Districts 2 and 5, while in the Districts 1 and 4 only one company per district is found. In District 3, on the other hand, there are 6 companies operating in the forest utilization sector. At present, therefore, in the pilot

protected area there are few companies operating in the biomass sector. This represents a strong limitation for the development of sustainable short supply chains for the production of bioenergy. The reasons for such a situation could depend on the existence of different types of barriers that limit the use of biomass, as assumed by some of the companies identified. These barriers, already identified during a specific deliverable of the project, will be further investigated in order to find the right solutions for overcoming them.

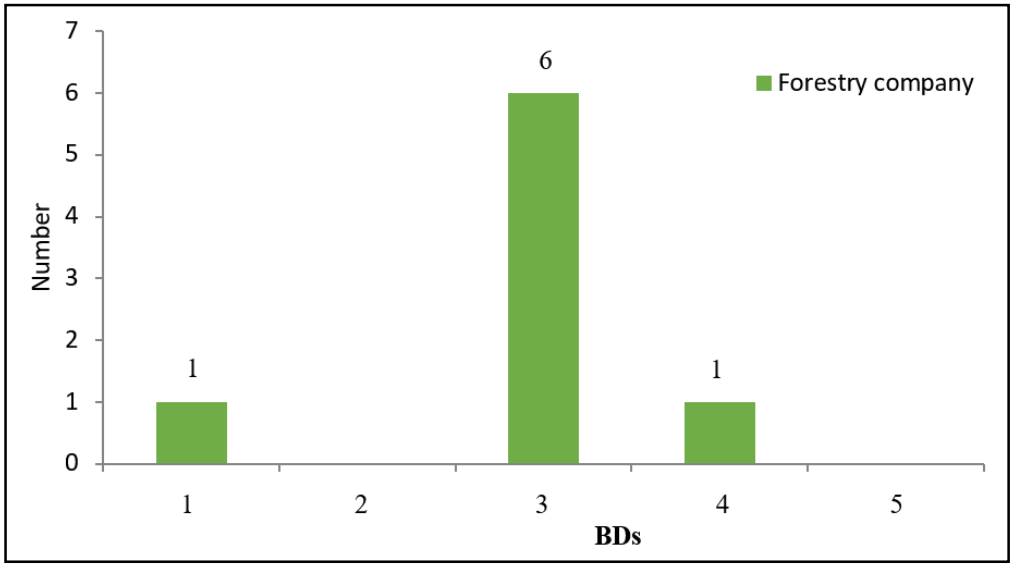


Figure 30 – Number of Forestry Company in the BDs.

3.3 Final remarks

The territory of the Regional Natural Park of Madonie is characterized by large environmental diversification and heterogeneity, either in terms of lithological, pedological, bioclimatic and land use aspects. Also the occurrence of 15 different municipalities made the identification of homogeneous Biomass District anything but simple. However, 5 Biomass Districts (BDs) have been identified, and the requirements of territorial contiguity, direct connection through the current road network, homogeneity in terms of territorial extent and availability of agroforestry areas for biomass harvesting have been met.

In the BDs, *forests* (Corine Land Cover, classes 311, 312, 313) cover from 6% (District 5) to 29% (District 1) of the total area of each district. *Permanent crops* (Corine Land Cover, classes 221, 222, 223) cover from 1% (District 4) to 27% (District 3) of the total area of each district. Importantly, we found a different distribution of *forests* in each BD. The vast majority of forest resources falls within the Natural Park of Madonie in Districts 2, 3 and 4, with percentage values ranging from 86% to 99%, whilst, conversely, *forests* are mostly outside the Natural Park of Madonie in District 1

(>78%). Just over half of *forests* fall within the Natural Park in District 5 (about 53%). Overall, agroforestry areas (*forests* plus *permanent crops*) cover from 10% (District 4) to 52% (District 1) of the total area of each district.

For what concerns restrictions, some differences among BDs were found. The areas falling within the Natural Park range from about 21% (District 1) to about 59% (District 2) of the total area of each BD. Natura 2000 network sites occupy from about 24% (District 5) to about 59% (District 2) of the total area of each BD. Hydrogeological restriction concerns more than 60% of total area of each BD in Districts 2, 4, more than 70% in District 5, and especially in District 1 (about 83%). Landscape restriction is the most widespread in the pilot protected area, covering the whole or almost the whole area of Districts 1, 2 and 3. It covers more than 66% of the total area of District 5. Differently, only about 43% of total area of District 4 is affected by landscape restriction. Overall, only 3% of District 3, about 9% of District 5, and about 26% of District 4 are represented by areas without any kind of restrictions.

Slope should not represent a big problem in the pilot protected area as only less 10% are high and very high slope classes in all the BDs. For what concerns the road network, large differences were found among BDs. District 2 and 3 are the worst served Districts with roads, whilst Districts 4 and 5 are the best served with different kind of roads. Energy needs ranged from about 68,000 MWh (District 2) to about 162,000 MWh (District 1). The ratio between the energy needs and the agro-forestry areas present was the most homogeneous possible. An exception was District 4, where this ratio was low due to the presence of the municipality of Petralia Soprana, characterized by a high energy need in relation to the effective availability of agro-forestry biomass.

Overall, there is the potentiality to establish a valuable short supply woody chain in the Natural Park of Madonie. However, up to now the most limiting factor is the limited occurrence of private companies operating in the biomass sector, being only 6 in District 3, and 1 in Districts 1 and 4.

3.4 References

Cozzi M., Di Napoli F., Viccaro M., Romano S., 2013. Use of Forest Residues for Building Forest Biomass Supply Chains: Technical and Economic Analysis of the Production Process. Forests 4, 1121-1140. doi:10.3390/f4041121

Maffeis G., Roncolato D., Cherubini A., Bernardoni A., Greco S., Boccardi A., Chiesa A., Brolis M., Fasano M. (2012). BIOPOLE: un sistema di supporto alle decisioni (DSS) web-GIS per la localizzazione ottimale degli impianti a biomassa. Atti 16a Conferenza Nazionale ASITA - Fiera di Vicenza 6-9 novembre 2012.

Martelli F., Maltagliati S., Chiaramonti D., Riccio G., Bernetti I., Fagarazzi C., Fratini R., Tondi G., Nibbi L.,(2003). "Biomass exploitation in Tuscany; a GIS-based planning tool and methodology for energy potential assessment", International Nordic Bioenergy Conference, Jyvaskyila, September 2003.

Martelli F., Maltagliati S., Riccio G., Bernetti I., Fagarazzi C., Fratini R., Chiaramonti D., Nibbi L., (2002). "A Gis-Based Planning Tool For Greenhouse Gases Emission Reduction Through Biomass Exploitation In Tuscany", Proceedings of the 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection, Amsterdam, June 17-23, 2002.

Noon C. E., Daly M.J., (1996). GIS-based biomass resources assessment with BRAVO. Biomass & Bioenergy, 10,101-109.

Pellerano A., Pantaleo A., Tenerelli P., Carone M.T., (2007). Studio per la valorizzazione energetica di biomasse agro forestali nella Regione Puglia. Università degli Studi di Bari, Dipartimento PROGESA - Progettazione e Gestione dei Sistemi Agro Zootecnici e Forestali.

Puletti N., Floris A., Scrinzi G., Chianucci F., Colle G., Michelini T., Pedot N., Penasa A., Scalercio S., Corona P., (2017). CFOR: un sistema di supporto alle decisioni per le foreste in Calabria. Forest@ 14: 135-140.

Rivas-Martınez S., Rivas Saenz S., Penas A., 2011. Worldwide bioclimatic classification system. Global Geobotany, 1: 1-634.

Sacchelli S., Zambelli P., Zatelli P., Ciolli M., (2013). Biomasfor: an open-source holistic model for the assessment of sustainable forest bioenergy. iForest 6 (4): 285-293.

4. GEOGRAPHICAL IDENTIFICATION AND DESCRIPTION OF BIOMASS DISTRICTS (BDs) WITHIN THE NOTRANJSKI KRAJINSKI PARK AND PRIMORSKO-NOTRANJSKA REGION (SLOVENIA)

4.1 Identification of BDs

Area we involved in the project for the biomass districts identification, consists of five local communities (municipalities), all of them are partly included into Škocjan Caves Regional Park and Pivka Lakes Nature Park. Municipalities within the study area are: Divača, Hrpelje – Kozina, Ilirska Bistrica, Pivka, Postojna. They were identified with GIS elaboration – we intersected the shapefile (.shp) of the municipal administrative units and shapefile of protected areas buffer zones.

The data used to show localization of urban centers is shapefile of agglomerations. It was used instead of suggested data of Corine Land Cover land use code ''11'' as it is more precise. Main urban centers within the area are Postojna, Pivka and Ilirska Bistrica.

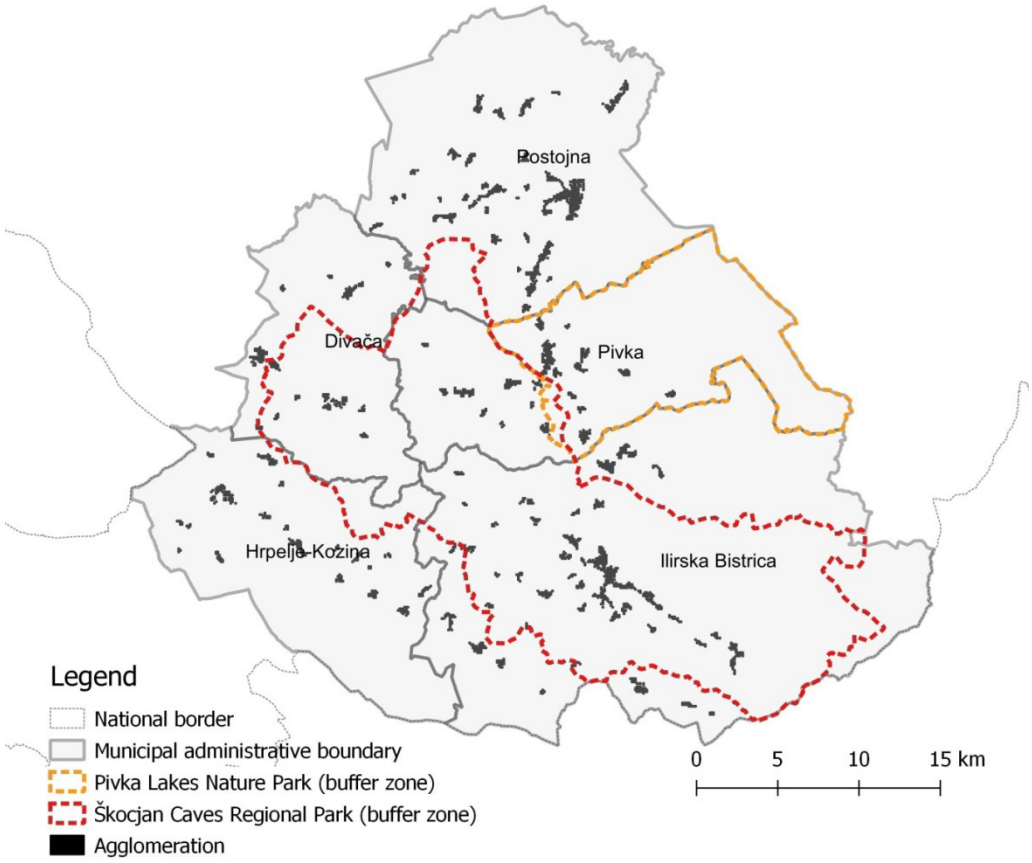


Figure 1: Municipalities, Škocjan Caves Regional Park buffer zone and Pivka Lakes Nature Park buffer zone

Municipalities Pivka, Postojna and Ilirska Bistrica belong to Primorsko-notranjska statistical region. Only 3% of the whole Slovenian population lived in this region in 2016. It was ranked by the lowest population density: on average, there were 36 people living on 1 km2. Municipalities Divača and Hrpelje – Kozina belong to Obalno-kraška statistical region, where 5% of the whole Slovenian population lived in 2016. It was ranked by the highest number of people that moved abroad.

Table 1: Municipalities within the pilot area - Škocjan Caves Regional Park buffer zone

Municipality	Area (ha)	Area within the Škocjan Caves Regional Park buffer zone (ha)	Share (%)
Divača	14.501	7.435	51,3
Hrpelje - Kozina	19.488	1.501	7,7
Ilirska Bistrica	47.991	26.725	55,7
Pivka	22.320	7.825	35,1
Postojna	26.979	1.435	5,3
Sum	**131.280**	**44.922**	**34,2**

The Škocjan Caves Regional Park buffer zone ecompasses the entire Reka River watershed. It covers 450 km^2, of that a great share of Divača and Ilirska Bistrica (more than 50%) as well as Pivka (35%) municipal area. More than one third of the study area is covered by Škocjan Caves Regional Park buffer zone.

Table 2: Municipalities within the pilot area Pivka Lakes Nature Park buffer zone

Municipality	Area (ha)	Area within the Pivka Lakes Nature Park buffer zone (ha)	Share (%)
Pivka	22.320	14.821	66,4
Sum	**22.320**	**14.821**	**11,3**

Pivka Lakes Nature Park is a landscape park founded by the Pivka municipality, in which it covers almost 15.000 ha. The Pivka Lakes Nature Park buffer zone covers approximately 66% of the Pivka municipal area.

Table 3: Areas of forests and extensive overgrowth within both parks with buffer zone and within municipal administrative boundary (Land use 2018)

Municipality	Area (ha)	FORESTS			AREAS OF EXTENSIVE OVERGROWTH		
		Area within the Park buffer zone (ha)	Area outside the Park buffer zone (ha)	Total Area (ha)	Area within the Park buffer zone (ha)	Area outside the Park buffer zone (ha)	Total Area (ha)
Divača	14.501	5.167	4.446	9.612	472	545	1.017
Hrpelje - Kozina	19.488	1.293	12.128	13.422	30	2.197	2.227
Ilirska Bistrica	47.991	18.344	16.778	35.123	1.753	1.342	3.095
Pivka	22.320	15.629	50	15.679	954	0	954
Postojna	26.979	1.240	16.785	18.025	21	927	948
Sum	**131.280**	**41.673**	**50.188**	**91.861**	**3.230**	**5.011**	**8.242**

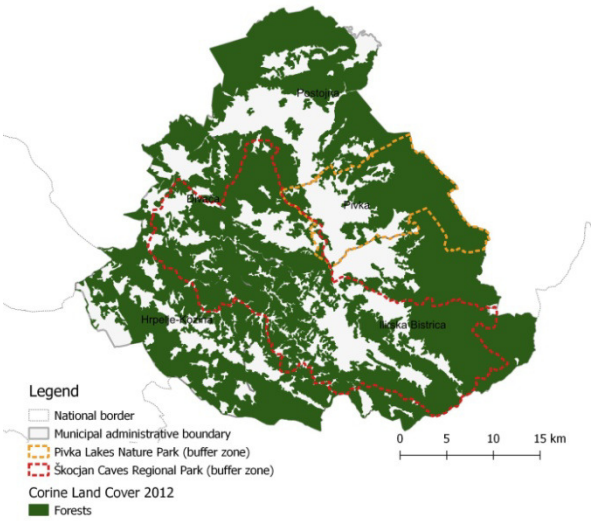
Table 4: Areas of forests and extensive overgrowth within protected area and within municipal administrative boundary (CLC 2012)

Municipality	Area (ha)	CLC, code 311, 312, 313		
		Area within the Park buffer zone (ha)	Area outside the Park buffer zone (ha)	Area (ha)
Divača	14.501	4.902	4.388	9.290
Hrpelje - Kozina	19.488	1.278	11.203	12.481
Ilirska Bistrica	47.991	17.589	16.072	33.662
Pivka	22.320	14.281	51	14.332
Postojna	26.979	1.288	16.207	17.495
Sum	**131.280**	**39.339**	**47.920**	**87.259**

Table 3: Overview of the available data of municipalities and agro-forestry resources, as well as energy needs, used to identify the Biomass Districts within the Pivka Lakes Nature Park and Škocjan Caves Regional park buffer zone

District ID	Municipality	Municipal area	Municipal area within the park	Forests			Areas of extensive overgrowth			Total area (forests plus areas of extensive overgrowth)	Energy needs	Energy needs/agro-forestry areas ratio
				Within the park	Outside the park	Total	Within the park	Outside the park	Total			
				a	b	c=a+b	d	e	f=d+e	g=c+f	h	i=g*100/h
		ha	ha	ha	ha	ha	ha	ha	ha	ha	MWh	%
1	Divača	14.501	7435	5.167	4.446	9.612	472	545	1.017	10.629	28.538	37
2	Hrpelje - Kozina	19.488	1501	1.293	12.128	13.422	30	2.197	2.227	15.649	*	*
3	Ilirska Bistrica	47.991	26725	18.344	16.778	35.123	1.753	1.342	3.095	38.218	155.578	25
4	Pivka	22.320	22269	15.629	50	15.679	954	0	954	16.633	161.687	10
5	Postojna	26.979	1435	1.240	16.785	18.025	21	927	948	18.973	80.809	23
Sum		**131.280**	**59.367**	**41.673**	**50.188**	**91.861**	**3.230**	**5.011**	**8.242**	**100.102**	**426.613**	

* **Energy needs are not available**



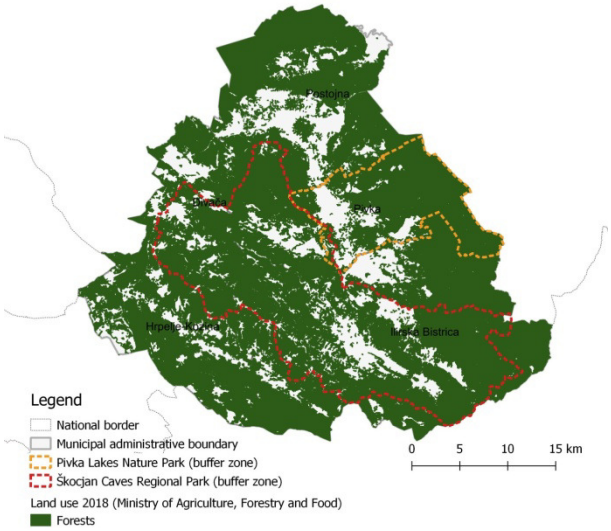


Figure 2: Corine Land Cover (codes 311, 312, 313) Figure 3: Forests according to Land use data

As suggested, CLC land use map, classified according to land use types for forest areas (codes 311, 312, 313) and agricultural areas (codes 221, 222, 223) and their area falling within and outside the protected area should be delivered.

In the area included in the study, agricultural areas (codes 221, 222, 223) are not present. Data of forest areas according to CLC land use (codes 311, 312, 313) are less detailed than national data on land use that is run by Ministry of Agriculture, Forestry and Food. Last shapefile is available for year 2018. As the process of overgrowing is present in our study area, it is crucial to use the last data available. Comparison of both data on forest areas is presented in the maps above. For further calculation and presentations of forests, the national data of land use is used.

Considering that agricultural areas (codes 221, 222, 223) are not present in these five municipalities, we concentrated on the areas of extensive overgrowth. They represent a potential for biomass production as well as an issue – as the grasslands that should have been maintained due to significant importance for biodiversity - are being overgrown. This is the main reason we decided to replace the input data with areas of extensive overgrowth from national data on land use.

4.1.1 *Biomass from forests*

Methods

Slovenian Forestry Institute has developed a methodology for the evaluation of the actual and theoretical estimates of the quantities of timber. The model which calculates quantity and

potential assessment of wood from Slovenian forests is based on detailed and up to date input data. These data were obtained from: the multi-annual censuses of agricultural holdings and sample censuses of agriculture by the Statistical Office Republic of Slovenia (SURS), the annual reports from Farmland and Forest Fund of the Republic of Slovenia (SKZG), the register of spatial units (GURS), the internal data from Slovenian Forestry Institute (GIS; egg. data from recording normative), and different databases of forest inventories from Slovenian Forest Service (ZGS).

The methodology for calculating quantity and potential estimates of wood is based on the market quantities of round wood. Thus, amount of wood consumed for own use of forest owners needs to be excluded. Estimates of actual and theoretical market quantities of wood are calculated. The theoretical potentials are representing the maximum amount of wood that can be harvested annually and sold on the market while also ensuring sustainable forest management. The actual potentials are representing the five years averages of wood that was priory marked by district foresters for harvesting and appears on the market. Actual market quantities are actual average annual wood quantities which were harvested in years 2009-2013 and put on the market. Theoretical market potential is maximum quantity of wood which could be harvested and offered on market (including home use) and meanwhile also ensuring sustainable forest management. Analysis was made separately for private forests and other forms of forest ownership. One should note, that it is not reasonable to use all available wood for energy purposes. It is rational to use only lower quality roundwood, forest residues and uncontaminated wood residues from wood industry. Quantities were calculated for lower quality wood. Lower quality wood includes pulpwood and wood harvested from main stems, branches and other parts of trees where these are harvested for fuel (wood fuel).

The entire methodology has been developed on basis of current market conditions and estimated use of wood in Slovenia. The results for the potential of lower-quality wood are calculated in oven-dry tons (ODT) for the case of energetic potential for wood of lower quality and where for the needs of this reports converted into a net cubic meter (m^3 without bark).

Results

Table 4 presents the assessment of the total theoretically marketable potential per year for each municipality. The total exploitable amount is 312.854 m^3 (Table 4), while the assessment of the actual quantity that entered the market per year amounts to 123.076 m3 (Table 3). This indicates a low biomass utilization rate in studied region, especially as far as privately-owned forests are

concerned (Table 3 and Table 4). The estimated theoretic annual market potential for private forest owners in studied region is 192.937 m^3, while the estimated actual annual market quantity is 31.416 m^3 (only 16 % of the theoretic potential). Regarding the tree species the greatest deviation is observed for the deciduous trees, which are also the most suitable for the wood biomass production. In total 83.405 m^3 of deciduous trees annually appeared on the market, which represents only 36 % of the total potential (233.414 m^3). The lowest utilization rate is in municipality Hrpelje - Kozina, where estimated theoretic annual market potential is 31.849 m^3, while the estimated actual annual market quantity is 8.004 m^3, which represents only 25 % of the theoretic potential. The highest utilization rate is in municipality Ilirska Bistrica, where estimated theoretic annual market potential is 70.276 m^3, while the estimated actual annual market quantity is 30.626 m^3 (only 44 % of the theoretic potential). The situation in this region is reflected at the level of the whole country as well as inside parks buffer zone. But it is necessary to be cautious with interpretation of results, as the analyses of the actual potential only observed the timber that was marked for harvesting by district forester, while in reality the harvested quantities are likely greater especially in privately owned forests. The highest annual biomass potential (both actual and theoretic market) can be found in municipality Postojna with absolute amount from 0,82 to 1,90 solid m^3 per hectare. The least biomass potential can be in municipality Divača with absolute amount from 0,51 – 1,23 solid m^3 per hectare. There are many different factors that can explain the difference. One of the most important shall be ascribed to geological and climate conditions (see Figure 5 and Figure 6). Another factor that affected the biomass potentials in municipality Divača (and widely in Carst area) was deforestation in the past. The occurrence of deforestation began in Illyrian times, in order to obtain cultivated areas and pastures. The intensive pasture of livestock in the past has contributed significantly to changing the landscape to grasslands and stonework.

Table 4: Estimated actual market annual quantities of lower-quality wood

Municipality	State forest		Private forests		Total [m^3]
	Conifers [m^3]	Deciduous [m^3]	Conifers [m^3]	Deciduous [m^3]	
Divača	64	278	5.832	1,231	7.405
Hrpelje-Kozina	896	421	5.259	1.428	8.004
Ilirska Bistrica	3.858	23.141	1.663	1.964	30.626
Pivka	3.976	8.760	1.362	1.086	15.184
Postojna	5.046	14.254	1.382	1.460	22.142
ForBioEnergy (parks buffer zones)	5.250	25.717	5.083	3.666	39.716
Total	**19.090**	**72.571**	**20.582**	**10.834**	**123.076**

Table 5: Estimated theoretic market annual quantities of lower-quality

Municipality	State forest		Private forests		Total [m^3]
	Conifers [m^3]	**Deciduous [m^3]**	**Conifers [m^3]**	**Deciduous [m^3]**	
Divača	1.702	2.185	5.516	8.455	17.859
Hrpelje-Kozina	2.713	3.046	8.937	17.153	31.849
Ilirska Bistrica	6.155	22.907	7.324	33.891	70.276
Pivka	5.622	10.333	4.660	15.773	36.387
Postojna	7.643	18.723	3.939	21.018	51.322
ForBioEnergy (parks buffer zones)	10.918	27.972	14.312	51.959	105.161
Total	**34.753**	**85.165**	**44.688**	**148.249**	**312.854**

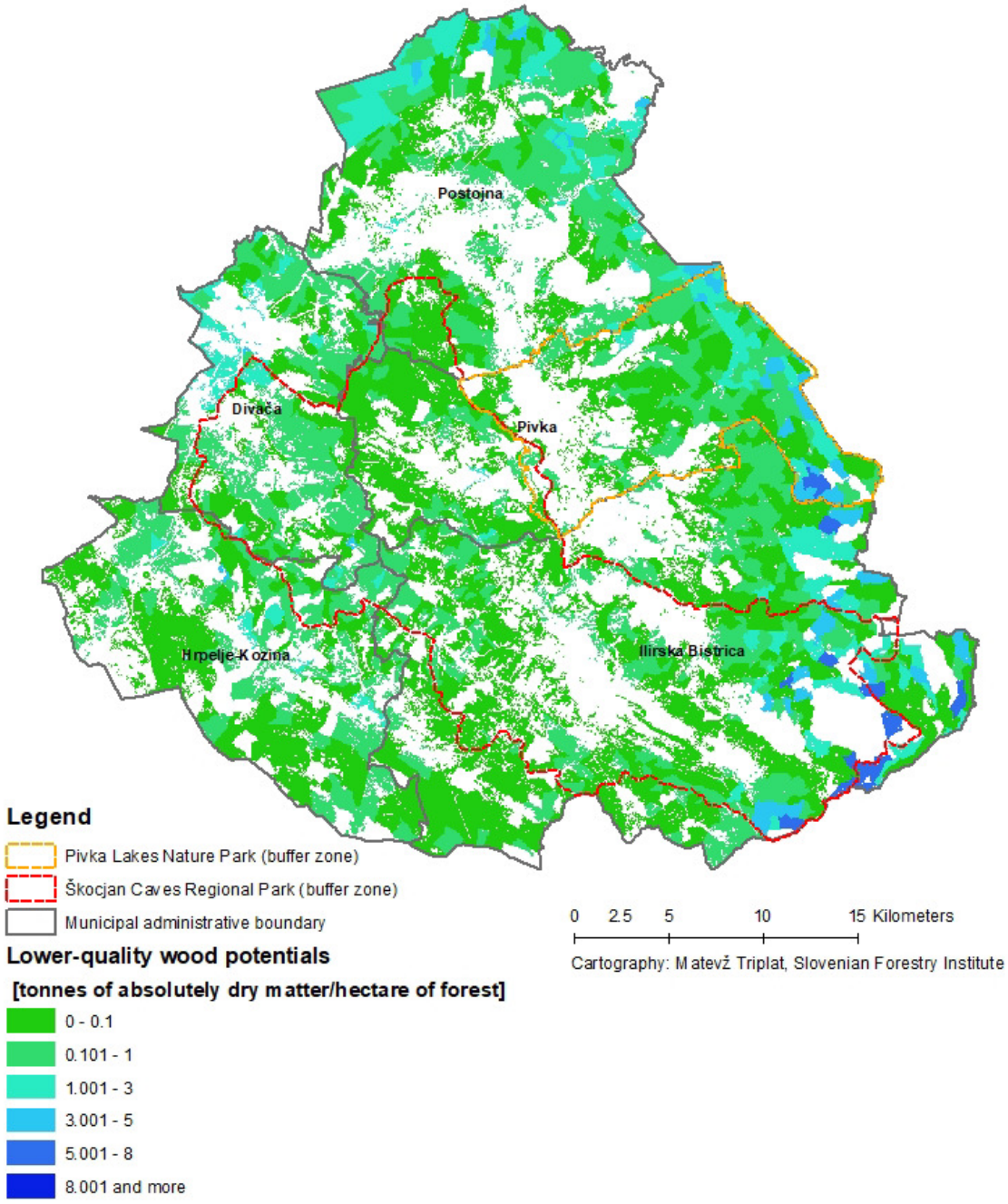


Figure 4: The map of actual market potential of lower-quality wood (in tonnes of absolutely dry matter per hectare of forest per year)

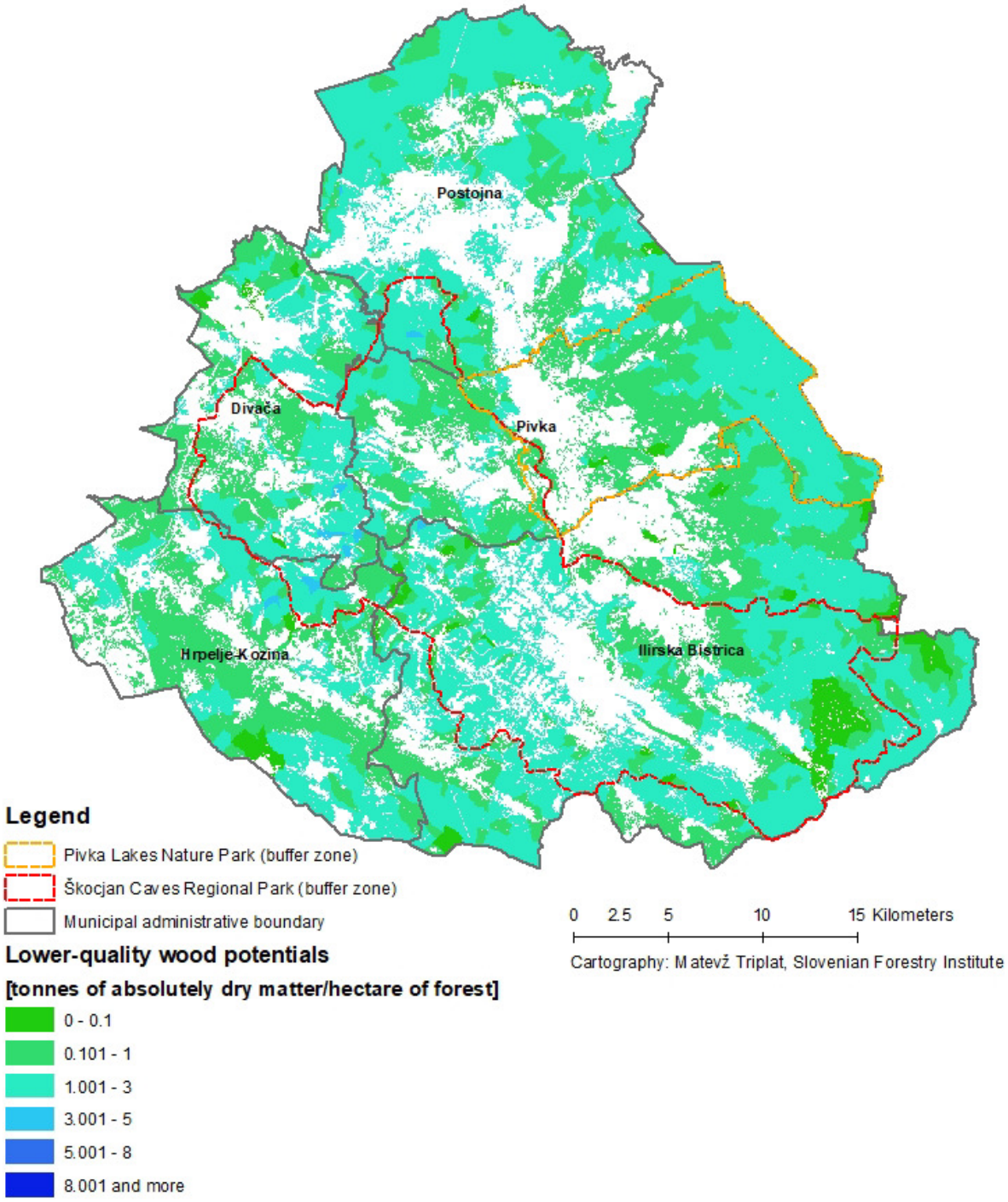


Figure 5: The map of theoretic market potential of lower-quality wood (in tonnes of absolutely dry matter per hectare of forest per year)

4.1.2 *Biomass from extensive overgrowth*

Methods

Extensive overgrowth is another possible source of biomass. We use it instead of Corine Land Cover codes 221, 222, 223 suggested by the partner in charge. The main reason is we did not recognize this land cover in pilot area. Source of extensive overgrowth is relatively huge in

Slovenia, because the process of abandonment of traditional agriculture use of meadows and pastures (grasslands) is still going on. It was not use for any purposes so far. Moreover, the process causes changes in landscape and threatens some species and habitat types, protected by Natura 2000 directives. With using this biomass, we can achieve two goals: remove the threats to species and habitat types and get new source of biomass for heating.

First, we prepared the list of Natura 2000 species and habitat types in pilot area. The layer of this item is run by the Institute of RS for Nature Conservation (IRSNC). Then we use the layer of extensive overgrowth, which is managed by the Ministry of Agriculture, Forestry and Food. The process was followed with overlapping of both layers. The result was several small patches all over the pilot area with some concentrations.

Then we checked the result on the digital orto foto maps and on the field. We found out surface was overgrown just a bit. There was still grassland with some initial stages of wood. But in the neighborhood, we saw much more biomass with much higher growing stock with high potential to become grassland again.

So, we changed our approach and changed the layer. We use just the layer of extended overgrowth. The patches became larger with higher growing stock, much more suitable for our purposes. They still follow the goal to remove the threat to the species and habitat types.

We checked our approach carefully with case study which took place on another area in Life project named Life to Grasslands. We found out in that case they removed even much more biomass, they removed also the sites, which already became forest but still had a potential to become the grassland. So, we conclude with our method we are still on the save side. In the future we can probably expand removal even into the edges of forest with clearcutting.

There are mostly tree types of overgrowing surface. Firstly, there are hedgerows, which expand in their width, the agriculture use of neighboring land is still alive (mostly meadows). We can remove the edges of hedgerow according to the guidelines of hedgelink (2015). Secondly there are huge areas of broadleaf bushes because of grazing abandonment. There we can remove whole biomass. The third type is extensive overgrowth of coniferous trees, mostly pine. In this case we are also allowed to remove whole biomass. In Slovenia INCRS is responsible for management or supervision of management of Natura 2000 sites. So, we asked it for nature conservation guidelines for removing of biomass on extensive overgrowth of pilot area.

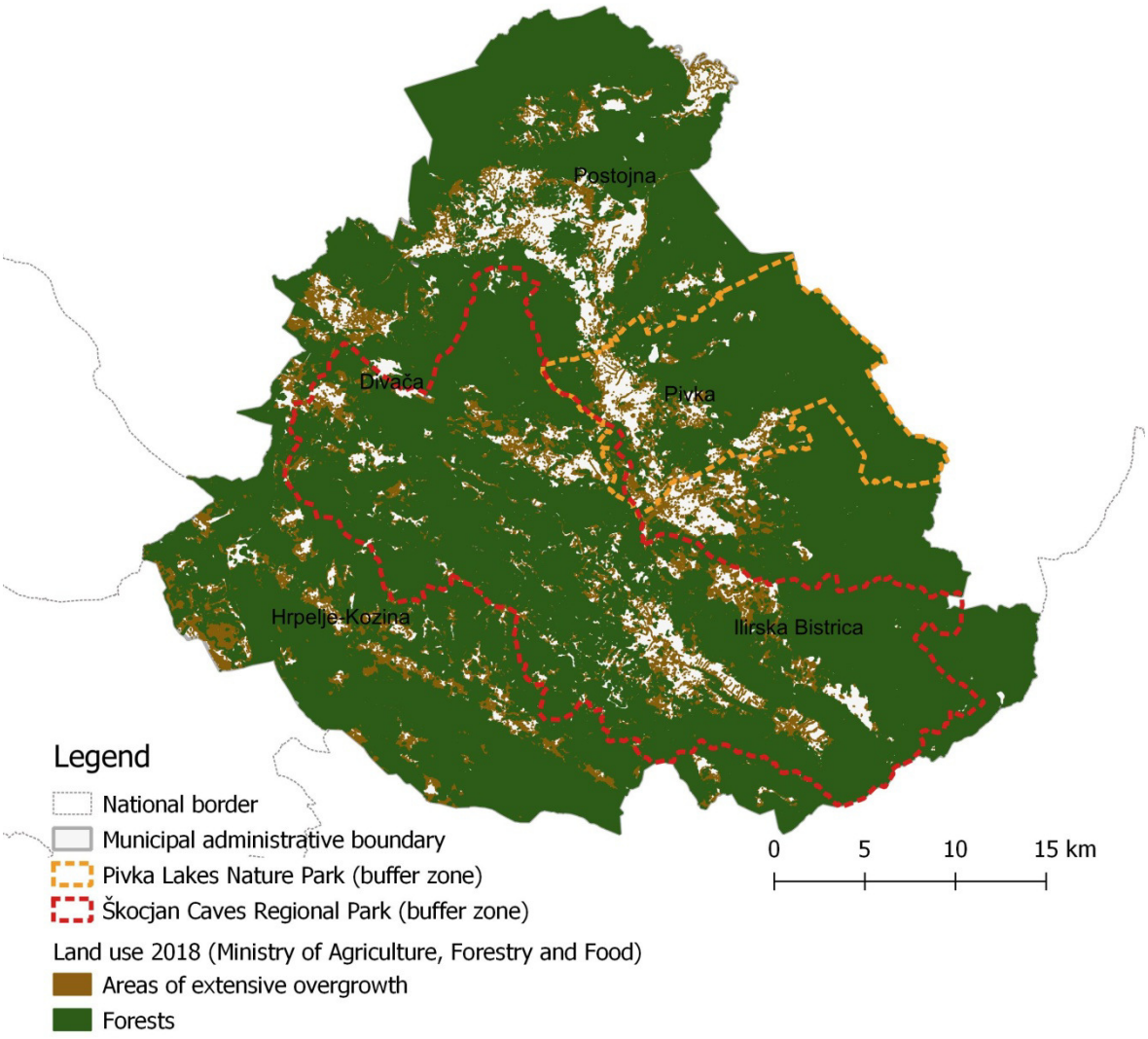


Figure 6: Areas of extensive overgrowth and forests

Results

First, we wanted to estimate the whole amount of biomass on extended overgrowth. We calculated an average growing stock. On the base of previous study (Mali et. all 2017), we estimate an average growing stock is 100 m^3/ha. In whole pilot are growing stock, available for biomass, is 824.200 m^3 (8.242 ha x 100 m^3/ha).

The tables below include the calculations of areas of extensive overgrowth and forests within and outside the park. Calculations are represented for the forests derived from the CLC land use data as well, to show the difference.

Considering CLC land use data, forests represent 66.5% of the area while the percentage of forests area derived from national land use data represent 70%. Areas of extensive overgrowth represent 6.3% of the area. All the calculations represent a share of forests and areas of extensive overgrowth of total municipal area – within and outside the park.

4.2 Description of BDs

Biomass districts' administrative borders are defined on the municipal administrative borders. Each municipality represents one biomass district as some information and data was easier to collect on municipal level.

Table 6: Municipalities, their energy needs and biomass districts

District ID	Municipality	Municipal area	Municipal area within the park	Total area (forests plus areas of extensive overgrowth)	Energy needs**
				g=c+f	h
		ha	ha	ha	MWh
1	**Divača**	14.501	7.435	10.629	28.538
2	**Hrpelje - Kozina**	19.488	1.501	15.649	*
3	**Ilirska Bistrica**	47.991	26.725	38.218	155.578
4	**Pivka**	22.320	22.269	16.633	161.687
5	**Postojna**	26.979	1.435	18.973	80.809
Sum		**131.280**	**59.367**	**100.102**	**426.613**

* no data available ** source: Local energy concepts of municipalities

Energy needs are defined in the local energy concept of each municipality. Local energy concepts also include the list of the existing public buildings and industry facilities (major consumers), their energy source and its annual consumption. This represents an input data of potential consumers of the biomass, especially the public buildings with high consumption of liquefied petroleum gas (LPG) and heating oil for heating purposes that should switch to wood biomass.

The areas of extensive overgrowth and forests are dispersed on the whole area. According to energy needs/agro-forestry areas ratio, municipalities differ. Ilirska Bistrica and Postojna are similar considering this aspect. There is no data available for municipality Hrpelje – Kozina.

Main road network is evenly spread with some concentrations around urban centers. Forest traffic routes and tracks are denser in the northern and eastern part of study area.

Some of the characteristics – e.g. geology and soils are similar for the whole study area. Where the situation is similar for all of the biomass districts, the description is general. Where distinctive differences are present, aspects are described for each biomass district.

4.2.1 *Geology and soils*

Generally, the area is geologically divided between permeable limestone bedrock areas and impermeable flysch with alluvium. The most represented soils in the BDs are Rendic Leptosol (36,6 %), Chromic cambisol (31 %), Dystric Cambisol (15,5 %) and Eutric Cambisol (10 %) – figure 7.

The biggest part of the area form high karstic plateaus Snežnik and Javorniki in the eastern part of study area. The surface, formed mainly of Cretaceous limestone, is heavily karstified; with Jurassic limestone and a small amount of dolomite at the top of Snežnik. North from Javorniki is southern part of Hrušica, another high karstic plateau, with Triassic dolomite, Jurassic limestone and Cretaceous limestone and dolomite.

Between Javorniki to the east, Hrušica to the north, and south edge of the Kras limestone area to the west is Pivka Valley, formed mainly of Eocene flysch and Holocene alluvium.

In the western part of the area is Brkini - Eocene flysch alternation of marlstone, sandstone, breccia and conglomerate with Holocene alluvium in the river Reka valley.

More to the west flysch is bordered by Cretaceous limestone and with a minor limestone and dolomite breccia of the Matarsko Podolje and Čičarija.

Duality in the bedrock is visible in the soils. On the carbonate rich bedrock in karst and mountainous part of the area are formed Chromic Cambisol, brown forest soil and rendzina; the type of the soil and their depth alternate over short distances.

On flysch district cambisol is formed. Due to quicker weathering the soil is deeper but because of impermeable bedrock, it is more affected by erosion.

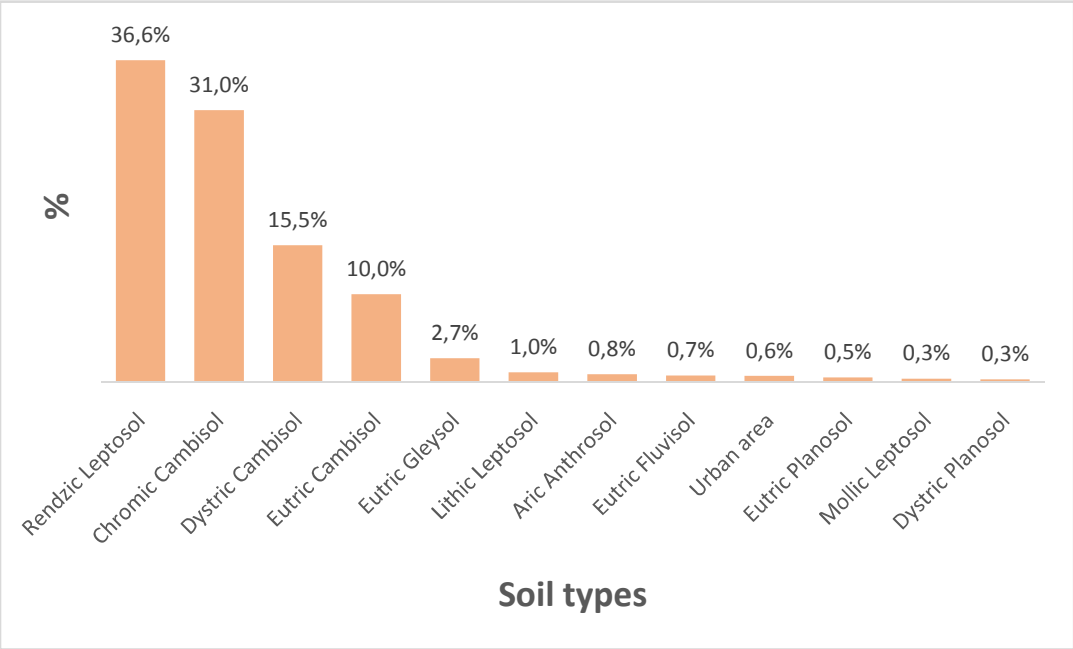


Figure 7: Soil types present in the project area

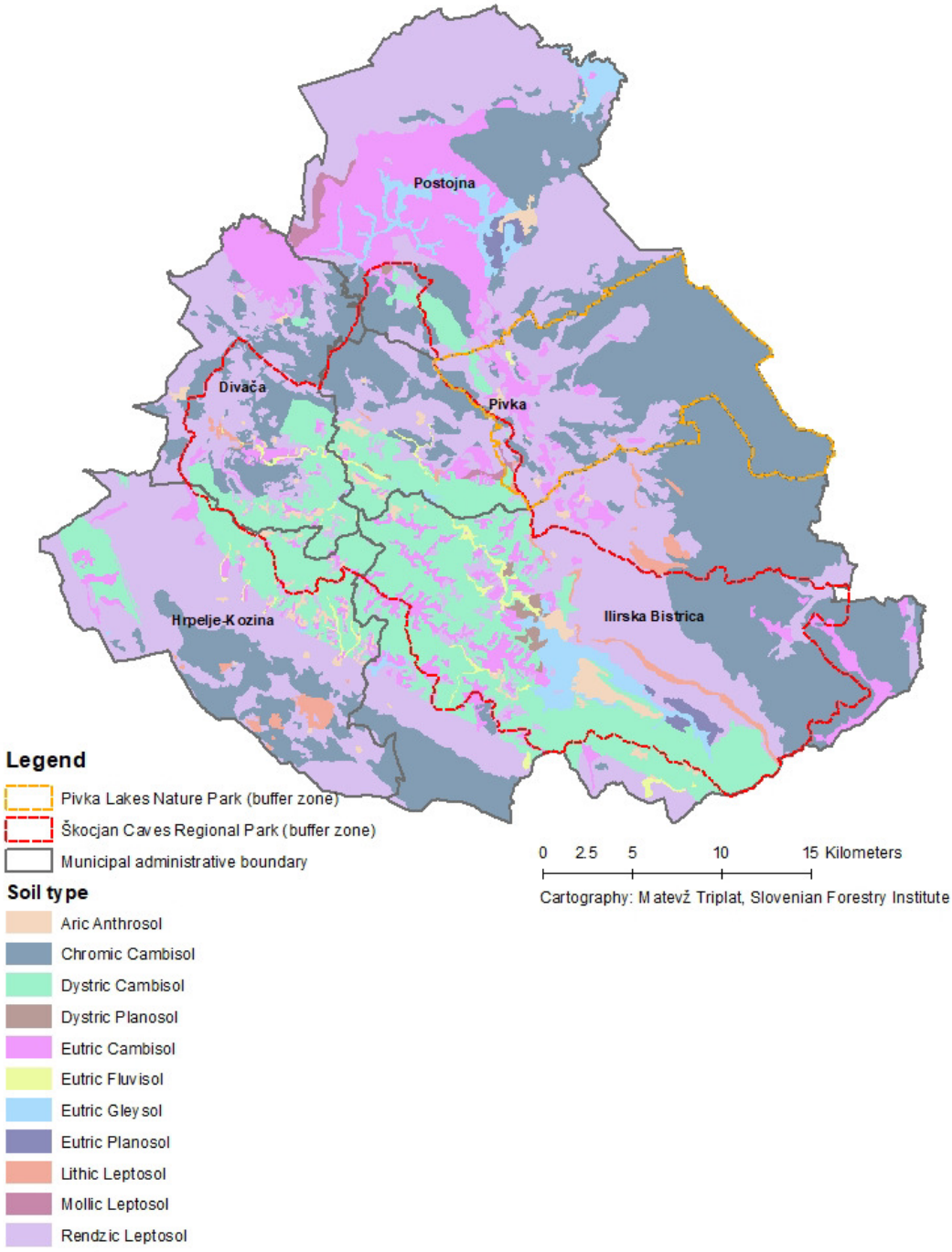


Figure 7: Soil resources within the project area

The most represented soil type in biomass districts (BDs) 1, 2 and 5 is Rendzic Leptosol and in BDs 3 and 4 Chromic Cambisol. In BDs 2 and 3 Dystric Cambisol present a considerable share and as well Eutric Cambisol in BD 5 (figure 9).

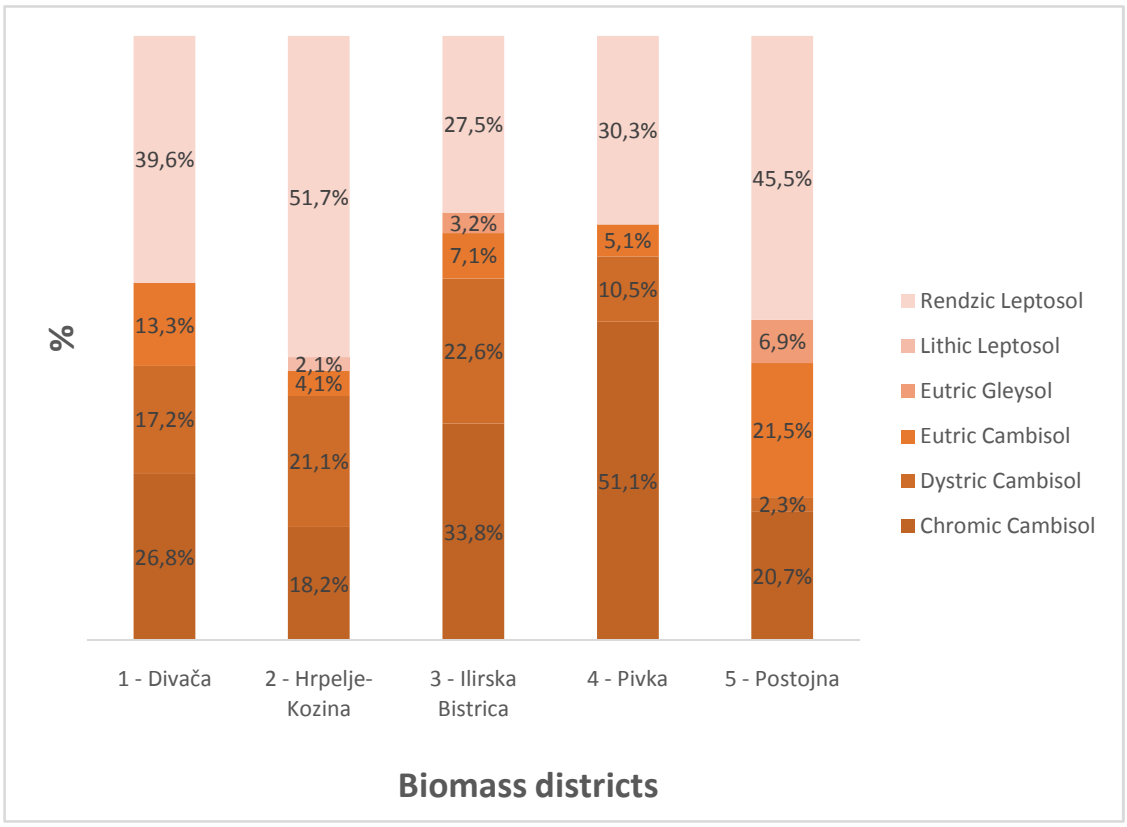


Figure 8: Distribution of the soil types present in the biomass districts. The percentage values lower than 2% are not reported in the graph.

4.2.2 *Climate*

In addition to the relief, the climate of the cultivated area is primarily a decisive geographical position between the Adriatic Sea in the continental part of Europe. The climate effects of the Atlantic and the Mediterranean on the continent are mixed here, so the swamp regions are of a very transient type. For the local microclimate, the high-quality karst plateaus and peaks, which direct the air currents and the proximity of the Trieste and Kvarner Bay, are of decisive importance (ZGS, 2012).

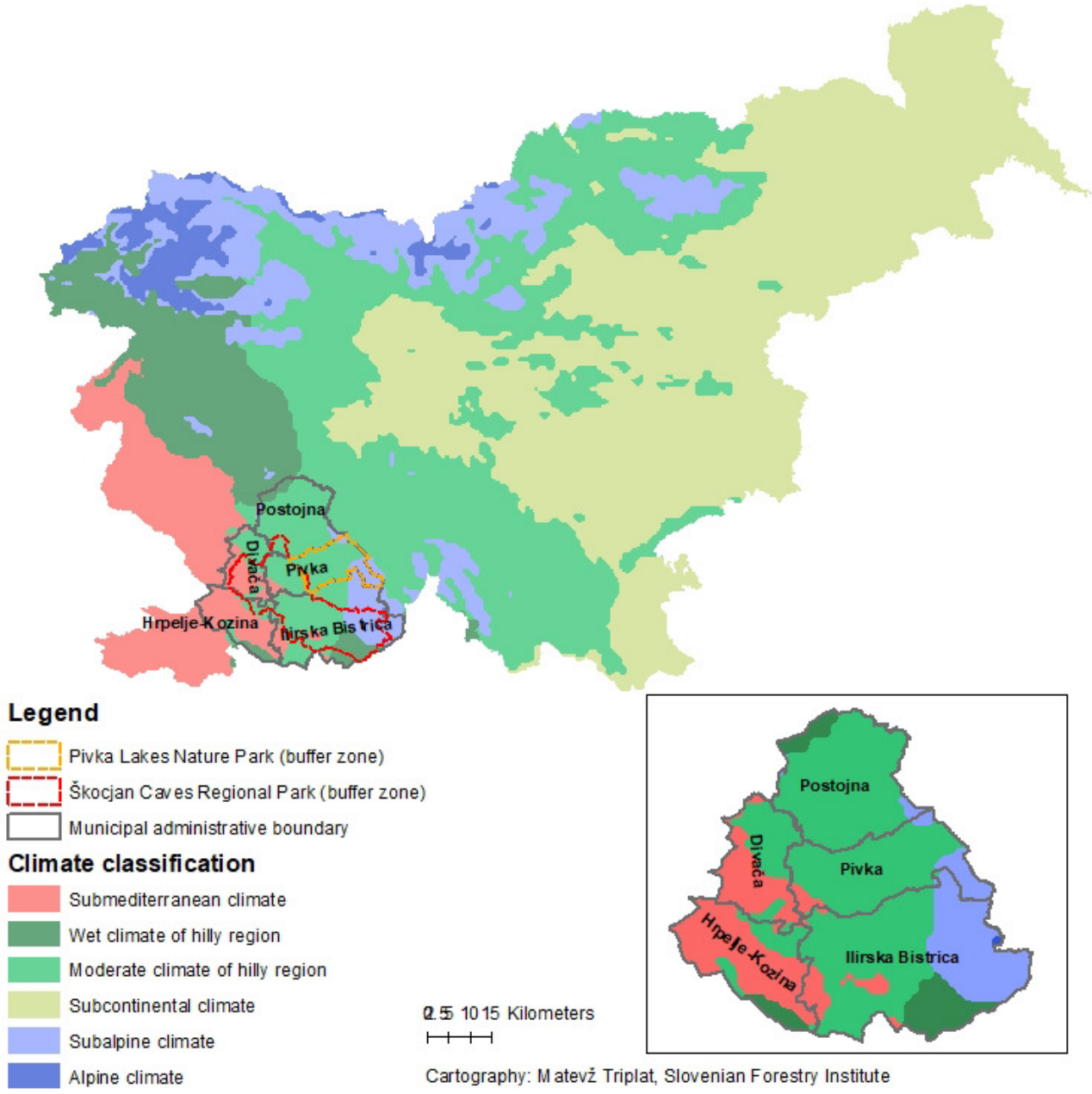


Figure 9: Climate classification of Slovenia and project area (Kozjek, 2017)

The most represented climate in the BDs are Moderate climate of hilly region (59 %), Submeditterranean climate (20 %), Subalpine climate (14 %) and Wet climate of hilly region (7%) – figure 11 and 12. A large part of the area - area around Ilirska Bistrica, Pivka and Postojna has a moderate climate of hilly region, the mean annual air temperature is between 8 and 10 °C. In the northwestern part of the study area the littoral influence is bigger (submediterranean climate). Therefore the mean annual temperature of the area around Kozina and Divača is a bit higher, between 10 and 12 °C. Air temperature generally drops with altitude; therefore the mean annual air temperature in the area of Javorniki and Snežnik is between 6 and 8 °C, on highest parts of

Snežnik between 4 and 6 °C. Also, only in Javorniki and Snežnik area, including Postojna and Hrušica in the north, the average January temperature drops below 0 °C.

Vegetation period is generally in lowlands from end of April until end of October, in mountains from middle of May until the end of September and varies each year. The annual timing of spring phenological phases (beech (*Fagus sylvatica* L.) and oak (*Quercus robur* L.) leaf unfolding, hazel (*Corylus avellana* L.) flowering and spruce (*Picea abies* A. Dietr.) growing young shoots), which are largely a response to temperature and reflect thermal conditions of the current year and location, shows around a difference of a month between area around Divača and Ilirska Bistirca and highest parts of Snežnik.

Precipitation increase from west, north-west to the south, east-south part of the study area and it varies between 1,400 mm and 1,500 mm per year in Čičarija while it exceeds to 3,200 mm in the most exposed slopes of Snežnik. There are two maximums: in late spring and in autumn.

Snowfall varies greatly due to the transitional nature of climate. Snow remains approximately 5 days in the area around Divača and Ilirska Bistrica and up to 5 months on the upper slopes of Snežnik.

Because of the temperature, precipitation and relief characteristics of the area, below 1,000 m above sea level often occurs heavy wet snow which causes tree breaks in forests. In the area below 800 m above sea level, sleet is often.

In the area there are northeastern wind called bora and south (southwest) wind. The bora is most common during the winter and it brings drought while south wind brings rain in spring and autumn. Adverse impacts of wind are breaking trees, curved growth and wind erosion.

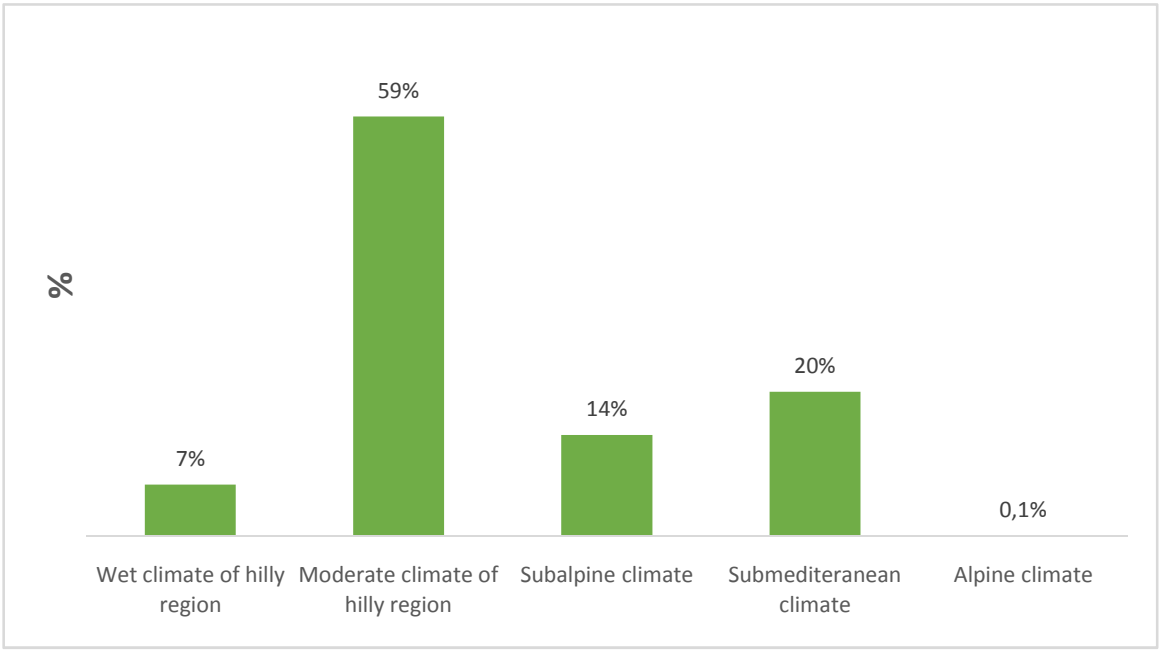


Figure 10: Climate classification in the project area (all biomass districts)

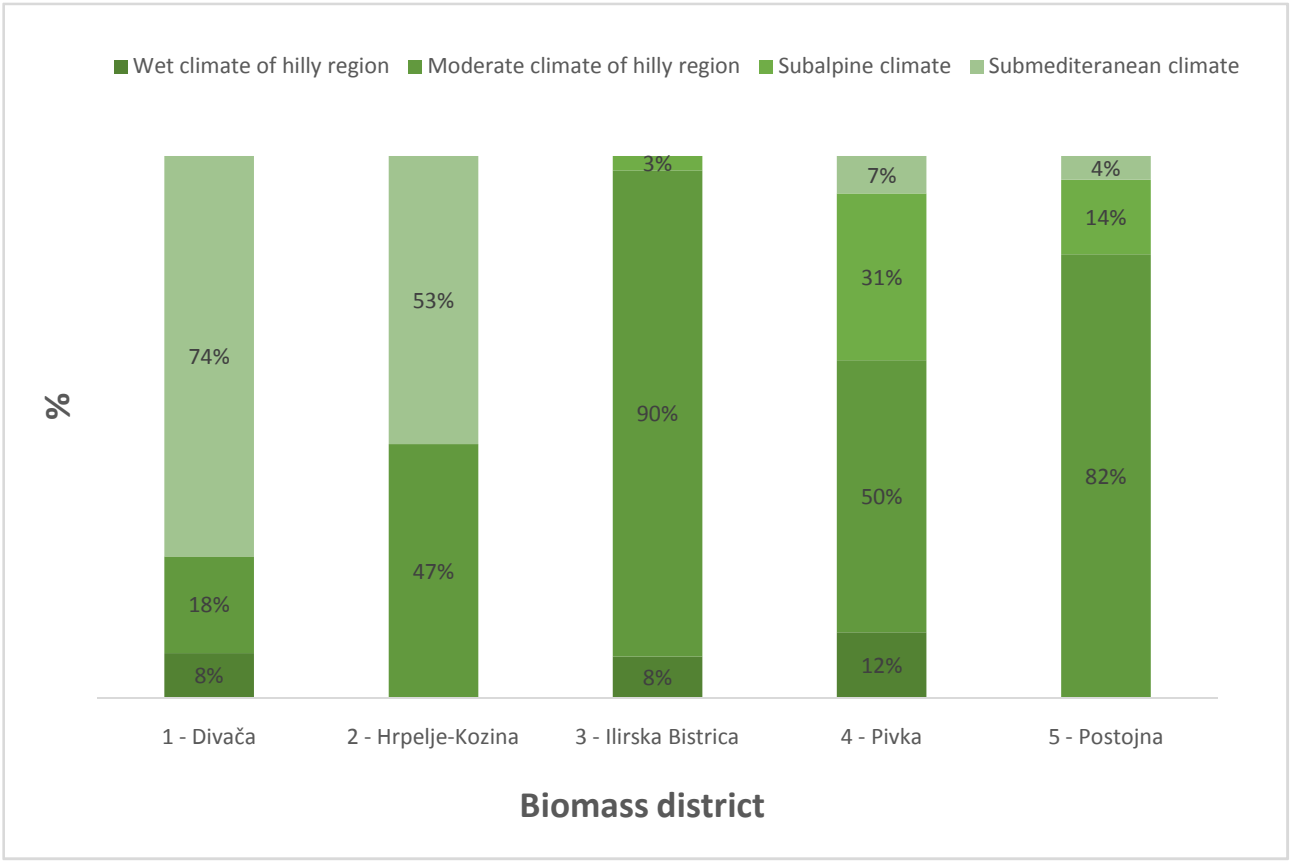


Figure 11: Distribution of the climate present in the biomass districts. The percentage values lower than 1% are not reported in the graph.

4.2.3 *Land use (including forests)*

The input data used for land use illustration is the national land use shapefile that the Ministry of Agriculture, Forestry and Food is responsible for. Within the study area forests represent majority

of the surfaces – nearly 70%; 6% represent the areas of extensive overgrowth, around 20% of the study area is used for agriculture.

Forests occupy 73,2% of Biomass District 3 area, followed by 70,2% Biomass District 4, 68,9% Biomass District 2, 66,8% Biomass District 5 and 66,3% Biomass District 1 (figure 13).

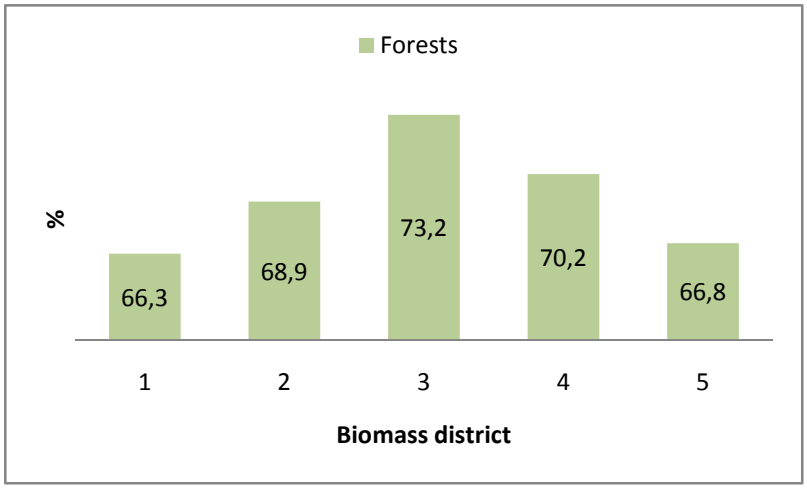


Figure 12: Representativeness of Forests in the Biomass districts

Areas of extensive overgrowth cover 11,4% of Biomass District 2, followed by 7% of Biomass District 1 and 6,4 % of Biomass District 3. In Biomass District 4 only 4,3% of the area are the areas of extensive overgrowth and 3,5% of Biomass District 5 (figure 14).

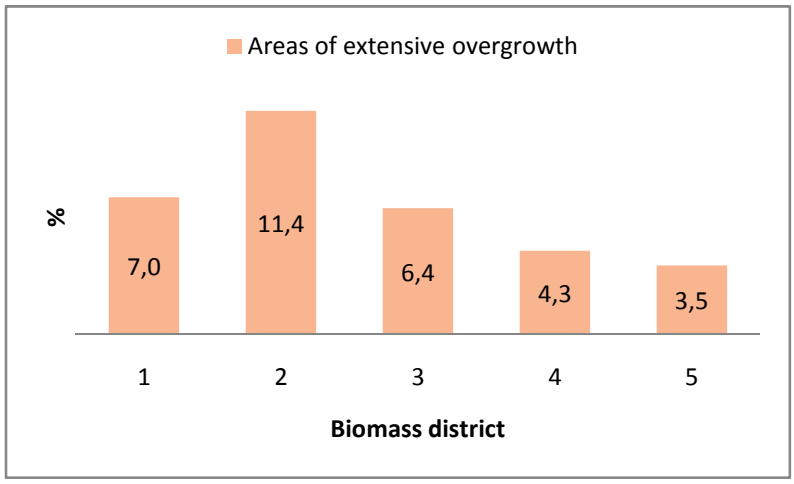


Figure 13: Representativeness of Areas of extensive overgrowth in the Biomass Districts

The land use is mainly defined by the karst geomorphology and the shallow soil that consequently represent unfavorable condition for agricultural use. Due to abandonment of agricultural use, areas of extensive overgrowth are increasing.

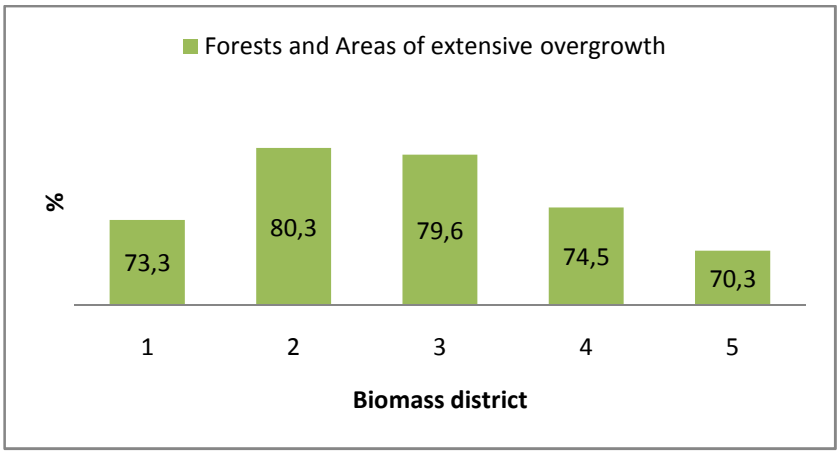


Figure 14: Representativeness of Forests and Areas of extensive overgrowth per Biomass district

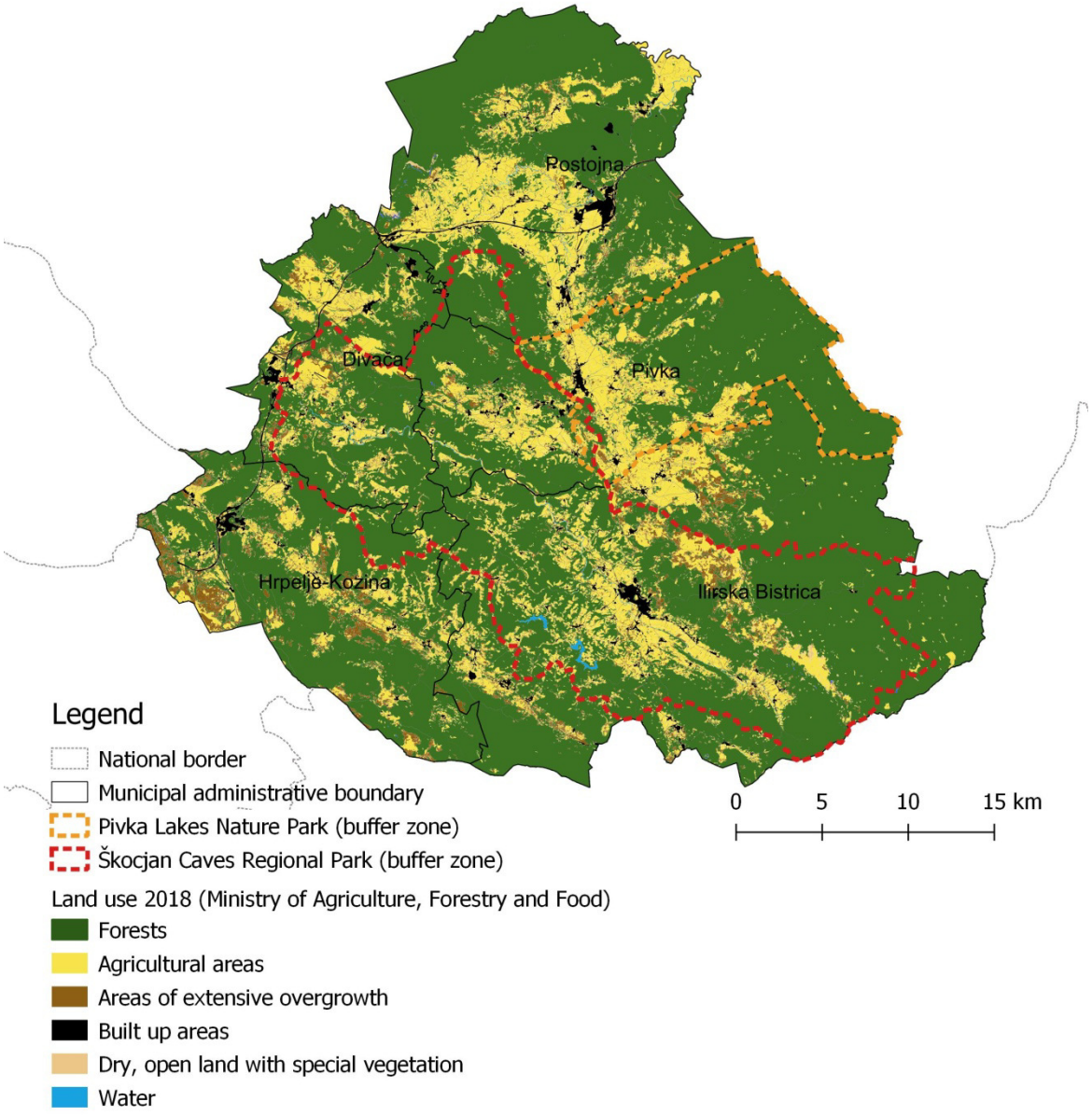


Figure 15: Land use within the project area

4.2.4 *Naturalistic, Environmental and Landscape restrictions*

Within the pilot area we are also faced with the large portion of Natura 2000 network and natural valuable features (natural heritage) (Figure 15, 16, 17 and table 8). More than 37% of Slovenia is covered by Natura 2000 network.

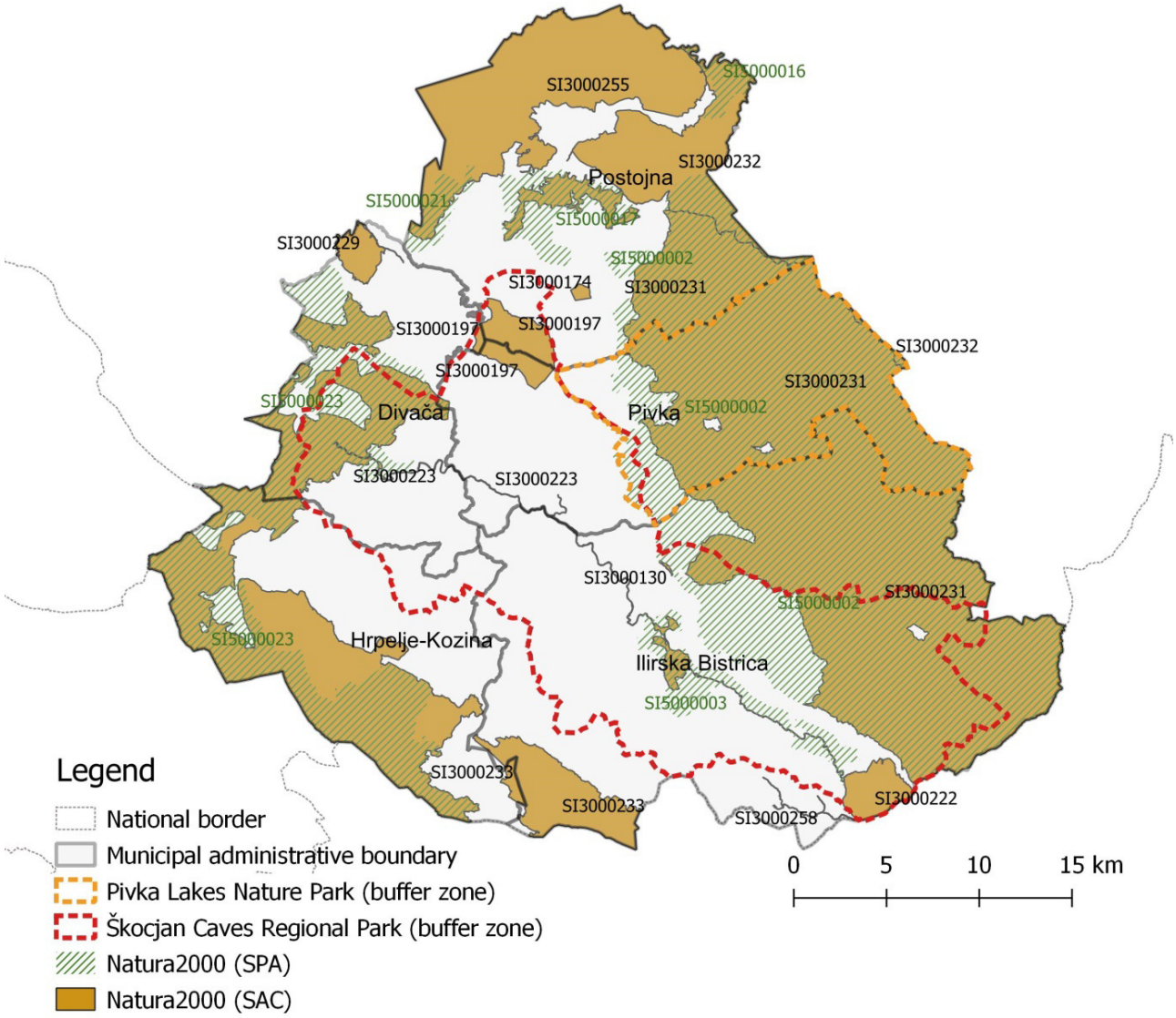


Figure 16: Natura 2000 sites

In next table (Table 7) the list of Natura 2000 sites within the study area in presented.

Table 7: List of Natura 2000 sites and share of the pilot area

Code and name of Natura 2000 site	Area (ha)	Area of the pilot area (%)
SI5000003 Dolina Reke (SPA)	1.865	1,42
SI5000023 Kras (SPA)	13.654	10,40
SI5000017 Nanoščica (SPA)	1.927	1,47

Code and name of Natura 2000 site	Area (ha)	Area of the pilot area (%)
SI5000016 Planinsko polje (SPA)	545	0,42
SI5000002 Snežnik – Pivka (SPA)	41.934	31,94
SI5000021 Vipavski rob (SPA)	716	0,55
SUM OF NATURA 2000 (SPA) SITES	**60.641**	**46,19**
SI3000226 Dolina Vipave (SAC)	6	0,00
SI3000231 Javorniki – Snežnik (SAC)	34.778	26,49
SI3000130 Kozja luknja (SAC)	12	0,01
SI3000276 Kras (SAC)	13.765	10,49
SI3000233 Matarsko podolje (SAC)	2.308	1,76
SI3000174 Mrzla jama pri Prestranku (SAC)	66	0,05
SI3000126 Nanoščica (SAC)	771	0,59
SI3000232 Notranjski trikotnik (SAC)	4.107	3,13
SI3000223 Reka (SAC)	441	0,34
SI3000197 Slavinski Ravnik (SAC)	1.185	0,90
SI3000258 Sušački, Smrdejski in Fabski potok (SAC)	19	0,01
SI3000255 Trnovski gozd – Nanos (SAC)	7.973	6,07
SI3000229 Vrhe nad Rašo (SAC)	515	0,39
SI3000222 Zabiče (SAC)	804	0,61
SUM OF NATURA 2000 (SAC) SITES	**66750,93**	**50,85**
SUM OF NATURA 2000 SITES	**78.733**	**59,97**

Valuable natural features are natural areas that represent natural heritage defined by the Rules on the designation and protection of natural values (Pravilnik o določitvi in varstvu naravnih vrednot (Uradni list RS, št. 111/04, 70/06, 58/09, 93/10 in 23/15)). They represent the entire natural heritage within Slovenia. Besides rare, precious or famous natural phenomenon, valuable natural feature can be a part of the living or non-living nature, natural area or a part of it, ecosystem, landscape or cultural landscape.

Where valuable natural features are defined, some activities and interventions can be implemented only if there are no other spatial or technical alternatives. Even in this case, it has to be carried out in a way that it does not represent a threat on the valuable natural feature existence or its characteristics.

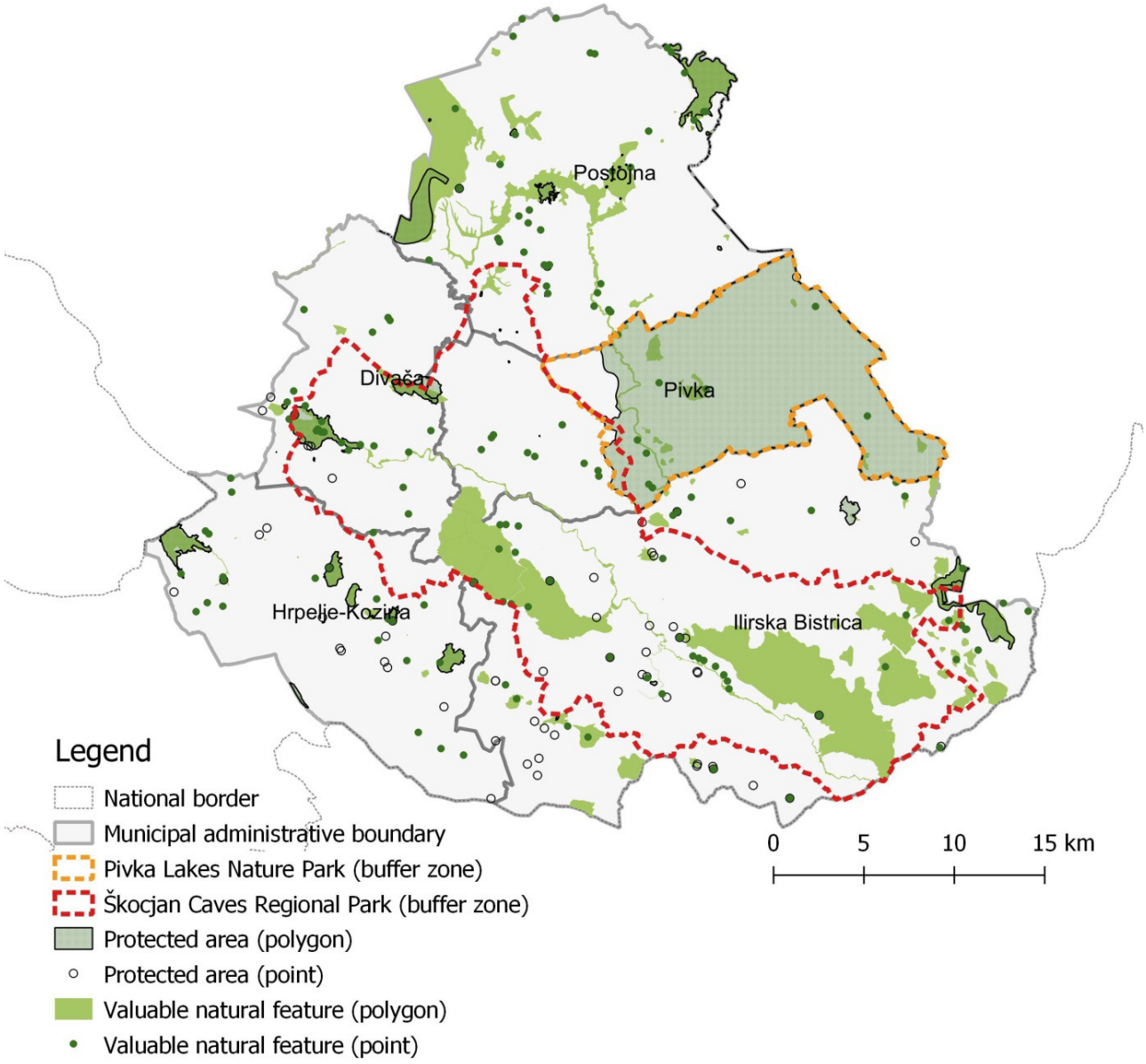


Figure 17: Valuable natural features and protected areas

Protected areas are one of the actions for nature protection. Nature Conservation Act (Zakon o ohranjanju narave (Uradni list RS, št. 96/04 – uradno prečiščeno besedilo, 61/06 – ZDru-1, 8/10 – ZSKZ-B, 46/14, 21/18 – ZNOrg in 31/18)) defines following categories of protection: National Park, Regional Park, Landscape Park, Strict Nature Reserve, Nature Reserve and Natural Monument.

Within the study area there is one Regional and one Landscape Park and several natural monuments.

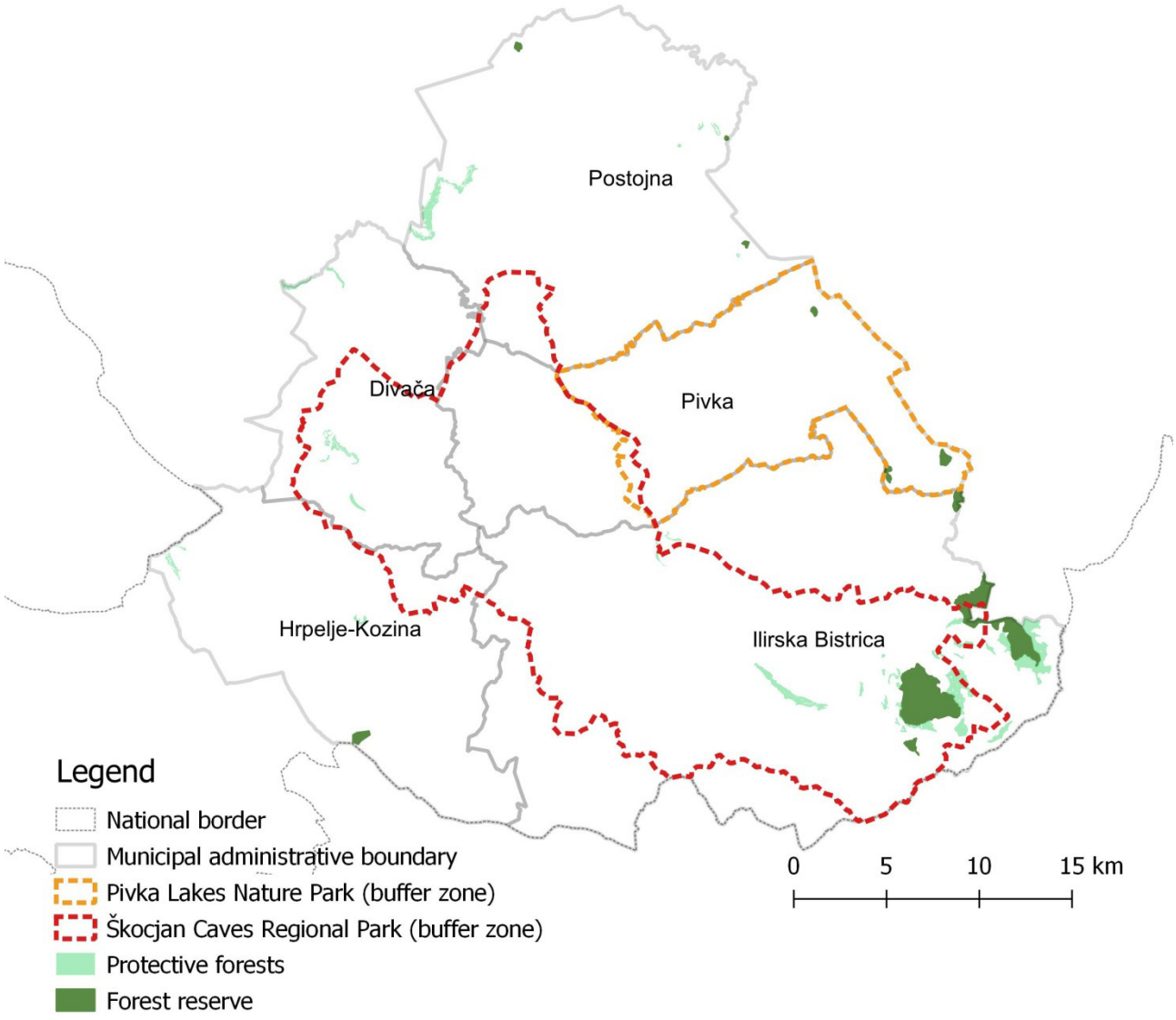


Figure 19: Protective forests and forest reserves

Protective forests and forest reserves and their special management regimes, the operators that are responsible for the management and those responsible for the provision of funds for its implementations are defined with the Decree on protective forests and forests with a special purpose (Uredba o varovalnih gozdovih in gozdovih s posebnim namenom (Uradni list RS, št. 88/05, 56/07, 29/09, 91/10, 1/13 in 39/15). Protective forests are forests that prevent from erosion processes, forests on the steep slopes; they have important function to prevent from noise, wind, negative impacts of water, avalanches and also forests that have important function for the biodiversity preservation in urban areas as well as the forests on the upper elevational limit of vegetation. For protective forests main objective set in the forest management plans is to

ensure stability of these forests and preserve their natural tree species composition and preservation or even improvement of their protective function. Forests with a special purpose with extraordinary research function are forest reserves. These forests are due to their development phase and their ongoing development extremely important for research, study and monitoring of the natural development of forests, biodiversity and natural valuable features protection as well as the cultural heritage. Forest reserves are excluded from forest management plans – no silvicultural measures are allowed within those areas.

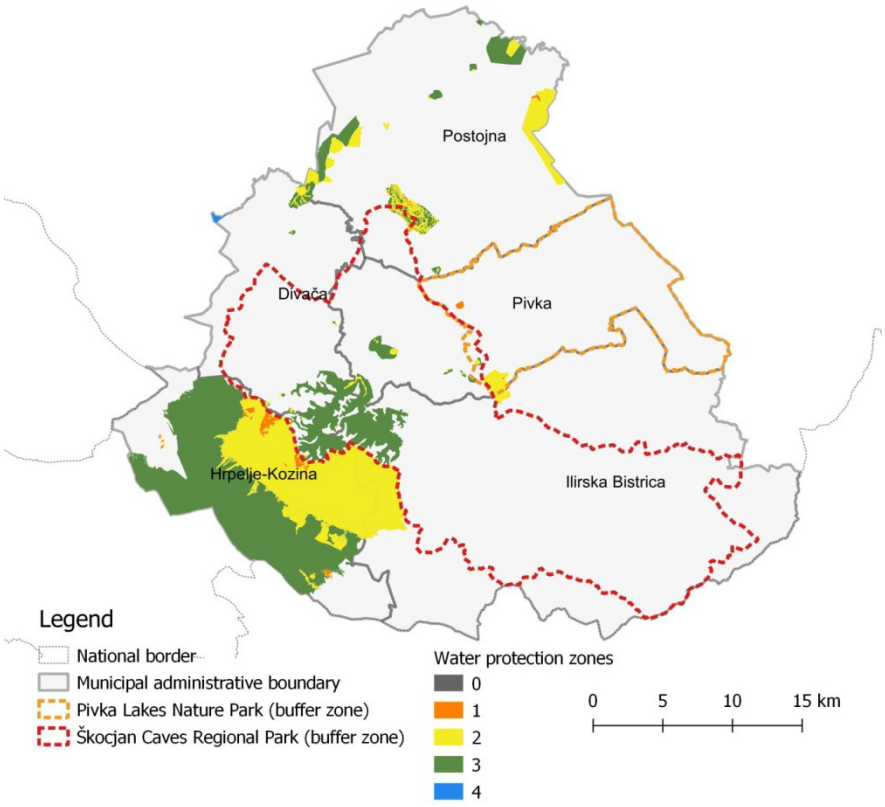


Figure 18: Water protection zones

It is important to assess the possible impacts of the forest management on the underground water. For the karst area the threat on the groundwater is high. The threat that forest management represent for the water protection zones is connected with the oil, petrol or diesel spills from the mechanization. It is important to warn the biomass producers of this danger. Water protection zones illustrated in the map above represent the strictest regime of water protection with number 1; 0 represents the area of water reservoir.

4.2.5 *Slope*

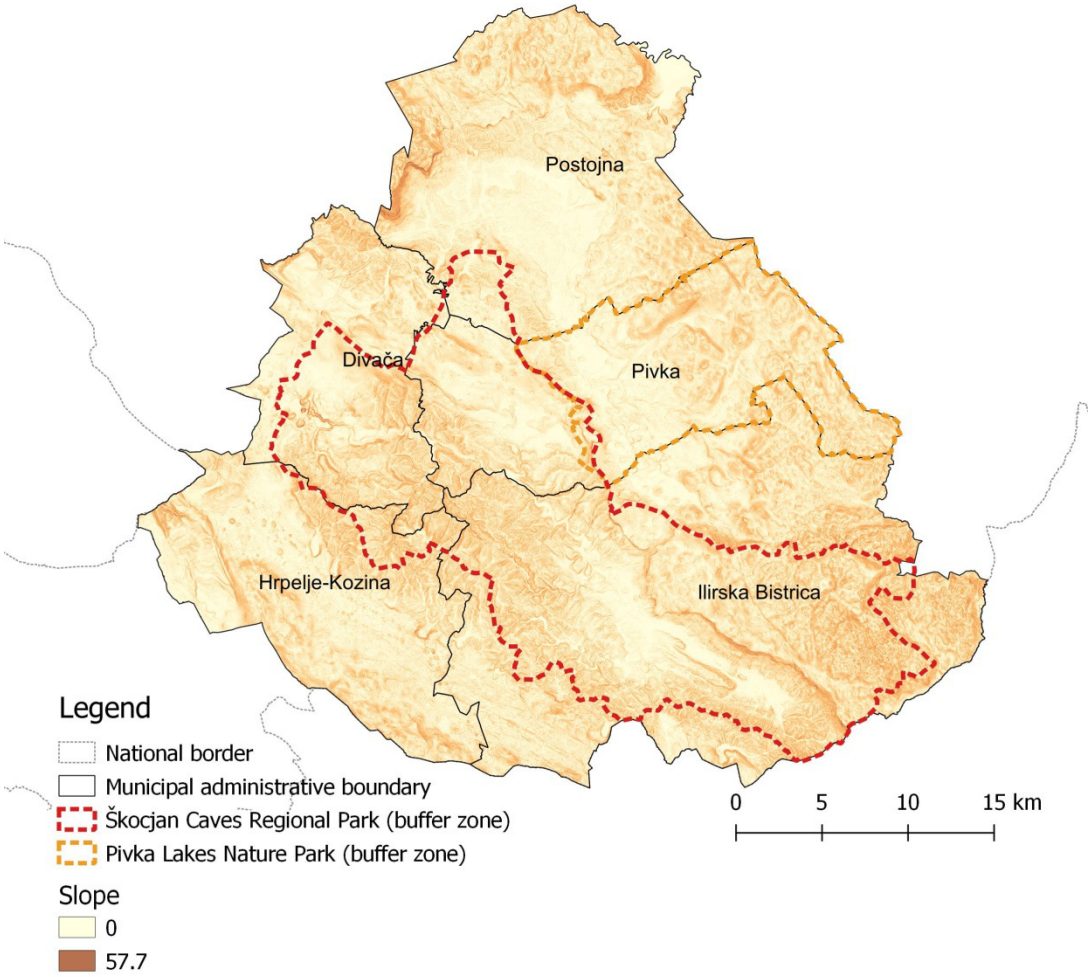


Figure 19: Slope within the study area

The upper map illustrates the slopes within the study area. Terrain inclinations are given in degrees. Slope range is between 0 (karst plateaus) and 57.7 degrees (steep mountain slopes). Map indicates that planes prevail over the steeper slopes.

Javorniki and Snežnik are high karst plateaus; due to the generally levelled surface the slopes are moderate. The surface is mainly stony, covered with patchy and shallow soil, except for the larger synclines. There are numerous dry valleys, deep sinkholes, collapse valleys, caves, shafts and cold-air pools. Because of the compact bedrock and shallow soil, there is low to insignificant chance for landslides to occur. Due to the karst nature of the plateaus, there is no groundwater.

The central and western parts of Brkini are hilly, while in the eastern part and the Jelšanska brda, the altitude difference is minor. Because of the moderate slopes and flysch bedrock there is high to very high chance for landslides to occur. This flysch terrain is on several points split by deep ravines or wider valleys through which stream waters are flowing. They sink in blind valleys under

the Matarsko podolje on the southern side of Brkini, while in the northern part of study area they flow into the Reka River.

Table 8: Slope clasess

Range (grade)	Slope class
0-10	flat/sub-flat
10-30	moderate
30-50	high
50-80	very high

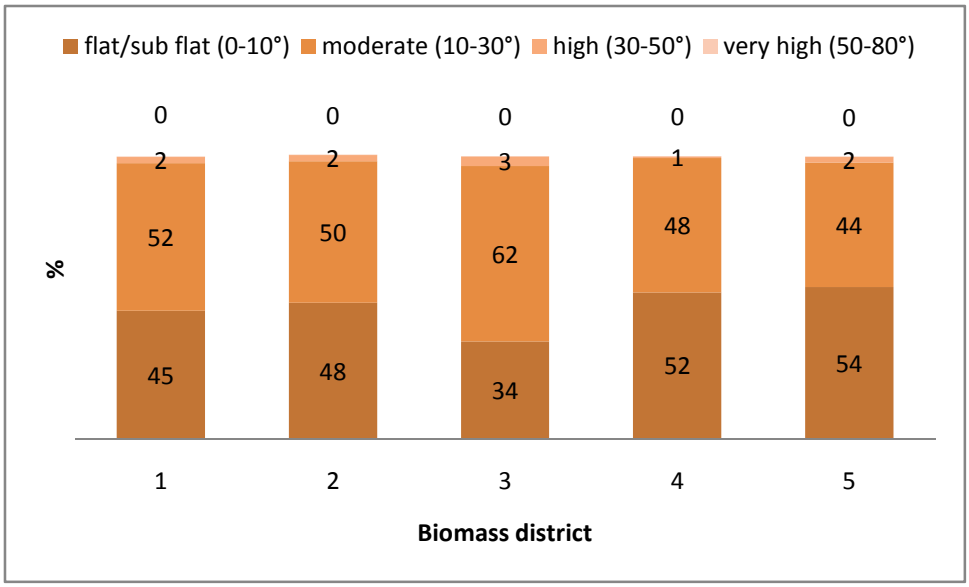


Figure 20: Distribution of Slope classes within the Biomass districts

As shown in figure 22, most of the territory of the BDs has a moderate slope. In District 1 the area with a gradient between 10 and 30 degrees is about 52% of the total, in District 2 it is about 50%, in District 3 it is 62%, in District 4 it is 48% and in District 5 it is 44%. The percentage of area with slope between 0 and 10 degrees (Flat/sub-flat) is also quite high in all BDs. In District 1 it occupies about 45% of the area of the district, in District 2 it occupies about 48%, in District 3 it covers 34%, in District 4 52% and in District 5 it occupies 54% of the total area. The areas with a gradient between 30 and 50 degrees (high slope) are very small - only in District 3 they cover 3% of the area, in District 1, 2 and 5 they cover 2%. Areas with a gradient between 50 and 80 degrees (very high slope) are negligible.

4.2.6 *Distribution and classification of the main road network*

In Slovenia a network of public roads are categorized in the following categories:

- Motorways – AC
- Expressways – HC,
- Expressways – HCH1,
- Main roads I – G1,
- Main roads II – G2,
- Regional roads I – R1,
- Regional roads II – R2,
- Regional roads III – R3,
- Regional tourist roads – RT,
- Local roads – LC,
- Main city roads – LG,
- Collection city roads – LZ,
- City/town roads – LK and
- Public paths – JP (Zlobec, 2014).

Data are collected by road managers: Motorway Company in the Republic of Slovenia (motorways and expressways with divisible carriageway), Directorate of the Republic of Slovenia for Roads (expressways without divisible carriageway, main and regional roads) and Municipalities (local roads and public paths). Each road manager reports data on roads into the Road Information Database, kept by the Directorate of the Republic of Slovenia for Roads.

Data of forest traffic routes and forest tracks is kept by Slovenia Forest Service (SFS).

For the biomass transport are suitable all the listed road categories of the network of public roads; motorways and major roads, main roads, regional roads, local roads and public paths. As well forest traffic routes are suitable for lorry roads, functional to transport biomass while forest tracks are suitable only for wood harvesting and skidding.

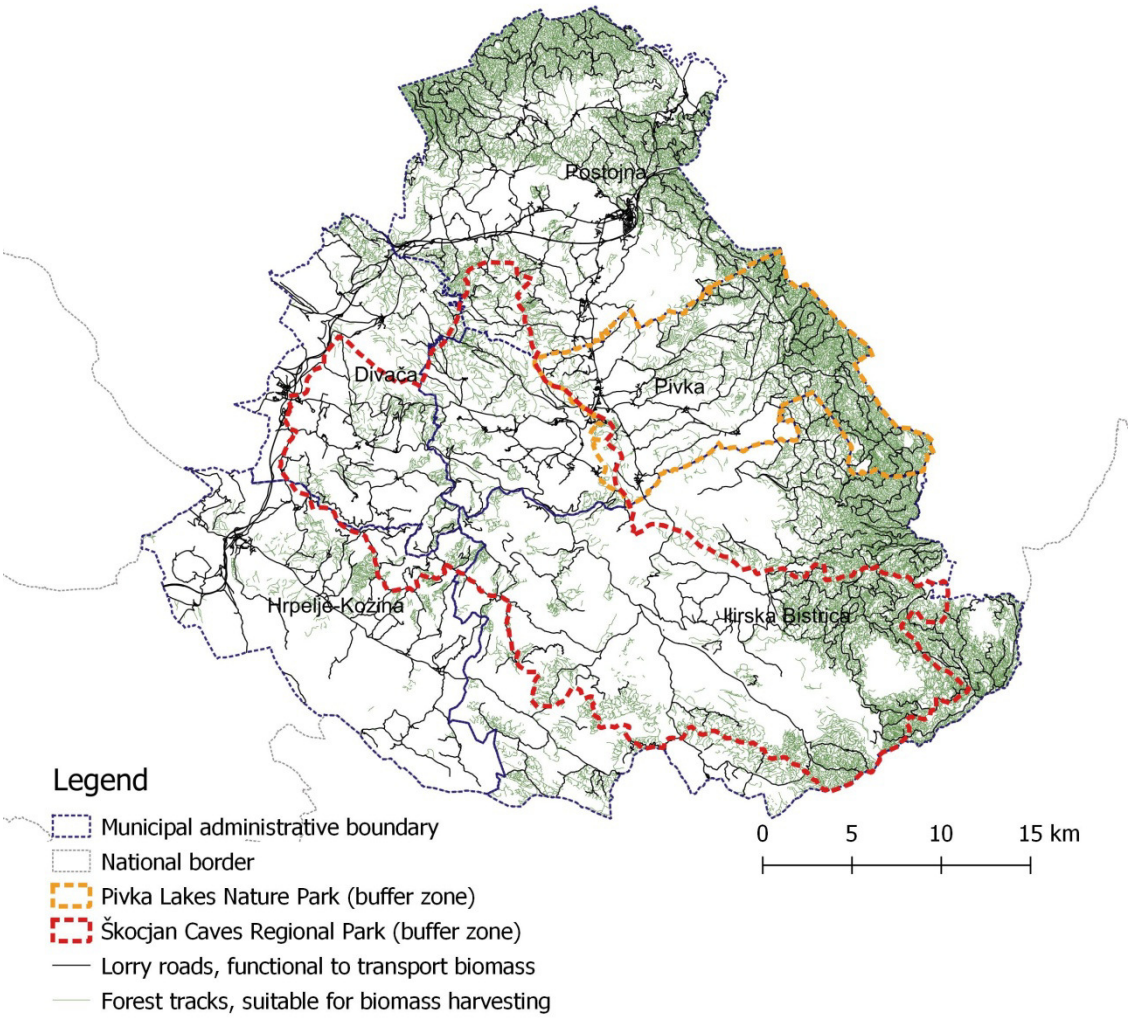


Figure 21: Characteristics and distribution of the main road network

Table 9: Length of lorry roads and forest tracks

Biomass District	Lorry roads, functional to transport biomass (km)	Forest tracks, suitable for biomass harvesting (km)
1 Divača	273	341
2 Hrpelje - Kozina	268	234
3 Ilirska Bistrica	532	2939
4 Pivka	394	1470
5 Postojna	544	2208

4.2.7 *Energy needs*

Data of energy needs within the study area were obtained from local energy concepts that are prepared for each municipality. Annual energy needs are categorized considering the energy consumer (residential buildings, public buildings. companies and industry and other consumers) as well as the energy resources (wood biomass, heating oil, liquefied petroleum gas or other energy sources).

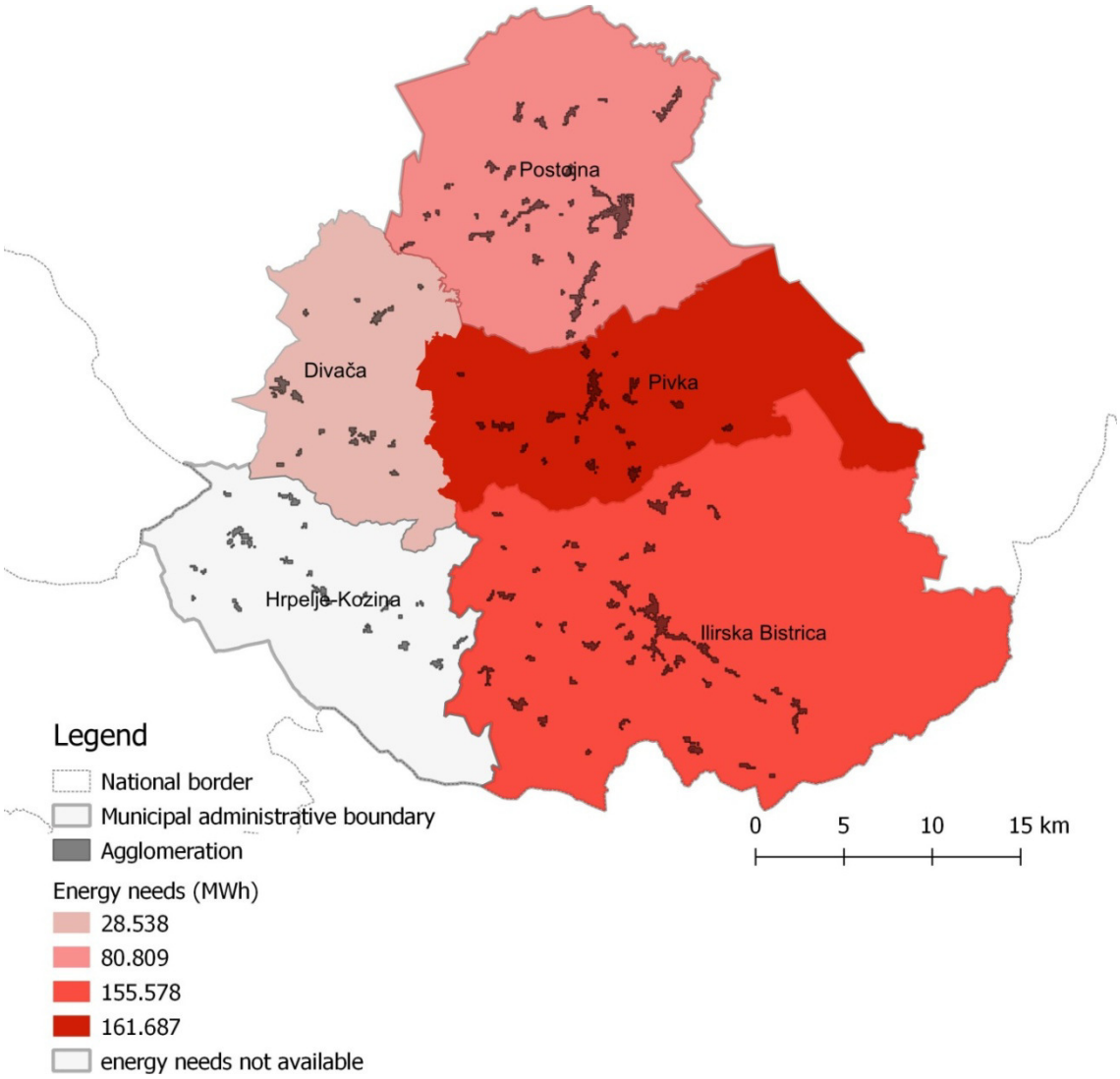


Figure 22: Energy needs within the study area

The map above represents annual energy needs of each municipality (biomass district). Highest energy needs are in municipalities of Pivka and Ilirska Bistrica. In the local energy concept of municipality of Hrpelje – Kozina data on energy needs are not available for all the energy consumers (data on companies and industry energy needs are not listed).

An important input for the project activities is the list of major consumers of energy, especially public buildings. Currently, there are many public buildings within the study area that are still using liquefied petroleum gas (LPG) and heating oil for heating purposes. This represents a big potential for the use of local biomass and consequently lower CO_2 emissions that are consistent with guidelines of local energy concepts. There the need for switch to alternative energy sources is pointed out.

Currently, approximately 70% of the energy needs are covered with wood fuels. All the public buildings that intend to refurbish the boiler station should be encouraged to switch to alternative energy sources (woody fuels, chips and pellets).

High share of energy needs for residential buildings is covered by wood fuels is a consequence of increasing prices of liquefied petroleum gas (LPG) and heating oil. Besides that many local people are forest owners and for them it is cheaper to take advantage of the wood biomass from their own forests. Other local residents usually buy the wood from local producers.

Biomass district 1: Municipality of Divača

Table 10: Energy needs in the Biomass district 1

Biomass district 1	Energy consumer	Wood fuels (KWh/year)	Heating oil (KWh/year)	Liquefied petroleum gas (KWh/year)	Other energy sources (KWh/year)	SUM of energy needs (KWh/year)	Share of energy need, covered by wood biomass (%)
DIVAČA	residential buildings	10.627.997	6.255.019	2.987.460	0	19.870.476	**53**
	public buildings	40.035	638.498	182.816	0	861.349	**5**
	companies, industry	131.821	5.757.232	167.343	0	6.056.396	**2**
	other consumers	186.456	1.563.754	0	0	1.750.210	**11**
	SUM	**10.986.309**	**14.214.503**	**3.337.619**	**0**	**28.538.431**	**38**

Considering the data on the use of energy sources, municipality of Divača has the lowest share of energy need, 38% of which is covered with use of wood fuels. As it is characteristic for the whole study area, majority of the wood fuels is used for the heating of residential buildings – 97% of all wood fuels used within the municipal area.

53% of the residential buildings energy needs are covered by the use of wood fuels. Compared to other biomass districts, share of heating oil consumption of residential buildings is rather high. Public buildings, companies and industry represent energy consumers that have the smallest share of energy needs covered by wood fuels.

Biomass district 2: Municipality of Hrpelje – Kozina

Table 11: Energy needs in the Biomass district 2

Biomass district 2	Energy consumer	Wood fuels (KWh/year)	Heating oil (KWh/year)	Liquefied petroleum gas (KWh/year)	Other energy sources (KWh/year)	SUM of energy needs (KWh/year)	Share of energy need, covered by wood biomass (%)
HRPELJE-KOZINA	residential buildings	19.215	7.383	371	0	26.969	**71**
	public buildings	400	833	747	0	1.980	**20**
	companies, industry	no data	no data	no data	no data	no data	**no data**
	SUM	**19.615**	**8.216**	**1.118**	**0**	**28.949**	**68**

Considering the data on the use of energy sources, municipality of Hrpelje – Kozina has 68% of energy needs covered by wood fuels. As there is no data available on energy needs of companies and industry, shares of wood fuels use, comparison to municipal energy needs is not relevant. 71% of the residential buildings energy needs are covered by use of wood fuels.

Biomass district 3: Municipality of Ilirska Bistrica

Table 12: Energy needs in the Biomass district 3

Biomass district 3	Energy consumer	Wood fuels (KWh/year)	Heating oil (KWh/year)	Liquefied petroleum gas (KWh/year)	Other energy sources (KWh/year)	SUM of energy needs (KWh/year)	Share of energy need, covered by wood biomass (%)
ILIRSKA BISTRICA	residential buildings	46.848.939	20.589.749	2.807.064	691.396	70.937.148	**66**
	public buildings	0	3.704.030	880.683	0	4.584.713	**0**
	companies, industry	64.954.150	5.796.240	675.514	6.030.600	77.456.504	**84**
	other consumers	0	2.600.000	0	0	2.600.000	**0**
	SUM	**111.803.089**	**32.690.019**	**4.363.261**	**6.721.996**	**155.578.365**	**72**

Considering the data on use of energy sources, municipality of Ilirska Bistrica 72% of energy needs are covered by use of wood fuels. 42% of all wood fuels used within the municipal area are used for the heating of residential buildings.

66% of the residential buildings energy needs are covered by use of wood fuels. Companies and industry have a great share of energy needs covered by use of wood fuels – 84%. Public buildings within this biomass district are using only liquefied petroleum gas (LPG) and heating oil for heating purposes.

Biomass district 4: Municipality of Pivka

Table 13: Energy needs in the Biomass district 4

Biomass district 4	Energy consumer	Wood fuels (KWh/year)	Heating oil (KWh/year)	Liquefied petroleum gas (KWh/year)	Other energy sources (KWh/year)	SUM of energy needs (KWh/year)	Share of energy need, covered by wood biomass (%)
PIVKA	residential buildings	21.698.598	10.796.815	599.823	0	33.095.236	**66**
	public buildings	866.983	904.629	590.286	0	2.361.898	**37**
	companies, industry	105.163.000	8.588.595	1.535.172	4.444.000	119.730.767	**88**
	other consumers	4.339.720	2.159.363	0	0	6.499.083	**67**
	SUM	**132.068.301**	**22.449.402**	**2.725.281**	**4.444.000**	**161.686.984**	**82**

Considering the data on use of energy sources within municipality Pivka, 82% of energy needs are covered by use of wood fuels. 42% of all wood fuels used within the municipal area are used for the heating of residential buildings.

66% of the residential buildings energy needs are covered by use of wood fuels. As well, companies and industry have a great share of energy needs covered by use of wood fuels – 88%. Share of wood fuels used in public buildings is the greatest within this biomass district – it covers 37% of all energy needs of public buildings within this biomass district.

Biomass district 5: Municipality of Postojna

Table 14: Energy needs in the Biomass district 5

Biomass district 5	Energy consumer	Wood fuels (KWh/year)	Heating oil (KWh/year)	Liquefied petroleum gas (KWh/year)	Other energy sources (KWh/year)	SUM of energy needs (KWh/year)	Share of energy need, covered by wood biomass (%)
POSTOJNA	residential buildings	40.771.887	15.314.095	4.063.928	2.360.152	62.510.062	**65**
	public buildings	299.545	2.362.675	501.576	1.342.776	4.506.572	**7**
	companies, industry	3.895.962	6.375.750	2.674.319	846.232	12.946.031	**30**
	SUM	**44.967.394**	**24.052.520**	**7.239.823**	**4.549.160**	**80.808.897**	**56**

Considering the data on use of energy sources within municipality of Postojna, 56% of energy needs are covered by use of wood fuels. 90% of all wood fuels used within the municipal area are used for heating of residential buildings.

65% of the residential buildings energy needs are covered by use of wood fuels. Companies and industry cover 30% of energy needs covered by use of wood fuels. Share of wood fuels used for heating purposes in public buildings represents 7% of all energy needs of public buildings.

Table 15: Public building within the study area as potential consumers of wood fuels for heating purposes

Potential public building	Heating oil	Liquefied petroleum gas
Biomass district 1: Municipality Divača		
Osnovna šola Divača	**x**	
Osnovna šola Senožeče	**x**	
Osnovna šola Vremski Britof	**x**	
Vrtec Divača	**x**	
Stara osnovna šola Divača	**x**	
Občinska stavba		**x**
Zdravstvena postaja Divača		**x**
Zdravstvena postaja Senožeče		**x**
Gasilni dom Senožeče		**x**
Škrateljnova domačija in muzej		**x**
Biomass district 2: Municipality Hrpelje – Kozina		
Občina Hrpelje-Kozina		**x**
ZD Sežana, Zdravstvena postaja	**x**	

Podružnična šola Obrov	x	
PGD Materija		x
Biomass district 3: Municipality Ilirska Bistrica		
OŠ Podgora Kuteževo		x
OŠ Antona Žnideršiča Ilirska Bistrica	x	
OŠ Toneta Tomšiča Knežak	x	
OŠ Rudolfa Ukoviča Podgrad	x	
OŠ Dragotina Ketteja Ilirska Bistrica	x	
OŠ Jelšane	x	
OŠ Rudija Mahniča – Brkinča Pregarje	x	
Enota vrtec pri OŠ Antona Žnideršiča Ilirska Bistrica	x	
Kraške lekarne Ilirska Bistrica	x	
Knjižnica Makse Samsa Ilirska Bistrica		x
Dom starejših občanov Ilirska Bistrica	x	x
Center za socialno delo Ilirska Bistrica		x
Zdravstveni dom Ilirska Bistrica – centralna stavba	x	
Zdravstveni dom Ilirska Bistrica – zobozdravstvo		x
Zdravstveni dom Ilirska Bistrica – ZP Podgrad		x
Glasbena šola	x	x
Gimnazija Ilirska Bistrica		x
Občinska stavba	x	
Biomass district 4: Municipality Pivka		
OŠ Pivka	x	
Vrtec Pivka - enota Vetrnica		x
Vrtec Pivka - enota Mavrica	x	
Podružnična šola Šmihel	x	
Podružnična šola Zagorje	x	
OŠ in vrtec Košana	x	
Občinska stavba		x
Zdravstvena postaja in Kraške lekarne Pivka	x	
Biomass district 5: Municipality Postojna		
Hotel, motel	x	
Trgovsko-nakupovalni center		x
Trgovsko-nakupovalni center		x
Stavba za posebne namene	x	
Srednja gozdarska in lesarska šola	x	
Trgovsko-nakupovalni center	x	
Stanovanjski blok	x	
Banka, zavarovalnica	x	
Stanovanjski blok	x	

The table above shows the list of public building within all 5 identified biomass districts that represent potential consumers of wood fuels. All the listed buildings are using liquefied petroleum gas (LPG) and heating oil for heating purposes.

4.2.8 *Private companies operating in the biomass sector*

The most important private beneficiaries in selected BDs are two Slovenian biggest wood pellet mills and sawmilling industry, which is situated in municipality Pivka and Ilirska Bistrica. There are also some small-scale district heating systems and woodchips producers.

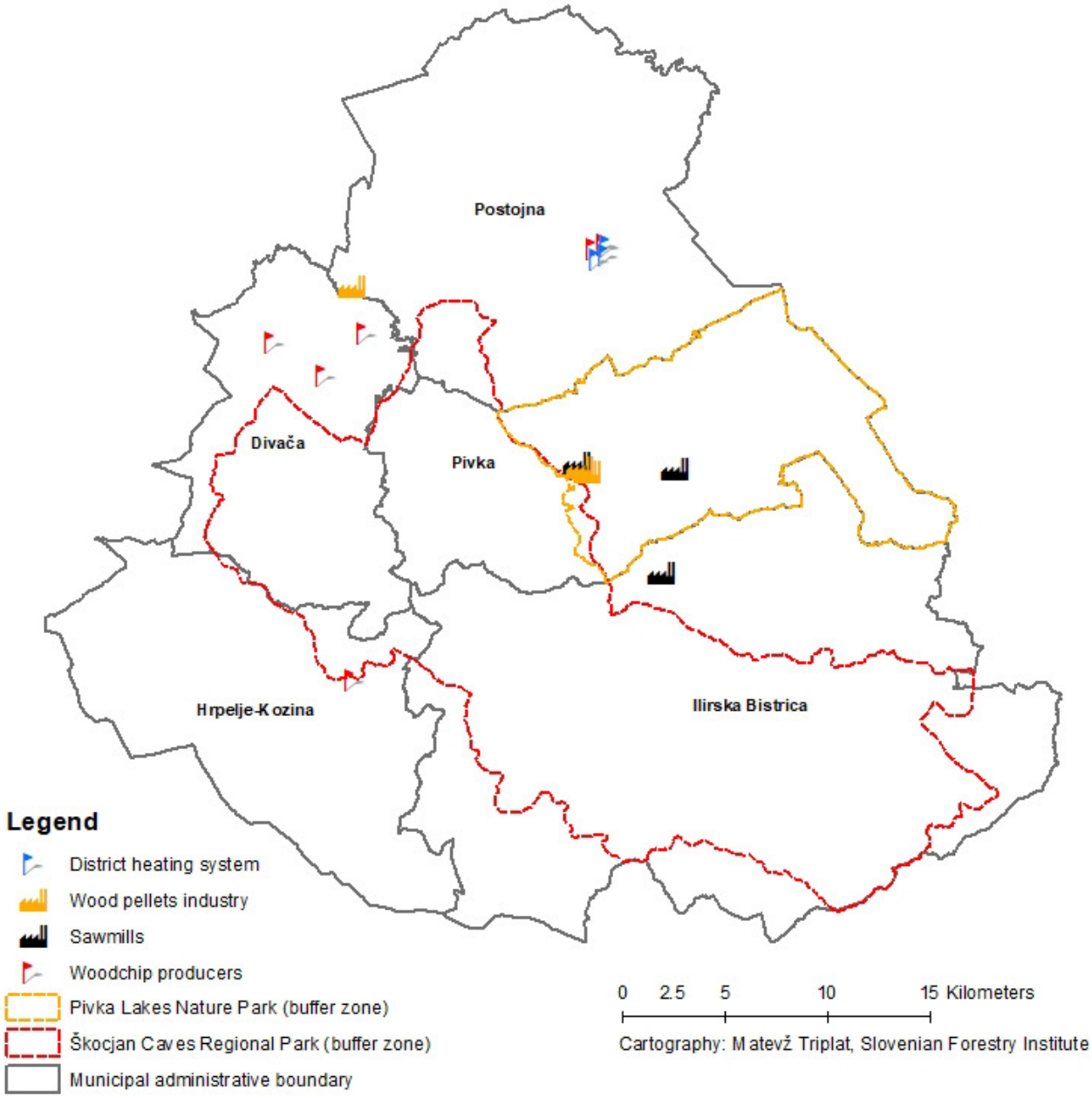


Figure 23: Characteristics and distribution of private companies operating in biomass sector

4.3 Final remarks

Available data about wood potentials and present wood biomass use were collected from different available resources. Also, other relevant data were collected and evaluated.

The specifics of selected and presented pilot area are:

- High available biomass potentials (not only from forests but also from the areas of extensive overgrowth).
- The demand for heat is high and according to available data around 40 % of households are still using fossil fuels for heating. Large potential users are also public buildings.
- There are only few larger wood biomass producers in the area.
- Natural conditions vary significantly in the pilot area.

Due to poor integration of stakeholders, biomass wood chains are not strong and fully developed yet. Considering the biomass heating systems, the interest for them is present but the investments costs are high and the reason people rarely decide for it.

4.4 References

Atlas okolja, Agencija Republike Slovenije za okolje. source: http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso (23.5.2018)

Decree on protective forests and forests with a special purpose (Uredba o varovalnih gozdovih in gozdovih s posebnim namenom (Uradni list RS, št. 88/05, 56/07, 29/09, 91/10, 1/13 in 39/15) source: http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED3176 (23.5.2018)

Eco Consulting, 2008. Energetski koncept občine Ilirska Bistrica – končno poročilo. 145 pages.

Eco Consulting, 2010. Energetski koncept občine Hrpelje - Kozina – končno poročilo. 153 pages.

eGeologija, Geološki zavod Slovenije. source: http://www.egeologija.si/geonetwork/srv/eng/catalog.search#/home (23.5.2018)

Goriška lokalna energetska agencija, 2011. Lokalni energetski koncept občine Divača – končno poročilo. 246 pages.

Goriška lokalna energetska agencija, 2012. Lokalni energetski koncept občine Pivka – končno poročilo. 246 pages.

Hedgelink 2015. Wood Fuel from Hedges. http://hedgelink.org.uk/index.php

Kozjek, K., Dolinar, M., Skok, G., 2017. Objective climate classification of Slovenia. International Journal of Climatology 37, 848-860.

Mali, B., Grah, A., Skudnik, M., Kobler, A., 2017: Vzorčenje in ocena zalog ogljika v nadzemni lesni biomasi na kmetijskih zemljiščih v letu 2017. Gozdarski inštitut Slovenije, 19 pages.

Ministrstvo za okolje in prostor, Agencija Republike Slovenije za okolje, Naravne vrednote – Varstvo naravnih vrednot. source: http://www.arso.gov.si/narava/naravne%20vrednote/ (23.5.2018)

Ministrstvo za okolje in prostor, Agencija Republike Slovenije za okolje, Zavarovana območja. source: http://www.arso.gov.si/narava/zavarovana%20obmo%c4%8dja/ (23.5.2018)

Nature Conservation Act (Zakon o ohranjanju narave (Uradni list RS, št. 96/04 – uradno prečiščeno besedilo, 61/06 – ZDru-1, 8/10 – ZSKZ-B, 46/14, 21/18 – ZNOrg in 31/18). source: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO1600 (23.5.2018)

Rules on the designation and protection of natural values (Pravilnik o določitvi in varstvu naravnih vrednot (Uradni list RS, št. 111/04, 70/06, 58/09, 93/10 in 23/15). source: http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV6035 (23.5.2018)

SIPPO, svetovanje in projektiranje na področju okolja, d.o.o., 2012. Lokalni energetski koncept občine Postojna. 183 pages.

Zavod za gozdove Slovenije (ZGS), Območna enota Postojna, 2012. Gozdnogospodarski načrt gozdnogospodarskegaobmočja Postojna (2011-2020), št. 05/11.

Zavod za gozdove Slovenije (ZGS), Območna enota Sežana, 2012. Gozdnogospodarski načrt kraškega gozdnogospodarskegaobmočja (2011-2020), št. 14/11.

Zlobec, M., 2014. Road infrastracture, Slovenia. source: http://www.stat.si/StatWeb/File/DocSysFile/8025 (23.5.2018)

5. GEOGRAPHICAL IDENTIFICATION AND DESCRIPTION OF BIOMASS DISTRICTS (BDs) WITHIN THE ZADAR COUNTY (CROATIA)

5.1 Identification of BDs

In Zadar county 3 pilot areas/nature parks are selected. These pilot areas are spatially dispersed troughout Zadar County. Nature Park Telaščica is located on Dugi otok (Long Island), Vransko lake is in the center of the County and Velebit is stretching from northern part of the County trough Lika-Senj County also. Due to size and other characteristics, Telaščica and Vransko jezero are set as distinctive biomass districts.

As for Velebit (Zadar county part), two biomass districts are created, one for the northern (inland part) and one form southern part (towards coastal side). These two BDs are very distinctive representing beech forests located inlands against mostly degraded sub-Mediterranean forests towards coastline.

We have also included CORINE categories 324 and 243 due to forest succession and agriculture cessation that are very expressed in these areas.

Table 1. Land cover classification

District ID	Protected area	Forests (311, 312, 313)			Succession (324, 243)			Permanent crops (221, 222, 223)			Total area (forests plus permanent crops)	Energy needs (expressed in m^3 of biomass)
		Within the park	Outside the park	Total	Within the park	Outside the park	Total	Within the park	Outside the park	Total		
		a	*b*	*c = a+b*	*d*	*e*	*f = d+e*	*g*	*h*	*i = g+h*	*j = c+f+i*	
		ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	m^3
BD 1	Velebit (Municipality Gračac)	10.083,92	32.445,88	**42.529,80**	**6.982,61** (wooded 6.686,18, agricultural 296,43)	**15.004,93** (wooded 8.503,02, agricultural 6.501,91)	**21.987,54** (wooded 15.189,20, agricultural 6.798,34)	-	-	-	**64.517,34**	3.154
BD 2	Velebit (Municipality Obrovac, Jasenice i Starigrad without National park)	1.980,81	3074,53	**5.055,34**	**9.206,83** (wooded 7262,78, agricultural 1.944,05)	**2.250,18** (wooded 2.210,86, agricultural 39,32)	**11.456,01** (wooded 9.473,64, agricultural 1.983,37)	-	-	-	**16.511,35**	4.639
BD 3	Telašćica (Municipality Sali)	182,25	3.084,60	**3.296,85**	wooded 102,58	**3.100,60** (wooded 2.284,77, agricultural 713,25)	**3.100,60** (wooded 2.387,35, agricultural 713,25)	240,35	1.120,20	**1.360,55**	**7.757,15**	1.739
BD 4	Vransko jezero (Municipality Pakoštane)	348,82	340,92	**689,74**	**243,24** (wooded 150,58, agricultural 92,66)	**1.231,41** (wooded 884,21, agricultural 347,20)	**1.474,65** (wooded 1.034,79, agricultural 439,86)	91,52	134,63	**226,15**	**2390,54**	2.692
Total		**12.595,80**	**38.945,93**	**51.571,73**	**16.535,26**	**26.544,73**	**38.018,8**	**331,87**	**1.254,83**	**1.586,7**	**91.177,23**	12.224

5.2 Description of BDs

5.2.1 BD 1 Nature Park Velebit (Municipality Gračac)

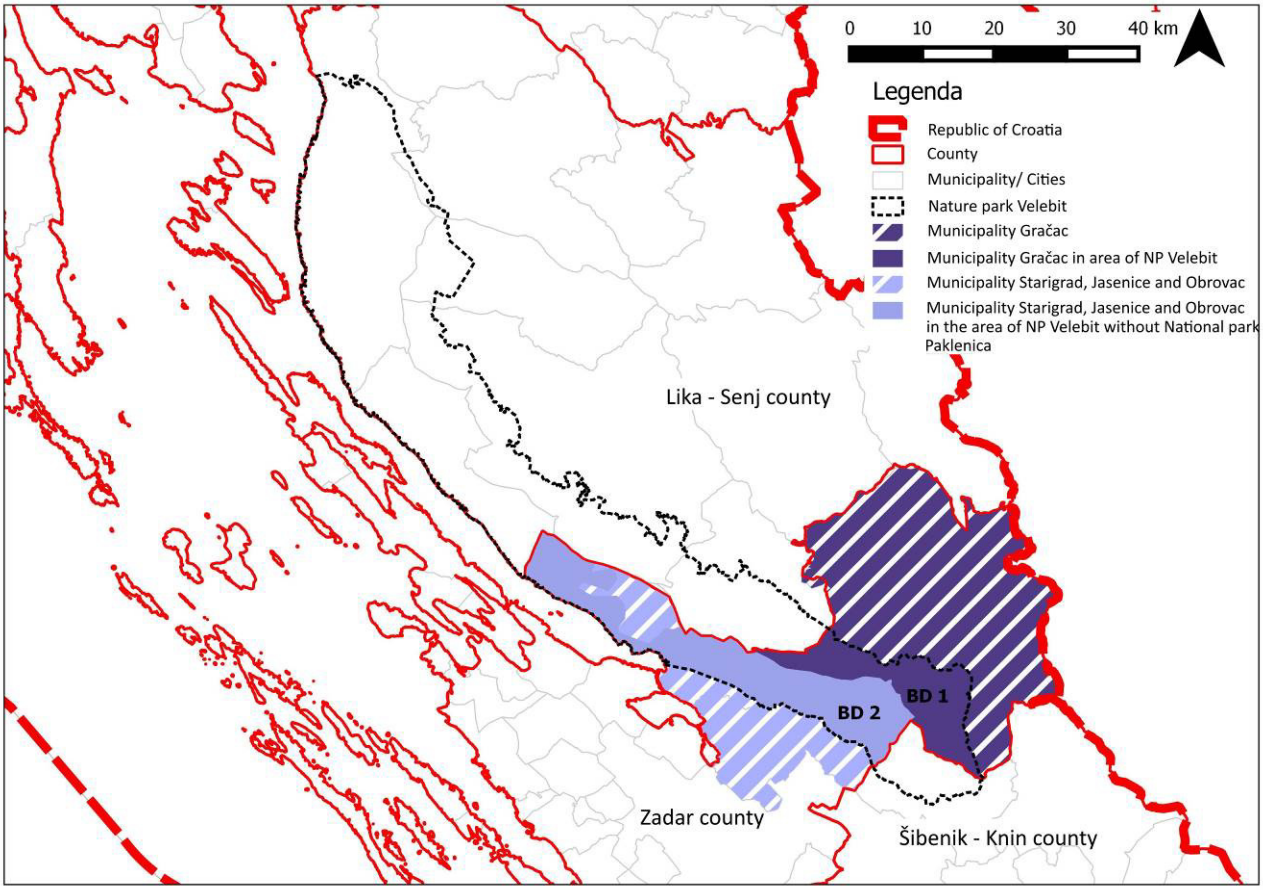


Figure 1. Administrative division for the area of Velebit Nature Park (Source: Oikon d.o.o.)

5.2.1.1 *Territorial and administrative borders*

Territorial, BD (Biomass district) 1 The Velebit Nature Park is located on the northeast slopes of Velebit, which are almost straightforwardly bordered in the east by the Zrmanja River Canyon, ie its upper course. Altitude in the mountainous part of this area ranges from 400 to 1400 m, while in the Zrmanja canyon are down to 250 m.

Administratively, Velebit Nature Park extends to the area of Lika-Senj, Zadar i Šibenik-Knin county. BD 1 Velebit Nature Park includes part of Gračac municipality in Zadar county. Part of the Velebit Nature Park, located in the municipality of Gračac, is located in the most southern part of the municipality, on the area of 17,526.15 hectares (Figure 1).

5.2.1.2 *Geomorphological features and soil*

In the area of BD 1 of the Velebit Nature Park, the limestones of different composition and age are most represented. Geologically speaking, there are paleozoic (carbon, permian) and mesozoic complexes (triassic, jurassic, cretaceous) of carbonate rocks.On such basis, the largest part (about 10,930 ha or 82%) is represented by Brown soil on limestone.

Table 2. Most common cartographic unit of soil in BD 1 area of Velebit Nature Park

Number	Systematic soil unit name	Representation (%)
56	**Brown on limestone**	**40**
	Calcareous – dolomite black	25
	Rendzine	10
	Illimerzied on limestone	10
	Ruddle	5
	Other	10

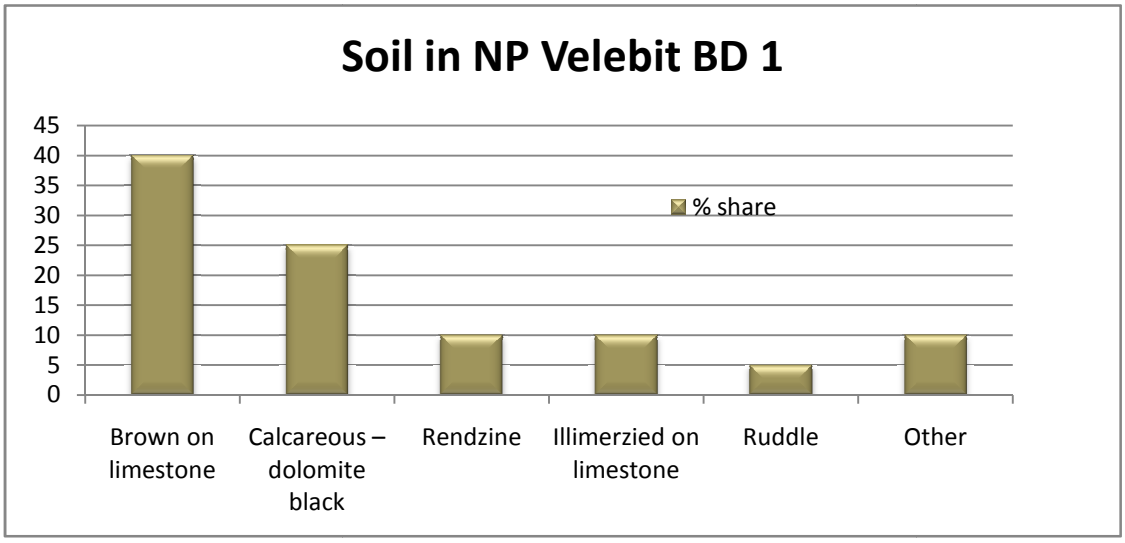


Figure 2. Soils in BD 1 Velebit Nature Park (Source: Oikon)

Brown soil on limestone and dolomite (calcicambisol)

Profile assembly Amo- (B) rz-R. It is formed solely on hard and clean limestones or dolomites that have less than 1% of unresolved residue. As a source of the mineral part of the soil, the dust material of the Eolian origin is also local. In the area of calcicambisols, distribution of rockiness (30-50%) is significant. The main substrate is pure limestone and dolomite, the mechanical composition is light clay, and the pH of the soil is 5.5-6.5. The depth of the soil ranges from 25 to 75 cm and the total porosity is 45-65%. The capacity of affordable water to plants ranges from 50 to 150 mm, so the precipitation regime is essential for the condition of water supply with water.

The content of humus and total carbon varies within wide limits (5-20% and 0.1-1%), and the soil is generally poorly supplied with phosphorus (about 1 mg / 100g soil) and medium-fed potassium (10-20 mg/100 g soil).

It enters the 3rd group for soil index, which includes moderately ground soil and moderately ground mineral carbonate soil.

More than 1% of the surface is followed by Rendzine on dolomite and limestone with about 9%, Lime-dolomitic black with a share of about 4%, Rendzinas on the gravel with a share of about 2%, and Dolomite brown with a share of only 1%. The spatial arrangement of these units is shown in Figure 3.

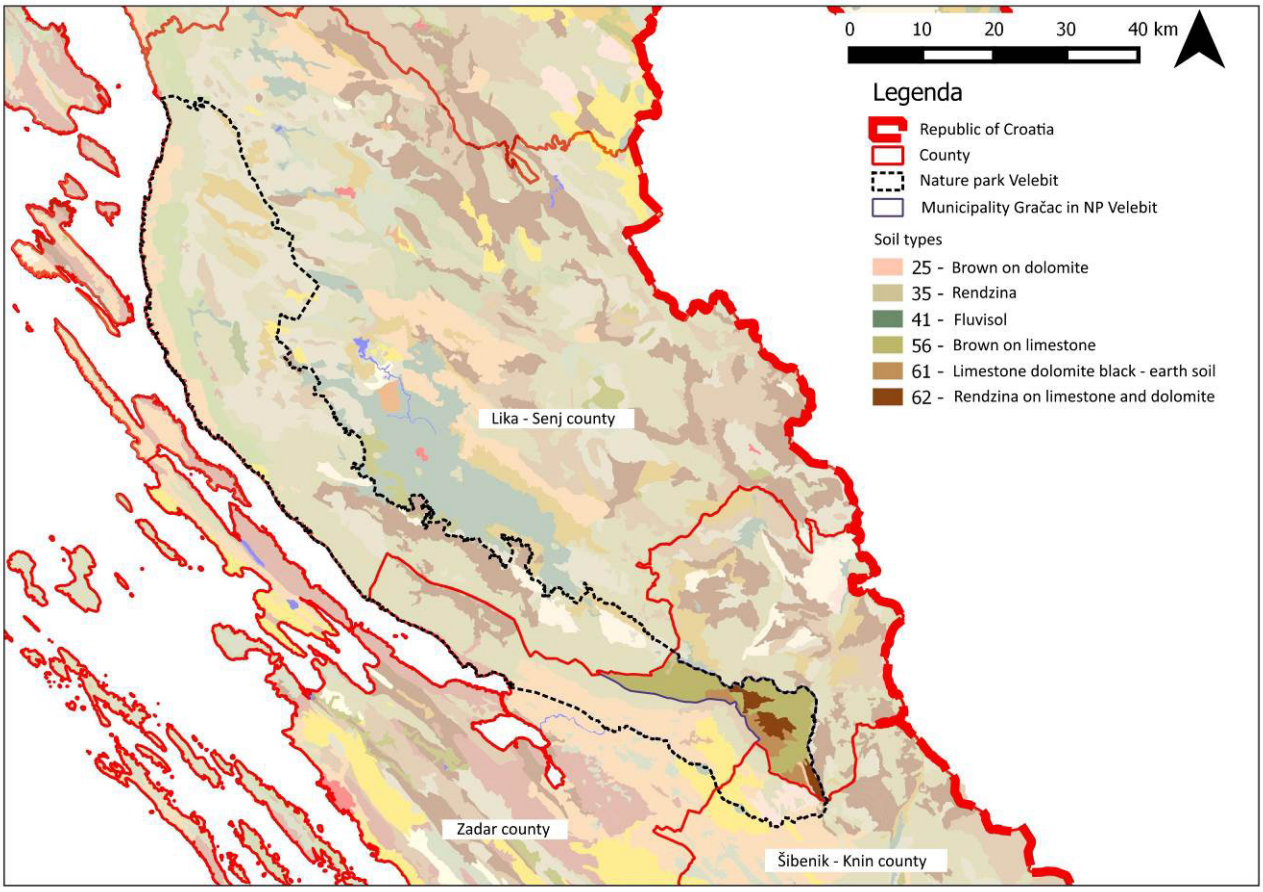


Figure 3. Soil map for BD 1 Velebit Nature Park (Source: Oikon d.o.o.)

Table 3. Slope for BD 1 Velebit Nature Park (Source: Oikon d.o.o.)

Slope (^{o})	Area (km^2)
0-2	4.62
2-5	14.29
5-12	46.87
12-32	104.63

Slope (°)	Area (km^2)
32-55	5.96
50+	0.02

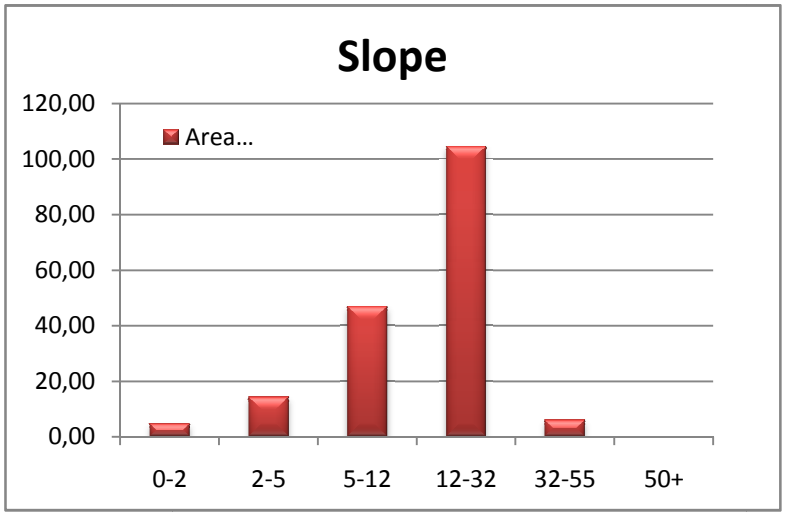


Figure 4. Slope for BD 1 Velebit Nature Park (Source: Oikon d.o.o.)

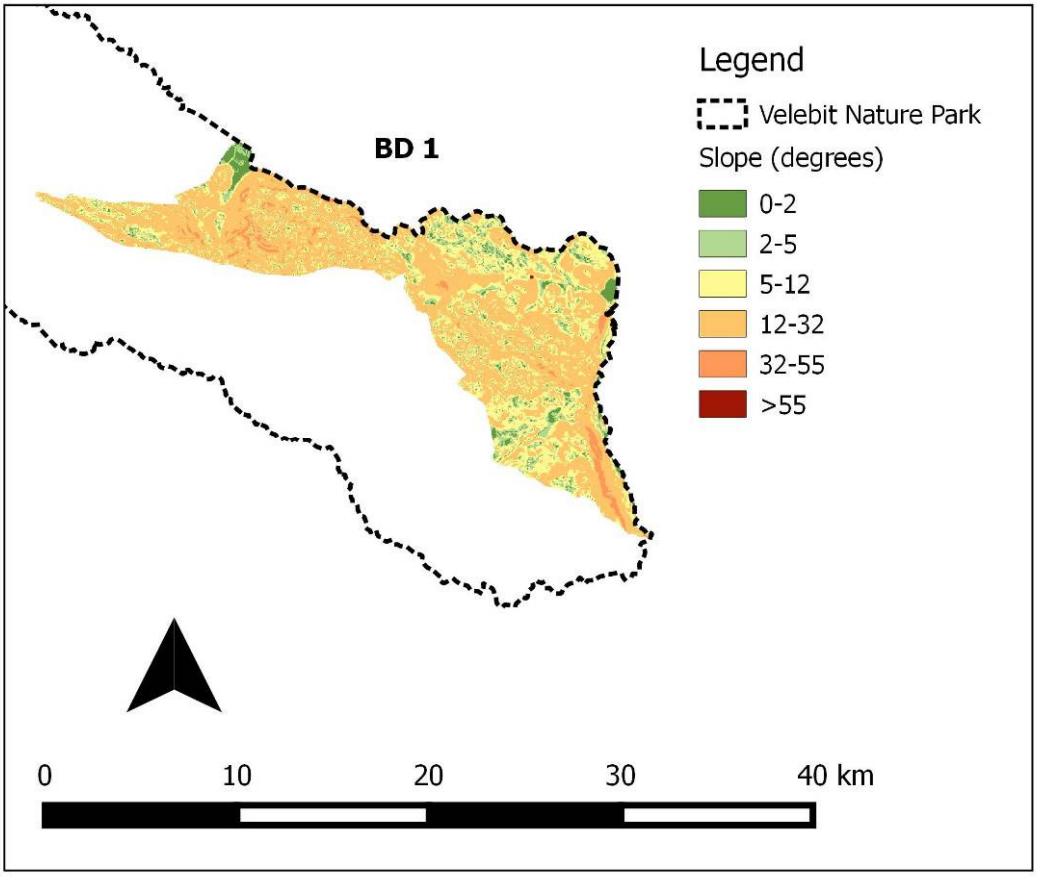


Figure 5 Slope map for BD 1 Velebit Nature Park (Source: Oikon d.o.o.)

Table 4. Aspect in in BD 1 Velebit Nature Park (Source: Oikon)

Aspect	Area (km^2)
N	22.79
NE	30.98
E	25.33
SE	19.36
S	22.56
SW	21.70
W	15.72
NW	17.95

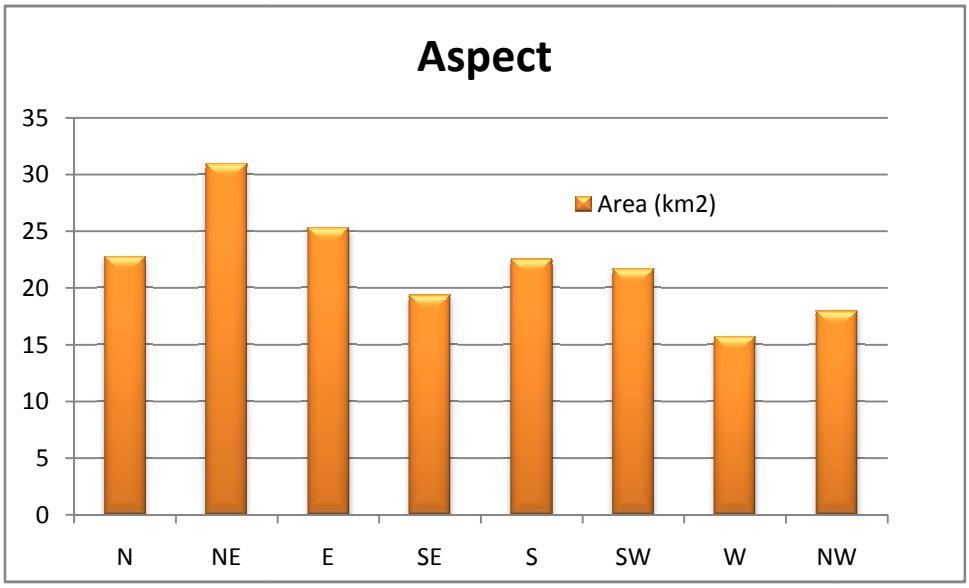


Figure 6. Aspect in in BD 1 Velebit Nature Park (Source: Oikon)

Table 5. Height above sea level in BD 1 Velebit Nature Park (Source: Oikon)

Height above sea level	Area (km^2)
0-100	2.55
100-200	4.31
200-300	3.99
300-400	17.67
400-500	23.04
500-600	38.55
600-700	46.88
700-800	23.24
800-900	9.67
900-1000	3.99
1000-1100	1.20
1100-1200	0.42

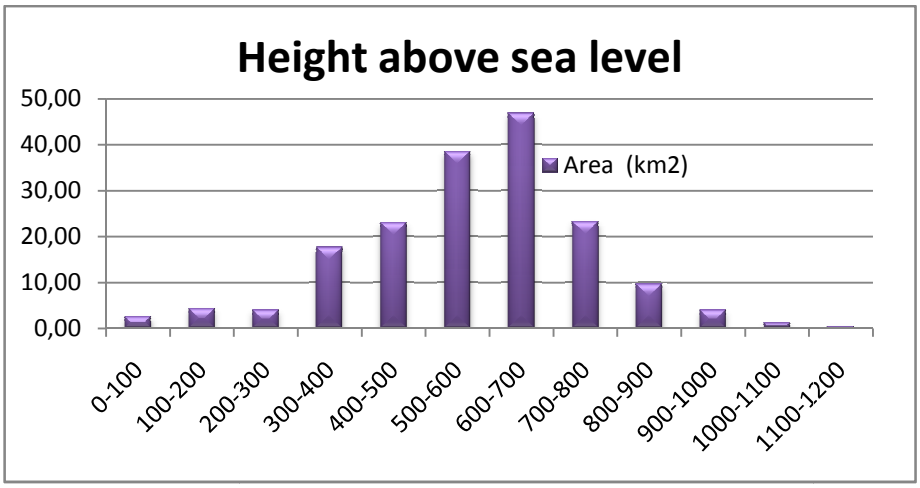


Figure 7. Height above sea level in BD 1 Velebit Nature Park (Source: Oikon)

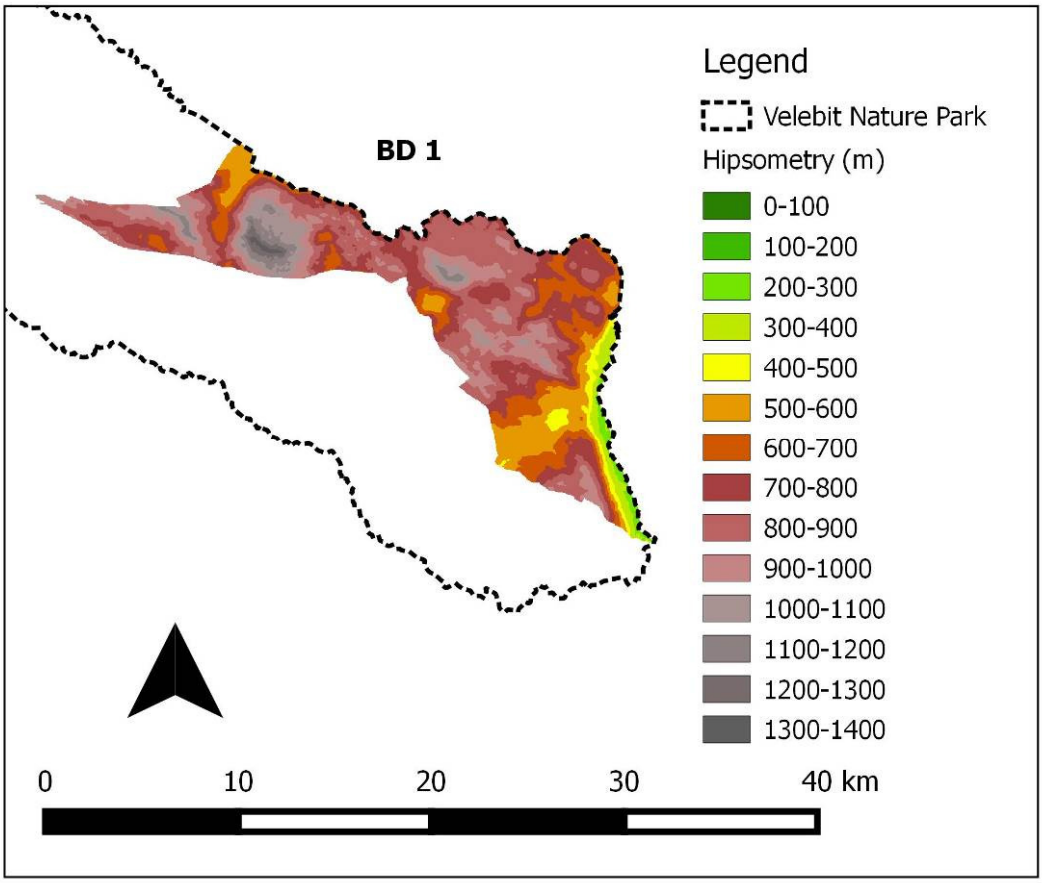


Figure 8. Height above sea level in BD 1 Velebit Nature Park (Source: Oikon) H.a.s.l.map

5.2.1.3 *Bioclimatic characteristics*

According to the Köppen climate classification, the BD 1 area of the Velebit Nature Park is the border of two types of climate with the Cfsbx (in the west, the higher parts) and Csbx (in the eastern, moderately high areas).C is a mark for a moderately warm rainy climate that governs in a large part of moderate widths. The average temperature of the coldest month is higher than -3 ºC

and below 18 ºC. The average monthly temperature is higher than 10 ºC for more than 4 months a year. During the year there are no dry months, and the minimum precipitation is in the summer (fs). In annual rainfall, two maximum, spring and autumn (x ") appear. The" b "mark indicates the average temperature of the hottest month below 22 ºC.

Phenocenological, the area covers beech forests with autumn and fall sasik, and in the far north part forest of oak and ash. Rocky pastures are also predominantly represented.

5.2.1.4 *Surface cover according to CORINE Land Use (CLC) classification*

Surface cover analysis according to CORINE Land Use (CLC) classification found that in the area of BD 1 the Velebit Nature Park is dominated by forests and natural vegetation (about 87%): predominantly white-wood forests with 7.204,32 ha (about 41%) and then transitional forests areas with 4.248,73 ha or about 24% of the area, and natural grasslands with 2.955 ha (about 17%). To a lesser extent, agricultural areas are represented (about 9%), predominantly pastures with 1.270,38 ha (about 7%) and agricultural areas with a significant share of natural vegetation with 295.54 ha (about 2%). The detailed area distribution by category is shown in Figure 10 and Table 6.

Table 6. Land cover in the area of BD 1 Velebit Nature Park (Source: CAEN, CLC RH 2012.)

Code	CLC category of surface cover and land use	ha	%
Unnatural surfaces			
112	Populated Areas (> 80% Built)	12,28	0,07
Agricultural land			
231	Grasslands	1.270,38	7,25
242	Mosaic of different ways of agricultural use	46,56	0,27
243	Agricultural land with a significant share of natural vegetation	295,54	1,69
Forests and natural vegetation			
311	Hardwood forest	7.204,32	41,11
312	Softwood forest	108,52	0,62
321	Natural grassland	2.955,00	16,86
323	Spherophilic vegetation	783,34	4,47
324	Transitional forest areas	4.248,73	24,24
333	Areas with sparse vegetation	565,20	3,22
Water			
512	Stagnant water	36,29	0,21
	Total	**17.526,16**	**100**

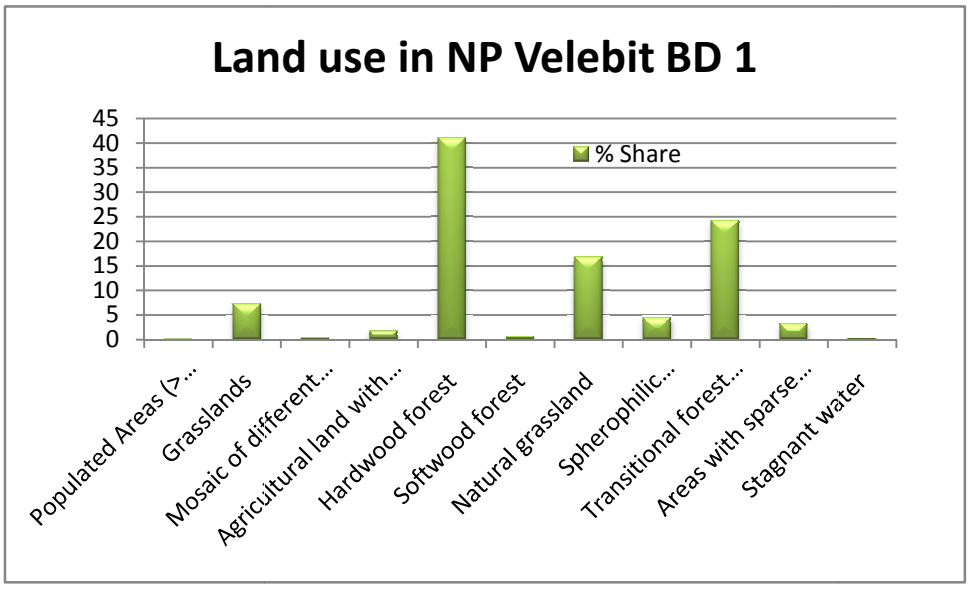


Figure 9. Land use in the area of BD 1 Velebit Nature Park (Source: CAEN, CLC RH 2012.)

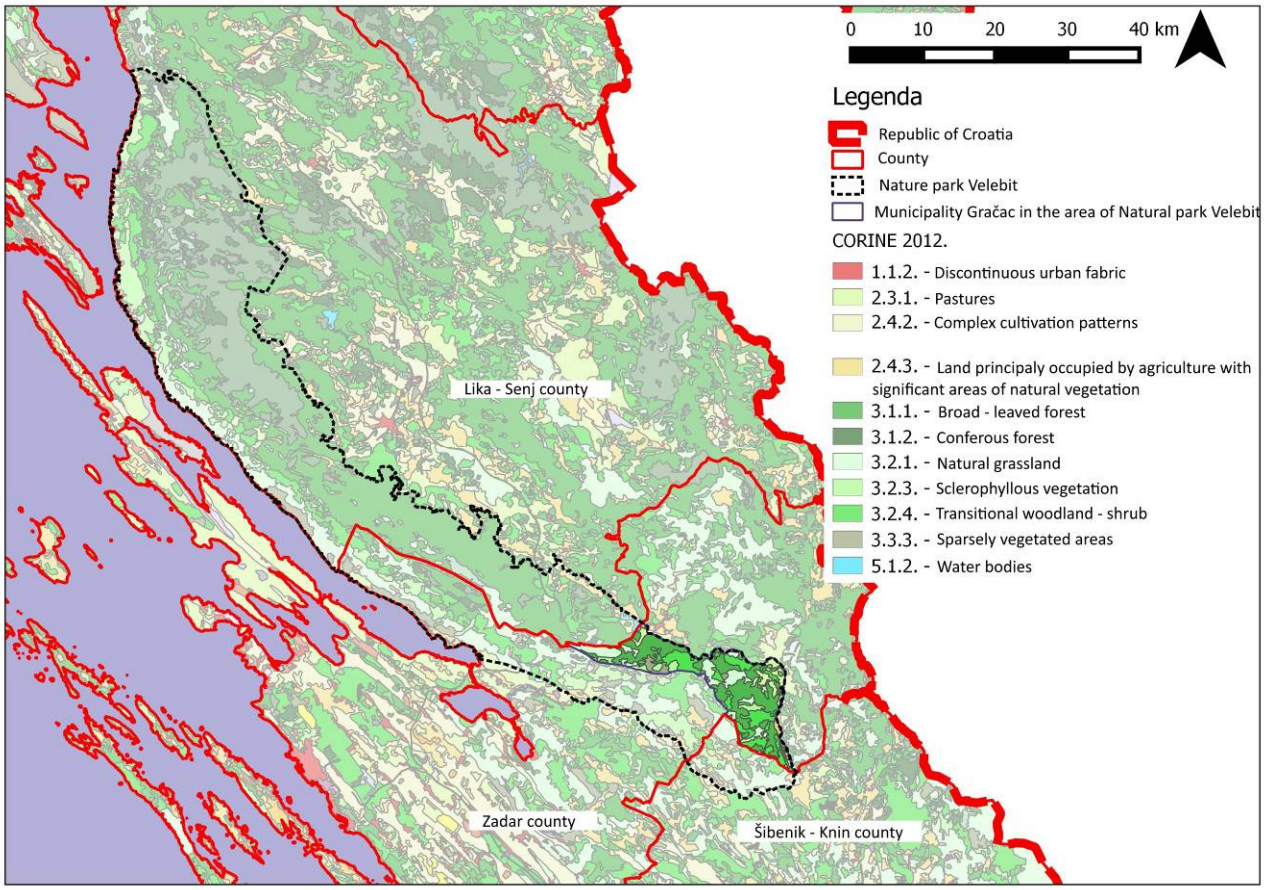


Figure 10. Land use in the area of BD 1 Velebit Nature Park (Source: CAEN, CLC RH 2012.)

5.2.2. BD 2 Nature Park Velebit (Municipality Obrovac, Jasenice and Starigrad without National Park)

5.2.2.1 *Territorial and administrative boundaries*

Territorial, BD (Biomass district) 2 The Velebit Nature Park is located on the southwestern slopes of Velebit, from the Starigrad area to the north, to the Obrovac area (and Kaštel-Žegarski settlements) in the south. The north-eastern section is higher with altitudes of 400 to 1350 m, while in the southwestern part they descend to the sea level in the coastal area, ie up to 20-50 m along the Zrmanja river canyon in the southwestern part of BD2.

Administratively, Velebit Nature Park extends to the area of Lika-Senj, Zadar and Šibenik-Knin County. BD (Biomass district) 2 The Velebit Nature Park covers the municipalities of Obrovac, Jasenica and part of the municipality of Starigrad (outside the National Park Paklenica) in Zadar County. These municipalities are located on the most southwestern part of the Velebit Nature Park, covering an area of 235,419.21 ha (Figure 1).

5.2.2.2 *Geomorphological features and soil*

The area of BD 2 of the Velebit Nature Park was built on limestone and dolomite pebbles, and on the 'coastline' of limestone breccias, conglomerates and fluticas within the Liburnian and promiscuous settlements of the Eocene-Oligocene Age. It is a poor karst and anchovy area where contemporary wool production did not take the momentum, it relies on the scarcity of accumulated soils in docs and sinkholes.

On such a base, the largest part (about 25,285 ha or 76%) is represented by Brown soil on limestone of different composition, as shown in Table 7.

Table 7. Most common mapping unit of soil in the area of BD 2 Velebit Nature Park

Number	Systematic soil unit name	% Share
56	**Brown on limestone**	**40**
	Limestone dolomite black – earth soil	25
	Rendzina	10
	Illimerized on limestone	10
	Terra rossa	5
	Karst	5
	Eutric brown	3
	Regosol	2

57	**Brown on limestone**	**35**
	Terra rosa typical and illimerized	20
	Limestone dolomite black – earth soil	15
	Rendzina	10
	Illimerized on limestone	10
	Rocky soil	5
	Regosol	5
58	**Brown on limestone**	**45**
	Illimerized on limestone	20
	Limestone dolomite black – earth soil	20
	Rendzina	10
	Colluvium	5

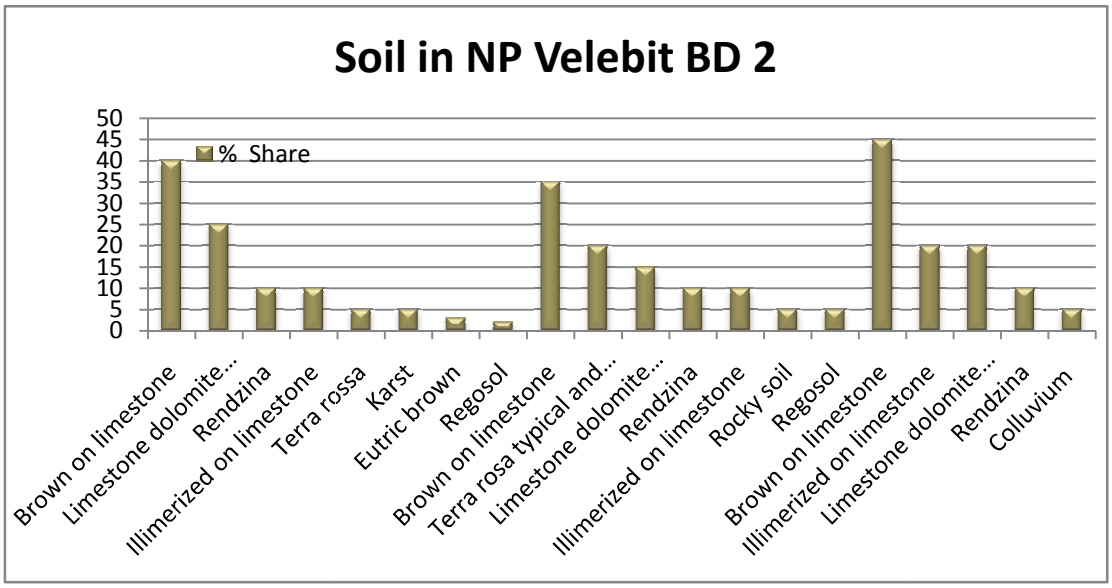


Figure 11. Soil in BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

A more detailed description of this cartographic unit of soil is given earlier in the text regarding the area of BD1 of the Velebit Nature Park.

By more than 1% stake in the surface follows ruddle shallow and medium deep with about 9%, limestone-dolomitic humus with a share of about 5%, rendzine on dolomite and limestone, and anthropogenic soil of karstic sinklets and colluvium with shares of about 3%. The spatial arrangement of these units is shown in Figure 12.

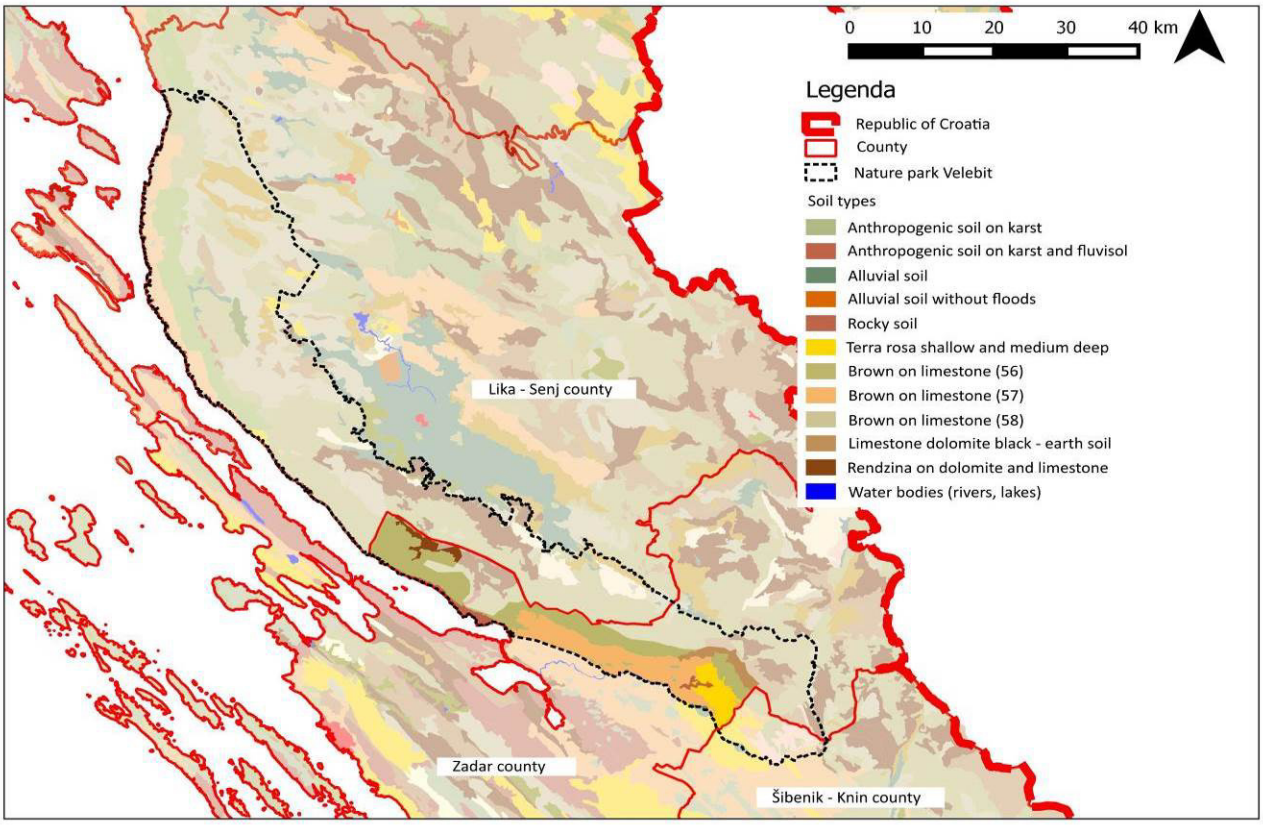


Figure 12. Soil map for BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

Table 8. Slope for BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

Slope (^{o})	Area (km^{2})	Percentage (%)
0-2	9,62	2,88
2-5	44,01	13,19
5-12	89,89	26,94
12-32	175,10	52,48
32-55	15,01	4,0
50+	0,04	0,01
Total	333,67	100

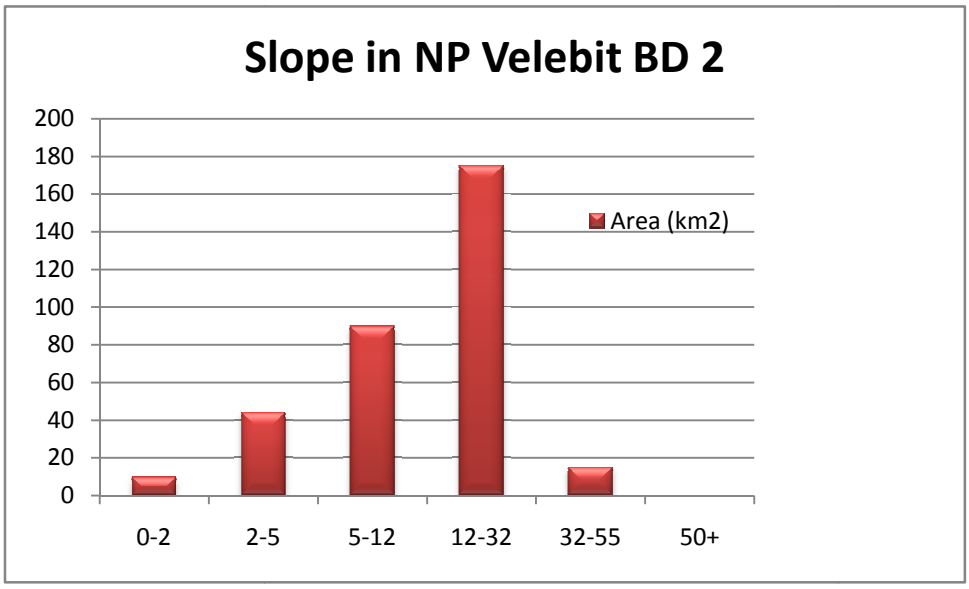


Figure 13. Slope for BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

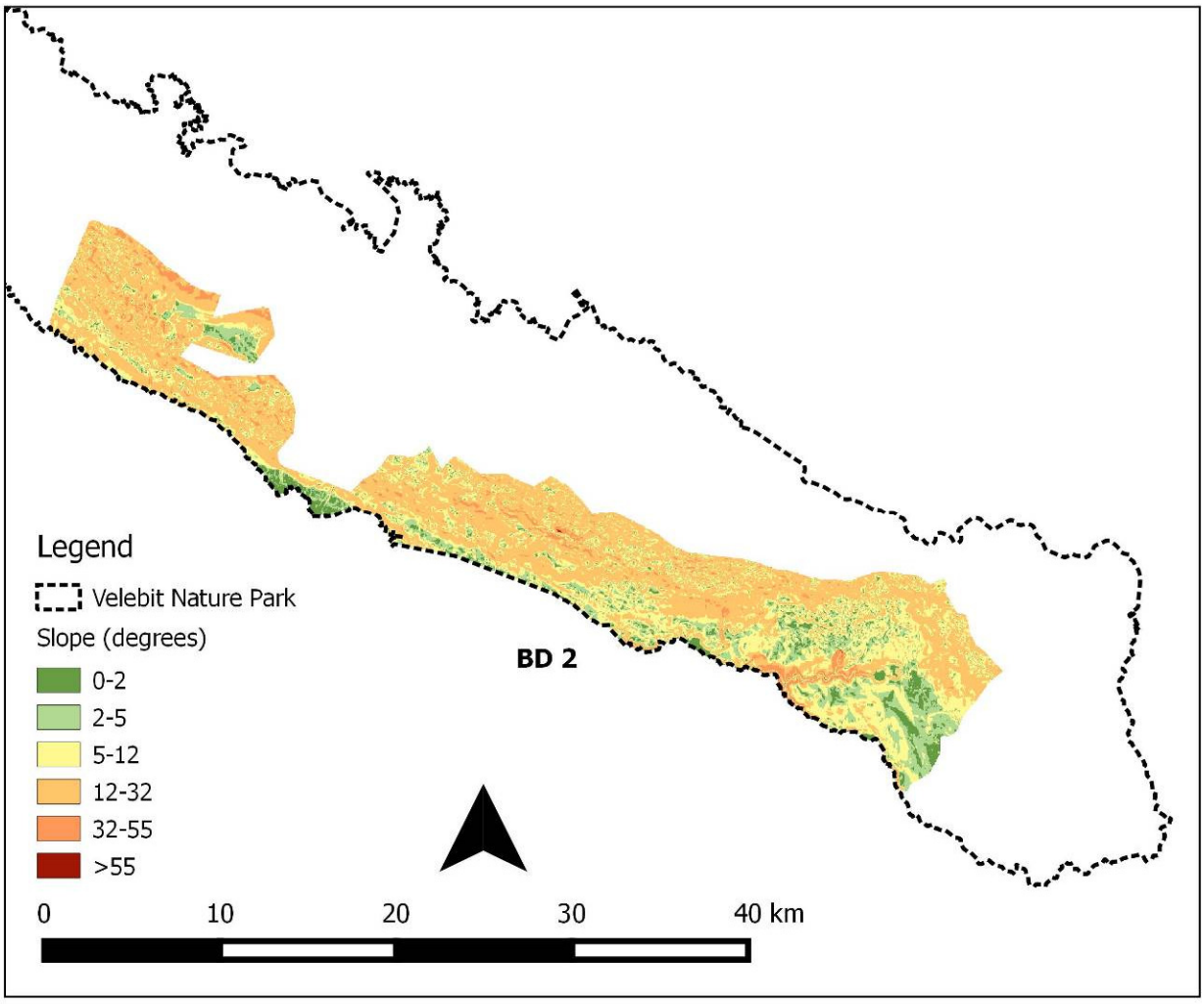


Figure 14. Slope map for BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

Table 9. Aspect for BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

Aspect	Area (km^2)	Percentage (%)
N	19,22	5,76
NE	18,22	5,46
E	18,44	5,53
SE	34,31	10,29
S	82,01	24,59
SW	94,22	28,25
W	43,90	13,16
NW	23,15	6,94
Total	333,47	100

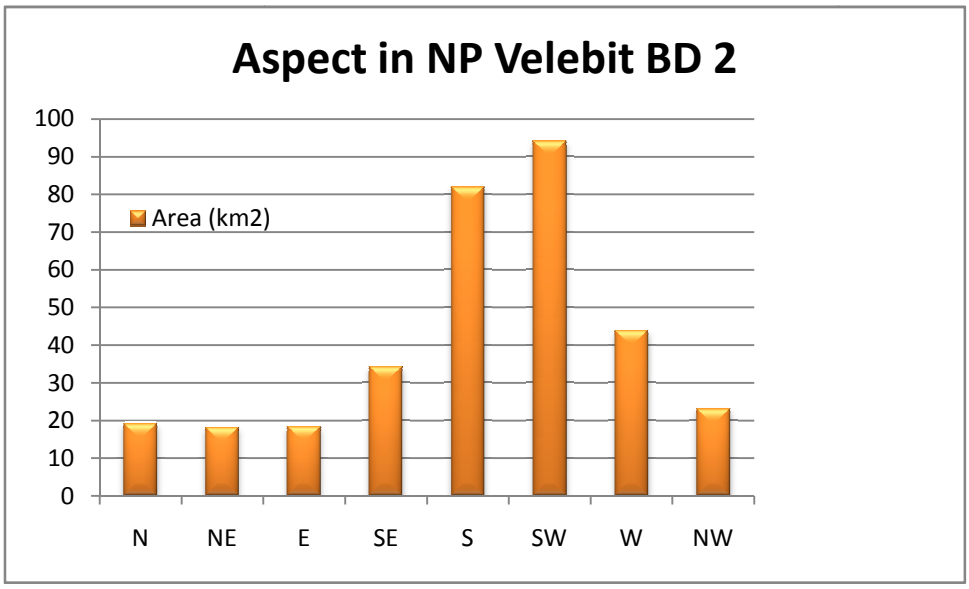


Figure 15. Aspect in BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

Table 10. Hight above sea level in BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

Height above sea level	Area (km^2)	Percentage %
0-100	27,16	8,18
100-200	42,41	12,77
200-300	50,84	15,31
300-400	35,75	10,76
400-500	28,49	8,58
500-600	21,88	6,59
600-700	27,31	8,22
700-800	29,40	8,85
800-900	28,62	8,62
900-1000	24,53	7,39
1000-1100	10,78	3,25
1100-1200	2,84	0,86
1200-1300	1,36	0,41
1300-1400	0,54	0,16

1400-1500	0,18	0,05
1500-1600	0,04	0,01
Total	332,13	100

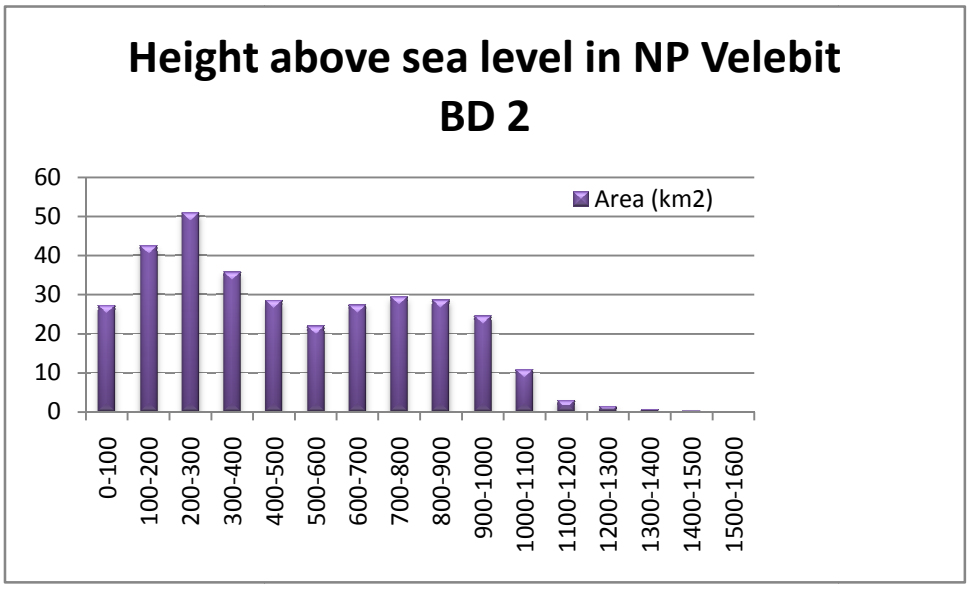


Figure 16. Height above sea level in BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

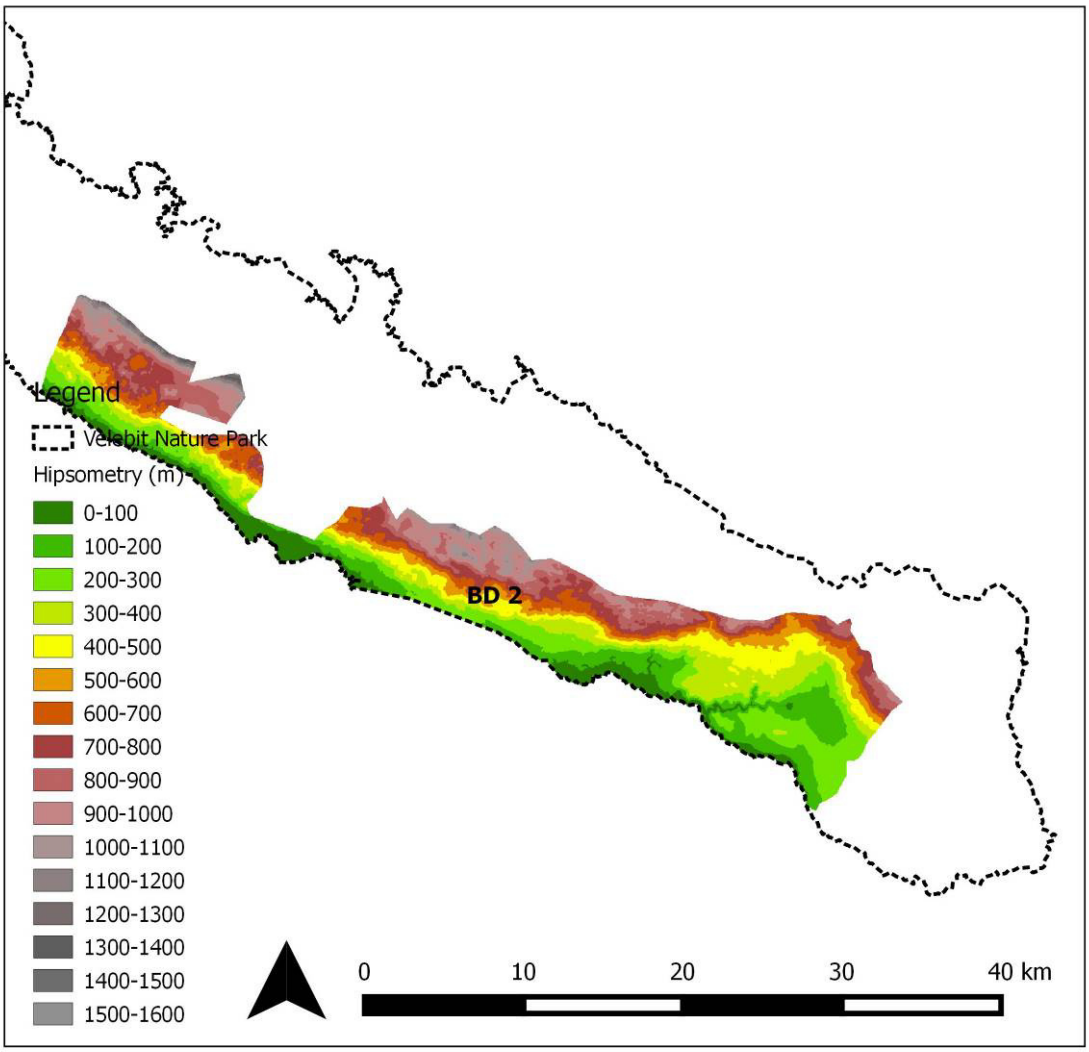


Figure 17. Height above sea level map in BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

5.2.2.3 *Bioclimatic characteristics*

According to Köppen's classification of the climate, the area of BD 2 of the Velebit Nature Park is the border of two types of climate:

- Moderate warm humid climate with Cfsbx (in the northeast, higher parts) and Cfsax (in the southeast, lower parts);
- Mediterranean climate: Csax (in the northwestern, coastal part) and Csbx (in the northeast, moderately high parts). Climate Csa is characterized by hot summers and mild winters with intermittent cold waves that can be very uncomfortable cold. Climate Csb is different from this somewhat cooler and humid.

C is a mark for a moderately warm rainy climate that governs in a large part of moderate widths. The average temperature of the coldest month is higher than -3 ºC and below 18 ºC. The average monthly temperature is higher than 10 ºC for more than 4 months a year. During the year there are no dry months, and the minimum precipitation is in the summer (fs). In annual rainfall, two maximum, spring and autumn (x ") appear. The" b "mark indicates the mean temperature of the hottest month below 22 ºC.

The phytocenological area covers mainly beech forests with fall sasik, while the central belt includes forests of hornbeam and black grouse and in the coastal belt forest of oak and whitewater oak. Rocky pastures are also predominantly represented.

5.2.2.4 *Surface cover according to CORINE Land Use (CLC) classification*

Land cover analysis according to CORINE Land Use (CLC) classification found that in the area of BD 2 Velebit Nature Park dominates forests and natural vegetation (about 82% of the surface): predominantly natural grasslands with 10.669,34 ha (about 28%) and then transitional forests areas with 7.255,99 ha (about 19%), sclerophilic vegetation with 5.266,09 ha (about 14%), areas with scarce vegetation with 3.789.56 (about 10%) and hardwood forests with 1.829,86 ha (about 5%).

To a lesser extent, agricultural areas are represented (about 10%): predominantly agricultural areas with a significant share of natural vegetation with 1,944.41 ha (about 5%) and pastures with 1.602,05 ha (about 4%). The sea surface represents about 12% of the BD2 area of the Velebit Nature Park and belongs to the municipality of Starigrad.

The detailed area distribution by category is shown in Figure 19 and Table 11.

Table 11. Land cover and methods of land use in the area of BD 2 Velebit Nature Park (Source: CAEN, CLC RH 2012)

Code	CLC category of surface cover and land use	ha	%
Unnatural surfaces			
112	Populated Areas (> 80% Built)	236,08	0,63
122	Roads with the associated land	131,12	0,35
142	Sports and recreation facilities	46,73	0,12
Agricultural land			
231	Grasslands	1.602,05	4,26%
242	Mosaic of different ways of agricultural use	99,62	0,26%
243	Agricultural land with a significant share of natural vegetation	1.944,41	5,17%
Forests and natural vegetation			
311	Hardwood forest	1.829,86	4,86%
312	Softwood forest	170,03	0,45%
313	Mixed forest	97,05	0,26%
321	Natural grassland	10.669,34	28,35%
323	Spherophilic vegetation	5.266,09	13,99%
324	Transitional forest areas	7.255,99	19,28%
333	Areas with sparse vegetation	3.789,56	10,07%
Water			
511	Rivers	44,60	0,12%
512	Stagnant water	46,91	0,12%
523	Sea	4.399,29	11,69%
	Total	37.628,72	**100**

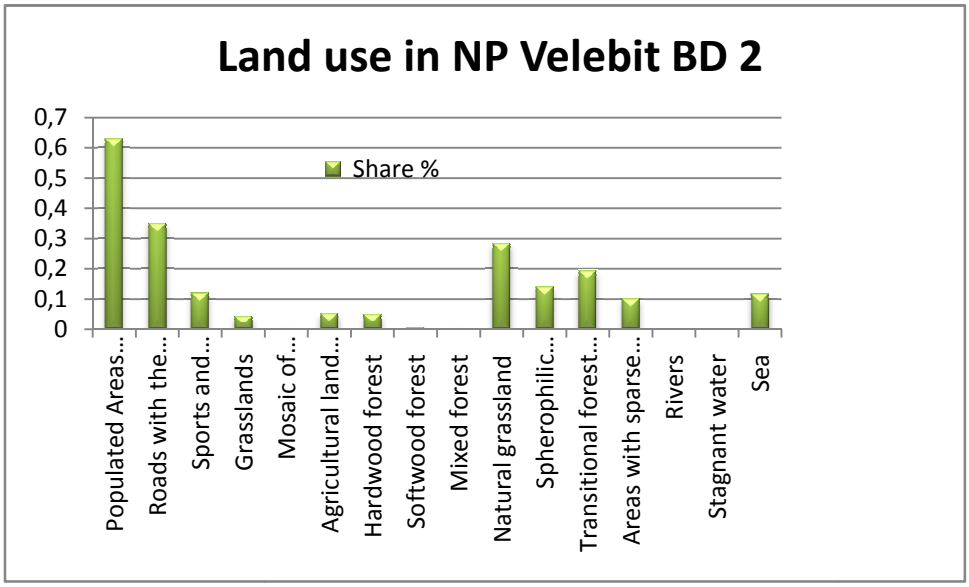


Figure 18. Land use in BD 2 Velebit Nature Park (Source: Oikon d.o.o.)

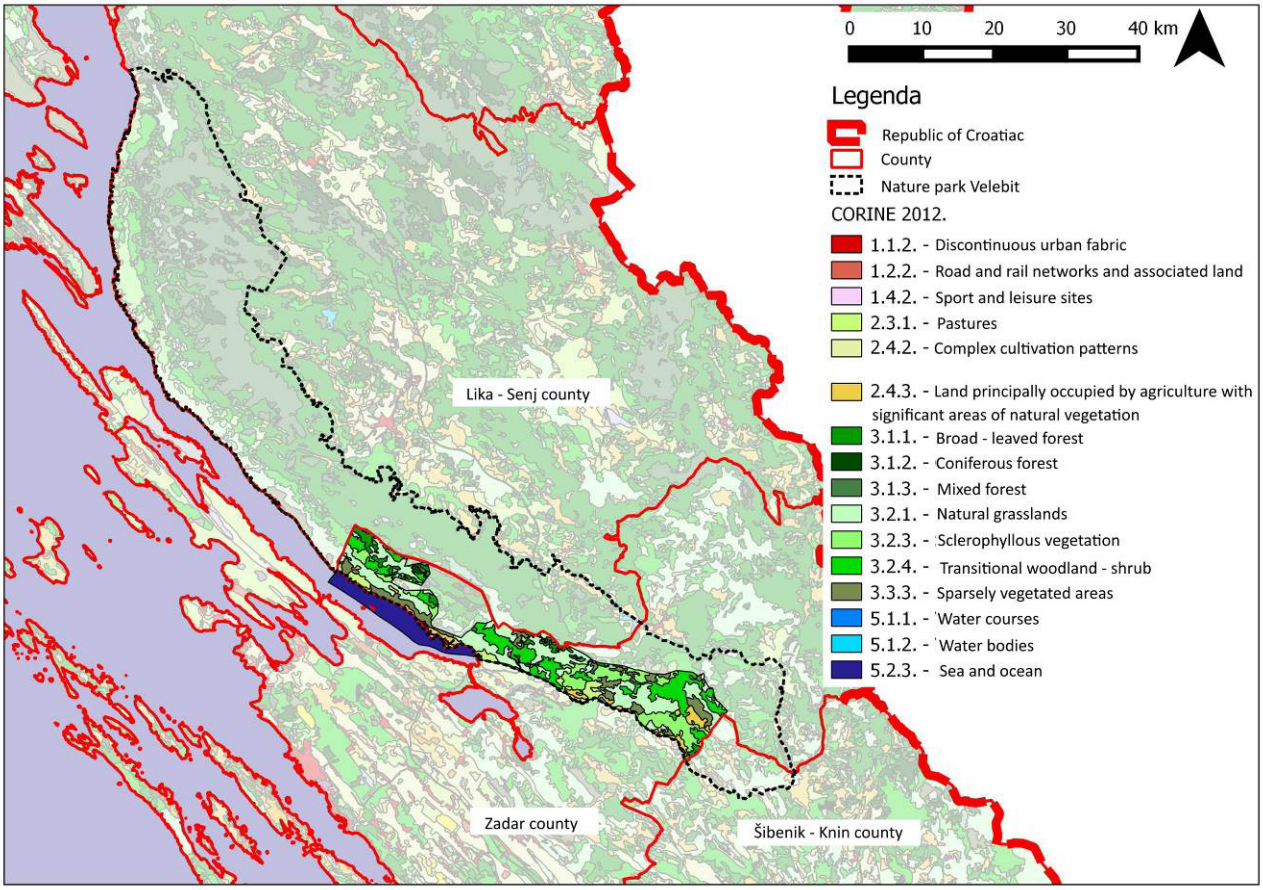


Figure 19. Land cover in the area of BD 2 Velebit Nature Park (Source: CAEN, CLC RH 2012.)

5.2.3. BD 3 Nature Park Telašćica (Municipality Sali)

5.2.3.1 *Territorial and administrative boundaries*

Territorial, Telašćica Nature Park is located on the most southwestern part of the island of Dugi otok, covering the mainland around the bay and the deeply gully bay (Telašćica bay) and numerous smaller islands and islets. Marked altitude from the sea level up to 190 m.

Administratively, Telašćica Nature Park is located on the territory of the Zadar County and the municipality of Sali, with an area of 6,999.28 ha (land area: 2,531.14 ha and seaside: 4,458.15 ha) (Figure 20).

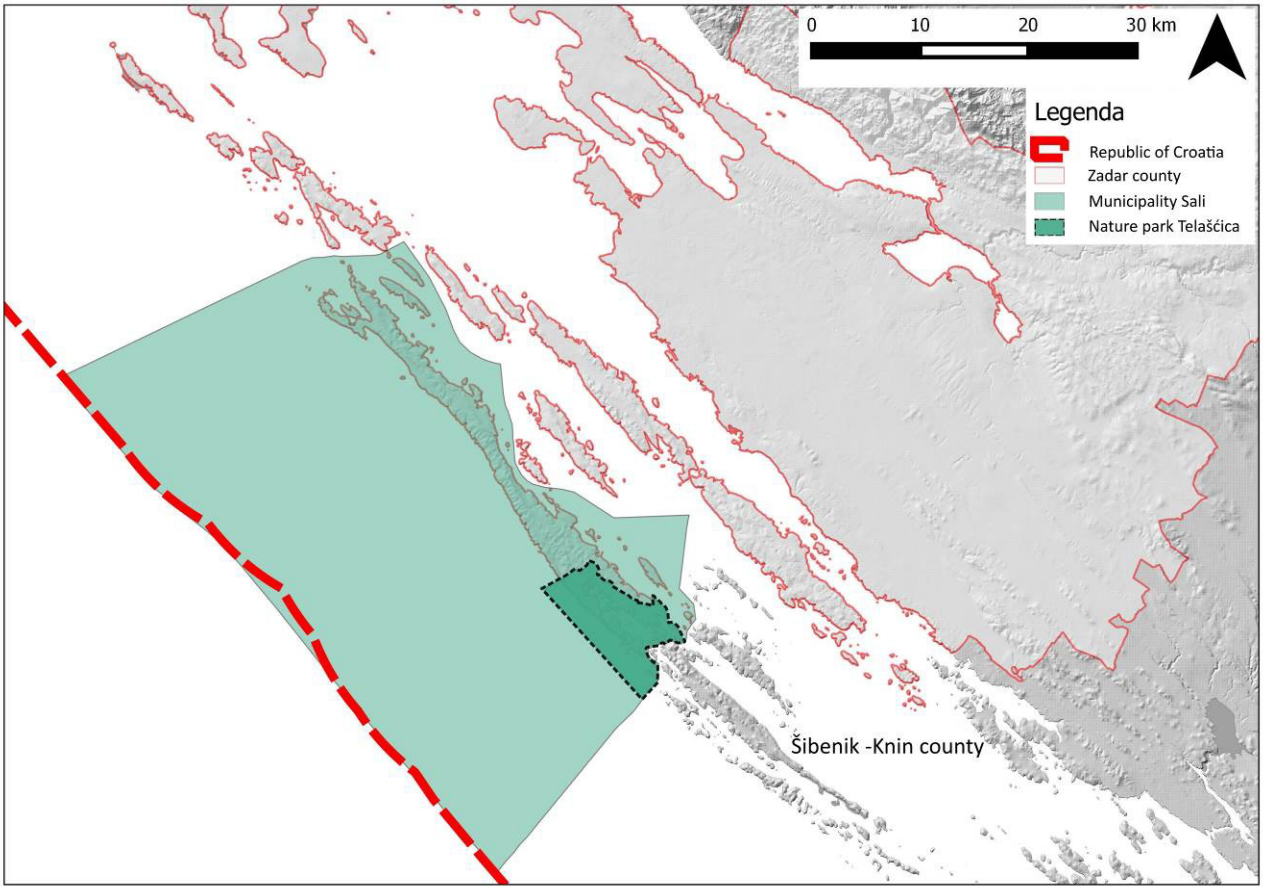


Figure 20. Administrative division for the area of Telašćica Nature Park

5.2.3.2 *Geomorphological features and soil*

The area of Telašćica Nature Park is predominantly made of limestone and dolomite. The first fertile flysch zones are mostly submerged by sea after the post-coastal rise of the sea level. After that, the peaks of the mountain hills became the land sections surrounding the deeply gully bay. The altitude ranges from the sea level to about 190 m, and the slope is particularly significant southwestern coast of the island where the strata are formed (reaches 160 m above sea level and below sea level up to 85 m) (Figure 21).

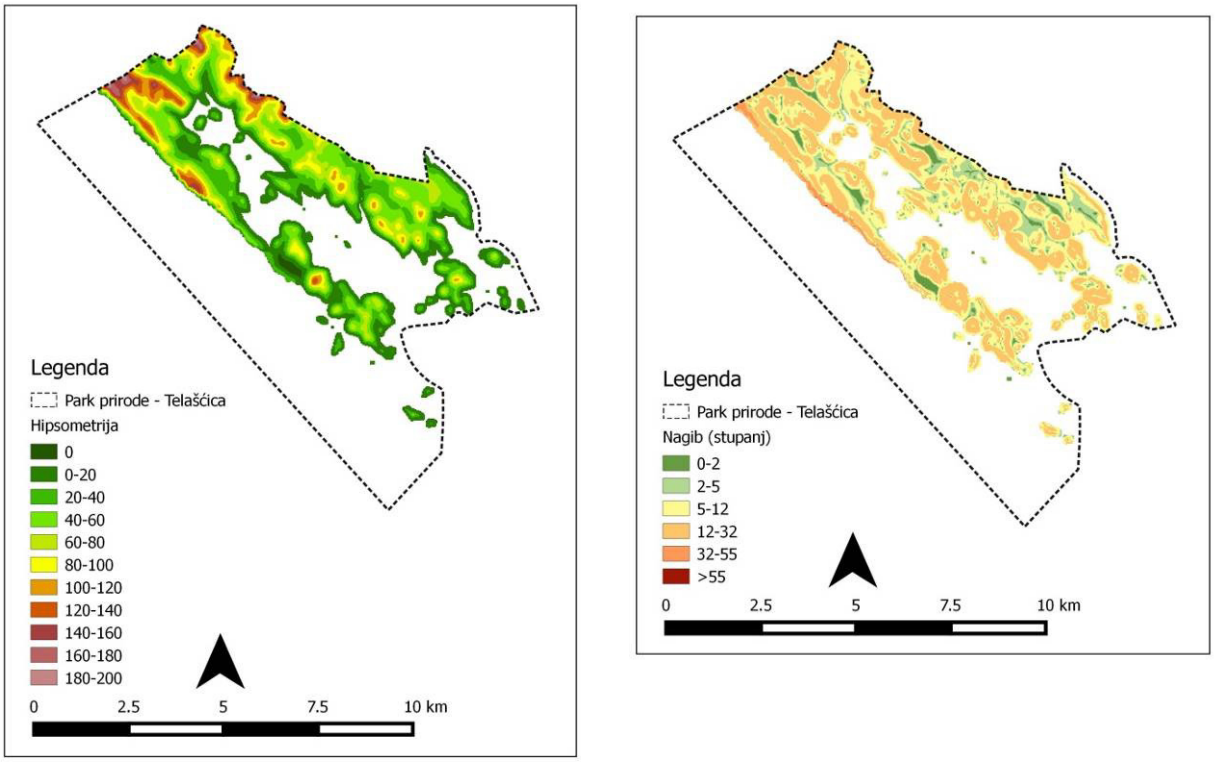


Figure 1. Hipsometry and inclination in the trea of Telašćica Nature Park

On this basis, the largest part (about 1,730 ha or about 69%) is represented by a rocky, which contains different proportions of other types of soil, as shown in Table 5. Other types of soil located in the area of Telašćica Nature Park include: limestone (about 19%) and anthropogenic soil on karst (about 13%). The spatial arrangement of these units is shown in Figure 22.

Table 13. Most common cartographic unit of soil in the area of Telašćica Nature Park

Number:	**Systematic soil unit name**	**% share**
54	Rocky soil	50
	Limestone dolomite black – earth soil	25
	Rendzina	10
	Brown on limestone	10
	Terra rossa	5

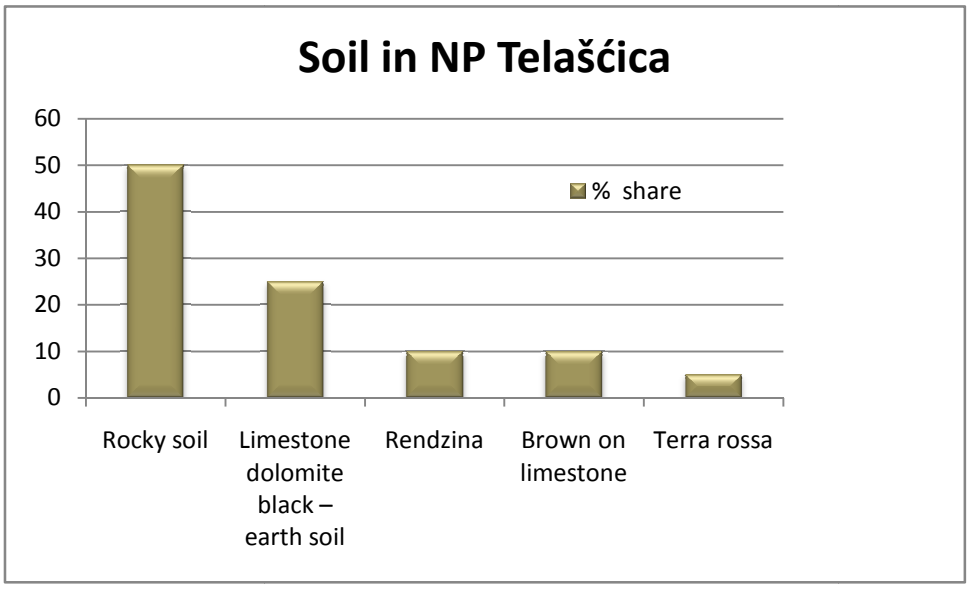


Figure 22. Soil in the area of Telašćica Nature Park (Source: Oikon)

Rocky soil (litosol)

Profile assembly (A) -R. Litosol is formed on rocks which in the mechanical decomposition give a rock detritus. We mainly find it in the Preplanine and Mediterranean Carpathian area. The dominant factor of soil formation is climatic conditions (freezing and heating of rocks), and humus accumulation is very weak. Its fundamental physical feature is the dominance of stone and heavy gravel in the soil. Litosol is characterized by extreme water permeability and almost complete inability to retain water. Due to the low adsorption surface and the reduced liquid phase it is poor for soluble forms of plant nutrients. The thickness of the lithosol in the pedogenic view is that in the initial horizon (A) a thickness of several centimeters of organic matter (humus) is dispersed between the mineral particles of the soil. As the first stage of evolution of the soil, lithosol still has no humoral and mineral formations characteristic of the humus-accumulative horizon of the soil. Litosole follows the peculiar vegetation of rocks and rocks, and because of their minimal fertility, they have no economic importance but are important in nature protection (binding the curtain).

It enters the 8 group for the soil indexing in which undeveloped soil belongs.

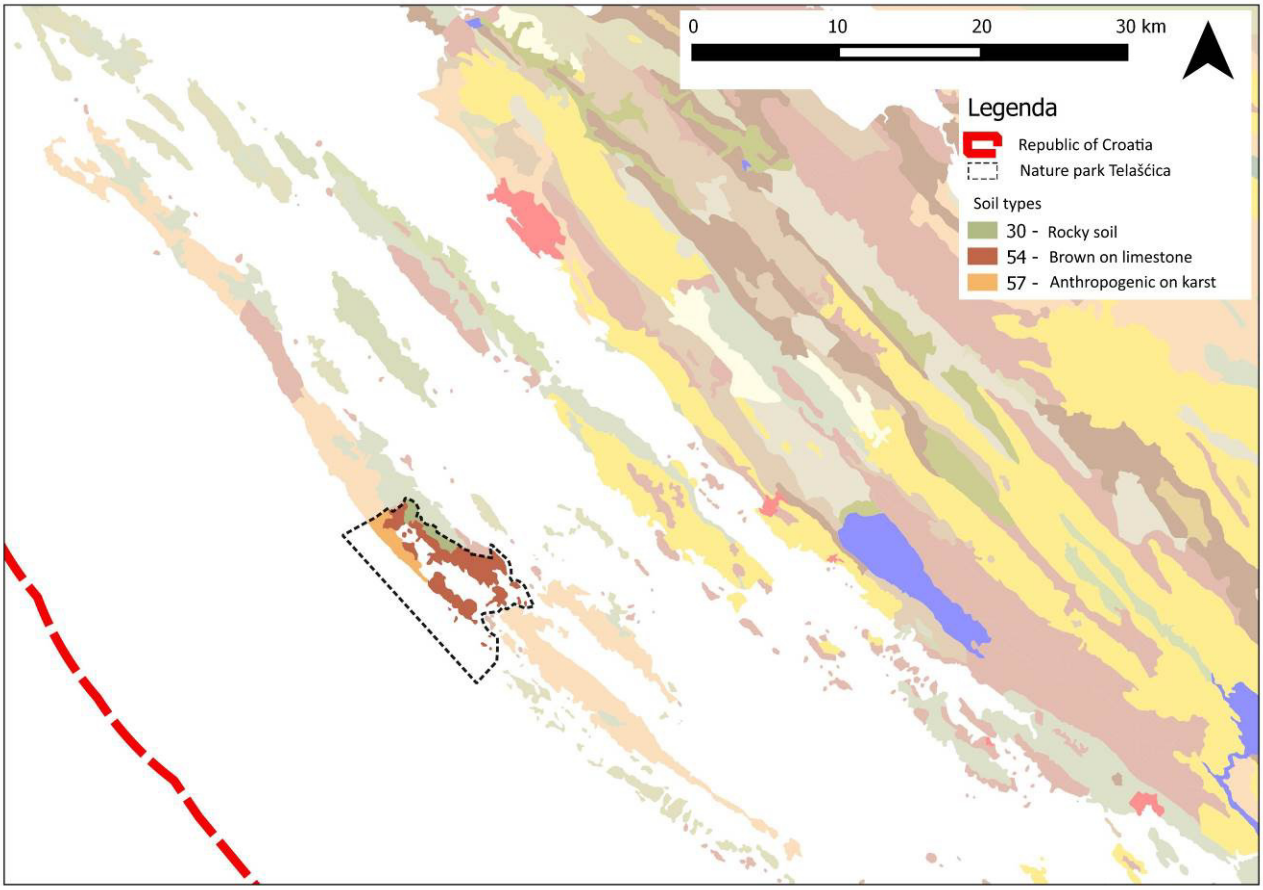


Figure 23. Soil map for the area of Telašćica Nature Park (Source: Oikon d.o.o.)

Table 14. Slope in the area of Telašćica Nature Park (Source: Oikon)

Slope (°)	Area (km^2)	Percentage (%)
0-2	0,75	2,63
2-5	3,01	10,55
5-12	11,69	40,96
12-32	12,69	44,46
32-55	0,40	1,40
50+	0,00	0,00
Total	28,54	100

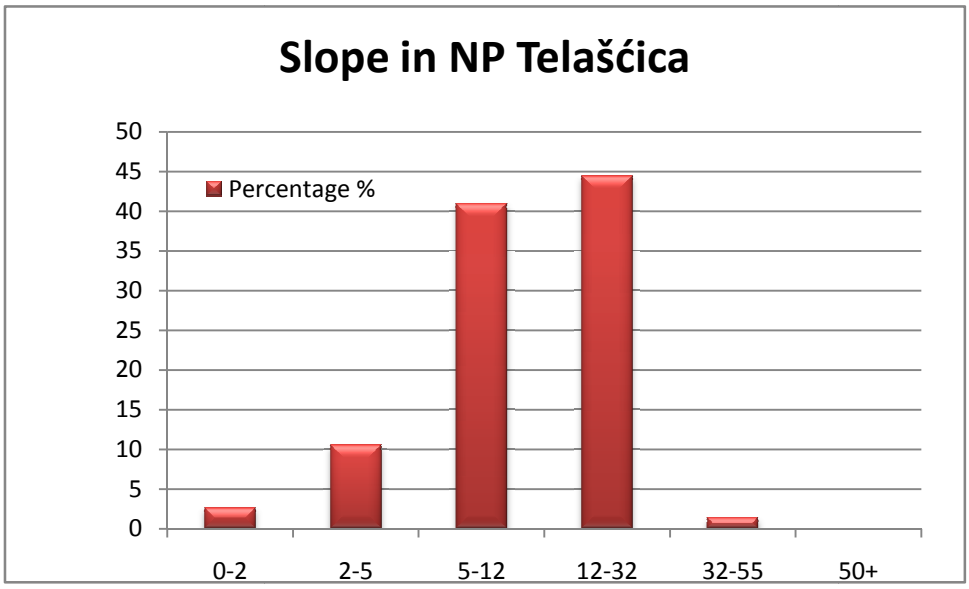


Figure 24. Slope in the area of Telašćica Nature Park (Source: Oikon)

Table 15. Aspect in the area of Telašćica Nature Park (Source: Oikon)

Aspect	Area (km^2)	Percentage (%)
N	2,29	8,05
NE	5,36	18,85
E	3,63	12,77
SE	2,63	9,25
S	3,39	11,92
SW	6,19	21,77
W	3,36	11,82
NW	1,58	5,56
Total	28,43	100

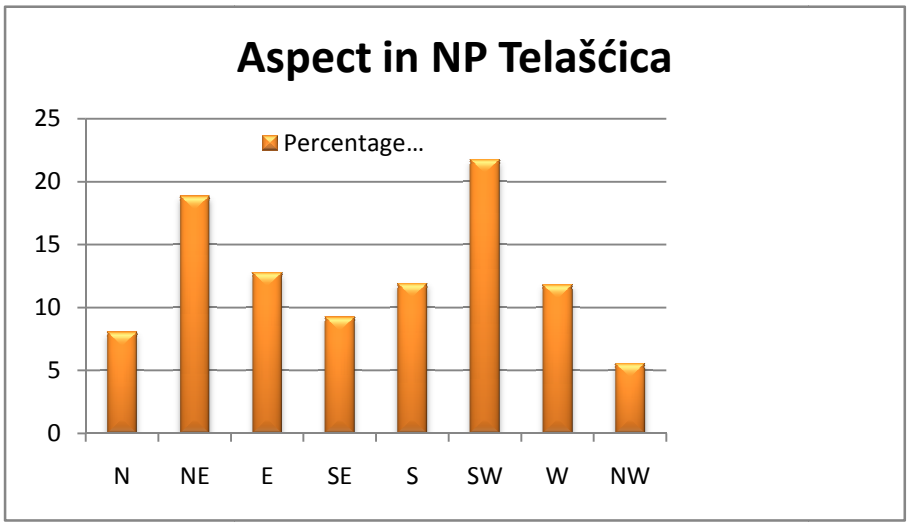


Figure 25. Aspect in the area of Telašćica Nature Park (Source: Oikon)

Table 16. Height above sea level in the area of Telašćica Nature Park (Source: Oikon)

Height above sea level	Area (km2)	Percentage %
0-20	7,12	25,58
20-40	5,86	21,06
40-80	9,67	34,75
80-100	2,46	8,84
100-120	1,40	5,03
120-140	0,78	2,80
140-160	0,34	1,22
160-180	0,16	0,57
180-200	0,04	0,14
Total	27,83	100

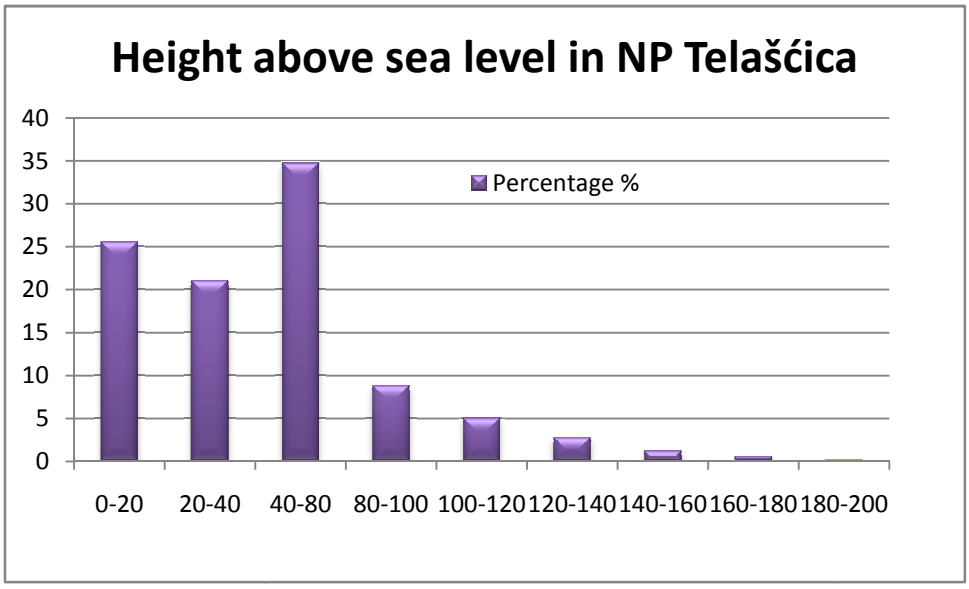


Figure 26. Height above sea level in the area of Telašćica Nature Park (Source: Oikon)

5.2.3.3 *Bioclimatic characteristics*

According to Köppen's classification of climate, the territory of the Telašćica Nature Park is located in the Mediterranean climate: (Csax). Climate C, a moderately warm rainy climate, is characterized by hot summers and mild winters with intermittent cold waves that can be very uncomfortable with cold. The average temperature of the coldest month is higher than -3 ºC and below 18 ºC. The average monthly temperature is higher than 10 ºC for more than 4 months a year. There are no dry months during the year, and in the annual rainfall occur two maxima, spring and autumn ("x").

Phenocenological, the area covers mostly pure Adriatic forests and macaws, while in the northeastern part there are Česmin's forests and macaws with black ash.

5.2.3.4 *Surface covering according to CORINE Land Use (CLC) classification*

According to the CORINE Land Use (CLC) classification, the surface area of Telašćica Nature Park is dominated by forests and natural vegetation (about 33% of the surface): predominantly natural lawns with 1.272,49 ha (about 18%) and then sclerophilic vegetation with 755 , 46 ha (about 11%).Agricultural areas are represented to a lesser extent (about 3%). The sea surface makes up about 64% of the area of Telašćica Nature Park (4.448,05 ha).

The detailed area distribution by category is shown in Figure 28 and Table 17.

Table 17. Land cover and methods of land use in the area of Telašćica Nature Park (Source: AZO, CLC RH 2012.)

Code	CLC category of surface cover and land use	ha	%
Agricultural land			
223	Olive groves	210,35	3,01
242	Mosaic of different ways of agricultural use	17,32	0,25
Forests and natural vegetation			
311	Hardwood forest	99,90	1,43
312	Softwood forest	54,70	0,78
321	Natural grassland	1.272,49	18,18
323	Spherophilic vegetation	755,46	10,79
324	Transitional forest areas	103,41	1,48
333	Areas with sparse vegetation	12,27	0,18
Vode			
512	Stagnant water	25,08	0,36
523	Sea	4.448,05	63,55
	Total	37.628,72	**100**

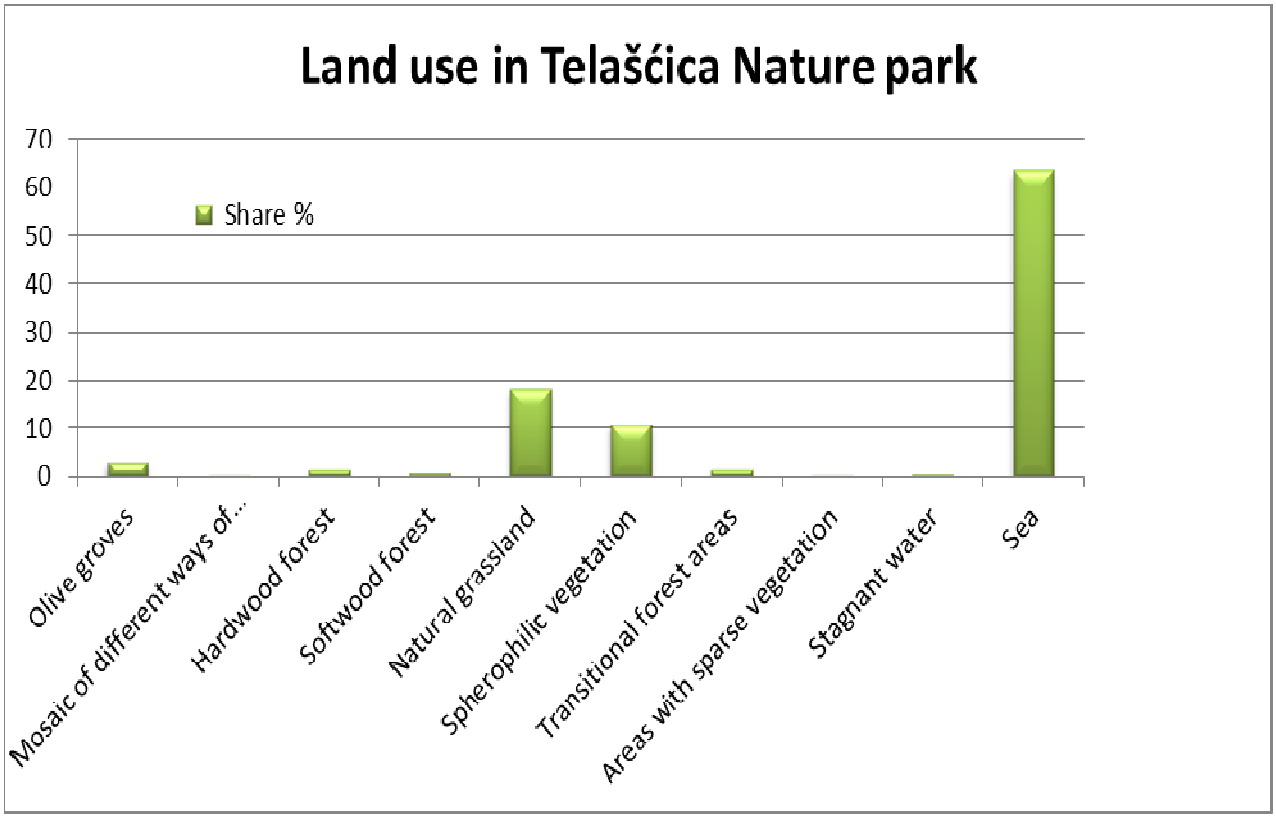


Figure 27. Land use in the area of Telašćica Nature Park (Source: Oikon)

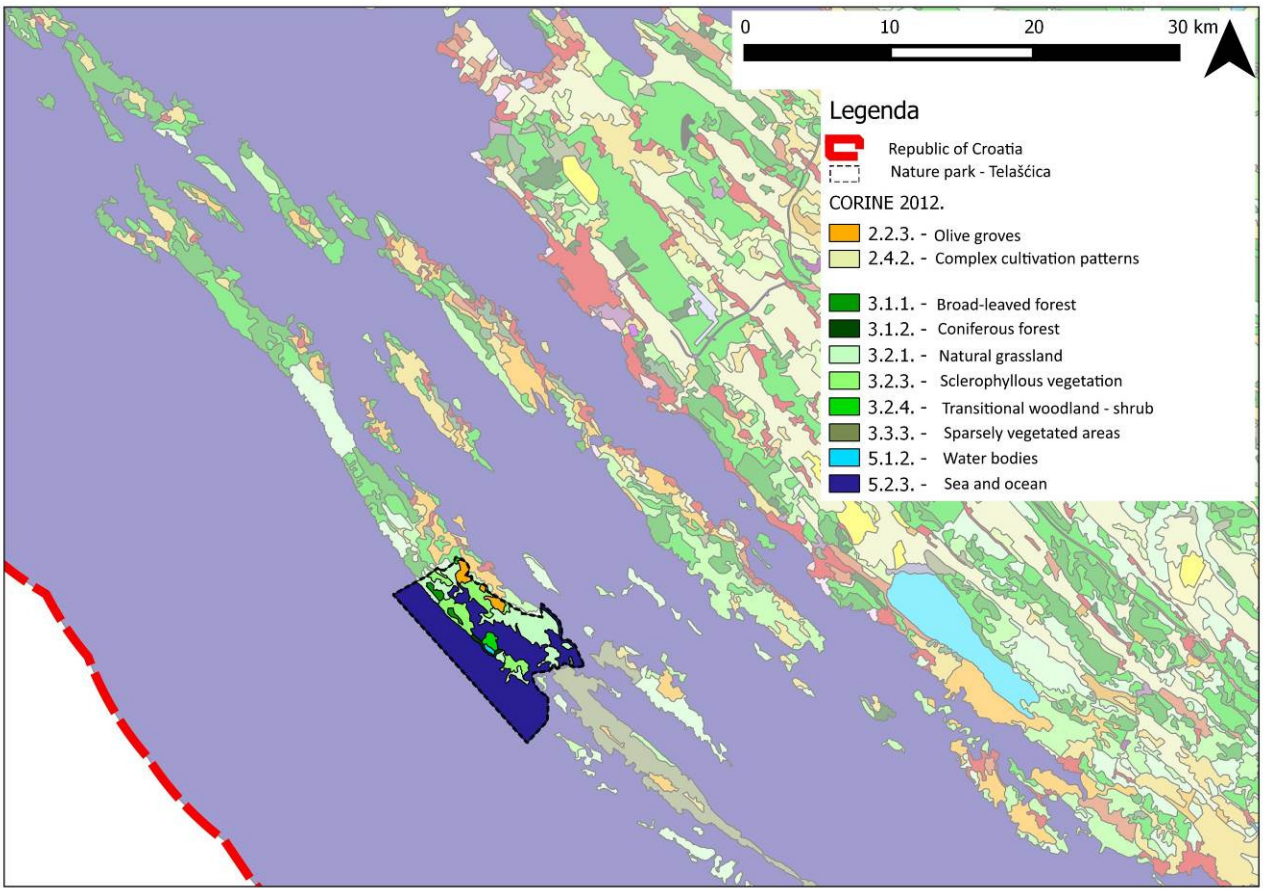


Figure 28. Surface cover and methods of land use in the area of Telašćica Nature Park (Source: AZO, CLC RH 2012.)

5.2.4. BD4 Vransko Lake Nature Park (Pakoštane Municipality)

5.2.4.1 *Territorial and administrative boundaries*

Territorial, Nature Park Vransko Lake is located in the area of Zadar-Biograd na moru, between Biograd and Pirovac, along the Pakoštane settlement. The Nature Park and the lake himself, are situated parallel to the sea shore, which is locally less than a kilometer away. They are located in the northwest-southeast direction. The altitudes in the area of the Pakoštane municipality range from about 0 to about 100 m in the northeastern part of the area.

Administratively, the Vransko Lake Nature Park is located at the border of two counties: Zadar and Šibeniko-Kninski County. The Zadar County is located in the Pakoštane and Stankovci municipalities and in the area of Benkovac (Figure 29). The Nature Park has an area of 5.748,99 ha (Figure 29), and the area of the part located in the Pakoštane municipality area is 3.923,94 hectares (about 68% of the total area of the Nature Park), and covers most of Vrana Lake itself (about 3,000 Ha).

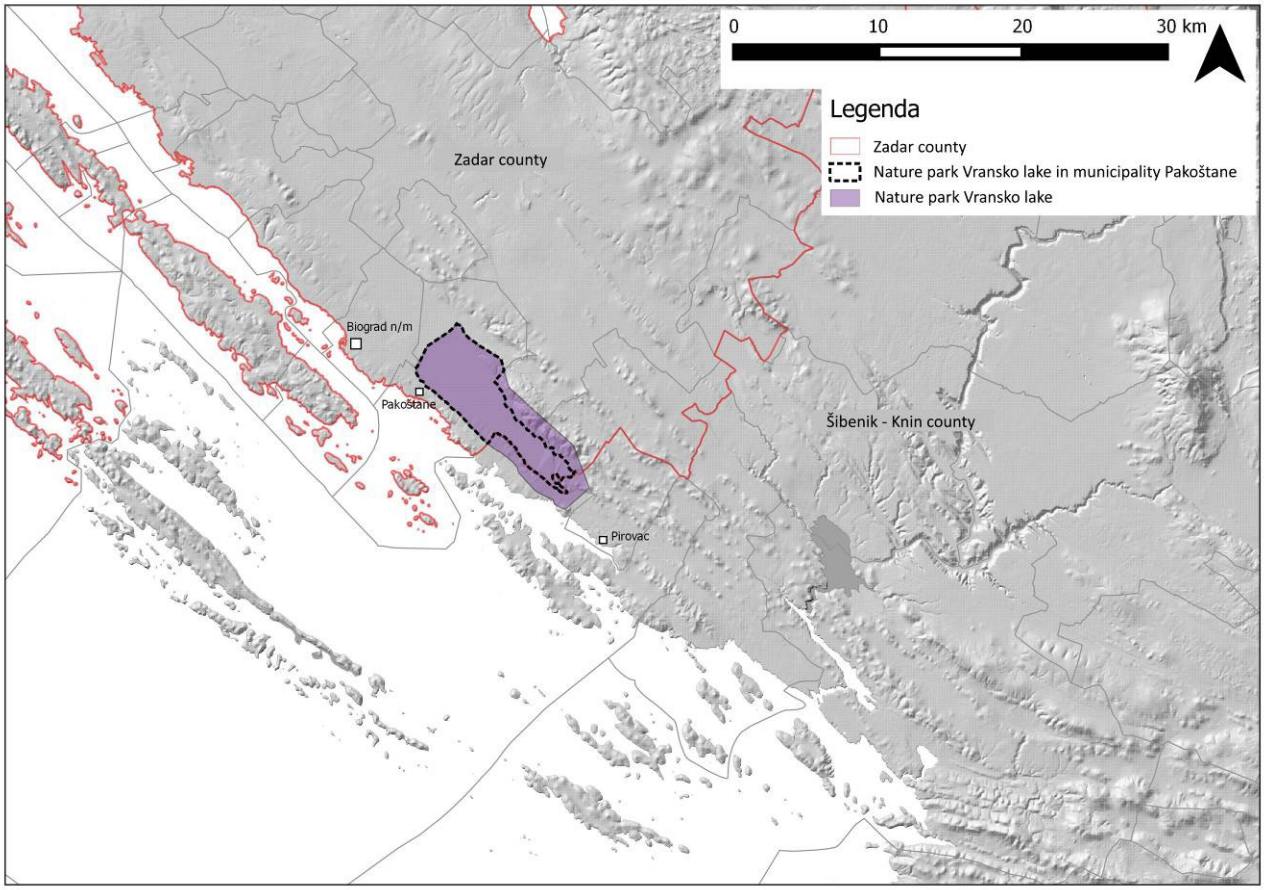


Figure 29. Administrative division of the Vransko Lake Nature Park

5.2.4.2 *Geomorphological features and soil*

The Vransko Lake Nature Park is predominantly made of limestone and paleogenesis. Vrana Lake is actually a karst filled with barckish water whose level is below 0 m a.s.l., ie it represents cryptodepression. The altitude in the Park area is about 0-100 m in the northeast part of the area (Figure 30).

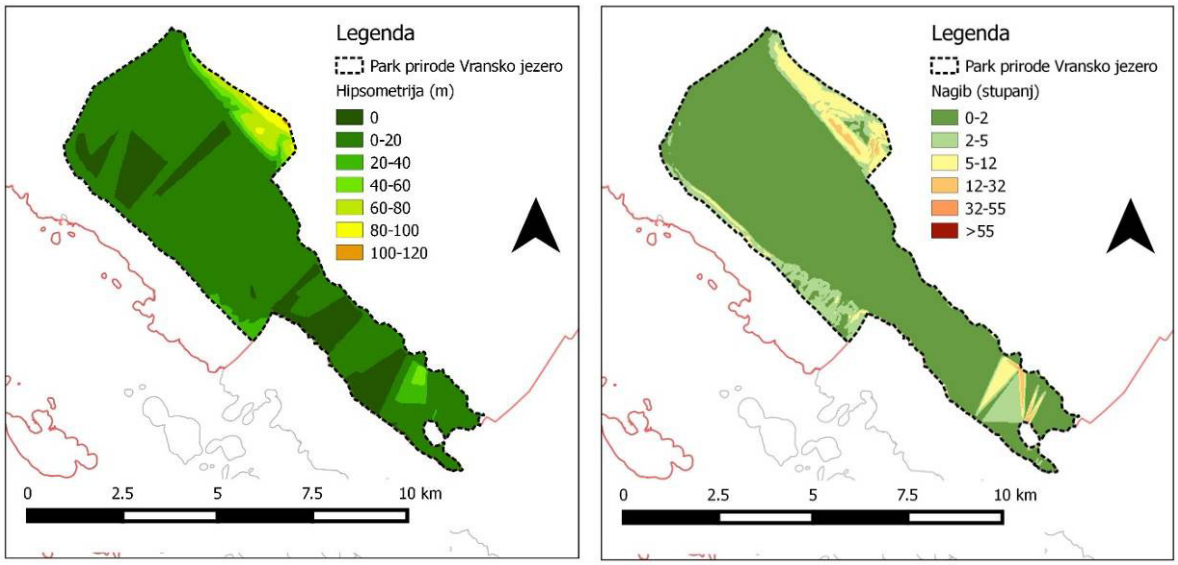


Figure 30. Hipsometry and slope in the area of Vransko Lake Nature Park (Pakoštane Municipality)

On such a base, the largest part (about 365 ha or about 9%) is represented by a rocky, containing different proportions of other types of soil, as shown in Table 7. Other types of groundwater located in the Vrana Lake Nature Park (Pakoštane Municipality) include Black limonite-dolomitic earth soil and swampy gully soil, partly hydromeliorated (about 5%) and Rendzine on planar (flush) or soft limestone (about 2%). The spatial arrangement of these units is shown in Figure 32.

Table 18. Most common mapping unit of soil in the area of Vrana Lake Nature Park (Pakoštane Municipality)

Number	**Systematic soil unit name**	**% share**
54	Rocky soil	50
	Limestone dolomite black – earth soil	25
	Rendzina	10
	Brown on limestone	10
	Terra rossa	5

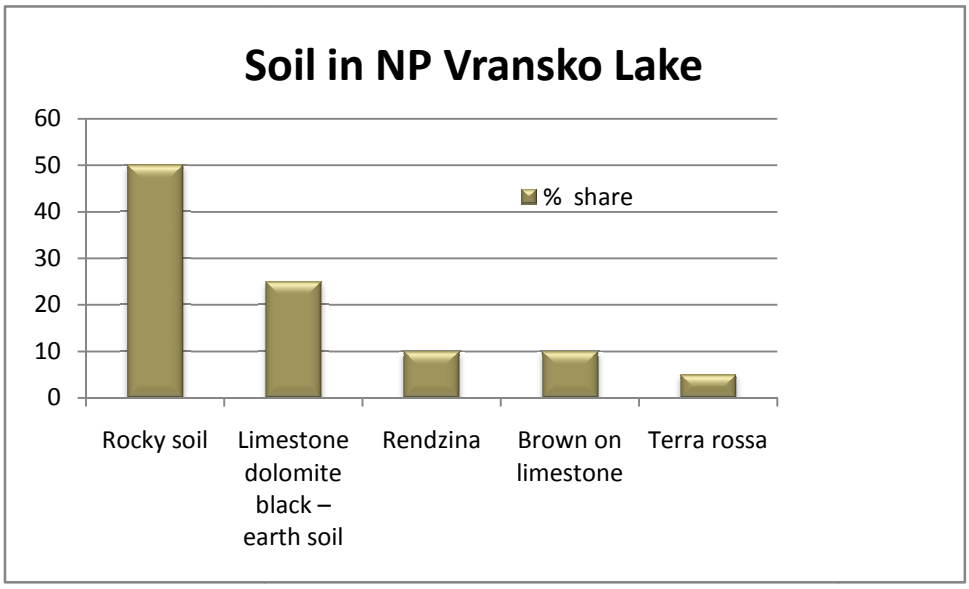


Figure 31. Soil in Vransko Lake Nature park (Source: Oikon)

A more detailed description of this cartographic unit of soil is given earlier in the text regarding the area of the Vrana Lake Nature Park.

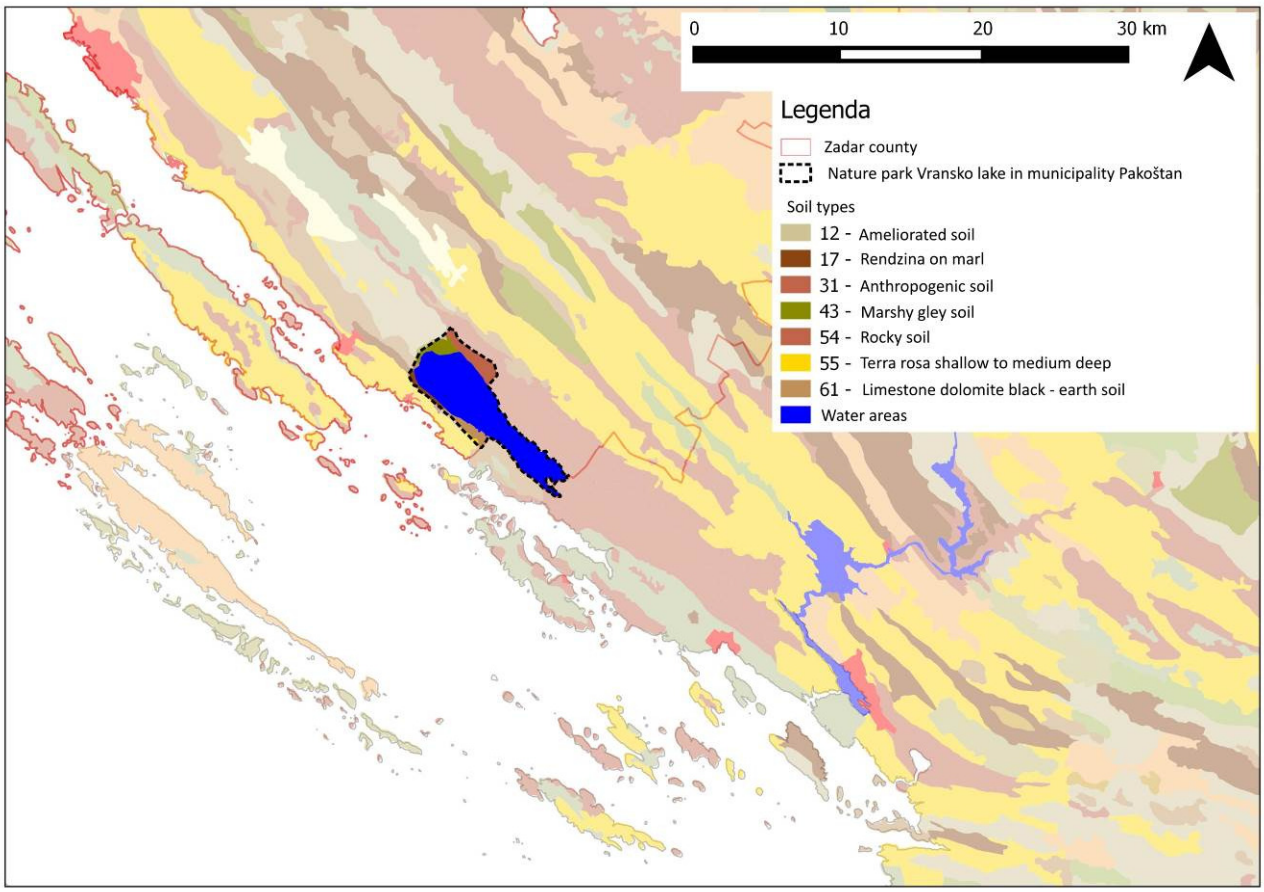


Figure 32. Soil map for the area of Vransko Lake Nature Park (Pakoštane Municipality) (Source: Oikon d.o.o.)

Table 19. Slope in Vransko Lake Nature park (Source: Oikon)

Slope (°)	Area (km^2)	Percentage (%)
0-2	30,99	78,04
2-5	4,93	12,42
5-12	3,33	8,39
12-32	0,46	1,16
32-55	0,00	0,00
50+	0,00	0,00
Total	39,71	100

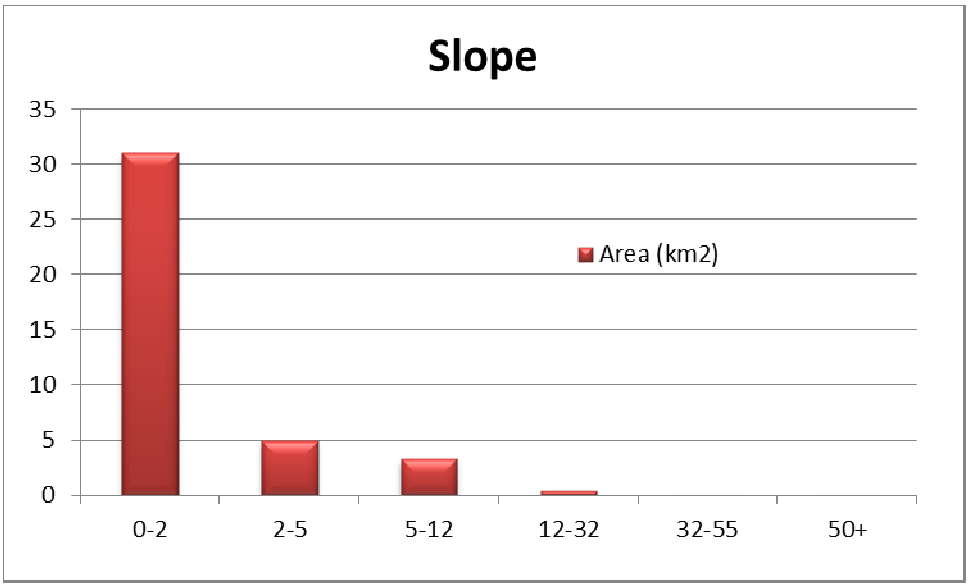


Figure 33. Slope in Vransko Lake Nature park (Source: Oikon)

Table 20. Aspect in Vransko Lake Nature park (Source: Oikon)

Aspect	Area (km^2)	Percentage %
N	0,92	9,42
NE	1,56	15,97
E	0,80	8,19
SE	0,52	5,32
S	1,33	13,61
SW	3,31	33,88
W	0,97	9,93
NW	0,36	3,68
Total	9,77	100
Lake without aspect	29,47	100

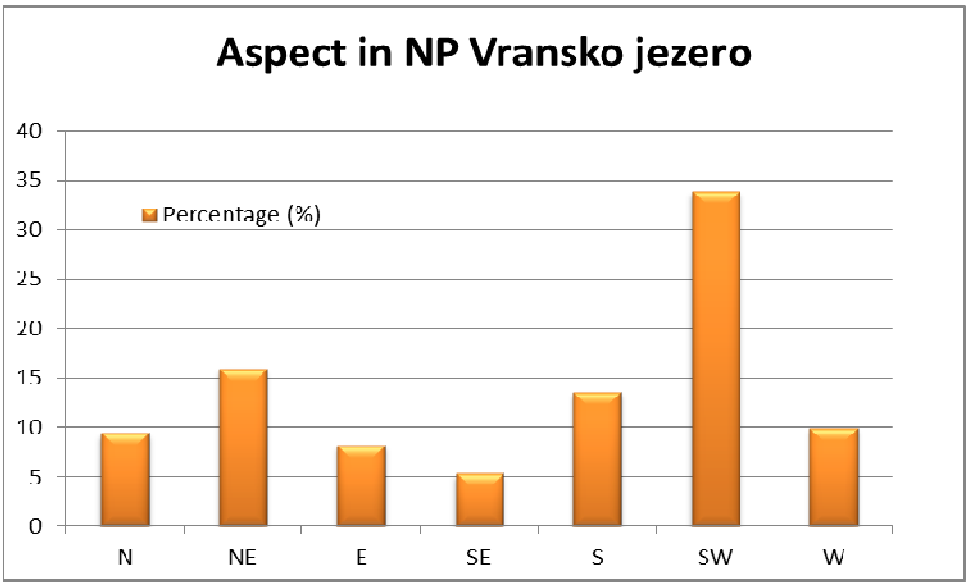


Figure 34. Aspect in Vransko Lake Nature park (Source: Oikon)

Table 21. Height above sea level in Vransko Lake Nature park (Source: Oikon)

Height above sea level	Area (km^2)	Percentage (%)
0-20	35,40	90,19
20-40	1,64	4,18
40-80	1,78	4,54
80-100	0,39	0,99
100-120	0,04	0,10
Total	39,25	100

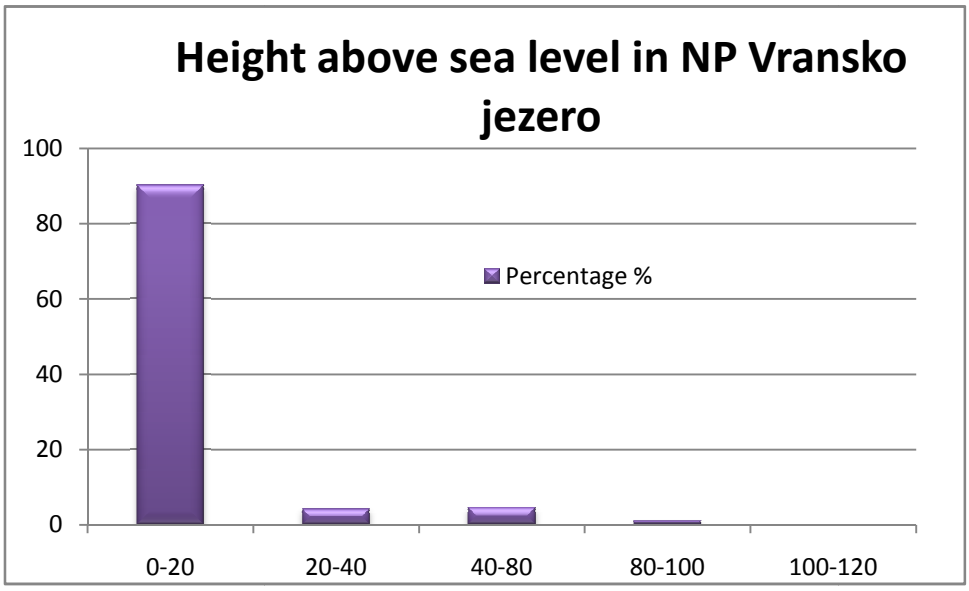


Figure 35. Height above sea level in Vransko Lake Nature park (Source: Oikon)

5.2.4.3 *Bioclimatic characteristics*

According to Köppen's classification of the climate, the area of the Vransko Lake Nature Park is located in the Mediterranean climate: (Csax). Climate C, a moderately warm rainy climate, is characterized by hot summers and mild winters with intermittent cold waves that can be very uncomfortable with cold. The average temperature of the coldest month is higher than -3 ºC and below 18 ºC. The average monthly temperature is higher than 10 ºC for more than 4 months a year. There are no dry months during the year, and in the annual rainfall occur two maxima, spring and autumn ("x").

Vegetation of Vransko Lake area belongs to mediterranean and submediterranean zones. The most valuable habitats in the Park area are open water and wetland habitats, reed beds, Holm Oak, Aleppo Pine and Mediterranean shrub and grassland.

5.2.4.4 *Land cover according to CORINE Land Use (CLC) classification*

According to CORINE Land Use (CLC) classification, the Vrana Lake Nature Park (Pakoštane Municipality) is dominated by forests and natural vegetation (about 15% of the surface): predominantly sclerophilic vegetation with 150.58 ha (about 4%), then transient forest areas, whitewashed forests and areas with scarce vegetation with about 3% share in the observed surface.Agricultural areas are represented to a lesser extent (about 7%), dominating agricultural areas with a significant share of natural vegetation. Lake (Vransko jezero) is the most represented category that makes about 78% of the Vrana Lake Nature Park in the Pakoštane municipality (3,046.64 ha).

The detailed area distribution by category is shown in Figure 37 and Table 22.

Table 22. Land cover and ways of land use in the area of Vransko Lake Nature Park (Pakoštane Municipality) (Source: CAEN, CLC RH 2012.)

Code	CLC category of surface cover and land use	ha	%
Agricultural land			
221	Vineyards	90,82	2,31%
223	Olive groves	0,70	0,02%
231	Grasslands	11,27	0,29%
242	Mosaic of different ways of agricultural use	78,74	2,01%
243	Agricultural land with a significant share of natural vegetation	92,66	2,36%
Forests and natural vegetation			
311	Hardwood forest	109,57	2,79%
312	Softwood forest	75,42	1,92%
321	Natural grassland	8,56	0,22%

323	Spherophilic vegetation	150,58	3,84%
324	Transitional forest areas	112,97	2,88%
333	Areas with sparse vegetation	109,57	2,79%
Swampland and water			
411	Land swamps	146,02	3,72%
512	Stagnant water	3046,64	77,64%
	Total	3.923,95	**100**

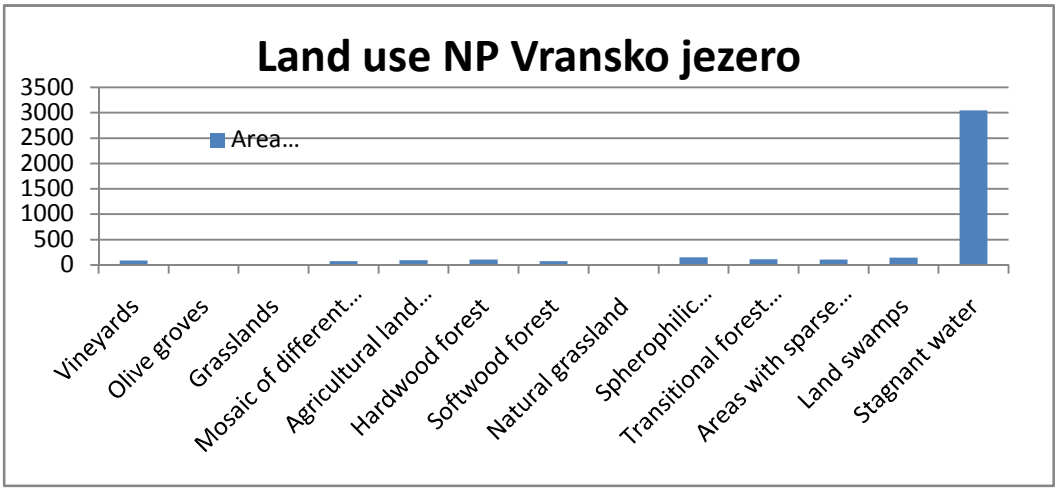


Figure 36. Land use in the area of Vransko Lake Nature Park (Pakoštane Municipality) (Source: AZO, CLC RH 2012.)

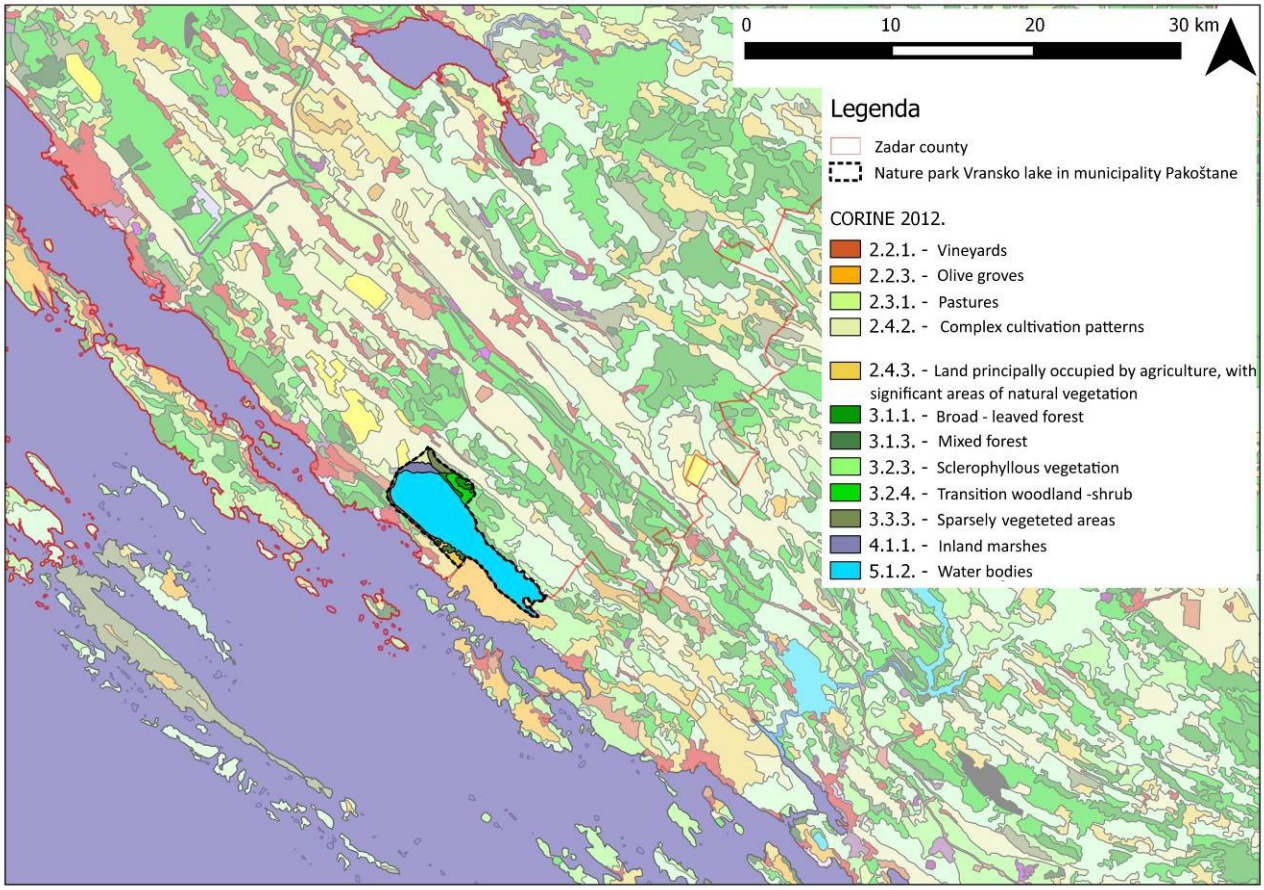


Figure 37. Land cover and ways of land use in the area of Vransko Lake Nature Park (Pakoštene Municipality) (Source: CAEN, CLC RH 2012).

5.2.4 *Naturalistic, Environmental and Landscape restrictions*

According to the Nature Protection Act, the Ministry of Environmental Protection and Energy permits and determines the nature protection conditions prior to the launch of the location permit procedure or during the procedure of issuing location permit for the project (including biomass exploitation) in the areas protected in the nature park category.

<u>Nature Park Velebit</u>

Nature park Velebit doesn't have a Spatial Plan nor Management plan in force. According to the Nature Protection Act (OG 80/13, 15/18), the Ministry of Environmental Protection and Energy permits and determines the nature protection conditions prior to the launch of the location permit procedure or during the procedure of issuing location permit for the project (including biomass exploitation) in the areas protected in the nature park category.

Nature Park Telašćica

Spatial plan

The spatial plan defines the following protection zones: Zone of strict protection, Zone of focused protection and Zone of usage.

The zone of strict protection is an area of exceptional value where any harmful human activity and the exploitation of natural resources are forbidden. The permitted activities are scientific research and monitoring of biodiversity and in part diving activities with the strict regulation and supervision of the Public Institution of the Park.

The zone of a focused protection makes most of the space within the scope of the Spatial Plan and represents a zone where different activities are permitted through the regulation and supervision of the Public Institution. Natural resources management is provided on the basis of appropriate management plans for natural resources, in accordance with the Ordinance on Protection and Conservation, the Nature Protection Act and other laws and subordinate legislation. The land area of the protected area includes grasslands, forests, agricultural areas and associated residues of traditional architecture, other traditional buildings, cultural assets, stonewalls, water tanks and ponds.

The zone of usage represents an area that is managed for purposes that are important for the development of the Park through tourist use. The zone of usage is intended for visiting and recreation and includes: Separate areas with already existing infrastructure and facilities, Dolac entrance, separate parking lots, paved roads and hiking trails and moorage locations.

General conditions for building and landscaping, in areas where construction is possible, are defined by a spatial plan. Within the scope of the Plan are allowed economic and other activities and activities that do not jeopardize its essential features and role. The manner of carrying out economic activities and the use of natural resources shall be carried out in accordance with natural resources management plans which, subject to special provisions in the field of nature protection, contain nature protection requirements.

Within the scope of the Plan are permissible projects and actions that do not impair it and do not change the properties for which it is protected.

It is forbidden to disturb the fundamental landscape values of the area within the scope of the Plan, and special care is given to the preservation of natural landscapes, which are marked as a whole of an indigenous landscape, from interventions in space not provided for by the spatial plan.

No conversion of land under olive trees, agricultural land and forest land is permitted.

Ecosystem conservation measures are carried out by the Public Institution and / or the owners and real estate rights holders and the concessionaires with prior consultation with the Public Institution and compliance with all legal requirements.

It is not permissible to endanger, damage and destroy the original natural values on the basis of which the prerequisites for proclaiming the Nature park are acquired.

Measures for prevention of negative impacts on environment

Spatial Plan sets out the measures to prevent adverse impacts on the environment, which encompass a set of activities aimed at preserving the environment in the original or slightly altered state.

Spatial Plan sets out guidelines for soil protection:

- it is necessary to ensure and maintain the soil functions in the long term qualitatively and quantitatively
- the measures to be taken are aimed primarily at the use of soil appropriate to the habitat, avoiding erosion and adversely affecting the structure of the soil as well as reducing the intake of matter
- special importance is given to the principle of preventiveness, which ensures the functionality and utilization of soil for different purposes as well as the availability of soil for future generations
- In the case of foreseeable hazards for important soil functions, priority should be given to protecting them in front of user interests
- For the purpose of preventive protection of ground functions, priority areas for certain uses have to be stated. In addition, appropriate measures should ensure valuable soil and sites including their use
- it is particularly important to support the aspirations and measures that are in line with soil protection and the goals of environmentally-oriented land use
- surfaces damaged by erosion and sliding must be preventively protected from repetition of denudation processes
- for the purpose of protection against erosion and harmful compaction of the soil, appropriate agricultural and forestry-specific procedures specific to each region ("Good Agricultural and Forestry Practices Rules")

- Encourage ecological or biotechnological farming and reduce the use of pesticides and mineral fertilizers to the smallest possible extent
- maintenance and use of forests should be adapted to the conditions of soil conditions.

All valuable land needs to be preserved, preferably improved, and abandoned agricultural land to revive agricultural production.

Air protection

In all areas, preventive measures should preserve existing air quality.

Sea protection

The spatial plan prohibits the discharge of oily water, waste oil, sanitary water from ships and all types of solid and liquid waste. (2) Measures of protection of the sea from extraordinary pollution (eg eventual incidents in which fuel leakage may occur) are taken from the valid Spatial Plan of the Zadar County. (3) In case of sudden pollution, the procedures and measures shall consist of the following actions: - stopping the release of substances, oils and / or mixtures of oils; - preventing further spread of the released substance, oil and / or mixture of oils; - collection of released matter, oil and / or oil mixture from the sea surface or bottom, if appropriate - disposal of the collected waste.

Noise protection

Within the scope of the Spatial Plan the noise level must be in accordance with the applicable regulations. It is exceptionally possible to produce noise in firefighting situations by aircraft, helicopters and similar.

Protection from fire

In the area within the scope of the Plan, fire burning is prohibited, except in places specifically designated and intended for this purpose.

Fire protection measures are organized and conducted in collaboration with public fire brigades, voluntary fire brigades, local self-government units and the representative body of the Zadar County.

For the purpose of preventive fire protection, it is necessary to provide a permanent observer's service.

For the purpose of preventing the spread of fires at adjacent buildings, the building shall be at least 4 m away from the adjacent buildings if it is proven taking into account the fire load, the speed of fire spread, the fire performance of the building material, the size of the openings on the exterior walls of the building that the fire will not be transferred to adjacent buildings or must be

separated from neighbouring buildings with a fire wall of fire resistance of at least 90 minutes, which in case the building has a roof structure (not applicable to a flat roof of fire resistance for at least 90 minutes) overhangs the building roof at least 0, 5 m or ends with a double console of the same fire resistance of at least 1 m below the roof covering, which must be of non-negligible material on the console length.

In order to enable the rescue of persons from the building and the fire on the building and the open space, the building must have a fire-fighting approach determined according to a special regulation, and when constructing or reconstructing water supply networks, there must be an internal and external hydrant network if it does not exist.

When designing a garage, use the applicable regulations or recognized technical rules.

Other fire protection measures shall be designed in accordance with applicable regulations.

Make an outline of the foreseen fire protection measures from which it will be possible to evaluate the selected fire protection system.

In the context of the fundamental features of the space that are contained in the policy of preserving natural values as the basic developmental resources of this area, it is necessary to immediately approach the valorisation of all the observed values and to stop those actions that could have unavoidable adverse environmental impacts. If this does not happen, a total condition that may have long-term implacable and irreparable consequences for the space can be aggravated. In this respect, the implementing measures will establish the lowest threshold for possible interventions in space and ways of controlling the use of space. Facilities that can be agents of imbalance in the environment are:

- uncontrolled construction
- the use of the coast and the landline for inappropriate contents that can pollute the coast and the waters.
- unregulated drainage of surface water
- lack of adequate waste water treatment and disposal systems.

When planning, designing and defining the purpose of the area in the nature park area, it is necessary to take care of the protection of the natural values recorded and to plan the design of the area and define the area of use so as not to disturb the natural equilibrium of existing ecosystems or in any way, endanger or damage the overall nature of the park. As basic functions of nature parks are scientific, educational and recreational, and the purpose of nature parks to protect the natural values and affirmation and presentation of these values as wider within the

circle of visitors and the population as a general category, it is one of the tasks and goals of spatial planning to go through defining the purpose of the space directly determines the appropriate degree of protection.

Protection of forests and forest land

It is based on the National Forestry Policy and Strategy and forest laws. Preservation of the total vegetation cover creates the preconditions for complex conservation of the natural heritage of the Park.

Management plan

In the Nature Park, there is no classical forest management in terms of exploitation, or forestry measures are not in function of a separate economic branch but in function of nature protection, forest and associated biocenosis. No specific objectives of the Management Plan are opposing the exploitation of wood biomass.

5.2.4.2 *Natura 2000 Network (Natura 2000 conservation objectives (SPA))*

The Park area is completely within the scope of the ecological network of the Republic of Croatia and also represents Natura 2000 area.

From the conservation objectives for target species of the area HR1000035, to which potential exploitation of biomass would have a negative impact, only the conservation objective for the eagle-owl (Bubo bubo) stood out. The objective is: to preserve the favourable habitat conditions through the Agro-ecological climate in the Rural Development Program; Do not conduct sports and recreational activities from 1.2. do 15.6. in a circle of 150 m around the known nests; designing and constructing the power infrastructure in a way to prevent bird collisions on high voltage (VN) transmission lines and bird electro-optics on mid-range (SN) transmission lines; on the sections of the existing transmission lines on which follow-up confirms the increased risk of collision and electrocution to carry out technical measures to prevent further bird fatalities. For target habitats and other species (other than birds) conservation objectives and measures are in the process of preparation by the government bodies.

Nature Park Vransko jezero

According to the Nature Conservation zonation, Vransko Lake Nature Park is divided into three basic zones: strict protection zone, active protection zone, zone of use (eco-resort Majdan area and areas with visitor acceptance function).

The Strict Protection zone covers 7.4% of the Park area and is entirely within the special area ornithological reserve. It covers the ecosystems of reeds and surrounding free water important for reproduction and conservation of water bird populations. In the strict protection zone, no projects in the area are allowed except for the reconstruction of the existing bird watching objects in the area of Južne bare in accordance with the special nature protection requirements prescribed by the competent ministry. Exceptionally, projects are only permitted in cases of need for localization of fire or removal of invasive allochthone species.

The Active Protection Zone covers the largest part of the Park area (91.8% of total area). Still and current land waters, forests, grasslands and cultivated agricultural areas are included in this zone. In the active protection zone, it is necessary to apply active conservation and revitalization measures to the ecosystem. Measures for renewal of natural water regimes, gradual revitalization of the ecosystem, and maintenance of grazing lawns by ways of mowing or removing overgrown trees are recommended. As one way of preserving the ecosystem, extensive (traditional) cattle breeding is encouraged.

The Spatial Plan determines the maintenance of traditional agriculture (cultivation of vineyards and olive groves) and prohibits land conversion.

The zone of usage covers 0.8% of the total area of the Park and represents all existing roads within and beyond the park, forest roads and areas of the Majdan eco-resort, separated areas of already existing or planned visitor or tourist infrastructure, harbors and docks.

Economic content within the boundaries of the Nature Park should respect local conditions, not to harm the environment and not to deteriorate the quality of water and land surfaces and to achieve nature protection conditions.

Agricultural areas of basic purpose (fields, gardens, orchards, meadows, etc.) are intended for performing traditional or ecological agriculture with the exception of the construction of greenhouses, on parcels larger than 10 000 m^2, with procurement of special nature protection requirements.

The spatial plan encourages the use of renewable energy sources (sun and biomass) for personal needs as much as possible since they contribute to reducing the use of traditional sources, there is less environmental damage, and spending is more rational.

The spatial plan defines measures to prevent adverse impacts on the environment, which encompass a set of activities aimed at preserving the environment in the the original, or slightly altered state.

5.2.4.3 *Hydrogeological restriction (Soil protection)*

- It is necessary to ensure and maintain the functions of long term quality and quantity of soil.
- The measures to be taken are mainly focused on land use appropriate to the habitat, avoiding erosion and adversely affecting soil structure as well as reducing agrochemical intake.
- The principle of preventiveness is of particular importance, which ensures the functionality and utilization of soil for different purposes as well as the availability of soil for future generations.
- In the case of foreseeable hazards for important soil functions, priority protection should be given to said functions before user interests.
- For the purpose of preventive protection of the soil functions, priority areas must be indicated for certain uses. In addition, appropriate measures should secure valuable soil and locations including their use.
- It is particularly important to support the aspirations and measures that are in line with soil protection and the goals of environmentally-oriented land use.
- The surfaces damaged by erosion and sliding must be preventively protected from repetition of denudation processes.
- For the purpose of protection against erosion and harmful soil compaction, appropriate agricultural and forestry-specific procedures specific to each region ("Good agricultural and forestry practice") should be applied.

Ecological or biological farming should be encouraged and use of pesticides and mineral fertilizers minimized.

- In order to protect from natural destruction, it is necessary to stimulate processes of natural rejuvenation of forests and indigenous forest communities.

- It is necessary to strive for a sheltered forest habitat. Maintenance and use of forests should be adapted to soil conditions.
- Swamp soils used in agriculture should be managed so as to prevent the degradation of organic matter in the soil and to ensure sustainable management through pasture use.

All valuable land needs to be preserved, preferably improved, and abandoned agricultural land needs to be revived for agricultural production.

5.2.6 *Distribution and classification of the main road network*

Road network was acquired from official data on Croatia public road and from Croatian forest ltd. Also, vector data from digital topographic maps (1:25000) was extracted to obtain lower categories of forest roads. Afterwards, additional visual classification was done to classify vector data into selected three categories. Table 23 representing total lengths of roads network within BDs.

Table 23. Road infrastructure classification in biomass districts.

Nature park	Biomass district	Asphalt	Macadam	Forest tracks	Total
Velebit	1	34.69	160.14	218.17	413.00
	2	122.98	487.65	445.55	1.056.19
Vransko jezero	3	2.06	36.26	31.64	69.96
Telaščica	4	10.29	18.15	8.66	37.11
Total		170.03	702.21	704.02	1.576.26

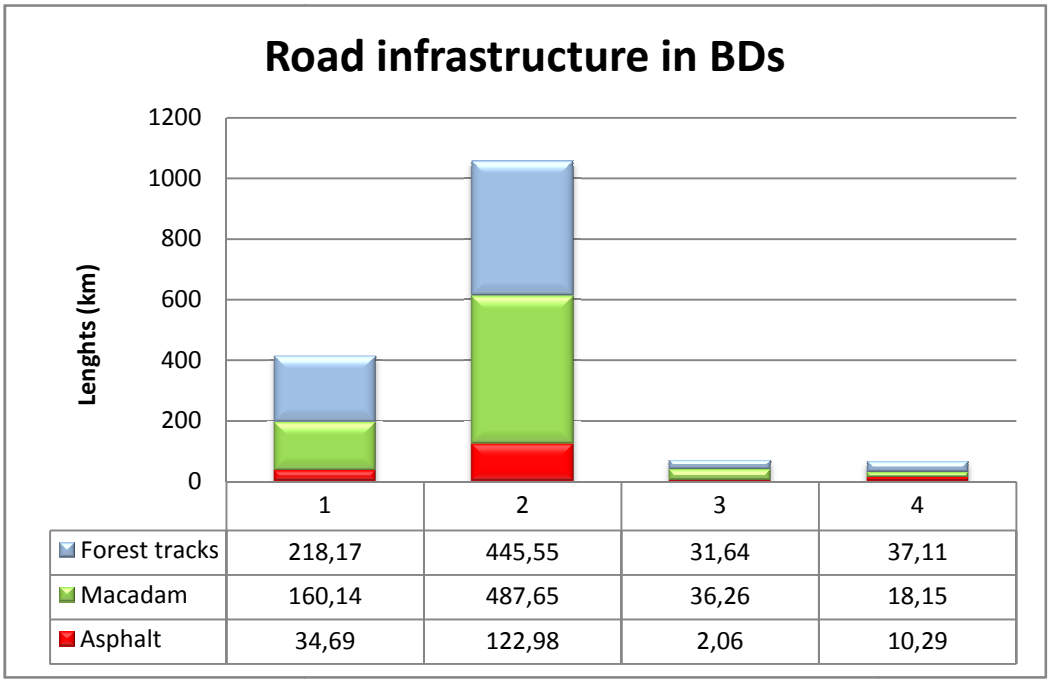


Figure 38. Road infrastructure classification in biomass districts.

As can be seen, for BD1 (Figure 38) forest openness with road is low considering that there is approximately 16.000 ha of forested areas giving 12.2 km[1] of roads per 1.000 ha. Forest tracks are not included in this calculation since truck transport is not possible on them.

If we observe only areas with forests where annual cut is prescribed (circa 4.500 ha) and select accompanied roads[2], openness is 21.3 km/1.000 ha, that is close to the recommended length.

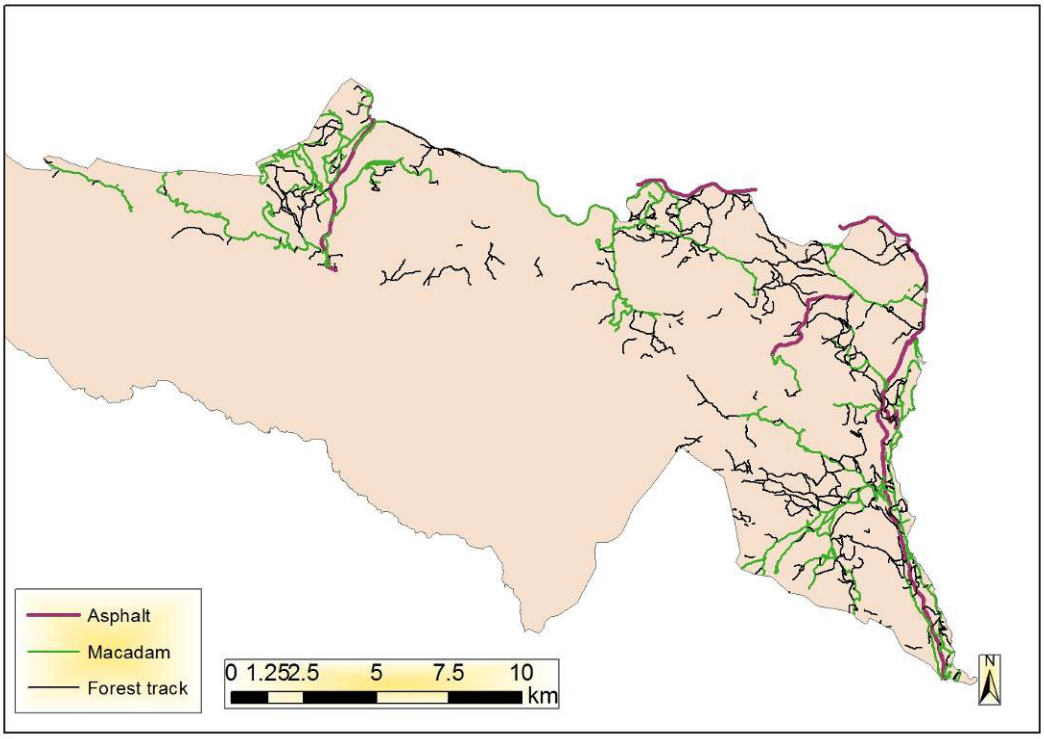


Figure 39. Forest road network in BD1

[1] By Rural Development Fund and related measure for investment in forest infrastructure for mountain area is recommended to have 25 km/1000 ha to have normal management.

[2] Asphalt and macadam roads and their parts that are encompased by 200 m buffer around areas with exploitable forests (by FMPs)

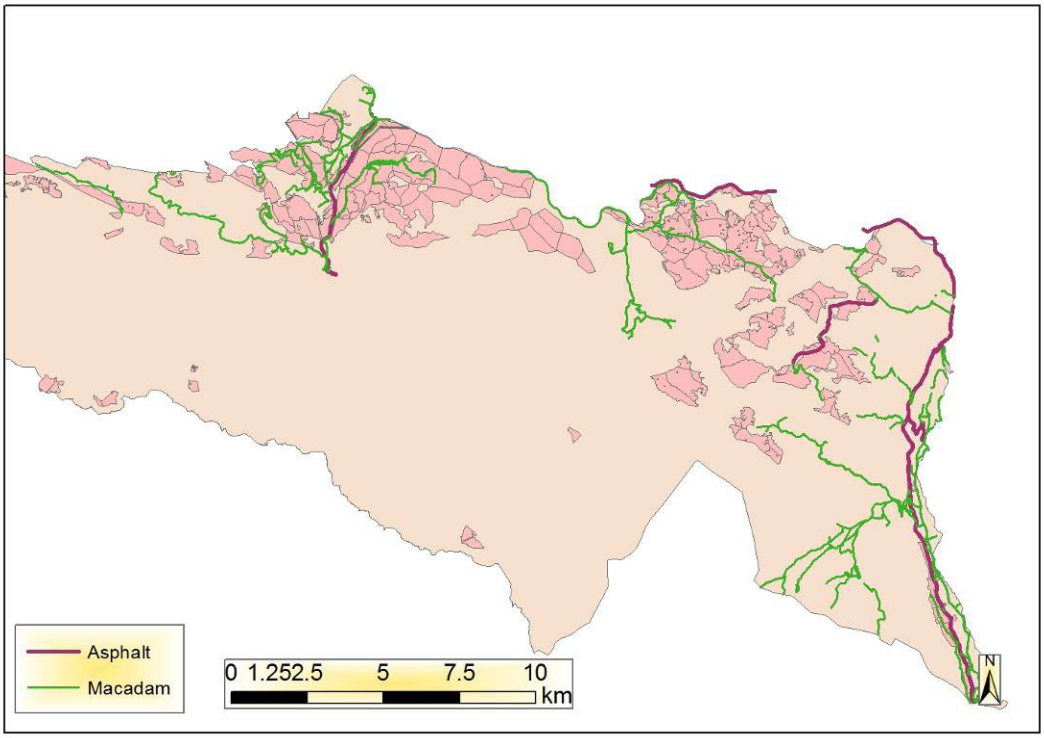


Figure 40. Overlay of exploitable forest and road network

Situation in BD2 is a bit different since there is circa 30.000 ha of forested areas and openness is 20.3 km/1000 ha. But, in this area forest that are exploitable are encompassing only 2000 ha and they are located mostly in remote areas openness is only 15 km/1000 ha.

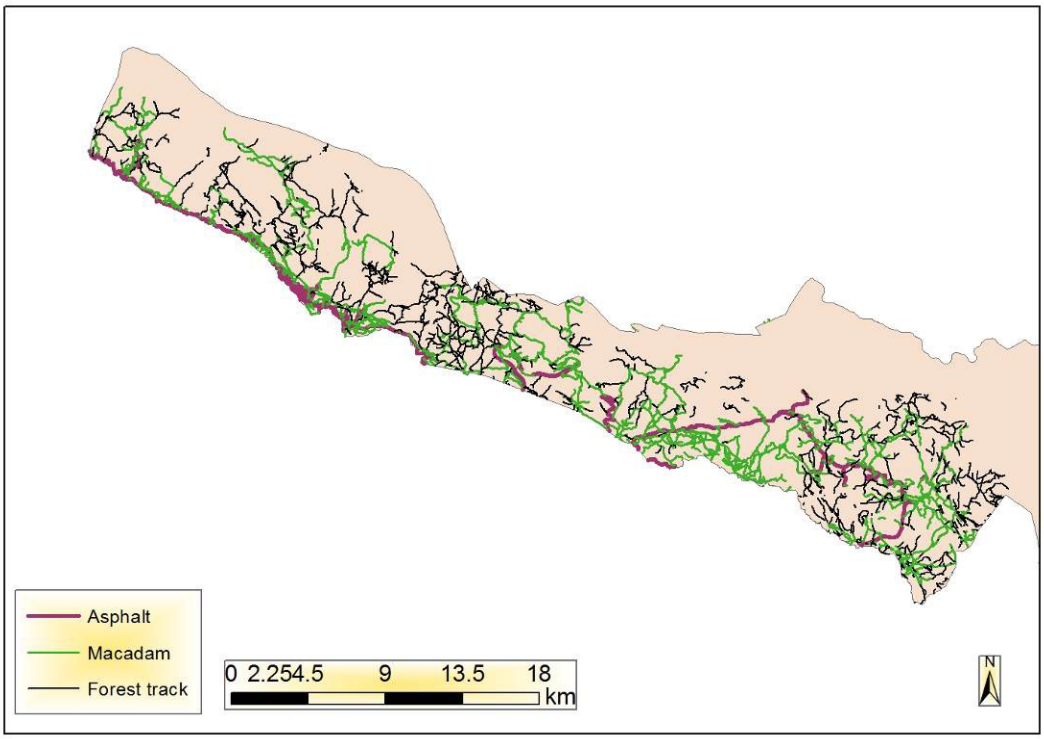


Figure 41. Forest road network in BD2

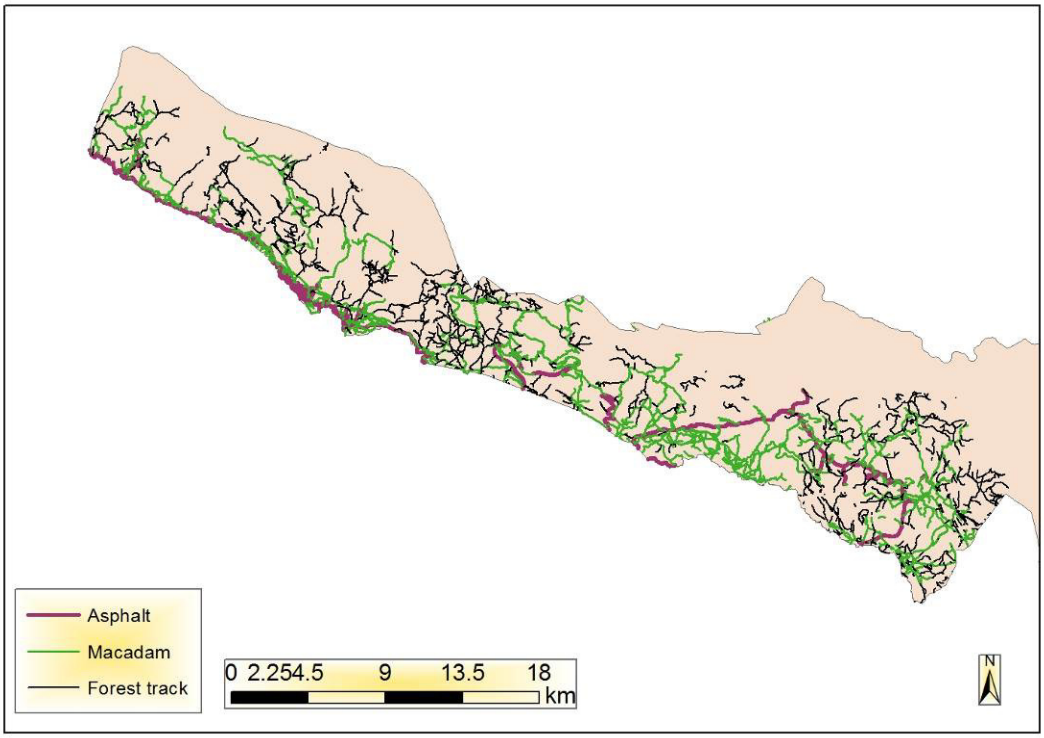


Figure 42. Overlay of exploitable forests and road network

At Vransko jezero (BD3) there are circa 1500 ha of forested areas resulting in openness of 25.3 km/1000 ha, but in this area only 75 ha are exploitable forest located in southern part of the area resulting in openness of 10 km/1000 ha (For carst areas, recommendation is 15 km/1000 ha).

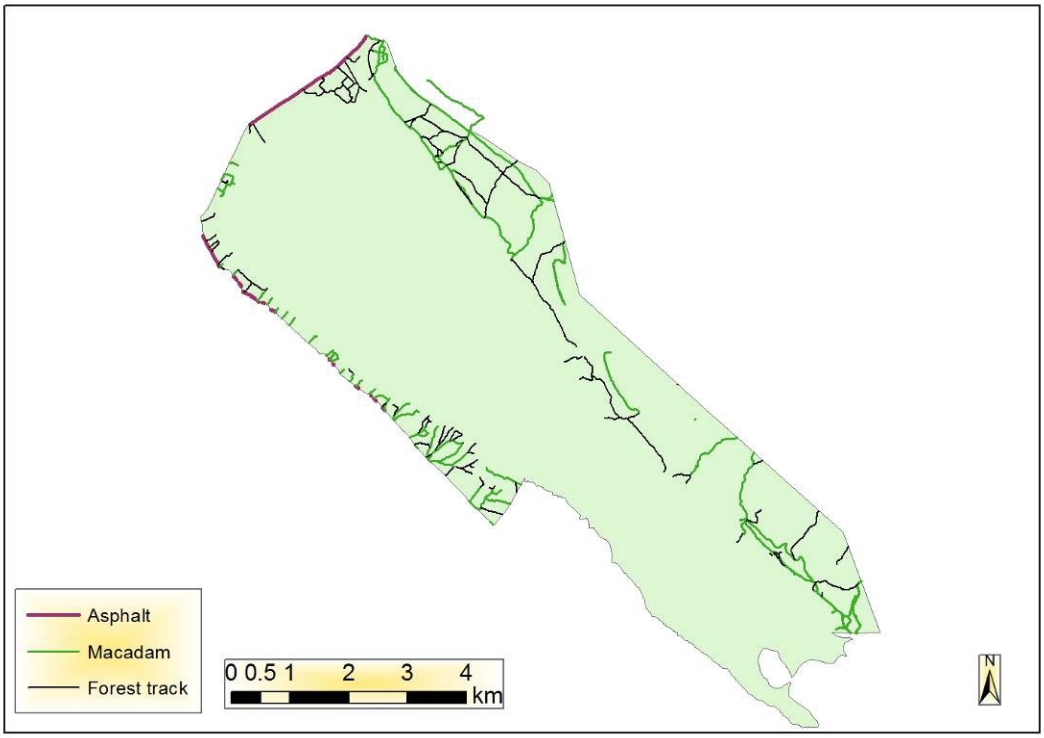


Figure 43. Road network in BD3

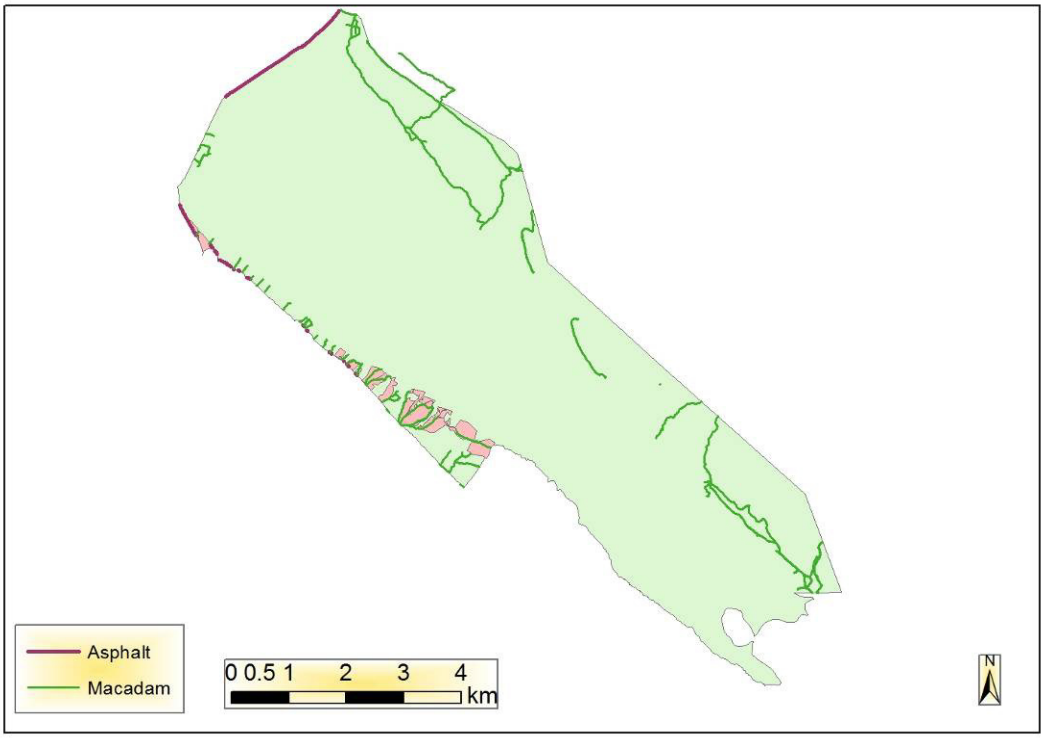


Figure 44. Overlay of exploitable forests and road network

In BD4 (Telaščica) there are only cca 250 ha of exploitable forests (although FMPs is not yet created since all of these are private-owned forests). Here we have openness for the exploitable areas of 12 km/1000 ha. As can be seen from picture 45, this is enough for part of the area while other part are still inaccessible.

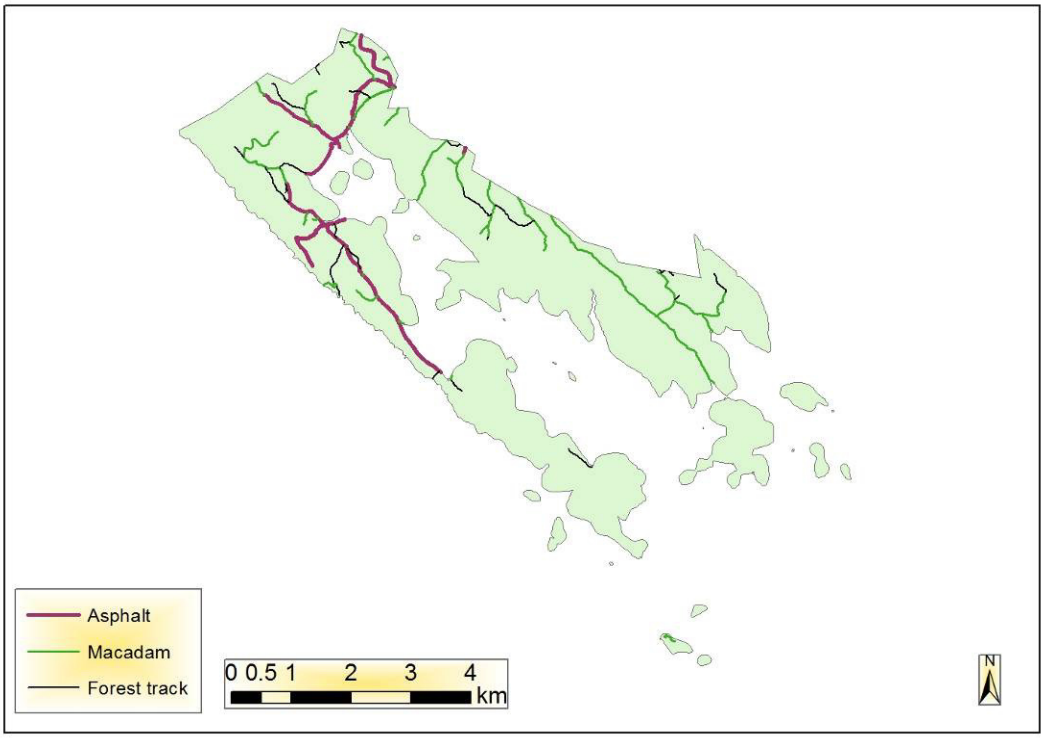


Figure 45. Road network in BD4

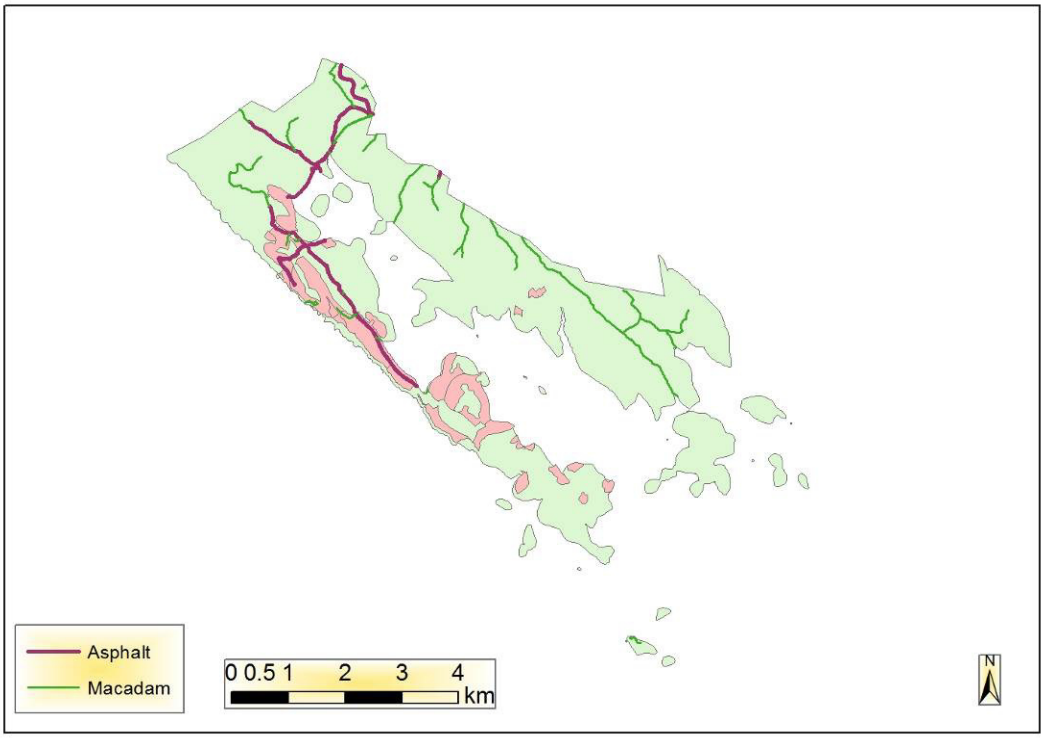


Figure 46. Overlay of exploitable forests and road network

5.2.7 *Energy needs*

It is very hard to determine the energy needs of involved municipalities since there the available data/calculations are done at County level in most cases without clear methodologies or used

input data. For this opportunity, we will use the results from IPA HOLISTIC project (Adriatic Holistic Forest Fire Protection, 1°STR/0001) that was finished 2 years ago. Within this project that was focusing on using more biomass in order to reduce fire fuel, available biomass and biomass needs (for heating and cooking) for the whole County (and separatelly for the municipalities) were calculated. Relevant data on BD level can be found below.

Table 24. Results from HOLISTIC project for biomass needs in relevant municipalities/biomass districts

		Population	Firewood users (%)	net biomass needed (m^3)
BD1	Gračac	3923	98.11	3154
BD2	Obrovac	3387	83.39	2279
	Jasenice	1329	95.12	874
	Starigrad	1893	91.28	1486
	Total	**6609**	**88.01**	**4639**
BD3	Sali	1820	87.72	1739
BD4	Pakoštane	3884	79.48	2692

5.2.8 *Private companies operating in the biomass sector*

The number of private companies operating in forestry and biomass sector in these areas are rather small. The reasons for that can be seen in:

- rural depopulation,
- small areas covered with economically exploited forests
- low price of works related to forestry and biomass extraction.

As can be seen in Table 25, in BD4 (Telaščica) there is no company related to the biomass extraction and processing. In BD3 (Vransko jezero) there are only companies involved in wood processing and marketing but some of them are registered for manufacturing souvenirs and small items from wood. At Nature Park Velebit (BD1 and BD2) there are some companies registered in relevant municipalities, as there are exploitable areas and forest management is conducted.

Table 25. Number of relevant companies

Biomass district	No of companies (felling and	No of companies (processing and	Total

	skiding)	marketing of wood)	
BD1	8	13	21
BD2	4	29	33
BD3	0	10	10
BD4	0	0	0

This represents a strong limitation for the development of sustainable short supply chains for the production of bioenergy. The reasons for such a situation could depend on the existence of different types of barriers that limit the use of biomass, as assumed by some of the companies identified. These barriers, already identified during a specific deliverable of the project, will be further investigated in order to find the right solutions for overcoming them.

5.2.9 Final remarks

Official data on forested land by CLC and exploitable types of forests according to Forest Management Plans have notable discrepancies. Limitation of the CLC and its methodology is well known, but there could be also some (intentional/unintentional) misclassifications of the management classes due to inaccesability of some areas during creation of FMPs. In BD1 there are almost 2500 ha of difference, for BD2/BD3 is more or less the same and for BD4 there is a difference of almost 300 ha in these data.

For BD1 and BD2 limmitation factor for exploitation is mountain relief and lower road openness. Observing BD3/BD4 limitations are small areas under non-degraded forests and lower openness, also.

However, in BD1/BD2 are almost 10.000 ha of actively managed forests and these areas could represent the viable source of biomass for local areas. In other BDs, main category of forested land is degraded forests, where current and available wood stock is not known. Therefore, the acitivities for these areas will be focused in determing available biomass with greater precision trough additional field/remote sensing research.

BD4 have unique situation since all forested areas are in private property for which there is no FMP created. But even with forest management plan, exploitation would be difficult due to cadastre situation in Croatia (non-updated state, small parcels, many owners).

Road network could be better in order to have more functional management but new road design and build is only possible for areas in state ownerships. This is due to a fact that for building the road, owners have to give consent for it and in Croatia it is very hard to obtain consents from all

(private) owners due to mentioned problems (small parcells, many owner, non-updated cadastre resulting having a owner that is deceased or moved abroad long time ago).

5.4 References

- Croatian Agency for Environment and Nature (Corine Land Cover)
- Croatian Chamber of Economy (companies info)
- Croatian forests ltd (roads, forest data)
- Croatian roads ltd (roads)
- HOLISTIC project deliverable 3e: “Detailed report on resources and potentials for creation of sustainable models for biomass utilisation for energy production in Zadar County, Croatia“
- Ministry of economy, entrepreneurship and crafts (info about crafts)
- Oikon ltd (other spatial and raster data)

6. GEOGRAPHICAL IDENTIFICATION AND DESCRIPTION OF BIOMASS DISTRICTS (BDs) WITHIN THE LIKA-SENJ COUNTY (CROATIA)

6.1 Identification of BDs

The most important goal of the DSS is to set the framework for decision making same as indicators to create a vision for the main parameters that can be used in spatial planning of future biomass districts. This framework is presented in this chapter. The biomass district within the protected area will represent administrative areas designated for company-level planning (companies, firms), taking into account the area and permanent crops surfaces that can be used, provided that these areas are, as much as possible, homogeneous. For the purpose of defining the district, the methodology was used according to the Guidelines - final version of the Interreg project „Forest Bioenergy in the Protected Mediterranean Areas“ (A 3.4, 2018). The following spatial data was used to determine the biomass district:

- total area of the municipal territories (further in text, abbreviation: LAU, local self-government units or local administrative unit[3], which is more adequate cause the state, in its nomenclature, distinguishes cities and municipalities);
- area of the LSG, within the protected area (in the Nature Park Velebit);
- agroforestry area of each municipality within Nature Park Velebit, obtained from the land use map according to the Corine Land Cover legend, distinguished in forests (codes 311, 312, 313) and permanent crops (classes 221, 222, 223);
- characteristics and distribution of the main road network;
- localization of urban centers;
- energy needs of each municipality.

In the analysis of the mentioned areas of forests and permanent crops, in the area covered by the LSG, the areas within the boundaries of the National Park "Northern Velebit" and the National Park "Paklenica" (hereinafter referred to as: NP Northern Velebit and NP Paklenica) are excluded; in these areas there is no organized economic use of forests and, therefore, they are not included into calculations regarding the exploitation of biomass in the area of Nature Park Velebit.

In order to define the biomass district, we have taken into account all the parameters given in the "Forest Bioenergy in the Protected Mediterranean Areas" Guidline (2018). The Park's area is

analyzed on the basis of its spatial position, administrative boundaries, bioclimatic, geomorphological and pedologic characteristics, calculated drainage areas, traffic features, protected habitats and areas, land and forest usage and the area of spreading of certain types of forests. For the purpose of performing all the analyses mentioned, various publicly available and discarded data were used. Data for analyzing the administrative framework of the Park was given by the Public Institution „Nature Park Velebit“.

For analyzing different natural features, we used publicly available data from the Bioportal and from the Environmental Protection Agency of the Republic of Croatia. For the GIS analysis, the digital elevation model (DEM) was publicly available thanks to NASA/MRTI/AIST/Japan Space Systems and the U.S./Japan ASTER Science Team. Data were also requested from Lika-Senj County, the Department of Construction, Environmental Protection and Nature and the Municipal Economy, on the conditions of construction for biomass plants.

6.2 Description of BDs

Considering the above-mentioned parameters, it is proposed to form three biomass districts corresponding to the area of activity of Forestry Administrations: Senj, Gospić and Zadar (branches of Hrvatske šume d.o.o.):

I. Senj;
II. Otočac, Perušić, Gospić, Karlobag, Lovinac, Gračac;
III. Ervenik, Obrovac, Jasenice, Starigrad.

I. Biomass district: Senj

The Biomass district: Senj (Figures 1. and 2.) administratively covers the area of LAU Senj, where is the largest settlement of Senj, which is compact coastal architecture and which, from the point of biomass usage, can be an interesting area (a larger number of consumers in a relatively small territory). Forests in the hinterland of Senj represent a very valuable resource and have been exploited for further production of wood assortments. The exploitation area is connected with Senj by state road: D23, where frequent traffic flows during the summer months (tourism season). Throughout the year, this road takes part of the traffic to Kvarner and the island of Rab to the ferry port of Stinica, located about 41.5 km south of the Senj settlement.

II. Biomass district: Otočac, Perušić, Gospić, Karlobag, Lovinac, Gračac

This Biomass district (Figures 1. and 2.) is the most significant biomass district; oriented towards the interior and on the continental slopes of Velebit and parts of Gacka and Lika fields. This is the area most densely populated within two LAU: Otočac and Gospić and several relatively bigger settlements. In this area, apart from the potential consumers, there is the management of the Public Institution „Nature Park Velebit“ and Forestry Administration Gospić. Also, Gospić is the administrative center of Lika-Senj County and there is a relatively large number of public buildings (compared to the number of inhabitants). LAU Karlobag is merged in this area because the most valuable part of the area, from the point of biomass exploitation, lies in the hinterland of this LAU. In the coastal part of LAU Karlobag, the forest has more features of soil protection than erosion and forests do not have economic value. Also, the Adriatic state road linking LAU Karlobag with LAU Senj and LAU Starigrad is very often closed, during the winter period of the year, due to unfavorable weather conditions (Bora wind).

III. Biomass district: Ervenik, Obrovac, Jasenice, Starigrad

Third Biomass district: Ervenik, Obrovac, Jasenica, Starigrad (Figures 1 and 2) are located in the southwest of NP Velebit. This area has no such economic significance as the second (II.) planned Biomass district. Also, this is a poorly populated area where can be planed a smaller heating plant for the area of Obrovac, as the only urban settlement in this territory.

Figure 1. Map of defined Biomass Districts.

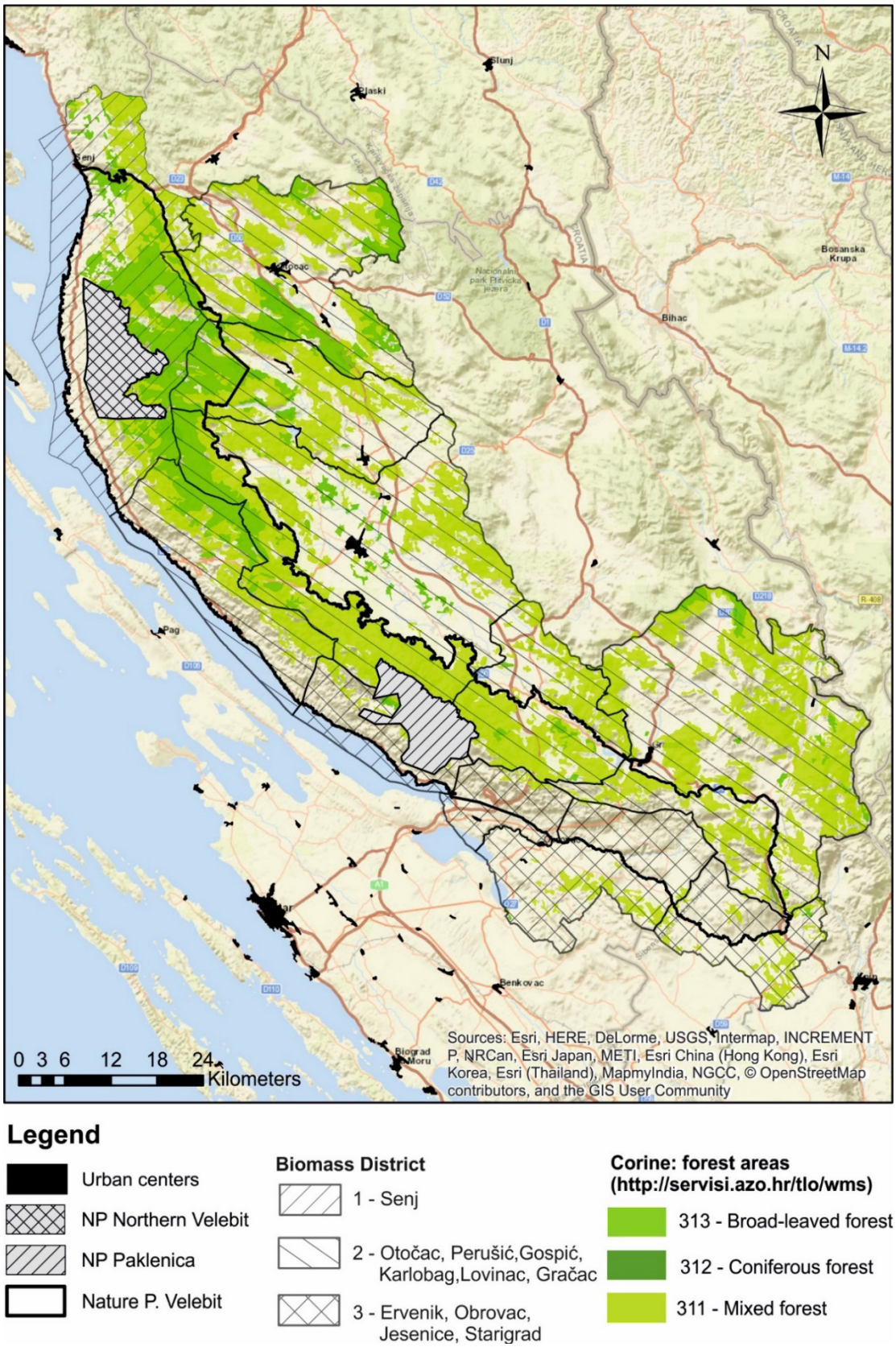


Figure 2. Map of defined Biomass Districts with separated forest areas.

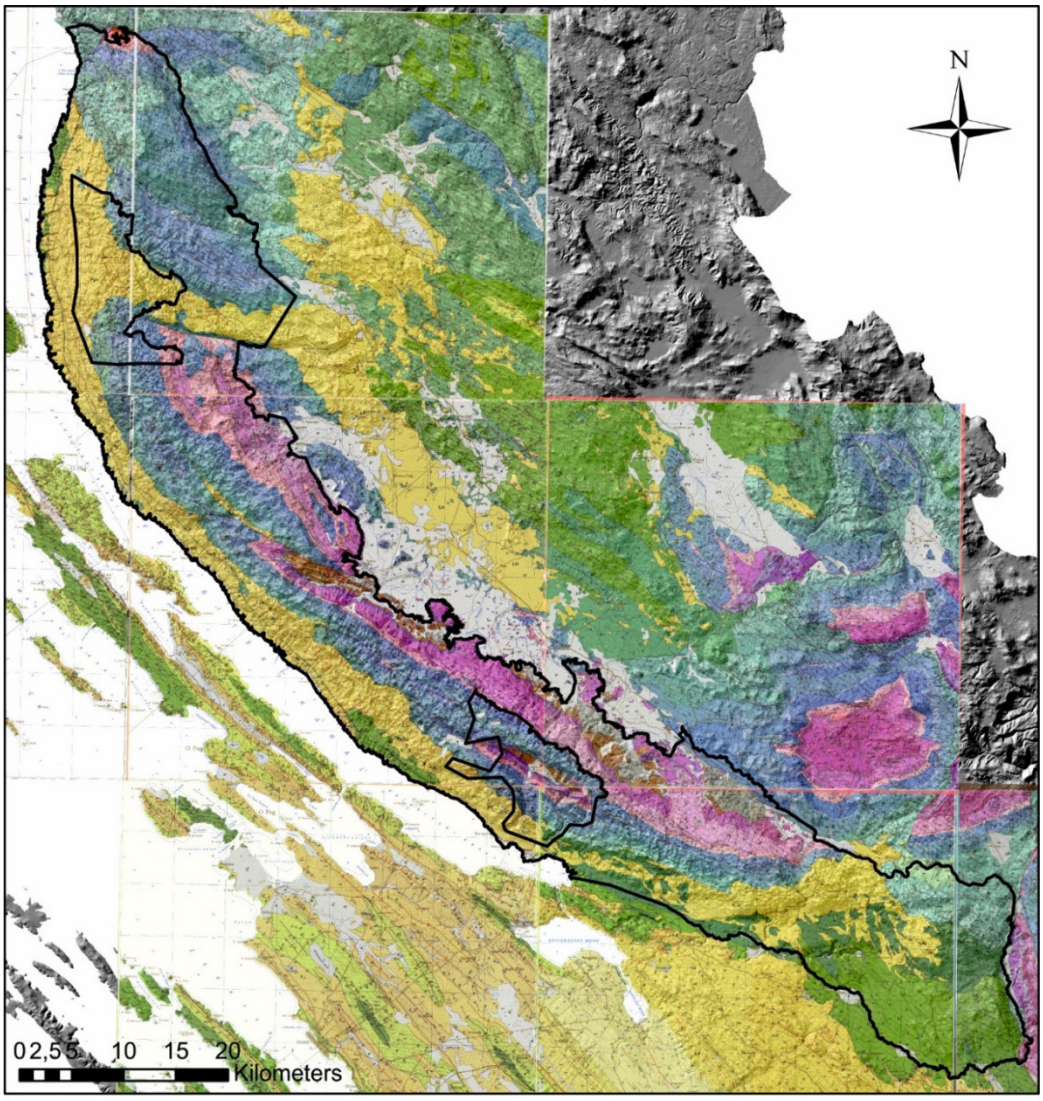
6.2.1 *Geology and soils*

From a geological point of view, in terms of the expansion of individual forest habitats, it is important to consider which types of rocks form the soil basement. Namely, by weathering and erosion of rock mass by various processes, a residue is created that will, among other things, form the soil. Different rocks will form soils of different composition, but also by disintegration of the same rocks, will not always form the same amount of residual material that will form the ground. Velebit Mountain is mainly built of sedimentary rocks and carbonates, of which a large proportion is made of limestone. The limestone rocks are extremely susceptible to chemical disintegration, i.e. the "dissolution" of water in the form of weak acids, resulting in a karstic landscape characteristic of Velebit.

On the geological map (Figure 3.), different colors marked rocks of different ages. Carboniferous, Permian and Triassic rocks make lithologically different rocks. The largest share is represented by sedimentary rocks, carbonates and clastic rocks of silicate origin. On certain locations within northern Velebit between locations of Senj and Vratnik and near location Donje Pazarište, the outcrops of volcanic rocks were mapped on the main geological maps of Yugoslavia (Mamužić & Milan, 1973; Sokač et al., 1976). Clastic deposits are relatively rapidly eroded when exposed to mechanical weathering (mainly due to the flow of water), while limestone is subject to chemical wear. Within carbonates, especially limestones, a great role in their weathering is played by the formation of a karst system with a high secondary porosity that will allow even faster erosion and water resolving. That is why we can expect the smallest cover of the soil on limestones and something more pronounced on dolomites. Clastic usually yield larger amounts of material that will form part of the soil, and we can expect on them significant vegetative cover. Unlike carbonates, the consumption of volcanic rocks usually results in soil rich in nutrients. In this way, we can associate the appearance of a significant plant cover on the Adriatic slopes of Velebit above Senj, where volcanic rocks are found, unlike the rest of the Velebit coastline, which is quite bare and characterized by a karst landscape. In addition, dense forests that have long history of economical exploitation in the area and near Štirovača area are mostly covered by the clastic rocks of the Triassic age. Velebit is mostly build by carbonate rocks of Cretaceous and Jurassic age (Figure 3.), which, if they are represented by limestone, will often condition karstic appearances, and, if they are represented by dolomites, the surface covers more plant cover. However, the most significant example of the effect of the lithological composition on the plant cover is the appearance of the Velebit (Jelar) breccia. The conditions and the genesis of these rocks are not

entirely clear, but their occurrence on Velebit coincides with the area where the karst is most developed. Most of the Velebit breccia was built from the clasts of resedimented older rocks, mostly carbonates, which suffered from short transport and mechanical weathering. On the geological map they mostly represent the surface marked with yellow color inside NP Velebit boundaries (Figure 3.). The clasts act like armature, so they are hard rocks, but very tectonized and very porous. Because of this, we often see them as bare structures. These rocks are mapped almost along the entire Adriatic side of the Velebit, but also in the area of the North Velebit, near Rožanski kukovi and Hajdučki kukovi, where they are perpendicular to Velebit (Figure 3.). They also build Dabarski kukovi in Central Velebit (Mamužić & Milan, 1973; Sokač et al., 1976).

On the influence of rocky substrate on the presence of certain types of soil, it is best to represent the pedological map itself (Figure 4.), which was assigned to this study by the PhD Vesna Vukadinović from University of Josip Juraj Strossmayer in Osijek (Faculty of Agronomy). Velebit is located in one of the largest soil erosion areas in Europe. The upper layer of the soil is shallow, and is mostly found on limestone and dolomite, and by the loss of the forest cover, the soil is rapidly washed away by mountain torrents. The problem of soil erosion is particularly visible in the coastal part of the Nature Park „Velebit“. Most of the Nature Park prevails on brown limestone, on clastics (acidic brown soil) and smaller brown soil on dolomites (Figure 4, Table 1.). Brown soils represent a very rocky forest soil created on clean, often karstificated limestones and dolomites. They prevail in a wide range, from sea ranges up to 1700 meters above sea level. This is the ground of a discontinuous cover with a varying depth of several centimeters and up to several meters.



Legend

Nature Park Velebit

Value

High : 254

Low : 0

Digital elevation model (DEM) of RH

Simplyfied legend of geological marks on map based on Basic Geological Map (OGK) 1:100 000; shets: Knin, Udbina, Obrovac, Zadar, Silba, Gospić, Rab, Otočac (Velić et al., 1974; Mamužić et al., 1969; Šušnjar et al., 1973; Majcen et al., 1970; Mamužić et al., 1970; Sokač et al., 1974; Grimani et al., 1972; Ivanović et al., 1973)

Stratigraphic age of rocks:

- Quaternary
- Tertiary
- Cretaceous
- Jurassic
- Triassic
- Permian
- Carboniferous

Some important structural elements marks of geological map:

- Orientation of sediment beding
- Anticlines and sinclines
- Reverse faults
- Normal faults

Figure 3. Compilation geological map.

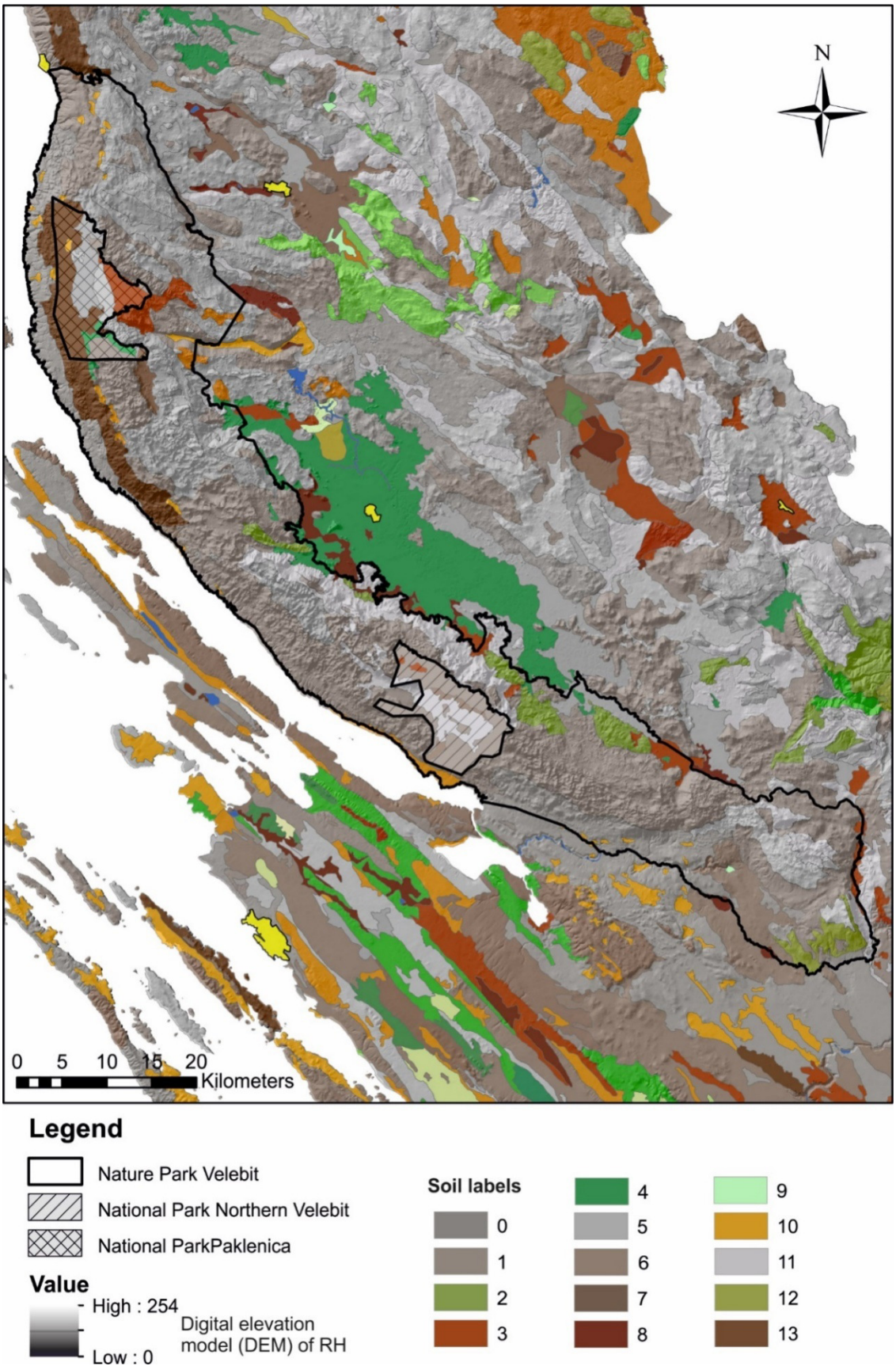


Figure 4. Pedological map. (Source: http://pedologija.com.hr/karte.htm)

Table 1. Types of soil within the area of NP Velebit.

	Soil marks in legend	Types of soils
1	0	Brown on limestone
2	1	Brown on limestone
3	2	Acidic brown on clastics
4	3	Rendzina on gravel
5	4	Acidic brown on loess and holocene sediment
6	5	Black limestone dolomite
7	6	Terra rossa shalow and medium deep
8	7	Rockery
9	8	Alluvial
10	9	Alluvial defended from flooding
11	10	Antropogenic on karst
12	11	Rendzina on dolomite and limestone
13	12	Brown on dolomite
14	13	Rendzina on limestone residue

6.2.2 *Climate*

Velebit, apart from geographically, climatically can be easily divided into two parts, sea or Adriatic, and Lika or continental. From this point of view, Velebit is exposed throughout the year by two different climatic parts that are sometimes mixed and may sometimes expose the mountain altogether under different climatic conditions, in a few hundred meters of air distance. We often witness to the great temperature differences that appear along the shore and on the peaks of Velebit, or the strong wind (called „Bora“) along the Velebit Channel. Of course, so different conditions influence the development of plant habitats. For such a reason, mountain Velebit, same as Park, is divided on two bioregions (Figure 5.) – Alpine and Mediterranean (http://bioportal.hr/). Within the Alpine bioregion, it is to expect better conditions for a forest cover, due to a humid climate. In the Mediterranean bioregion we expect different types of forests, more with lower plants. An important role in the formation of a forest cover is the strong wind from northeast, Bora, especially in winter, brings the sea salt on the mainland and thus greatly hampers the growth and formation of economically interesting forests.

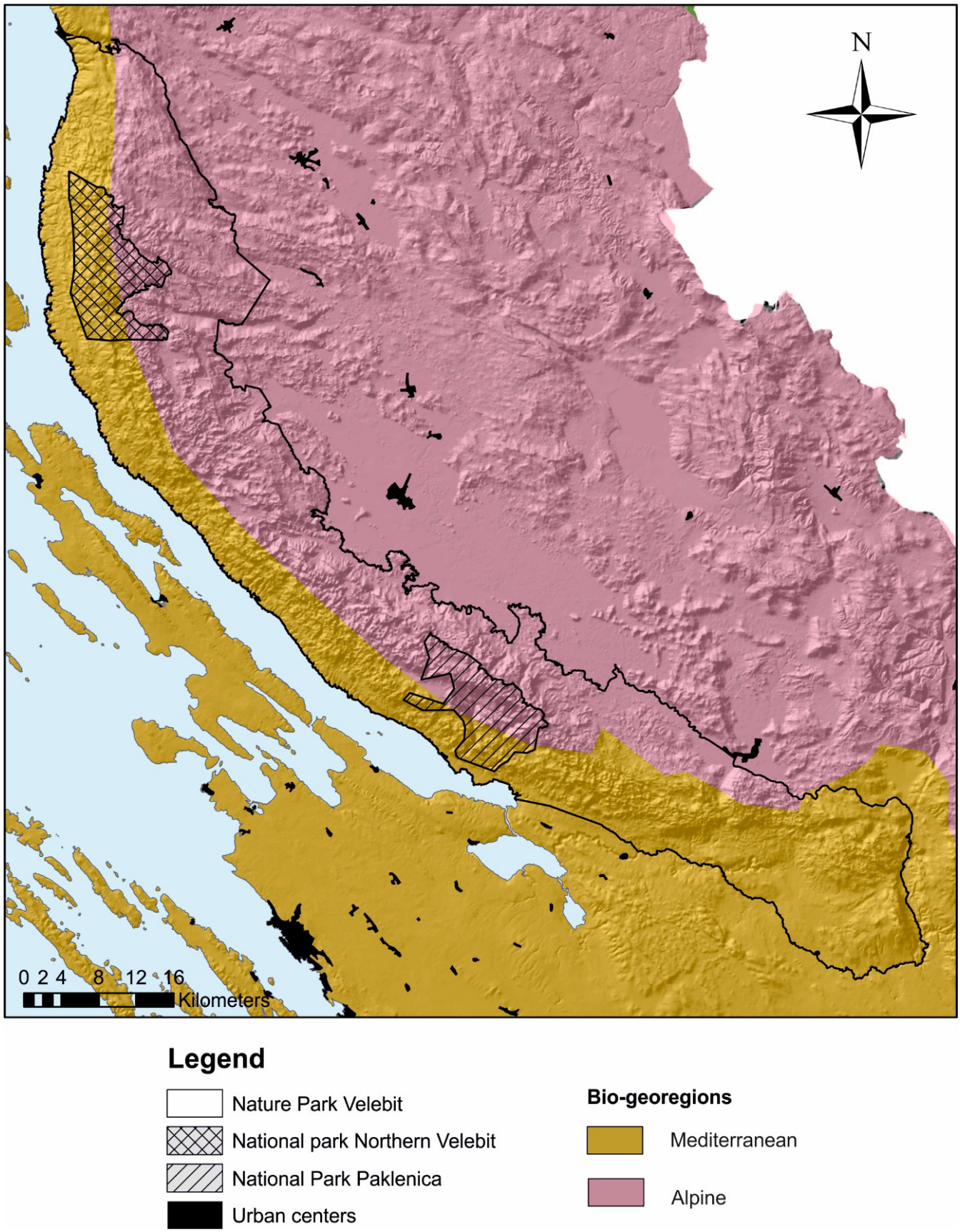


Figure 5. Bioregion map in the area of NP Velebit. (Source: http://services.bioportal.hr/wms)

6.2.3 *Land use*

In order to make an analysis of the land use within the Park it was necessary to map defined tags from the Corine Land Cover database that we used from http://servisi.azo.hr/tlo/wms server on the website of the Croatian Environment Agency. According to "Forest Bioenergy in the Protected Mediterranean Areas" Guideline (2018.) it was necessary to map the forests of the mark: 311, 312 and 313, and the permanent crops marked with: 221, 222, 223. Corine Land Cover analysis defined the area of PP Velebit there are no permanent crops areas but there are only forest areas in the presence of deciduous (311), coniferous (312) and mixed (313) forests (Figure 12.). Also, in areas of LAU outside the NP Velebit borders, there are no permanent crops marked with: 221, 222, 223 (Table 2).

Once these areas are mapped, they are overlaid with the areas of LAU. Then, the forests of each of the 11 LAU within the borders of NP Velebit can be calculated (Table 2).

At the level of LAU there is no data on direct energy consumption. The only official data on direct energy consumption can be obtained at the county (regional) level, which was required to produce the first Energy Efficiency Programs in the final energy consumption over the period 2012.-2014. In the Programs, the reference year was taken in 2012, and the interpreted data in the Table refer to data from 2012. (Author`s comment: All counties have not adopted new Programs, so it is also considered optimal to use the data on direct energy consumption for 2012 for data equation and comparability). It is estimated that in the period 2012-2017. There were no such demographic and/or economic developments that would have a significant impact on the energy needs of the area. The data for local self-government units (LAU) located within the administrative boundaries of Lika-Senj and Šibenik-Knin counties were obtained by interpreting data on direct energy consumption (industry, transport, households, services and agriculture, excluding deliveries to the energy conversion sector and the energy industry itself) at the county level. Existing data on the direct consumption of energy at the county level are divided by the total number of households and the average household direct consumption is obtained, multiplied by the total number of households in a single unit of local self-government (single LAU).

The total direct energy consumption in Šibenik-Knin County was estimated at 6.1877 PJ in 2012, and in Lika-Senj County at 3.2353 PJ. In the reference year (2012), the Zadar County spent 10.4299 PJ in immediate consumption, reflecting the population, but also the strength of its economy (which is higher than other two counties).

Interpretation of data in the way described for Lika-Senj and Šibenik-Knin counties results in very high estimated energy needs, which do not correspond to the strength of the economy of these areas, which mainly live in agriculture and tourism, expressed seasonality.

Table 2. Overview of the main data used to determine the biomass district within NP Velebit.

Biomass district ID	**LAU (Town/ Municipality)**	**LAU Municipal area**	**LAU area within NP Velebit**	**Forests[1]**			**Permanent crops[2]**			**Total area (forests plus permanent crops)**	**Energy needs MWh**
				Within the Park	Outside the Park	Total	Within the Park	Outside the Park	Total		
				a	b	c=a+b	**d**	**e**	**f=d+e**	**g=c+f**	
		ha	***ha***	***ha***	***ha***	***ha***	***ha***	***ha***	***ha***	***ha***	
I	**Senj**	66.083	42.000	24.003,69	6.758,01	30.761,70	n/a	n/a	n/a	30.761,70	133.038
II	**Otočac**	56.500	1.500	1.412,24	28878,58	30.290,82	n/a	n/a	n/a	30.290,82	160.754
	Karlobag	28.300	28.300	14.010,82	0,00	14.010,82	n/a	n/a	n/a	14.010,82	20.799
	Gospić	96.664	28.400	24.718,93	24.363,59	49.082,52	n/a	n/a	n/a	49.082,52	214.080
	Perušić	38.069	6.800	6.210,01	16.965,36	23.175,37	n/a	n/a	n/a	23.175,37	52.180
	Lovinac	34.192	17.300	12.067,40	7.271,77	19.339,17	n/a	n/a	n/a	19.339,17	20.615
	Gračac[3]	95.500	17.500	7.276,25	35.503,16	42.779,41	n/a	n/a	n/a	42.779,41	n/a
III	**Starigrad[3]**	17.010	10.600	1.333,18	0,00	1.333,18	n/a	n/a	n/a	1.333,185	n/a
	Jasenice[3]	12.144	8.300	548,84	0,00	548,84	n/a	n/a	n/a	548,84	n/a
	Obrovac[3]	35.000	14.200	250,09	2.838,28	3.088,37	n/a	n/a	n/a	3.088,37	n/a
	Ervenik	13.200	8.300	415,61	2.972,86	3.388,47	n/a	n/a	n/a	3.388,47	21.466
	TOTAL	**492.662**	**183.200**	**92.247,06**	**125.551,61**	**217.798,67**	**n/a**	**n/a**	**n/a**	**217.798,67**	**622.912**

Source: Croatian Bureau of Statistics, Corine Land Cover.17010+

[1] *Corine Land Cover (classes 311, 312, 313)*

[2] *Corine Land Cover (classes 221, 222, 223)*

[3] *Energy needs not available*

6.2.4 *Naturalistic, Environmental and Landscape restrictions*

The entire area of PP Velebit is covered by the Natura 2000 ecological network and also represents conservation areas important for birds (Croatian abrev.: POPs, English: SPA areas[4]) and

[4] The SPAs are designated under the Birds Directive 79/409/CEE and they are strategic suitable areas for the protection of the most threatened birds species. The BirdLife International project, called Important Bird Areas (IBA),

conservation areas of species and habitat types (Croatian abrev.: POVS, English: SCI areas[5]) (Figure 6.). Within the area of Nature Park „Velebit“ there are also areas of two National parks: Northern Velebit and Paklenica where no commercial use of forests is allowed (Figure 6.). In the Park area, according to the NP „Velebit“ 2007-2017. Management Plan, are separated four specially protected areas. Also, with the same document, are defined separated parts of the ecological network (Table 3). Since all separated parts of the ecological network are defined as spot locations, and only a special reserve of Štirovača forest vegetation is located in a forest area with defined area of spreading, only that site is excluded, together with the total areas of National parks: Northern Velebit and Paklenica, from the forest management analysis for the purpose of exploitation of biomass.

Table 3. Particularly separated parts of the ecological network NATURA2000 within NP Velebit

Objekti krša	**Šume/šumsko zemljište**	**Rijeke/potoci/izvori**	**Uvale/vrulje**
HR2000013 Cerovačka špilja donja	HR2000857# Nadžak bilo	HR2000064# Krupa izvor	HR3000032# Uvala Ivanča
HR2000014# Cerovačka špilja gornja	HR2000858# Štirovača	HR2000641# Zrmanja	HR3000033# Uvala Malin; uvala Duboka
HR2000017# Čavle špilja	HR2000859# Klepina duliba	HR2000874# Krupa	HR3000034# Uvala Zavratnica
HR2000041# Ivina jama	HR2000860# Ramino korito	HR2000877 Tisovac	HR3000035# Uvala Krivača
HR2000044# Jama iznad Kugine kuće	HR2000861 Sadikovac		HR3000036# Uvala Vrulja
HR2000143# Špilja kod Mrkvišta	HR2000862 Visočica		HR3000037# Uvala Jurišnica
HR2000150# Špilja kod Starigrad Paklenice	HR2000863# Veliki i Mali Kozjak		HR3000047# Novigradsko i Karinsko more
HR2000192# Vranovinski ponor	HR2000865# Rončević dolac		HR3000048 Uvala Modrič do Tankog rta
HR2000197# Vrtlina jama	HR2000866# Šatorina		HR3000049 Vrulja Plantaža
HR2000302 Ledenica	HR2000867 Vlažne livade uz potok Ljubica		HR3000266# Špilja na uvali Pećice
HR2000307 Modrič špilja	HR2000868# Velinac - Bačić kuk - Brizovac - Soline - Budakovo brdo		HR3000276# Morska špilja u Velikoj dragi
HR2000334 Ponor Štirovača 1	HR2000960 Cret uz potok Ljubica		HR3000278 Vrulja Modrič
HR2000362 Ponor Štirovača 2	HR2000975 Vlažne livade na Štirovači		HR3000283# Šibuljina 1
HR2000550# Krug	HR2000976 Sunđerac		HR3000284# Šibuljina 2
HR2000869 Tulove grede	HR2000977 Sunđer		HR3000266# Špilja na uvali Pećice
HR2000870 Duboke jasle	HR2001003# Prikinuto brdo - nalazište velebitske		HR3000276# Morska špilja u Velikoj dragi

was the scientific reference point to institute the SPAs. The selected strategic areas are extremely important for the protection of birds, as they are specific areas connected to their reproduction, nutrition or migration.

[5] Natura 2000 sites are selected on the basis of national lists proposed by the Member States. For each biogeographical region the Commission adopts a list of Sites of Community Importance (SCI) which then become part of the network. Finally, the SCI are designated at the national level as Special Areas of Conservation (SAC).

	degenije		
HR3000031 Sv. Juraj - otočić Lisac	HR2001013# Gračačko polje		
HR5000022# Velebit	HR2001101# Devčića tavani		

Source: Public institution „Nature park Velebit“

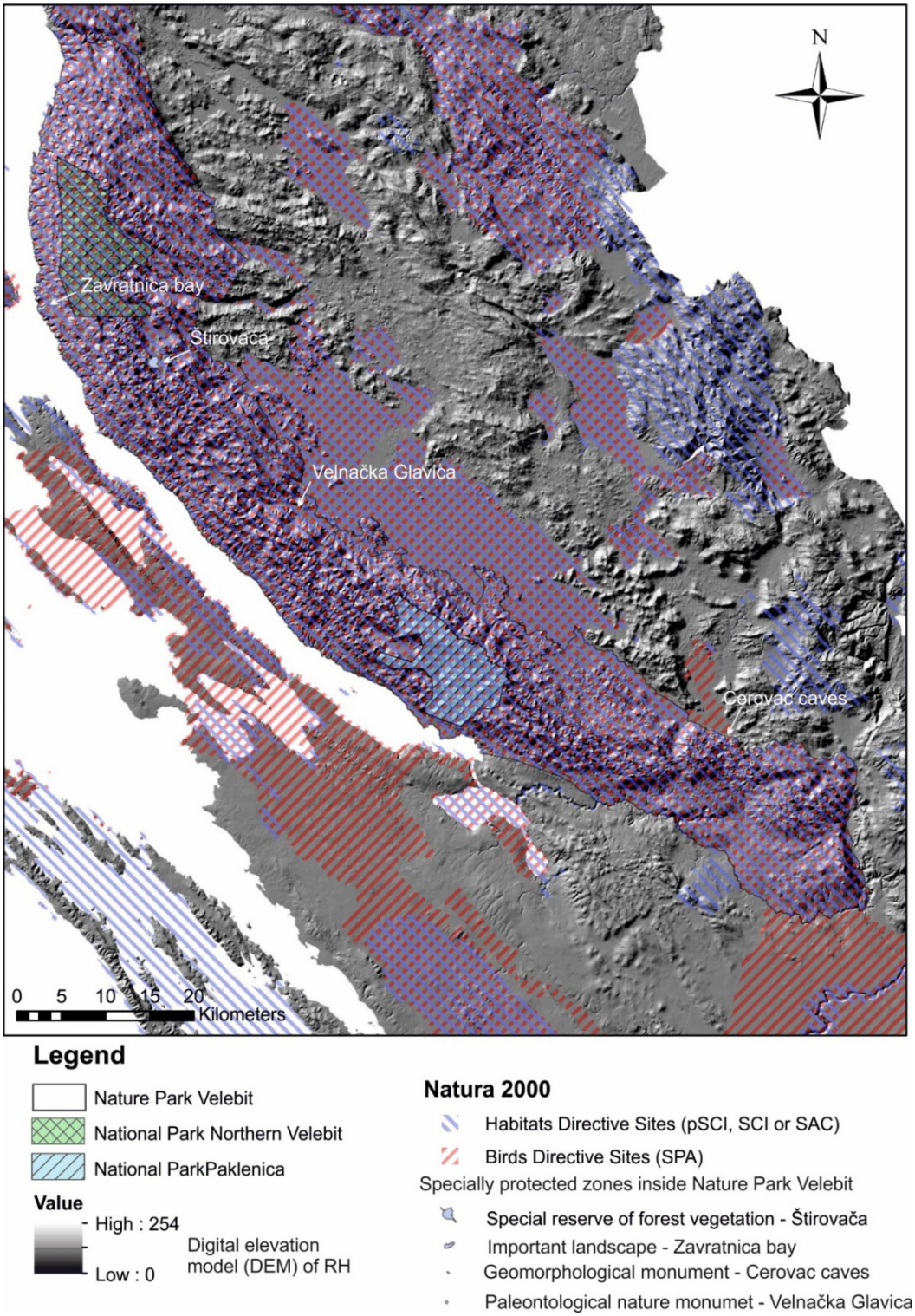


Figure 6. Map of Natura 2000 with separate protected areas within NP „Velebit“. (Source: http://servisi.azo.hr/priroda/wms)

6.2.5 *Slope*

According to the final guidelines for A 3.4 given in "Forest Bioenergy in the Protected Mediterranean Areas" (2018) a map of the ground elevation has been made. The map was calculated using GIS tools, and DEM was used as the input parameter. On the map, elevation of terrain is classified in 10 classes or grades. Elevations are expressed in percentages where the inclination of 45° (angle that closes the surface of the terrain with a horizontal plane) represents a 100% inclination. The elevation is represented in percentages for comparison with the elevation of the roads, which are also commonly displayed in percentages.

The elevation map indicates that the Park area has a distinct relief that can be expected given that it is a mountainous area that is, in turn, extremely narrow and stretched along a series of valleys, canyons and karst valleys. Also, the higher parts of the Park, which cover almost the whole North, Central and South Velebit, have marked inclinations in values that exceed 30% of the incline (yellow to red on the elevation map, Figure 7.), while the relief of the Southeastern Velebit is somewhat mild (more green painted surfaces on the elevation map; Figure 7). However, within these relatively steep elevated areas of the Park, there are numerous surfaces with significantly lower elevation values (green on the map, Figure 7.), which are often represented by smaller surfaces from all sides surrounded by higher elevations. Such a slope distribution is expected in the karst area within which numerous sink-holes. These sites are often covered with forest cover because they are found in morphologically protected domains of adverse climatic influences, such as strong wind influences, and again, due to topographical downhill positions at a more favorable location hydrologically. Detailed analysis of the relief by using this map could certainly contribute to the definition of individual sites where forest management and exploitation of biomass can be defined, particularly from the aspect of transport accessibility. Namely, the biggest obstacle to exploitation of such locations is road isolation, which limits the fast and efficient transport of biomass. In this sense, such a map could, at a larger scale, define individual locations within the morphologically enclosed zones that could be planned from the transport system point of view. So far, such maps are not created and such data is not available.

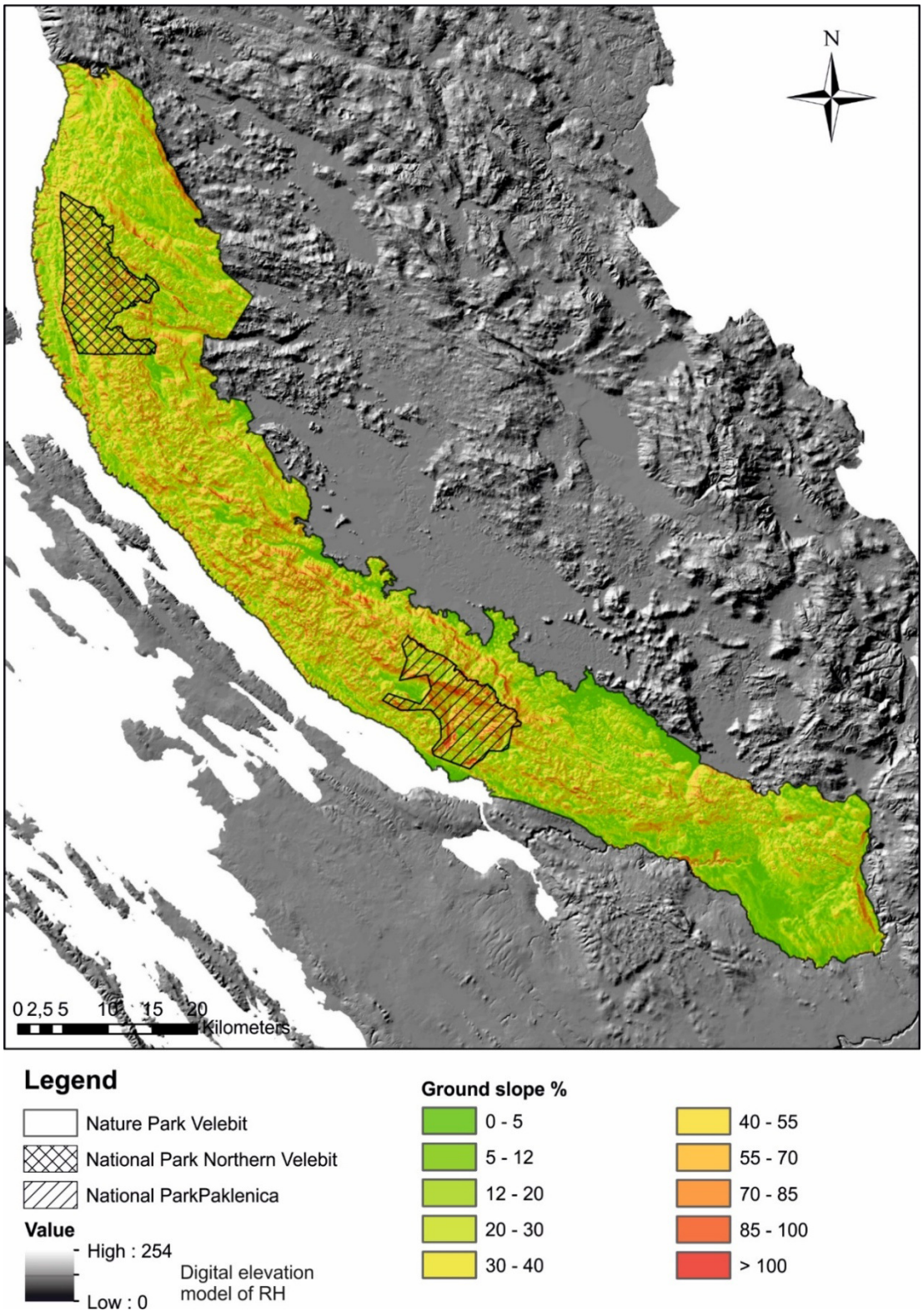


Figure 7. The ground elevation map, expressed in percentages. (https://asterweb.jpl.nasa.gov/gdem.asp).

6.2.6 *Distribution and classification of the main road network*

A very important parameter in further analysis is the existing road network, which is needed to define the transport system for the purpose of exploitation of biomass. The existing road network,

as well as the administrative framework, are important parameters when defining the biomass district. Velebit is crossed by numerous road directions of different levels or transport importance (Figure 8.). Through Gacko and Ličko polje pass the A1 highway, along the Adriatic coast passing state road D8[6], and the state roads D25[7] and D23[8]. County and local roads connect settlements in the Park area. In addition to the regular roads of local, county and state levels, within the Park, there are a number of roads that are used for the purpose of forest management, so called forest roads. All roads in the Park area, other than the A1 highway, are defined as roads that can be used for the purpose of transport and management of forests and are allocated for this purpose between individual forest management unit (Forest Administration, as branch of Hrvatske šume). The Forest Administration Senj, forest management of the Senj branch (hereinafter: FA Senj) manages the forest roads within the administrative boundaries of the LAU: Senj (brown on the map, Figure 8.), and the Forest Administration Gospić (hereinafter: FA Gospić) manages the forest roads within the administrative boundaries located within LAU: Otočac, Perušić, Gospić, Karlobag, Lovinac and Gračac. For LAU: Starigrad, Jesenice, Obrovac and Ervenik we did not have data.

6.2.7 *Energy needs*

At the level of LAU there is no data on direct energy consumption. The only official data on direct energy consumption can be obtained at the county (regional) level, which was required to produce the first Energy Efficiency Programs in the final energy consumption over the period 2012-2014. In the Programs, the reference year was taken in 2012 and the interpreted data in the Table refer to data from 2012 (Author`s comment: *All counties have not adopted new Programs, so it is also considered optimal to use the data on direct energy consumption for 2012. for data equation and comparability*). It is estimated that in the period 2012.-2017 there were no such demographic and/or economic developments that would have a significant impact on the energy needs of the area. The data for local self-government units (LAU) located within the administrative boundaries of Lika-Senj and Šibenik-Knin counties, as set in Table 2., were obtained by interpreting data on direct energy consumption (industry, transport, households, services and agriculture, excluding deliveries to the energy conversion sector and the energy industry itself) at the county level. Existing data on the direct consumption of energy at the county level are divided by the total

[6] The Adriatic state road, D8: Border pass Pasjak (border with Slovenia) – Šapjane – Rijeka – Zadar – Split – G.P. Klek (border with Bosnia and Herzegovina) – Border pass Zaton Doli (border with Bosnia and Herzegovina) – Dubrovnik – Border pass Karasovići (border with Montenegro)

[7] State road, D23: Duga Resa (D3) – Josipdol – Žuta Lokva – Senj (D8)

[8] State road, D25: Korenica (D1) – Bunić – Lički Osik – Gospić – Karlobag (D8)

number of households and the average household direct consumption is obtained, multiplied by the total number of households in a single unit of local self-government (single LAU).

The total direct energy consumption in Šibenik-Knin County was estimated at 6.1877 PJ in 2012, and in Lika-Senj County at 3.2353 PJ. In the reference year (2012), the Zadar County spent 10.4299 PJ in immediate consumption, reflecting the population, but also the strength of its economy (which is higher than other two counties).

Interpretation of data in the way described for Lika-Senj and Šibenik-Knin counties results in very high estimated energy needs, which do not correspond to the strength of the economy of these areas, which mainly live in agriculture and tourism, expressed seasonality.

6.2.8 *Private companies operating in the biomass sector*

Few pellet plants, located on the County area, produce pellets and have different capacity. Although some of plants have certain financial difficulties due to insufficient own capital, a preliminary change of ownership structure can be expected rather than cessation of production.

Table 4: Pellets and briquettes producers on the Lika-Senj County area.

Producer	**Product**	**Installed capacity**
Viševica komp d.o.o. (Perušić)	pellet	25.000 t/year
Moderator d.o.o. (Udbina)	pellet	50.000 t/year
Lika pelet d.o.o. (Gospić)	pellet	10.000 t/year*
TOTAL		**85.000 t/year***

6.3 Final remarks

From the obtained data, ownership of forests and organizational charts based on the legislation of the Republic of Croatia, the proposed Biomass Districts coincide with the branches of the Hrvatske šume d.o.o. such as FA Senj (Biomass district I: Senj), FA Gospić (Biomass district II: Otočac, Perušić, Gospić, Karlobag, Lovinac, Gračac) and FA Zadar (Biomass district III: Ervenik, Obrovac, Jasenice, Starigrad). Mainly because most of the forests are state-owned and managed by the Hrvatske šume d.o.o. (Croatian State Forestry Company, Ltd.).

According to the data obtained, it is to be expected that until all planned plants using biomass will be built by 2023., there will be a supply crisis if exploitation is not increased, not only in economic forests in the area of NP Velebit but throughout the Lika-Senj County. In order to achieve this, it is necessary, first of all, to increase the openness of the forest under administration of FA Gospić and

this company will have to consider the viability of additional biomass production in relation to current production practices.

For such a purpose, it would be necessary to draw up a study of the appropriateness of forest opening in order to estimate the financial resources for this project. Is it suggested to create such study ad pilot project for one to several economic units in the area of NP Velebit (or any other area, determined in cooperation with Hrvatske šume d.o.o.).

So far, capital which was connected with exploitation of biomass projects, in the territory of the Lika-Senj County, entered without cooperation with the local community in such a way that the community maximized the benefits of biomass and established a chain that contributes little to the well-being of the local community. In order to improve this situation, a predictability study for the construction of a public biomass heating plant for the Senj settlement area is proposed (in the area of Senj there are no biomass plants planned or in function).

It is also necessary to inform and educate owners of the private forests and Hrvatske šume d.o.o. with the results of this project - in the proposed districts, and in collaboration with the same, find a model to make the biomass districts live in practice. Existence of Biomass districts must become part of the Hrvatske šume d.o.o. business policy, which can be said to fully determine the destiny of forestry in the County and throughout the Republic of Croatia.

6.4 References

„Forest Bioenergy in the Protected Mediterranean Areas“, Planning biomass based energy production at regional and sub-regional level in protected areas, Workpackage 3 - Testing Activity A.3.4. - Planning biomass based energy production at regional and sub-regional level in protected areas, Guidelines for the implementation of activity_ Final version (2018.)

ForestGreen, “Baseline review/Situational analysis of production / biomass potential of Lika-Senj County - focusing on the Nature park “Velebit” protected area“ (PO T 3.2), „Forest Bioenergy in the Protected Mediterranean Areas“, 2017.

ForestGreen, “Impact assessment of threats and benefits of increase the biomass use in the protected areas - focusing on the Nature park “Velebit” protected areas“ (PO T 3.5), „Forest Bioenergy in the Protected Mediterranean Areas“, 2017.

Grimani, I., Šikić, K., Šimunić, A. (1972): OGK list Knin 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

HROTE, Hrvatski operator tržišta enegije d.o.o.; Godišnji izvještaj o sustavu poticanja proizvodnje električne energije iz obnovljivih izvora energije i kogeneracije u Republici Hrvatskoj za 2016. godinu; Zagreb; 2017

http://bioportal.hr/

http://services.bioportal.hr/wms

http://servisi.azo.hr/priroda/wms

http://servisi.azo.hr/tlo/wms

https://asterweb.jpl.nasa.gov/gdem.asp

https://www.dinarskogorje.com/

https://www.pinterest.com/pin/513903007471752813/

https://www.summitpost.org/in-the-chaos-of-rozanski/21691

Ivanović, A., Sakač, K., Marković, S., Solač, B. (1973): OGK list Obrovac 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Ličko-senjska županija; Program energetske učinkovitosti u neposrednoj potrošnji energije Ličko – senjske županije 2014-2016.

Majcen, Ž., Korolija, B., Sokač, B., Nikler, L. (1970): OGK list Zadar 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Mamužić, P., Milan, A., Korolija, B., Borović, I., Majcen, Ž. (1969): OGK list Rab 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Mamužić, P., Sokač, B., Velić, I. (1970): OGK list Silba 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Odluka o razvrstavanju državnih cesta, „Narodne novine“ broj 103/17, 17/18

Plan upravljanja Park prirode Velebit 2007-2017

Šibensko-kninska županija; Program energetske učinkovitosti u neposrednoj potrošnji energije Šibensko-kninske županije 2012-2014. godine; 2012.

Sokač, B., Nikler, L., Velić, I., Mamužić, P. (1974): OGK list Gospić 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Šušnjar, M., Sokač, B., Bahun, S., Bukovac, J., Nikler, L., Ivanović, A. (1973): OGK list Udbina 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Velić, I., Bahun, S., Solač, B., Galović, I. (1974): OGK list Otočac 1:100000. Stručno tehnička redakcija Seizmološkog zavoda SRS Beograd.

Zadarska županija; Godišnji plan energetske učinkovitosti Zadarske županije; 2017.

7. FINAL SUMMARY (LP)

The document contains the identification and the description of the Biomass Districts (BDs) by each partner, following the methodology proposed aimed at allowing the utilization of forest biomass for energy purpose in a sub-regional planning context.

In all the pilot areas, 3-5 BDs have been identified and characterized. The ratio between the energy needs and the agro-forestry areas present was quite homogeneous in the Italian pilot area (8-15%), with the exception of BD4, where the ratio was only 2%. In Slovenia, the ratio was highly variable, ranging from 10% to 37%. Interestingly, approximately 70% of the energy needs are met by wood fuels. In Italian pilot area, according to CLC classification, altogether forests and permanent crops (agroforestry areas) cover from 10% (BD4) to 52% (BD1) of the total area of each BD. Slovenia did not use the CLC classification but the data by Ministry of Agriculture, Forestry and Food, which were considered more reliable and updated. The area covered by forests and areas of extensive overgrowth accounted for 70% and 6.3% of total area of BDs, respectively. In Croatian Zadar County pilot area, agroforestry areas cover 32% of total area of BDs, with a 53,5% of forests. In all the pilot areas, there are several types of restrictions that may limit forest utilization, including naturalistic (Regional park and Natura2000 sites), hydrogeological and landscape restrictions, affecting large areas in all countries. In the Italian pilot protected area, the annual energy needs ranged from 68.000 to about 162.000 MWh. In Slovenia, the annual energy needs ranged from 28.500 to about 162.000 MWh. In Croatian Lika-Senj pilot area, energy needs ranged from 20.500 MWh per year to 214.000 MWh per year but many data are lacking and were obtained only at the county (regional) level. The main constraint to establish a short wood supply chain in the Italian pilot area is the very limited number of enterprises operating in the biomass sector, being only 8, and 6 of them concentrated in just one BD. In Slovenia there are only few larger wood biomass producers in the area, two big wood pellet mills and sawmilling industry, as well as some small-scale district heating systems and woodchips producers. In Croatian Zadar County pilot area, the number of private companies operating in forestry and biomass sector is relatively low (>60), but it is much higher than in the other countries. In Croatian Lika-Senj pilot area, few pellet plants, located on the Lika-Senj County area, produce pellets, with production capacity ranging from 10.000 to 50.000 t per year.

A common problem in all the pilot areas is the the progressive abandonment of rural and mountain areas which caused the lack of management and exploitation of many forest areas. In all the countries, short supply wood chains are not fully developed yet. In effect, the lack of the forest

management plans is considered one of the major issues for the development of the biomass sector in protected areas.

Altogether, the results coming from each partner suggest a low biomass utilization rate in forests, especially in private forests. Such finding, together with the increasing demand for local wood for energy purposes, indicates the necessity to increase the sustainable use of forest resources, enhancing the integration of stakeholders involved in the wood supply chain in the local community.

The collected information will be used for the design of an open source decision support system (DSS) aimed at planning biomass supply chains for energy use in protected areas, ensuring ecological and socio-economic sustainability.

Forest Bioenergy in the Protected Mediterranean Areas

www.interreg-med.eu\ForBioEnergy

REGIONE SICILIANA
ASSESSORATO REGIONALE DELL'AGRICOLTURA, DELLO SVILUPPO RURALE E DELLA PESCA MEDITERRANEA
DIPARTIMENTO REGIONALE DELLO SVILUPPO RURALE E TERRITORIALE

Municipality of Petralia Sottana

ENVELAND

GOZDARSKI INŠTITUT SLOVENIJE
SLOVENIAN FORESTRY INSTITUTE

RDA Green Karst

amufor
municipios forestales valencianos

Cámara Valencia

VELEBIT

Disclaimer