UNIVERSITY OF LJUBLJANA
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Belén Muñoz Ruano

COMPARISON OF VEGETATION BETWEEN THE SAW OF CALAR DEL MUNDO AND ŠMARNOGORSKA GRMADA

GRADUATION THESIS
University Studies

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PRIMERJAVA MED VEGETACIJO POGORJA CALAR DEL MUNDO IN ŠMARNOGORSKE GRMADE

DIPLOMSKO DELO
Univerzitetni študij

COMPARACIÓN DE VEGETACIÓN ENTRE LA SIERRA DEL CALAR DEL MUNDO Y ŠMARNOGORSKA GRMADA

TESIS DE GRADUACION
Estudios de universidad

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The thesis "Comparison of vegetation between the saw of Calar del Mundo and Šmarnogorska Grmada" is the end of my university studies.

This thesis has been realized at the Biotechnical Faculty University of Ljubljana (Department of Agronomy) where I have been as Erasmus student.

The mentor of this thesis has been Professor Franc Batič who together with Professor Jose María Herranz has corrected it.

This thesis has been done by me and I allow that it is included in the electronic library of Biotechnical Faculty. This version is identical to printed form.

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AB A comparison between mediterranean Spanish vegetation and continental Slovenian vegetation has been made in this thesis, having into account the geology, lithology, edaphology, climatology and human aspects. These are the main factors that determine the distribution of the vegetation. This comparison is focused in the saw of *Calar del Mundo* in Spain and *Šmarnogorska Grmada* in Slovenia.

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AI V diplomskem delu je bila narejena primerjava med mediteransko vegetacijo Španije in kontinentalno vegetacijo Slovenije, pri čemer so bili upoštevani geologija, litologija, edafologija, klimatologija in humani vidiki. To so najpomembnejši dejavniki, ki vlivajo na razporeditev vegetacije. Primerjava je osredotočena na pogorje Calar del Mundo v Španiji in na Šmarnogorsko Grmado v Sloveniji.

INDEX

1 INTRODUCTION

The place where I live is called the province of Albacete. One of its main tourist attractions is the saw *Calar del Mundo*. It is the less arid area of the province of Albacete, with a large variety of vegetation species (many of them being endemic). This area is also very interesting from a geological point of view due to its relief and topography. It provides plenty of opportunities to a visitor to enjoy its rainfall, mountains, paths and views in general.

Concerning *Šmarnogorska Grmada*, it has been selected to make a comparison of the vegetation because of several factors. Firstly, it is quite close to the city in which I stayed in Slovenia, Ljubljana. Secondly, and more important, due to the similarities in height and riversides, and to the relevance of this area as a tourist attraction, similar to the one in Spain; both receive a large amount of visitors each year.

Having these considerations into account, I think that this thesis could be interesting from a botanic point of view. The differences between the vegetation of both areas can be appreciated considering each one of the factors and differences that there are between them.

2 MATERIAL AND METHODS

In order to make a comparison between the vegetation of *El Calar del Mundo* and *Šmarnogorska Grmada*, a compilation of data has been made through different bibliography and Internet sites.

Once the main characteristics of the area of study have been known, I've taken some data on the main location of *Šmarnogorska Grmada*. This field work has been made walking along both the northern and southern slopes of the hill and through the different altitudes of the coline and montane bioclimatic belts, from the riverside to the upper areas. This field work has been made with the cooperation of Professor Franc Batič, who is the person that has recognised the different species that we could find in this area.

On the other hand, the making of a field work in *Calar del Mundo* has not been possible because this project has been made, almost entirely, in Slovenia. So, the vegetation of this area has been studied with the help of the book *"Flora y vegetación del macizo del calar del Mundo y Sierras adyacentes del sur de Albacete"* (Lopez Velez, 1996).

Once the information of both areas has been taken, a comparison between them has been made, based on the obtained data.

3 RESULTS

3.1 FOREST OF THE IBERIAN PENINSULA

The woodlands of the Iberian Peninsula are distinct ecosystems on the Iberian Peninsula, spanning Spain and Portugal. Although the various areas are characterized by distinct vegetation, there are some similarities across the peninsula.

While the borders between these regions are not clearly defined, there is a mutual influence which makes it very hard to establish boundaries and some species find their optimal habitat in the intermediate areas.

Origin and characteristics

The flora of the peninsula, because of bio-historical, geographical, geological, and orographic conditions, is one of the more rich and varied of Europe, rivaled only by countries as Greece and Italy; it is estimated that the Iberian Peninsula has more than 8,000 distinct species of plants, many of them endemic.

The Iberian Peninsula, located on an important route between Africa and Europe, was enriched by the arrival, following the climate change, of wetland plants, thermophilic plants (those that require a great deal of heat), xerophilic plants (those that require a dry climate), orophilic (sub-alpine) plants, Boreo-alpine plants, and so on, many of which managed to remain, thanks to the diversity of environments that exist in the mountain ranges, and which allowed them to rise in altitude if the climate was too warm, or descend if it became too cold. The geological complexity of the majority of Iberian mountains, especially of the Cordillera Bética,

Sistema Iberico, and Pyrenees, also greatly increased the number of new environments to which it was possible to adapt, resulting in today's wide variety of flora.

The Eurosiberian region

The "Eurosiberian" Atlantic zone extends through northern Portugal, Galicia, Asturias, Cantabria, the Basque Country and the western and central Pyrenees. It is characterized by a humid climate which is moderated by the influence of the ocean, with somewhat cold winters and the lack of a distinct dry season.

The vegetation is deciduous oak forest: both *Quercus petraea* and *Quercus robur*, with *Fraxinus excelsior* and *Corylus avellana* in the coolest and deepest soil at the bottom of the valley. The montane belt is characterised by the presence of *Fagus sylvatica* and at times, in the Pyrenees, by *Abies alba*; these beeches and silver firs occupy the cool slopes with shallow soil. The Mediterranean influence is felt in the presence of *Quercus ilex* with *Laurus nobilis*, which are situated on the warmest crests and slopes, especially above chalky soil, where the dryness becomes more pronounced.

The Mediterranean region

The Mediterranean region occupies the rest of the peninsula. The principal characteristic of the region is the existence of a quite lengthy period of summer drought, which may last anywhere from 2 to 4 months, but which, regardless of length, is always quite distinct. Rainfall can range from 1500 mm to less than 350 mm. Temperatures range from regions that have no frost for many years to those that reach -20 °C, or even lower, every winter.

The typical Mediterranean peninsular forest is made up of evergreen trees: oak forests, cork oaks, wild olives, juniper, and so on. These are accompanied or replaced in the warmer regions and eroded by forests of *Pinus halepensis* and in areas of sandy ground and fixed sand dunes by juniper and *Pinus pinea* forests. Exceptions to the rule are the more arid region in the southeast, the lower regions of the provinces of Murcia and Almeria, where the only vegetation is *Chamaerops humilis*, and thorny thickets of blackthorn and at higher altitudes, *Quercus coccifera* and *Pistacia lentiscus.*

"CALAR DEL MUNDO"

3.2 GEOGRAPHICAL FRAME

3.2.1 Situation and limits of the area of study

The saw *Calar del Mundo* is placed in the South-West of the province of Albacete and includes an approximate extension of something more of 600 km².

It is included within a rectangular area delimited by the geographical coordinates 2°31'10,7" and 2°11'10,7" longitude West and the 38°18' and 38°30'0,4" latitude North.

Picture 1. Situation of the Calar del Mundo (Lopez Velez, 1996)

3.2.2 The relief

The *Calar del Mundo* is located inside a mountain area, with an enormous density of level curves, which are a consequence of the pronounced relief of the area. Mountains and the valleys are abundant in this territory, which is an important part of the *Cordilleras Béticas* (a mountain range that is situated in the South-West of Spain).

The *Calar del Mundo* presents a height of 1631 m.

3.3 GEOLOGY AND LITHOLOGY

3.3.1 Introduction

It may be necessary to explain that, at the moment of doing a geological synthesis, I used the aspects that influence in a more direct way the composition of the current flora and vegetation, since they can be related to the tectonic and to the lithologic substratum. The latter, together with the biological plant activity and the climatic conditions, will determine the composition of the soil.

In order to make the geological study of the area we'll take as a guidance map, the one by RODRIGUEZ – ESTRELLA, which is included in the book "Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete", by GEMMA LÓPEZ VÉLEZ (1996).

3.3.2 Geological synthesis of the internal Prebético

From a geological point of view, the Calar del Mundo belongs to the internal Prebético, which is characterized by a powerful statigraphic succession. Its thickness is of more than 2000 meters of sedimentary Mesozoic and Cenozoic rocks of carbonic and detrital nature. The outcrops are progressively more modern from West to East, although a clear predominance of cretaceous materials (high Cretaceous mainly) can be observed on the surface.

3.3.2.1 The Cretaceous

An apparent disagreement does exist among scientists about the low Cretaceous and the high one. The materials of the low Cretaceous use to constitute pressed anticlines, whereas those of the high Cretaceous form wide and soft synclines.

Synclines of Calar del Mundo:

They are the most extensive and important part of Calar del Mundo, with 23 Kilometres length and 5 to 6 kilometres width. These synclines constitute a North - South synclinorium, where we can also find the anticline of the cave of the Chorros and the syncline of the Pedorrilla. The emergent materials correspond to the high Cretaceous.

3.3.2.2 The Triassic

The important Triassic outcrops are a part of the fault of the *Río Mundo* and they extend from Northeast to Southwest (*Riópar - La Altera)*. It is lithologically constituted by a clayey set, which is inserted between calcareous sections. The gypsum appears in these clayey substrates. The reddish sandstones are also frequent along this band of outcrop.

The Trías has played an important role in the sedimentation and has been the one that has imposed the directives of folding and changes in the adjacent structures.

3.3.2.3 Lithologic considerations

CRETACEOUS: The predominance of the outcrops takes place in the internal *Prebético.*

- Low Cretaceous:
  - **Neocomiense**. It is formed by sections in which sandy marls, dolomites and sandstones are frequent.
  - **Barreniense and Apitense**. Limy with marly and sandy inserted levels.
  - **Albiense.** It appears locally with yellowish clays in total absence of $CaCO_3$; marls with calcareous levels and very pure white sands.

- High Cretaceous:
  - **Cenomanense - Turonense**. Clayey dolomites and clays.

TRIASSIC: It is shown in the area of study, in the fractures mainly. Its lithologic characteristics are distributed in three sections:

- Low section. Red sandstones and red clays alternating with grey and green gypsums. This section corresponds to the Buntsandstein.
- Average section. Limy and clayey grey dolomites. This section corresponds to the Muschelkalk.
- Top section. Red and grey lutites with green gypsums. They are distributed along the Keuper.

3.4 EDAPHOLOGY

3.4.1 Introduction

This area has not been studied in an extensive way, from an edaphological point of view, so it has been necessary to use the information of areas which are close to the *Calar del Mundo*.

In order to make the edaphological description we will use the soil classification proposed by the F.A.O. in 1988 which is included in the book *"Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete"*, by GEMMA LÓPEZ VÉLEZ (1996).

3.4.2 Edaphologic typology

According to this methodology, the following types of soils have been recognized in the zone of study:

- **Leptosols**. Soils of profile scantily developed. They are limited in depth by constant rock within a minor or equal depth of 30 cm. They can have A mollic or ocric horizon and cambic horizon.
- **Fluvisols.** Soils of small ravines and creeks. They are characterized by a continuous rejuvenation. There are no other horizons of diagnosis but A ocric or mollic.
- **Regosols**. Not consolidated soils that only present a horizon A ocric. Soils formed from dolomites with more than 30 cm depth belong to this group (calcareous Regosols).
- **Kastanosems.** They are the soils climax in most of the territory. They are rich in CaCO3 with a calcic or gypsic horizon, or soft powdery limestone inside the first 125 cm from the surface, and with an A mollic horizon.
- **Luvisols.** They present a horizon without or almost without calcium carbonate and a A ocric or mollic horizon. The horizon Bt was formed by the dissolution of limy hard rocks and accumulation of clays; these clays are rich in ferric oxides, responsible for the reddish colour of the horizon.

3.5 HYDROLOGICAL SYSTEM

3.5.1 Introduction

The hydrology data have been taken from the works by LÓPEZ BERMUDEZ (1958) and RODRIGUEZ- ESTRELLA (1979), which appear in the book "*Flora y vegetación del Macizo del Calar del Mundo y sistemas adyacentes del sur de Albacete*" (Lopez Velez, 1996).

3.5.2 Hydrological system of the Calar del Mundo

The *Calar del Mundo* is a karstic system placed between the villages of *Riópar* and *Mesones* in the North, saw of *Cujón* in the East, saw of *Ardal* in the South and *saw of Cuquillo* in the West. The surface of the system is 140 Km².

This karstic system origins the rivers *Mundo*, *Frío* and *Cotillas*.

It constitutes a typical karstic system. The factors that determine these forms and its evolution correspond to a mountain karst, typical of the folded regions of the Mediterranean. Its period of emersion took place in the high Cretaceous, due to the action of the Trías.

The forms of karstic relief that appear in the *Calar del Mundo* are of absorption, of movement and of emergence.

3.5.2.1 Forms of absorption

They take place in the surface and favour the infiltration of water. These forms of absorption are:

- **Lapieses**: they are represented by fissures, orifices, etc. The *Calar del Mundo* alternates lapieses of several centimetres depth to lapieses of a meter underground.
- **Dolines**: There are approximately a thousand of them, which favour the high degree of absorption of the water deposited in the shape of snow. The dolines appear in zones of scanty slope in the high parts. The majority of them are circular or elliptical. They present either unsymmetrical or symmetrical edges.

3.5.2.2 Forms of movement

There is a big rate of infiltration in surface and movement in depth, determined by the existing fractures in the limy soil of the high Cretaceous that form the *Calar del Mundo*. This infiltration and later movement determine the existence of three big caves: *Los Chorros, El Farallón and La Pedorrilla*.

3.5.2.3 Form of emergence

**** Río Mundo:***

It was discovered by the Arab AL-Zuhiri, who described its birth before the Ninth Century.

It is the principal tributary of the river Segura. Its source takes place at 1200 metres above the sea level.

The river Mundo is born in a spectacular waterfall of more than 80 meters height. The cave known as Los Chorros has an entrance of 25 meters of diameter and drains the rain water fallen on the Calar del Mundo. The source of the Río Mundo is one of the major tourist attractions of the area.

3.6 BIOCLIMATOLOGY

3.6.1 Introduction

The climatic characteristics of a territory are a determinant factor of its vegetation. This area offers a great climatic variability, which affects in the composition of the vegetation.

3.6.2 Data sources

The information for the bioclimatic characteristics has been taken from the bioclimatic station placed in *Riópar*, which is the nearest village to the area of study (8 Km from the zone of study).

Riópar's observatory is placed in the mesomediterraneous bioclimatic belt.

This observatory is 1000 m height.

3.6.3 The bioclimate

In order to make the bioclimatical classification of the *Calar del Mundo* we've used the one made by RIVAS-MARTÍNEZ (1993), which is included in the book *"Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete"* (Lopez Velez, 1996).

3.6.3.1 Oromediterraneous bioclimatic belt

It is restricted to the high part of the *Calar del Mundo* with an altitude between 1600 and 1700 m (there are certain variations depending on the exposure).

The disappearance of the holm oak forest and its substitution for the formations of *Pinus nigra* subsp. *mauretanica* is a good sign to recognize this bioclimatic belt. At a floral level we can observe, in this area, the presence of *Aenaria tetraquetra* subsp. *murcica, Thymelaea granatensis, Pterocephalus spathulatus, Convolvulus boissieri,* etc.

3.6.3.2 Supramediterraneous bioclimatic belt

It is characterized by an eight months period of plant activity and by a period of frosts that lasts from October to May. The winter is cold. The supramediterraneous bioclimatic belt is represented by two horizons, low and high, with an altitude between 1100 and 1600 m. As this bioclimatic belt is hotter than Oromediterraneous one, it is characterized for the disappearance of *Quercus coccifera* and *Stipa tenacísima* and for the presence of *Berberis hispanica , Acer granatense, Echinospartium boissieri,*

Heather anthyllis. The following species appear at ground level:

Arenaria grandifolia, Armory alliacea,Dianthus subacaulis subsp. *brachyanthus, Draba hispanica,* etc.

3.6.3.3 Mesomediterraneous bioclimatic belt

The frosts occur from October to April. This belt is characterized by a nine- ten months period of plant activity. The winter type is between warm, fresh or cold.

The coldest altitudinal belt is between 750 and 1000 m and the hottest is up to 750 m.

3.6.3.4 Other bioclimatic indexes

- ***Index of thermal annual extent:***

The thermal annual extent index expresses the difference between average temperatures of the hottest months and the coldest ones of the year in centigrade degrees. According to this index, the *Calar del Mundo* presents a Semioceanic environment.

Table 1: Index of thermal annual extent in different environment types (Lopez Velez, 1996)

TYPE	INDEX OF THERMAL ANNUAL EXTENT
Hyperoceanic	0-6
Oceanic	6-12
Semioceanic	12-20
Semicontinental	20-28
Continental	28-45
Hypercontinental	45-65

Table 2: Index of thermal annual extent at Riopar (Lopez Velez, 1996)

LOCATION	INDEX OF THERMAL ANNUAL EXTENT	TYPE
Riópar	17, 8	Semioceanic

Table1 and 2 have been taken from RIVAS-MARTÍNEZ (1993) which is included in the book *"Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete"*, by GEMMA LÓPEZ VÉLEZ (1996).

3.6.4 Ombroclimate

The distribution of the vegetation is directly related to the average rainfalls, which have been obtained by the meteorological stations along a certain number of years.

RIVAS-MARTÍNEZ (in Lopez Velez, 1996) proposed different types of ombroclimates for the Mediterranean region.

Table 3: Ombroclimate types in Mediterranean region (Lopez Velez, 1996)

OMBROCLIMATE	PRECIPITATION(mm)
Humid	900- 1600
Subhumid	500- 900
Dried	350- 500
Semiarid	150- 350

Table 3 have been taken from RIVAS- MARTÍNEZ (1981) which is included in the book *"Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete"*, by GEMMA LÓPEZ VÉLEZ (1996).

Table 4: Precipitation amount and ombroclimate type of Rioparegion (Lopez Velez, 1996)

LOCATION	**PRECIPITATION** (mm)	**OMBROCLMATE**
Riópar	787	Subhumid

3.6.4.1 Seasonal distribution of the rainfalls

The seasonal allotment of the rainfalls determines a notable importance for the plant communities.

The Table 5 indicates the seasonal allotment of the rainfalls in *Riópar* in percentage (Sm = summer, Sp = spring, A = autumn, W = winter).

Table 5: seasonal allotment of the rainfalls in *Riópar* (López Vélez, 1996)

LOCATION	**W %**	**Sp%**	**Sm%**	**A%**	**SEASONAL ALLOTMENT**
Riópar	33,5	23,2	9,2	34,1	A>W>Sp>Sm

Table 5 has been taken from the book *"Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete"* (Lopez Velez, 1996).

3.7 HUMAN ASPECTS

3.7.1 Economic resources

There are several sources of income, which can be considered economically weak.

Some appointments of the XV century reveal that the vegetation of this area in this epoch matched with the stage of maximum biological stability. Nevertheless, the effect of agriculture was remarkable in the valleys. The conflicts among the local town halls, arisen from the management of the mounts, produced the indiscriminate destruction of the local pine groves. Groves of this form of evergreen oaks and natural pine declined in favour of the *Pinus pinaster*.

The industry is practically void. There is a factory of metallic gold work in *Riópar,* with exploitation of lead and zinc, which had importance in the last century because of the natural resources of the water flow. The installation of these industries produced important trees felling to supply wood for the houses, stores, workshops, etc. These factories used char-coal for smelting.

The cattle breeding of Riópar's region is smaller than would be expected.

The agricultural activity represents limited extent and it is of little interest.

3.7.2 The tourism

The tourism is very important in this area, and has been increased in the last years.

There are witnesses of the serious ecological risks that the presence of the man causes in this natural area.

3.8 VEGETATION OF *CALAR DEL MUNDO*

3.8.1 Introduction

The vegetation has been studied by the phytosociologycal method of the school ZURICH – MOMPELIER, initiated by BRAUN-BLANQUET and updated with the new landscape tendencies that are grouped in GÉHU & RIVAS- MARTÍNEZ (1982) and RIVAS-MARTÍNEZ (1986), which is included in the book *"Flora y vegetación del Macizo del Calar del Mundo y sierras adyacentes del sur de Albacete"* (López Vélez, 1996).

3.8.2 Vegetation

***<u>Top North side:</u>**

Daphno oleoidos- Pineto sylvestris:

It is spread between 1600 and 1700 m. The climate, with low temperatures in winter and very dry summers, provides the conditions that define the presence of this series. This area is characterized by the presence of strong winds.

Among the clearings of this community or close to it there uses to appear a vivacious low density and coverage grassland belonging to the association *Seseli granatensis - Festucetum hystricis or Scorzonero - Pterocephaletum spathulatae.*

- **Tree layer:**

- *Pinus nigra* subsp. *mauretanica*

- **Bush layer:**

- *Juniperus communis* subsp. *hemisphaerica*
- *Daphne hispanica*

- **Ground layer; forest floor vegetation:**

- *Potentilla petrophylla*
- *Campanula velutina*
- *Jasione minuta*
- *Arenaria grandiflora*

- *Thymus orospedanus*
- *Berberis hispanica*
- *Erinacea anthyllis*
- *Thymus clandestinus*
- *Thymus orospedanus*
- *Amelanchier rotundifolia*
- *Arenaria armerina*
- *Carex halleriana*
- *Echinospartium boissierii*
- *Helianthemum croceum*
- *Lonicera etrusca*
- *Polygala boissierii*
- *Acer granatensis*
- *Acinos meridionalis*
- *Crataegus monogyna*
- *Prunus prostrata*
- *Daphne latifolia*
- *Genista pseudopilosa*
- *Helleborus foetidus*
- *Ononis aragonensis*
- *Prunus mahaleb*
- *Viola suavis*
- *Anthyllis montana* subsp. *hispanica*
- *Anthyllis vulneraria* subsp. *argyrophylla*
- *Sideritis incana*

***Medium north side:**

Berberido hispanicae- Querceto rotundifoliae:

This series appears inside the Supramediterraneous bioclimatic belt, developing in an extensive way in this territory, approximately between 1200 and 1500 meters. It appears in form of coppice forests where 6 or more meters height oaks dominate.

Massive felling of this forest has been carried out for the purpose of cattle breeding. As a consequence, thorny species of vegetation and groves of evergreen oaks became more opened. The most important thorny invaders are *Berberis hispanica, Crataegus monogyna, Crataegus laciniata, Rosa canina,* etc.

- **Tree layer:**

- *Quercus rotundifolia*
- *Quercus faginea*
- *Pinus nigra* subsp. *mauretanica*

- **Bush layer:**

- *Quercus rotundifolia*
- *Quercus faginea*
- *Crataegus monogyna*
- *Crataegus laciniata*
- *Acer granatensis*

- **Ground layer; forest floor vegetation:**

- *Ruscus aculeatus*
- *Paeonia microcarpa*
- *Paeonia broteroi*
- *Berberis hispanica*
- *Helleborus foetidus*
- *Viola reichenbachiana*
- *Brachypodium sylvaticum*
- *Carex halleriana*
- *Rosa canina*
- *Clinopodium arundanum*
- *Erinacea anthyllis*
- *Arenaria armerina*
- *Fumana procumbens*
- *Fumana paradoxa*
- *Koeleria vallesiana*

- *Carex halleriana*
- *Orchis cazorlensis*
- *Aphyllanthes monspeliensis*
- *Avenula bromoides*
- *Berberis hispanica*
- *Festuca hystrix*
- *Melica ciliata*
- *Senecio minutus*

***Medium south side:**

Junipero phoeniceae- Pineto salzmannii:

This type of vegetation is thriving on steep slopes or on compact rocks with rocky outcrops and boulders. The community is typical of exposed sites with full sun light. It appears approximately between 1200-1500 meters, inside the Supramediterraneous bioclimatic belt.

- **Tree layer:**

- *Pinus nigra* subsp. *mauretanica*
- *Juniperus oxycedrus*
- *Juniperus phoenicea*
- *Juniperus hemisphaerica*

- **Bush layer:**

- *Juniperus oxycedrus*
- *Juniperus phoenicea*
- *Juniperus hemisphaerica*
- *Quercus rotundifolia*
- *Quercus faginea*
- Crataegus monogyna

- **Ground layer; forest floor vegetation:**

- *Amelanchier rotundifolia*
- *Carex halleriana*

- *Vincetoxicum nigrum*
- *Acer granatensis*
- *Berberis hispanica*
- *Cerastium gibraltaricum*
- *Echinospartium boissieri*
- *Erinacea anthyllis*
- *Rosmarinus officinalis*
- *Daphne latifolia*
- *Thymus orospedanus*
- *satureja gracilis*
- *Teucrium leonis*
- *Fumana procumbens*
- *Fumana paradoxa*
- *Anthyllis rupestris*
- *Lavandula latifolia*
- *Thymus clandestinus*
- *Scabiosa anadryalifolia*
- *Koeleria vallesiana*
- *Carex halleriana*
- *Orchis cazorlensis*
- *Asphodelus ramosus*
- *Berberis hispanica*
- *Festuca hystrix*
- *Poa ligulata*
- *Senecio minutus*
- *Festuca hystrix*
- *Fumana baetica*
- *Centaurea postrata*
- *Jurinea humilis*
- *Silene legionensis*
- *Paronychia aretioides*

*** Low side:**

Paeonio coriaceae- Querceto rotundifoliae:

It occupies the upper area of the Mesomediterraneous bioclimatic belt, between 750-900 meters or 1200 meters at the most sunny sites. It is difficult to find formations in good conditions due to the agriculture.

- **Tree layer:**

- Quercus rotundifolia

- Quercus coccifera

- Juniperus oxycedrus

- Juniperus phoenicea

- Pinus pinaster

- **Bush layer:**

- Quercus coccifera

- Juniperus oxycedrus

- Juniperus phoenicea

- Pistacia terebinthus

- Crataegus monogyna

- **Ground layer; forest floor vegetation:**

- Onobrychis matritensis

- Santolina pectinata

- Eryngium campestre

- Sanguisorba muricata

- Thymus mastichina

- Helianthemum hirtum

- Helianthemum ledifolium

- Medicago rigidula

- Centaurea pullata

- Plantago lanceolata

- Salvia verbenaca

- *Bellis perennis*
- *Echium boissierii*
- *Allium roseum*
- *Thymus orospedanus*
- *Trifolium stellatum*
- *Cistus albidus*
- *Lavandula latifolia*
- *Poa bulbosa*
- *Leontodon longirostris*
- *Cynara baetica*
- *Eryngium campestre*
- *Centaurea castellanoides*
- *Dactylis hispanica*
- *Thapsia villosa*
- *Armeria longiaristata*
- *convolvulus arvensis*
- *Tanacetum anuum*
- *Heliotropum europaeum*
- *Atriplex patula*
- *Fallopia convolvulus*
- *Polygonum aviculare*
- *Biscutella auriculata*
- *Erodium cicutarium*
- *Silene vulgaris*

*** River bank:**

Saliceto discoloro- angustifoliae and Saliceto purpureo- albae:

The closest vegetation to the water is represented by the community *Saliceto discoloro - angustifoliae* and the more remote area from the river bank is represented by the *Saliceto purpureo- albae.*

-Saliceto discoloro- angustifoliae:

- **Tree layer:**

- Salix angustifolia
- Salix lambertiana
- Salix atrocinerea
- Salix fragilis
- Salix discolor
- Populus alba
- Juglans regia
- Populus nigra
- Fraxinus angustifolia

- **Bush layer:**

- Rubus ulmifolius
- Crataegus monogyna
- Ficus carica
- Vitis sylvestris
- Prunus spinosa
- Fraxinus angustifolia

- **Ground layer; forest floor vegetation:**

- Clematis vitalba
- Cornus sanguinea
- Solanum dulcamara
- Brachypodium sylvaticum
- Humulus lupulus
- Lonicera hispanica
- Lythrum salicaria
- Brachypodium phoenicoides
- Cirsium pyrenaicum
- Cirsium rosulatum

- *Hedera helix*
- *Equisetum arvense*
- *Lisymachia vulgaris*
- *Lisymachia ephemerum*
- *Poa trivialis*
- *Carex flacca*
- *Carex pendula*
- *Potentilla reptans*
- *Potentilla recta*
- *Mentha langifolia*
- *Mentha suaveolens*
- *Lactuca viminea*
- *Lactuca virosa*
- *Ranunculus granatensis*
- *Teucrium scordioides*
- *Veronica anagallis- aquatica*
- *Samolus valerandi*
- *Verbena officinalis*
- *Senecio laderoi*
- *Trifolium pratense*
- *Anagallis tenella*

-Saliceto purpureo- albae:

- **Tree layer:**

- *Salix atrocinerea*
- *Salix fragilis*
- *Salix angustifolia*
- *Salix lambertiana*
- *Acer granatense*
- *Fraxinus angustifolia*
- *Populus nigra*
- *Populus alba*

- *Populus deltoides*
- *Ulmus glabra*

- **Bush layer:**

- *Prunus spinosa*
- *Corylus avellana*
- *Crataegus monogyna*
- *Rubus caesius*
- *Rubus ulmifolius*
- *Viburnum opulus*
- *Vitis sylvestris*
- *Fraxinus angustifolia*
- *Vitis sylvestris*
- *Ligustrum vulgare*
- *Ficus carica*

- **Ground layer; forest floor vegetation:**

- *Clematis vitalba*
- *Brachypodium sylvaticum*
- *Rosa canina*
- *Rosa nitidula*
- *Rosa micrantha*
- *Rosa pouzinii*
- *Daphne latifolia*
- *Lonicera hispanica*
- *Cornus sanguinea*
- *Humulus lupulus*
- *Equisetum ramossisimum*
- *Equisetum telmateia*
- *Lythrum salicaria*
- *Hedera helix*
- *Mentha longifolia*

- *Mentha suaveolens*
- *Primula officinalis*
- *Erica erigena*
- *Dorycnium rectum*
- *Rubia peregrina*
- *Equisetum arvensis*
- *Helleborus foetidus*
- *Lisymachia vulgaris*
- *Viola dennhardtii*
- *Helleborus foetidus*
- *Solanum dulcamara*
- *Malus sylvestris*
- *Tamus communis*
- *Sambucus nigra*
- *Viburnum opulus*
- *Cirsium ferox*
- *Carex pendula*
- *Carex pendula*
- *Dorycnium pentaphyllum*
- *Dorycnium rectum*
- *Vinca minor*

3.9 VEGETATION OF BALKANS

Balkans is the historic and geographic name used to describe a region of southeastern Europe.

Most of the area is covered by mountain ranges running from north-west to south-east. The main ranges are the *Dinaric Alps* in Slovenia, Croatia and Bosnia, the Šar massif which spreads from Albania to Republic of Macedonia and the Pindus range, spanning from southern Albania into central Greece. In Bulgaria there are ranges running from east to west: the *Balkan mountains* and the *Rhodope mountains* at the border with Greece.

On the coasts the climate is Mediterranean, in the inland it is moderate continental. In the northern part of the peninsula and on the mountains, winters are frosty and snowy, while summers are hot and dry.

During the centuries many woods have been cut down and replaced with bush and brush. In the southern part and on the coast there is evergreen vegetation. In the inland there are woods typical of Central Europe (oak and beech, and in the mountains, spruce, fir and pine). The tree line in the mountains lies at the height of 1800-2300 m.

The soils are generally poor, except on the plains where areas with natural grass, fertile soils and warm summers provide an opportunity for tillage. Elsewhere, land cultivation is mostly unsuccessful because of the mountains, hot summers and poor soils, although certain cultures such as olives and grapes flourish.

CROATIA

80% of croatia forests consists of trees with leaves, 13% of pinus, 7 % of mixed forests. Forests cowers 37 % of croatia.

The flora of Adriatic coast consists of evergreen plants like *Rhamnus, Pistacia, Myrtus, Smilax aspera, Quercus, Laurus nobilis*, *Rosmarinus officinalis* and other plants.

SERBIA

Serbia belongs to continental region, just one small part of it is mediteranean. Serbia is one of the European countries with less forests. Forest only cover 26% of the country.

Vegetation of Serbia is seperated in 5 vegetation blets.:

- Low lying belt: *Quercus robur, Fraxinus excelsior, Populus L. , Salix...*
- Hilly belt: *Quercus frainetto, Quercus cerris, Quercus petraea* and *Castanea sativa.*
- Pre-mountain belt: *Pinus leucodermis, Quercus petraea, Fagus sylvatica, Abies alba.*
- Mountain belt: *Picea abies, Pinus mugo, Salix caprea, Fagus sylvatica.*

BOSNA & HERCEGOVINA

In south bosnia there is evergreen vegetation, but inside of the country you find *Quercus.*

Forests covers 42,2% of the country.

MACEDONIA

Macedonia has submediteranian climate with hot and dry summers and cold and damp winters. Temperatures are getting cold from south to north of the country.

Average yearly rainfall in mountains is between 1000 – 1500 mm and in lower parts of the country 600 – 700 mm.

In the lower parts of the country we find *Quercus pubescens, Carpinus betulus* and *Quercus cerris* and In the higher parts we find *Fagus sylvatica* and *Abies alba*.

We can also find mediteranian evergreen vegetation in the southern parts.

"ŠMARNOGORSKA GRMADA"

3.10 GEOGRAPHY

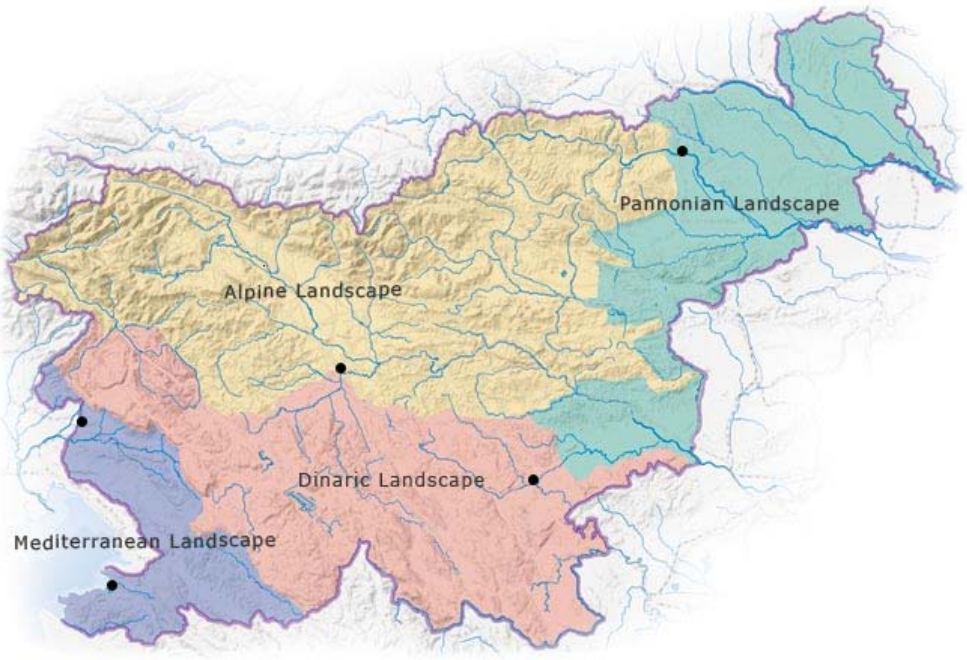
3.10.1 Introduction

According to a natural geographic regionalization, the country Slovenia consists of four macroregions. These are the Alpine region, the Mediterranean region, the Dinaric region and the Pannonian region. Macroregions are defined according to major relief units (the *Alps*, the *Pannonian plain*, and the *Dinaric Mountains*) and climate types (continental, alpine, mediterranean). These are often quite interwoven.

Macroregions consist of multiple and very diverse mesoregions. The main factor that defines them is the relief together with the geologic composition. Mesoregions in turn consist of numerous microregions.

Our zone of study belongs to the Pre-Alpine region.

The first regionalizations of Slovenia were made by geographers ANTON MELIK (1935-1936) and SVETOZAR ILEŠIČ (1968). The newer regionalization was made by Ivan Gams which is included in Wikipedia (2007).



Picture 2. Natural geographic regionalization of Slovenia (Wikipedia, 2007)

3.10.2 Situation and limits of the area of study: Šmarnogorska Grmada

The area of study is a mountain called *Šmarnogorska Grmada*, a few kilometers away from Ljubljana situated on the left bank the of the river *Sava*.

Ljubljana is in latitude: 46-04N, length: 14-31E.

Šmarnogorska Grmada is approximately 700 meters high.

3.11 GEOLOGY AND LITHOLOGY

3.11.1 Introduction

The following data have been taken from (Wikipedia, 2007)

According to the natural geographic regionalization:

3.11.1.1 The Alps region

The *Alps* arose as a result of the pressure exerted on sediments of the Tethys Oceans basin as its Mesozoic and early Cenozoic strata were pushed against the stable Eurasian landmass by the northward-moving African landmass. Most of this occurred during the Oligocene and Miocene epochs. The pressure formed great recumbent folds, or nappes, which rose out of what had become the Tethys Sea and pushed northward, often breaking and sliding one over the other to form gigantic thrust faults.

The landscape seen today is mostly formed by glaciations during the past two million years. At least five ice ages have done much to change the region, scooping out the lakes and rounding off the limestone hills along the northern border. Glaciers have been retreating during the past 10,000 years, leaving large granite erratics scattered in the forests in the region. As the last ice age ended, it is believed that the climate changed so rapidly that the glaciers retreated back into the mountains in a span of about 200 to 300 years.

3.11.1.2 The Dinaric region

They extend for 645 km along the coast of the Adriatic Sea (northwest-southeast), from the *Julian Alps* in Slovenia in the northwest down to the Šar-Korab massive in Albania and Macedonia, where the mountain direction changes to north-south.

The Dinaric Alps comprise the most rugged and extensively mountainous area of Europe outside of the *Caucasus Mountains, Alps* and *Scandinavian Mountains*. They are formed largely of secondary and tertiary sedimentary rocks of dolomite, limestone, sand, and conglomerates formed by seas and lakes that had once covered the area.

During the Alpine earth movements that occurred 50-100 million years ago, immense lateral pressures folded and overthrust the rocks in a great arc around the old rigid block of the north-east.

The *Dinaric Alps* were thrown up in more or less parallel ranges, stretching like necklaces from the *Julian Alps* up to the areas of northern Albania and Kosovo where the mountainous terrain subsides to make way for the waters of Drin and the fields of Metohija. The *Šar* and *Korab* mountains then rise and the mountainous terrain continues southwards to the Pindus of Greece and the mountains of the *Peloponnese* and Crete, Rhodes to the *Taurus* Mountains of southern Turkey.

The Mesozoic limestone forms a very distinctive region of the Balkans, notable for features such as the Karst. The Quarternary Ice Ages had relatively little direct geologic influence on the Balkans. No permanent ice caps existed, and there is little evidence of extensive glaciation.

One geological feature of great importance to the present-day landscape of the Dinarides must be considered in more detail: that of the limestone mountains, often with their attendant faulting. They are hard and slow to erode, and often persist as steep jagged escarpments, through which steep-sided gorges and canyons are cleft by the rivers draining the higher slopes.

During subsequent millennia these work deeper, leaving in their wake enormous waterless caverns, sinkholes, and grottoes and forming underground labyrinths of channels and shafts. The roofs of some of these caverns may eventually fall in, to produce great perpendicular-sided gorges, exposing the water to the surface once more.

3.12 HYDROLOGICAL SYSTEM

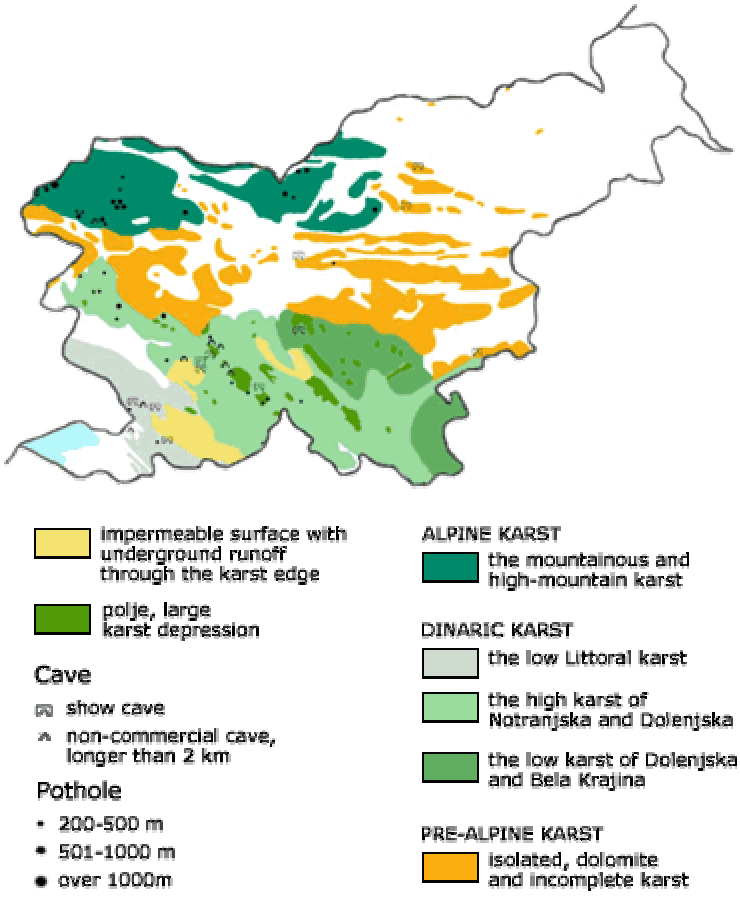
3.12.1 Introduction

The Hydrological data have been taken from internet (Kras and Karst, 2007).

3.12.2 Karst in Slovenia

According to all documentation collected till now, some 9000 km^2 or 44% of the territory of Republic of Slovenia can be classified as karst area. Over two thirds of this territory (6300 km^2) consist of limestones, mainly Mesozoic, whereas karst areas on other rocks (dolomite, conglomerate, calcarenite and breccia) occupy some 30% of the entire karst areas of Slovenia. The karst in Slovenia is commonly divided in relation to geological, hydrological and geomorphological characteristics into three major units:

- Alpine karst
- Dinaric karst
- Isolated karst of the intermediate area



Picture 3. Karst in Slovenia (Kras and Karst, 2007)

3.12.2.1 The Alpine karst

The Alpine karst can be classified as the fractured orogenetic karst.

The Alpine karst region is dissected by deep valleys, lying between ridges at an altitude from 1000 to 2800 m.

In Alpine karst areas the karstic hydrology is often the karst phenomenon. The underground waters can rise to the impervious ground but flow out to normal valleys.

Karst waters come out as the sources in the Quaternary deposits at the bottoms of the valleys or directly from the steep rocky slopes in the form of waterfalls (the Savica, Boka, Soča). The Alpine karst waters are comparatively pure because the surface is barren, without thicker layers of soil, and less populated.

3.12.2.2 The Dinaric karst

The Dinaric karst includes continuous karst areas in western and southern Slovenia. It can be divided into three elongated parallel belts according to geological, geomorphological and hydrological characteristics. They are the Littoral Karst, the Karst of Notranjsko and the Karst of Dolenjsko.The Littoral Karst, extending along the Adriatic coast.

Cave research organizations of Slovenia have till now registered more than 700 caves and potholes in the area of ca. 500 km2 of the Classical Kras.

The Karst of Notranjsko (Inner Carniola) belongs to the central highest Dinaric belt. It is high, wooded and scarcely populated karst plateaus at an altitude of 800 to 1700 m with intermediate lower valley-like karst depressions at an altitude between 400 and 600 m are predominant in this area.

Lying between these high areas of out-flow karst is the central part of the through-flow karst of Notranjsko. Across it the surface and underground waters flow forming intermittently flowing streams that flood the karst poljes. A considerable part of the through-flow karst belongs to the drainage basin of the Ljubljanica river, but some waters drain also towards the Kolpa and Krka rivers. The area is mostly covered by high grown common beech-silver fir forests, the community *Omphalodo-Fagetum*, the most representative forest type of north Balkan.

The karst of Dolenjsko belongs to the shallow out-flow through-flow karst of the inner Dinaric or Peripanonnian belt. The surface is covered with the thicker layer of the red karst soil, the typical terra rossa, which has made possible denser population in more continuous tracts of agricultural land-use. Gentler forms, dolines, uvala like depressions, even small karst poljes and rounded hills, are predominant in the karst relief. Waters derive from the impervious and dolomitic rims of the karst areas and flow only at small depth under the surface or even in shallow open canyons.

3.12.2.3 The isolated karst

The isolated karst in sub-Alpine and sub-Dinaric Slovenia is subdivided into several homogenous isolated units. The hydrographical significance of the isolated karst depends on the location and size of carbonate rock. The isolated patches of the karst are important natural reservoirs of underground water for local supply.

3.12.3 Hydrology

**River Sava:*

The river Sava crosses Slovenia from the northwest. From its source,in the Alps,crossing the center of the country towards Croatia. Along its course receives the tributaries of Sava Bohinka, the rivers Sora, Ljubljanica, Savinja, Krka and Sotla. From its source up to its river mouth in the Danube by Belgrade it has a measure of 940 km long.

3.13 BIOCLIMATOLOGY

3.13.1 Introduction

There are three types of climates: Alpine and moderated continental, with the exception of the coastal zone that has a Mediterranean climate. The littoral, is much more sunny.

3.13.2 Data sources

The information about the bioclimatic characteristics have been taken from the bioclimatic data sources of Ljubljana, due to the fact that they were the nearest to the area of study.

3.13.3 The bioclimate

The mountain *Šmarnogorska Grmada* belongs to the coline and the montane belts, extending from about 300 m at the river Sava bank to 700 m, at the top of *Šmarnogorska Grmada*, a sister hill of *Šmarna gora*. The coline and the montane belts are two of the four altitudinal bioclimatic belts that are recognized in the EuroSiberian region.

3.13.3.1 Coline bioclimatic belt

The Coline bioclimatic belt is in the lowest zone of mountain, where broad-leaved mezic forests prevail. Mixed stands of species like *Quercus petraea, Quercus pubescens, Fagus sylvatica, Acer pseudoplatanus, Castanea sativa, Carpinus betulus, Tilia cordata, Abies alba, Picea abies* etc. are the most common.

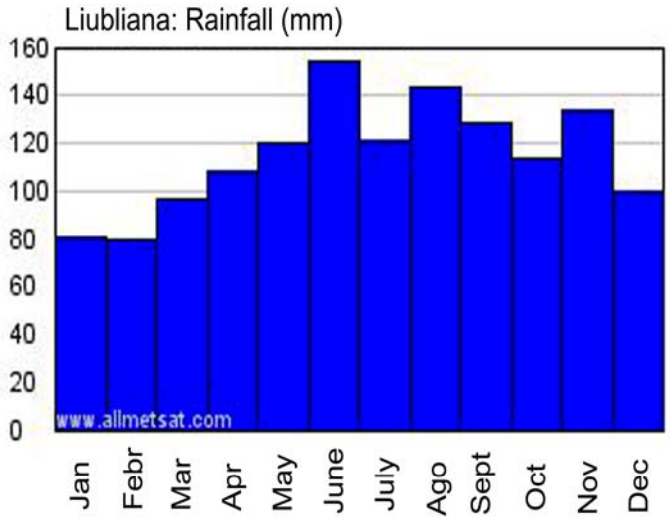
3.13.3.2 Montane bioclimatic belt

In the montane belt forests of common bech, Fagus sylvatica is widely developed. Other trees are intermixed, depending on exposition, steepness of slopes and soil types. On deeper soils *Quercus petraea, Carpinus betulus, Acer campestre, A. pseudoplatanus* and *Tilia cordata* are present. Species like *Quercus pubescens, Ostrya carpinifolia, Fraxinus*

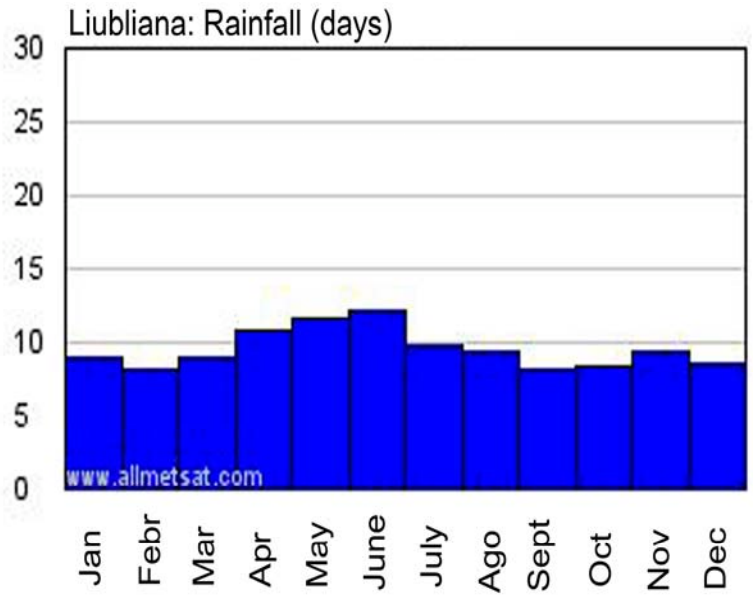
ornus and *Sorbus aria* are dominant on steep, south exposed slopes with shallow rendzinas.

3.13.4 Distribution of the rainfalls

In spite of its geographical location, at the edge of the Mediterranean, the entry of humid winds and the big elevations near to the coast make this an area with high rainfalls, even in summer.



Picture 4. Povprečne mesečne padavine v Ljubljani (Valores climatológicos normales, 2007)



Picture 5. Število dni s padavinami po mesecih v Ljubljani (Valores climatológicos normales, 2007)

3.14 HUMAN ASPECTS

More than fifty per cent of the territory of Slovenia is covered of forests.

It is a country where the mountain tourism is very developed because there is a fantastic network of signed paths, there is an excellent chain of refuges and alpine huts, and therefore mountaineering is a very popular and traditional sport in Slovenia.

In the area of study there is a great daily flow of citizens who go to walk, to run and to enjoy the landscape of *Šmarna gora* and *Šmarnogorska Grmada.*

3.15 VEGETATION OF ŠMARNOGORSKA GRMADA

3.15.1 Introduction

The vegetation has been taken of the book ”Komentar k vegetacijski karti gozdnih z družb Slovenije v merilu 1:50000” (Marinček et al., 2006).

*** <u>Top North side:</u>**

Arunco- Fagetum:

The Arunco- Fagetum is an azonal forest association thriving on shady and steep to very steep slopes dissected by deep gullies up to an altitude of 1.200 meters. This is a climax

vegetation type of the mountain region of Slovenia with fresh summers, moderately cold winters, and plenty of precipitation during the vegetation period. The geological material consists of dolomite covered with medium deep to skeletal rendzic leptosols with well decomposed form of humus. Deeper soils are found only at foot of slopes and in wider gullies where they are deposited by water from higher locations.

- **Tree layer:**

- *Fagus sylvatica*
- *Ostrya carpinifolia*
- *Sorbus aria*
- *Picea abies*
- *Acer pseudoplatanus*
- *Fraxinus excelsior*

- **Bush layer:**

- *Fagus sylvatica*
- *Picea abies*
- *Lonicera xylosteum*

- **Ground layer; forest floor vegetation:**

- *Cardamine enneaphyllos*
- *Mercurialis perennis*
- *Helleborus niger*
- *Helleborus odorus*
- *Hepatica nobilis*
- *Erythronium dens- canis*
- *Symphytum tuberosum*
- *Polygonatum multiflorum*
- *Anemone trifolia*
- *Cyclamen purpurascens*
- *Asarum europaeum*
- *Aquilegia nigricans*
- *Listera ovata*
- *Laburnum anagyroides*

- *Peucedanum austriacum*
- *Aposeris foetida*
- *Galium sylvaticum*
- *Galeobdolon montanum*
- *Fraxinus excelsior*
- *Neottia nidus-avis*
- *Carex digitata*
- *Carex alba*
- *Convallaria majalis*
- *Prenanthes purpurea*
- *Phyteuma ovatum*
- *Aconitum degenii* subsp. *paniculatum*
- *Polygala chamaebuxus*

*** <u>Montane belt; moderately steep slope above the ridge between the peaks of Šmarna gora and Šmarnogorska Grmada, north exposition, cca 600m of altitude:</u>**

Haquetio- Fagetum:

The Haquetio- Fagetum is a zonal forest association of a submontane vegetation belt. It covers hills and mountains from the lowlands up to an altitude of around 600 meters. On shady slopes, its growth limit is somehow lower while on sunny slopes it extends to an altitude of 800 meters. Submontane beech forest grow on carbonate bedrock of dolomite and limestone of various geological formations. The soils below the submontane beech forests are tessellated with a span of soils ranging from luvisol to rendzic leptosols on ridges. In general, there is medium deep chromic cambisol. The climate is moderately warm with average annual temperatures from 6,5 to 8 °C. Precipitation ranges from 1.000 to 1.600 mm annually with a maximum in early summer.

- **Tree layer:**

- *Fagus sylvatica*
- *Sorbus aria*

- **Bush layer:**

- *Fagus sylvatica*
- *Acer pseudoplatanus*

- *Fraxinus ornus*
- *Lonicera caprifolium*
- *Picea abies*

- **Ground layer; forest floor vegetation:**

- *Anemone trifolia*
- *Rubus hirtus*
- *Erythronium dens- canis*
- *Fagus sylvatica*
- *Acer pseudoplatanus*
- *Hieracium murorum*
- *Aposeris foetida*
- *Vaccinium myrtillus*
- *Sorbus aria*
- *Symphytum tuberosum*
- *Melica ciliata*
- *Mercurialis perennis*
- *Prenanthes purpurea*
- *Galium sylvaticum*
- *Phyteuma ovatum*
- *Helleborus niger*
- *Cephalanthera* sp.
- *Primula auricula*
- *Polygonatum multiflorum*
- *Carex alba*
- *Tanacetum corymbosum*
- *Crocus vernus*
- *Sanicula europaea*
- *Lilium carniolicum*
- *Calamagrostis varia*
- *Hacquetia epipactis*

*** South slope:**

Querco- Ostryetum carpinifoliae:

The Querco- Ostryetum carpinifoliae is a thermophilous and xerophilous extrazonal association with its distribution in the central part of Slovenia. It grows on steep, rocky southern slopes and crests from lowlands to a height of 700 meters. It thrives only on carbonate bedrock. The association represents the sites of numerous thermophilous plant species that have a closed areal in the submediterranean area while in the interior they grow on individual sites as relicts of warmer periods of the Holocene. They thrive on the sunny side of slopes in shallow rendzic leptosols where a dry microclimate with pronounced temperature extremes prevails that hinders the growth or even renders impossible the thriving of mezophilous plant species.

- **Tree layer:**

- *Quercus pubescens*
- *Fraxinus ornus*
- *Ostrya carpinifolia*

- **Bush layer:**

- *Quercus pubescens*
- *Fraxinus ornus*
- *Ostrya carpinifolia*

- **Ground layer; forest floor vegetation:**

- *Cornus mas*
- *Cornus sanguinea*
- *Viburnum lantana*
- *Berberis vulgaris*
- *Rhamnus saxatilis*
- *Carex humilis*
- *Carex digitata*
- *Polygala chamaebuxus*
- *Galium* sp.
- *Allium* sp.
- *Melittis melissophyllum*
- *Dictamnus albus*

- *Lonicera caprifolium*
- *Hypericum richeri*
- *Chamaecytisus hirsutus*
- *Chamaecytisus purpureus*
- *Dorycnium germanicum*
- *Globularia elongata*
- *Cyclamen purpurascens*
- *Ajuga genevensis*
- *Phyteuma ovatum*
- *Helleborus odorus*
- *Symphytum tuberosum*
- *Centaurea montana*
- *Mercurialis ovata*
- *Viola hirta*
- *Galium lucidum*
- *Orchis pallens*
- *Valeriana collina*
- *Campanula persicifolia*
- *Thymus praecox*
- *Acinos alpinus*
- *Anthericum ramosum*
- *Asplenium ruta- muraria*
- *Pseudolysimachion barrelieri*
- *Sorbus aria*
- *Geranium sanguineum*
- *Leontodon incanus*
- *Silene nutans*
- *Helianthemum ovatum*
- *Rhamnus cathartica*
- *Amelanchier ovalis*
- *Origanum vulgare*
- *Digitalis grandiflora*

- *Euphorbia cyparissias*
- *Lotus corniculatus*
- *Biscutella laevigata*
- *Potentilla australis*
- *Teucrium montanum*
- *Thesium divaricatum*
- *Hypericum perforatum*
- *Orchis masculata*
- *Silene vulgaris*
- *Clematis recta*
- *Euphorbia angulata*
- *Laserpitium latifolium*
- *Laserpitium siler*

*** <u>Low side "Plate": Plateau above the bottom of the mountain, called "Kuhinja" (kitchen).</u>**

Castaneo sativae- Fagetum sylvaticae:

The association Castaneo- Fagetum sylvaticae, also known as "acidophilus beech forest", is an azonal forest association growing on noncalcareous bedrock. They grow on the sunny side of medium steep to steep slopes dissected by deep gullies in some places. They appear mostly in the submontane zone at an altitude of 300 to 700 (900) meters. They thrive on very different noncalcreous stones where sandstone, marl, and shale of various geological formations predominate. The soil is mainly medium deep- to-deep skeletal dystric cambisol.

- **Tree layer:**

- *Fagus sylvatica*
- *Quercus petraea*
- *Acer pseudoplatanus*
- *Tilia cordata*
- *Fraxinus excelsior*
- *Carpinus betulus*
- *Castanea sativa*

- *Abies alba*
- *Picea abies*

- **Bush layer:**

- *Fagus sylvatica*
- *Quercus petraea*
- *Acer pseudoplatanus*
- *Tilia cordata*
- *Fraxinus excelsior*
- *Carpinus betulus*
- *Castanea sativa*
- *Abies alba*
- *Picea abies*
- *Acer campestre*
- *Euonymus verrucosa*

- **Ground layer; forest floor vegetation:**

- *Anemone nemorosa*
- *Galeobdolon montanum*
- *Symphytum tuberosum*
- *Viola reichenbachiana*
- *Aposeris foetida*
- *Primula auricula*
- *Convallaria majalis*
- *Salvia glutinosa*
- *Helleborus odorus*
- *Crocus vernus*
- *Festuca gigantea*
- *Rubus hirtus*
- *Sanicula europaea*
- *Asarum europaeum*
- *Viburnum opulus*

- *Prunus avium*
- *Lonicera caprifolium*
- *Lonicera xylosteum*
- *Ulmus glabra*
- *Pulmonaria officinalis*
- *Anemone nemorosa*
- *Galanthus nivalis*
- *Milium effusum*
- *Carex sylvatica*
- *Carex mucronata*
- *Galium sylvaticuM*
- *Lamium maculatum*
- *Athyrium filix- femina*
- *Dryopteris filix- mas*
- *Maianthemum bifolium*
- *Hacquetia epipactis*

*** River bank:**

Salicetum albae:

In the cultural landscape, the occurrence of the association of white willow (*Salix alba*) has been reduced to small areas along watercourses. These communities develop under the direct influence of the watercourse immediately above its medium water level. The area is frequently flooded. Only sedimentation layersare encountered in undeveloped soils and parent material. In spiteof a great quantity of organic remains (leaves and withered parts of plants), there is not much humus because the organic remains are covered by river sediment every year. Consequently, decay is rendered very difficult.

- **Tree layer:**

- *Populus nigra*
- *Salix alba*
- *Salix daphnoides*
- *Salix elaeagnos*
- *Salix fragilis*

- **Bush layer:**

- *Salix purpurea*
- *Frangula alnus*
- *Fraxinus excelsior*
- *Rhamnus cathartica*
- *Cornus sanguinea*
- *Alnus glutinosa*
- *Alnus incana*
- *Tilia cordata*
- *Prunus avium*
- *Malus domestica*
- *Carpinus betulus*
- *Viburnum opulus*
- *Crataegus monogyna*
- *Quercus robur*

- **Ground layer; forest floor vegetation:**

- *Genista tinctoria*
- *Rubus caesius*
- *Carex ornithopoda*
- *Euphorbia cyparissias*
- *Sanguisorba minor*
- *Calamagrostis varia*
- *Lythrum salicaria*
- *Juncus articulatus*
- *Galium mollugo*
- *Galium aparine*
- *Plantago lanceolata*
- *Carex elata*
- *Ononis arvensis*
- *Medicago falcata*
- *Humulus lupulus*
- *Geum urbanum*

- *Veronica hederifolia*
- *Parietaria officinalis*
- *Urtica dioica*
- *Alliaria petiolata*
- *Impatiens glandulifera*
- *Rumex obtusifolius*
- *Saponaria officinalis*
- *Anthriscus sylvestris*
- *Lamium orvala*
- *Ranunculus lanuginosus*
- *Equisetum arvense*
- *Aster novi- belgii*
- *Pirus piraster*
- *Hypericum tetrapterum*
- *Agrostis stolonifera*
- *Brachypodium sylvaticum*
- *Solidago canadensis*
- *Leontodon autumnalis*
- *Trifolium pratense*
- *Primula vulgaris*
- *Melilotus altissima*
- *Solidago gigantea*
- *Taraxacum officinale*
- *Phalaris arundinacea*
- *Poa compressa*

4 CONCLUSIONS

The altitudinal gradient, the climate (fog, precipitation, insolation, winds), the edaphology, the action of the man and other factors explain the distribution of the vegetation and the landscape that we find at the present time. The more relevant factor regarding the distribution of the vegetation is the climate, mainly the precipitations and the temperature. The comparison we are going to do between our study areas in Slovenia and the one in Spain will be distributed by bioclimatic belts since the altitude is one of the most important factors in the distribution of the vegetation.

Altitudinal belts and exposition:

In the upper montane belt of north exposition of the *Šmarnogorska Grmada* the beech (*Fagus sylvatica*) is the main arboreal species. It needs regular and abundant precipitations (higher than 1000 mm year) and a great environmental humidity without drought in summer. Beech is accompanied by *Quercus petraea*, *Picea abies*, *Sorbus aria* and *Acer pseudoplatanus.* These species require similar conditions in humidity and temperatures.

These conditions don't occur in *Calar del rio Mundo* since the precipitations are less abundant and the high temperatures in summer cause a period of drought between June and October. Due to these conditions in *Calar del rio Mundo* the *Pinus nigra* subsp. *mauretanica* appears as the main arboreal species, accompanied by *Juniperus communis* subsp. *hemisphaerica.* If we lowered a little in height the *Pinus nigra* appears, accompanied by *Quercus rotundifolia* and *Quercus faginea,* which aren´t very demanding in precipitations and support the high temperatures of summer.

In the areas in which the beech forest is more developed, it causes in summer an atmosphere of penumbra and humidity in its interior -an own microclimate-, with few vegetation in its grounfloor, due to the lack of light.

In spring, before the leaves of the beech and other deciduous trees fall, the light can enter and there is a great proliferation and flowering of several groundfloor plants, first of all winter-green species such as *Helleborus niger, Vinca minor, Cyclamen purpurascens, Anemone hepatica, Carex digitata, C. sylvatica, Stellaria holostea, Rubus hirtus, Milium efusum* and plenty of geophytes such as *Galanthus nivalis, Leucojum vernum, Crocus vernus, Scila bifolia, Gagea lutea, Anemone nemorosa, A. trifolia, A. ranunculoides, Corydalis cava,C.solida,Polygonatum multiflorum, Convallaria majalis.* All these species' bulbs and rhizomes are dried and reduced at the end of spring or in summer until the next spring, as a consequence of lack of light, due to the development of the leaves of the deciduous trees.

Regarding the type of soils, *Fagus sylvatica* and *Pinus nigra* subsp. *mauretanica* are indifferent, although both prefer limestone grounds. In both study areas soils on limestone are found, so soils won't be the element that defines the differences between them.

Upper montane belt and south exposition:

In the upper montane belt and south exposition of *Šmarnogorska Grmada* we can find *Quercus pubescens,* which thrives well on limestone soils and doesn't need as much humidity as *Fagus sylvatica.* It also supports in a better way the summer drought.

Accompanying the *Quercus pubescens* we find the *Fraxinus ornus, Ostrya carpinifolia*, etc. In the same conditions of altitude and exposition in *Calar del río Mundo* we find *Pinus nigra, Juniperus oxycedrus*, *Juniperus phoenicea, Juniperus hemisphaerica.* These species are very well adapted to the sunny and drought slopes.

Vegetation of river banks:

The presence of a river bed determines the ecological conditions of surrounding land.

The most important determinant factor is the greater water availability in comparison to other areas that are not by the river and that are above the phreatic level. As the environmental humidity also increases, there is a greater amount of water available and the evapotranspiration is greater. The vegetation of riverside fundamentally depends on the humidity of the ground.

For that reason, the vegetation of the riverside has as main conditioning factor: the greater or smaller proximity and height respect to the river bed. This doesn't mean that it is totally independent of the climatic factors (precipitation and temperature), but it affects to it in a smaller degree than to another type of vegetation that depends on the great climatic zones.

The vegetation is also affected by the thermal regime. A diminution in the maximum temperatures takes place because the evapotranspiration process consumes more energy. Therefore, the riverside mean is more humid and fresh than the not riverside mean.

The vegetation arranges itself in parallel bands in the edges of the river according to the humidity requirements and to the resistance to the overflows of the river.

The soils where the vegetation is rooted are formed by alluviums of the river deposited in the avenues. The lack of structure characterizes this soil, plus good ventilation and the constant presence of high water table.

All this explains why the vegetation of riverside of both sites of the study is so similar and why those significant differences don't exist, but species composition within the genera is different due to difference of flora of Balkan and Iberian Peninsula.

5 LITERATURE

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