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CROSS BORDER OL

**CROSS-BORDER COOPERATION FOR SUSTAINABLE DEVELOPMENT AND
TOURISM, THROUGH VALORIZATION OF RURAL CULTURAL HERITAGE AND
CONSERVATION OF NATURAL ASSET OF AREAS WITH ANCIENT OLIVE GROVES**



Maps and Census of Ancient Olive Trees



Agricultural University
of Tirana - AUT



CIHEAM
BARI



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URBAN RESEARCH
INSTITUTE



Park Authority
of Venafrò



Municipality of Bar



Association for Sustainable
Regional Groves - Valdano



PROJECT DELIVERABLE

| | |
|---------------------------|--|
| <i>Project Partner</i> | <i>PP 5 Municipality of Bar, Montenegro</i> |
| <i>Work Package</i> | <i>WP T1 Identification and conservation of landscape with ancient olive trees and orchards (A00s)</i> |
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Table of Contents

| | |
|---|----|
| INTRODUCTION | 4 |
| PROJECT AREA | 5 |
| FIELD WORK..... | 13 |
| CLIMATIC DATA..... | 14 |
| SOIL DATA | 17 |
| CENSUS OF THE ANCIENT OLIVE TREES | 23 |
| CENSUS OF THE CULTURAL-HISTORICAL ASSETS..... | 32 |
| CENSUS OF THE ROADS AND TRAILS..... | 42 |
| CONCLUSIONS..... | 44 |

Project “*CROSS BORDER OL*” is going to contribute to the promotion of sustainable tourism activities, conservation and protection of natural resources in areas with ancient olive trees. Furthermore, one of the main outputs is to recover and raise the awareness of local population on their own cultural heritage linked to traditional olive growing.

Main objective of the project is to promote sustainable tourism development based on the natural asset of the landscape with ancient olive orchards (AOOs). The attractiveness of such territories is going to be preserved to increase and promote smart and sustainable tourism rural development on the territories.

Activity *A.T1.1 – Mapping olive trees and groves* includes census and mapping of ancient olive trees and orchards in the project area. The position of AOOs is recorded using a GPS tool. Measures of canopy half-radius and circum-reference of the trunk are performed on the field. After climate and soil research, and soil survey of olive growers followed by data validation on-field, data-base and data-records are created, available in digital formats.

Džidžarin olive orchard is located at the territory of Bar municipality, southern Montenegro. The study area is situated approximately 5 km away from the Adriatic Sea and the largest port in Montenegro - Port of Bar.

Situated on a steep base of Rumija Mountain, Džidžarin rises above the city of Bar with elevation between 75 and 265 meters a.s.l. Total surface area of the olive orchard equals 68.28 ha, however this report will identify part of the grove that has high potential for tourist valorisation.

Figure 1 shows the location of Džidžarin olive orchard in Bar municipality and its vicinity to the two main cultural-historical treasures of the area, Old town of Bar and Old olive tree.



Figure 1: Location of the project area – *Džidžarin* olive orchard

Area of *Džidžarin* is bordered with the three watercourses – Suva river on the north, Vruća river on the south and Bunar river on the south-west. The canyon of Suva Rijeka separates the two mountains rising above Bar, Rumija and Lisinj. This river is particularly interesting for canoeing and adventurous exploring. Its canyon abounds in rich and versatile natural life, while their vertical cliffs are natural habitat of wild pigeons, one of the rare bird species in Europe.

Peculiarities of Vruća river are also very interesting from the tourist point of view, since this river is rich in water throughout the whole year. During the summertime, Vruća river is perfect from swimming and diving, due to the crystal clear water and round-shaped colourful stones. Vruća River abounds in indigenous eel fish species, while the Bunar River is known for the local species of trout, very attractive for fishing. Indigenous

eel was used in this area for the purposes of cleaning drinking water tanks.

Within this area, there are various cultural-historical objects, such as ancient bridges, olive mills, remains of the religious objects etc. These are visible architectural remains of the rich history that were arising from the Middle Ages to the late XIX century. These assets are even more attractive considering the beauty of the surrounding area - natural landscapes, rapid and sparkly rivers and ecological habitats of endangered species. This area is covered with old olive orchards, often terraced with elongated dry-stone walls.

There are numerous stories, myths and legends from the time when olive growing and processing started in this area. One of the most famous local legends is correlated with the origin of Džidžarin olive orchard. According to the legend, a young man was disappointed due to the low yield in his olive grove caused by the water shortage, when he threw away his tool from the walls of Old City of Bar. At that moment, water started to flow from the five inexhaustible sources ("Five wheels").

Water source "*Kajnak*" supplies large suburban part of Bar municipality with high-quality drinking water. It is located in the foothill of the walls of Old City of Bar, nearby the remains of the old mills and ancient stone-arch bridges.

There are 67 mostly private owners in *Džidžarin* olive complex. However, there are few orchards owned by the local government, Orthodox, Catholic and Islamic communities.

The olive trees owned by the Islamic community are marked with the letter “V” (“vakuuf”), which is an useful tool for orientation.

In order to conduct a research on ordinary agronomic practices of the local olive growers, we conducted a survey (Figure 2) in February 2019. All the data were processed and validated on-field. The survey showed that olive growing in the area is on the extensive level, based on traditional practices. There are about 10,000 olive trees of different age, and almost 70% of them may be considered as ancient or monumental (from few hundreds (200-500) to two thousand years old). Autochthonous olive variety Žutica is present with more than 98%. Overview of the most important characteristics of this olive variety is given in the Table 1.
















| | | |
|---|--|--|
| Olive orchard description Džidžarin | |  Interreg - IPA CBC Italy - Albania - Montenegro CROSS BORDER OL |
| Survey number: | | |
| Date: | | |
| Cadastral number: | | Owner: |
| Area size in m ² /ha/ac: | | Number of olive trees: |
| Tick the planting method in your olive orchard: | | |
| <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>irregular</p> </div> <div style="text-align: center;">  <p>in quinconce</p> </div> <div style="text-align: center;">  <p>in square</p> </div> <div style="text-align: center;">  <p>in rectangular</p> </div> </div> | | |
| Tick the type of your olive orchard: | | |
| <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Single olive orchard</p> </div> <div style="text-align: center;">  <p>Olive with other cultivated ligneous plants</p> </div> <div style="text-align: center;">  <p>Olive with other cultivated non ligneous plants</p> </div> </div> | | |
| Tick the olive crochets shape: | | |
| <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>natural round</p> </div> <div style="text-align: center;">  <p>polycentric</p> </div> <div style="text-align: center;">  <p>dichotomous</p> </div> <div style="text-align: center;">  <p>pollard</p> </div> </div> | | |
| Tick the predominant vegetative crochets type: | | Average age of your olive orchard: |
| <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>sparse</p> </div> <div style="text-align: center;">  <p>good</p> </div> <div style="text-align: center;">  <p>rich</p> </div> </div> | | <input type="checkbox"/> Non-productive young olive orchard <input type="checkbox"/> Productive olive orchard <input type="checkbox"/> Monumental olive orchard (hundred and/or thousand years old olive trees) |
| Olive varieties present in your orchard: | | Average olive tree height: |
| <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"> <input type="checkbox"/> Žutica </div> <div style="width: 50%;"> <input type="checkbox"/> Lumbardeška </div> <div style="width: 50%;"> <input type="checkbox"/> Sitnica </div> <div style="width: 50%;"> <input type="checkbox"/> Dužica </div> <div style="width: 50%;"> <input type="checkbox"/> Šarulja </div> <div style="width: 50%;"> <input type="checkbox"/> Crnica </div> <div style="width: 50%;"> <input type="checkbox"/> Zinzulača </div> <div style="width: 50%;"> <input type="checkbox"/> Barkinja </div> <div style="width: 50%;"> <input type="checkbox"/> Fran </div> <div style="width: 50%;"> <input type="checkbox"/> Lumbardina </div> <div style="width: 50%;"> <input type="checkbox"/> Drobnica </div> <div style="width: 50%;"> <input type="checkbox"/> Arbequina </div> <div style="width: 50%;"> <input type="checkbox"/> Gloginja </div> <div style="width: 50%;"> <input type="checkbox"/> Others </div> </div> | | <input type="checkbox"/> Majority of trees lower than 6 m <input type="checkbox"/> Majority of trees higher than 6 m |
| What is your average olive yield (kg/m², t/ha)? | | Agrotechnical and pomotechnical activities: |
| Do you use any fertilizers and/or organic manure? YES / NO | | <input type="checkbox"/> Deep tillage (on 60-100 cm) <input type="checkbox"/> Tillage (on 30-60 cm) <input type="checkbox"/> Surface tillage <input type="checkbox"/> Irrigation <input type="checkbox"/> Pruning <input type="checkbox"/> Organic manure and/or fertilizers <input type="checkbox"/> Pest and diseases protection <input type="checkbox"/> Other |
| <input type="checkbox"/> How many times do you fertilize per year? <input type="checkbox"/> Which type of fertilizers do you use? <input type="checkbox"/> Do you do the fertigation? | | Do you use any type of pesticides? (fungicides, insecticides, herbicides) <input type="checkbox"/> Number of treatments? <input type="checkbox"/> In which period of the year? <input type="checkbox"/> Which types of pesticides do you use? |

Figure 2: Survey sheet

| |
|---|
| <p>Do you irrigate your olive trees?</p> <ul style="list-style-type: none"> • YES / NO <input type="checkbox"/> Surface irrigation <input type="checkbox"/> Sprinkler irrigation <input type="checkbox"/> Micro-drip irrigation <input type="checkbox"/> Other |
| <p>Are there any traditional stone abutments in your orchard?</p> <ul style="list-style-type: none"> • YES / NO <input type="checkbox"/> How well are the abutments preserved from 1 (critical) to 10 (excellent)? <input type="checkbox"/> What is the average height and length of the abutments? |
| <p>During 2014 and 2015, a research has been conducted through an EU funded project, co-funded and implemented by UNIDO in partnership with UNDP and Ministry of Economy of Montenegro. Age certificate for the 50 monumental olive trees has been issued by Wood Anatomy and Tree-Ring Research Laboratory, Faculty of Forestry, Istanbul University, Turkey.</p> <p>Have you participated in the above mentioned project? (If yes, please indicate what is stated in the certificate)</p> |
| <p>Is there in your orchard or nearby any historical-archeological peculiarity which could become potential touristic location?</p> |
| <p>Tell us what is the real necessity of olive production in Bar municipality? We will do our best to raise local olive production on a higher level through the incoming projects!</p> |



There are several ways to determine the age of the olive tree. By definition, *as an old olive is considered a tree with the diameter of trunk larger than 3.5 meters, measured at a height of 1.3 meters from the ground.*

We will use this way to determine which are ancient trees, locate them and make tourist maps that will connect them with visitors.

Table 1: Main characteristics of *Žutica* olive variety

| Characteristics | | Description |
|--------------------------------------|---------------|---|
| Origin of <i>Žutica</i> | | Unknown; most probably from Greek Irelands (Corfu) |
| Prevalence in Montenegro | | 65% of all the olive trees in Montenegro 91% of the olive trees in the olive growing region Bar-Ulcinj- Budva; 98% of the olive trees in Bar and Ulcinj |
| Meaning of the name | | <i>Žutica</i> means “yellowish” Color of the fruit begins its change from straw-yellow towards wine-purple to black at the end |
| Morphological characteristics | <i>Trunk</i> | Very pronounced bumps and cracks (hyperplasia) At the height of 180cm main branches started to occur |
| | <i>Canopy</i> | Numerous branches; round shape |
| | <i>Leaf</i> | Leaf short and narrow with small leaf pedicel; smooth surface; color is olive green on the upper side and greyish-green from the inside |
| | <i>Flower</i> | From 2 to 26 flowers grouped into inflorescences |
| | <i>Fruit</i> | Oval shape (avg. 21,6 x 16,7 mm) and L/W ratio 1,28 Average fruit mass is 2,7 g (medium-small fruit); auto fertile variety |
| | <i>Pit</i> | Light-brown, smooth surface with white threads Average dimensions: 13,3mm length; 7,2mm width; Average mass: 0.37g Elliptic pit according to the L/W ratio (1,28) |
| Phenological stages | | Flower from the middle of May to the beginning of June (14 days in average) Beginning of the fruit ripening in the first half of October until the end of January (three months) |
| Olive oil | | High content of olive oil (23% in average); Both quantity and quality strongly influenced by meteorological conditions |
| Pest and disease | | Resistant to <i>Pseudomonas savastanoi</i> (Olive knot disease) Sensitive to <i>Spilotea oleagineae</i> (Peacock spot) Susceptible to the <i>Bactrocera oleae</i> (Olive fruit fly) |

Source: Adapted from Moric et al, 2017.

According to the results of the survey, single olive growing is present in the area, without intercropping with other fruit trees and cereals or vegetables. Average yield (from 4 to 8 kg per tree) is not satisfactory for both producers and processors. Despite high quality of olive fruit and olive oil, low quantities enable to cover local and national consumption needs.

Pruning is performed every year or once in two years. However, even though this practice is quite regular, most of the trees are from 7 to 10 meters high, which is a limiting factor for implementation of intensive agriculture. Irrigation systems are not part of this grove, so the olive growing in this plantation may be classified as 100% rainfed. This is one of the agronomic practices (amelioration measures) that should be changed, especially taking into consideration vicinity and availability of water sources. Historic climate data show irregularities in precipitation and severe resource paradox (there is enough annual rainfall in terms of quantity on the annual level; however during the period of the maximum air temperatures, most severe water stress occurs).

Twenty years ago, airplane protection of the olive trees was carried out and quality and quantity of the olive and olive oil yield was significantly better. Also, alternative fertility of Žutica variety, prone to this phenomenon, was reduced. However, due to the environmental protection (preservation of bees), this method was abandoned.

Nowadays, protection is performed individually. Due to the poorly accessible terrain and high olive trees, protection from the most severe pest and disease is often neglected. Harvesting is still performed manually in terms of collecting from the ground, with seldom usage of harvesting tools. The farmers are not familiar with mechanical shakers, and it leaves negative impact on the fruit and oil quality.

Field work consists of the two set of activities.

First set includes validation of the ordinary agronomic practices on-field and identification of the best agronomic practices, landscape and terrain description, opening of the soil profile and sampling, soil moisture control, testing of irrigation implementation and prediction of the olive fruit yield increment. Laboratory analysis included analysis of the soil physical, chemical and moisture properties, performed at Biotechnical Faculty (University of Montenegro) and Faculty of Agriculture (University of Belgrade).

Second set of activities included identification and recording of the ancient olive trees, measurements of the canopy and trunk diameter, estimation of the ancient olive trees age, identification of various cultural-historical objects, roads and trails with high potential for tourist valorisation. The last step within the second set of activities included population of database from all the data collected and their digitization in the Geographic Information System.

Institute of Hydrometeorology and Seismology of Montenegro provided historical datasets of the climatic data (1980-2018) for the nearest meteorological station, located at the seashore.

Furthermore, during the experimental period from February to September 2019, local meteorological station was providing daily climatic data for Bar municipality (average air temperature (°C), minimum air temperature (°C), maximum air temperature (°C), rainfall amount (mm), sunshine duration (hours), average relative humidity (%), average wind speed (m/s), maximum wind speed (m/s) and wind direction).

For the considered period, the highest amount of rainfall occurred in 2014 (1,913.1 mm), while the lowest amount was recorded in 2011 (758 mm). September 6th 1990 was recorded as the rainiest day, with 224 mm of precipitation. Average annual amount of precipitation for thirty-eight years equals to 1,335.3 mm (Figure 3). The driest month was July, while the rainiest was October. Daily weather data showed once again that Bar is the sunniest town in Montenegro, with 17.87 MJ/m²/day of average net radiation and total sunshine duration equals 1,810.3 hours.

The most frequent wind direction is north (N) and north-east (NE); however, north-west (NW) and north-north-west (NNW) winds occur often as well. The average wind speed was the only parameter that did not reflect the real situation on the field. The meteorological station is located directly at the sea shore, and therefore recorded average wind speed was significantly higher

than the real wind speed in the olive orchard (due to the higher elevation and sheltered position of the grove from in the mountain slopes).

One of the recommendations that should be taken into account is placing an agro-meteorological station within this grove, since *Džidžarin* olive orchard has a tremendous potential for various environmental researches.

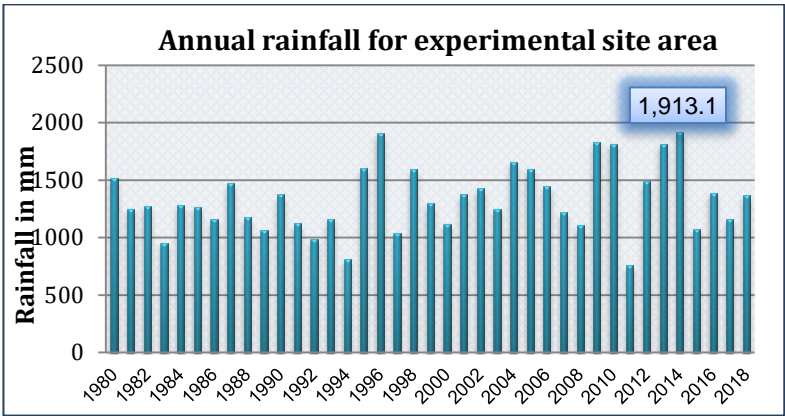


Figure 3: Annual rainfall for experimental site area (1980 - 2018)

Average annual air temperature for the territory of Bar municipality range between 15.6°C and 16.5°C (Figure 4 and Figure 5). The coldest month is January, while the warmest is July. Temperature extremes were recorded on two occasions, in 1983 (Tmin -6°C) and in 1987 (Tmax 37.7°C). Average minimum temperature is -2.14 °C, while the average maximum is 34.6 °C.

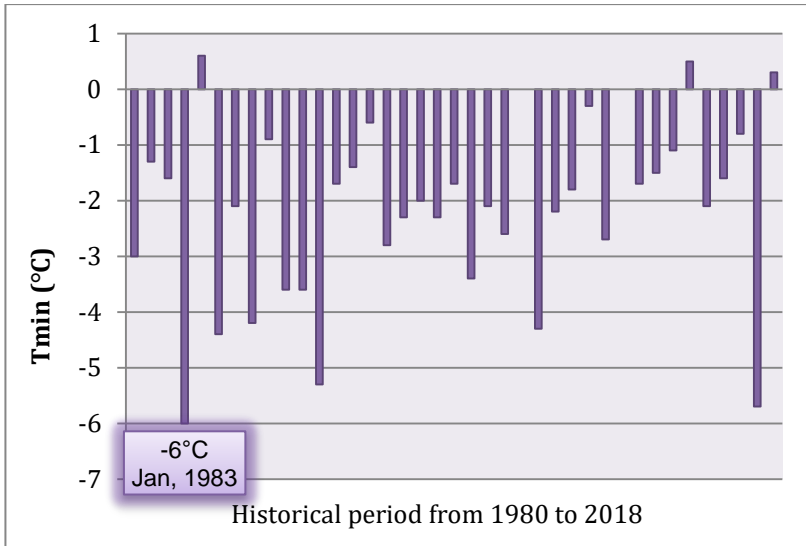


Figure 4: Minimum daily air temperature for the experimental site area (1980-2018)

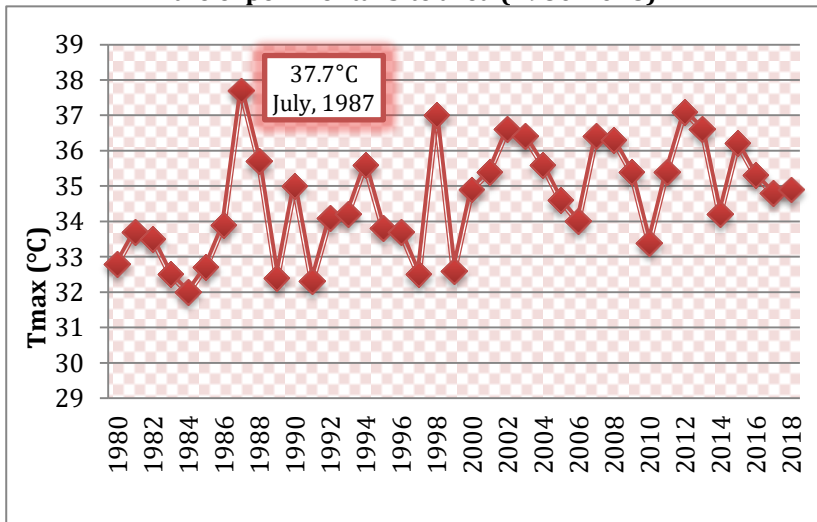


Figure 5: Maximum daily air temperature for the experimental site area (1980-2018)

For the purposes of identification of the Best agronomic practices for conservation of ancient olive orchards – Soil management and Fertilization, soil profile was opened and described in details. Also, samples in both disturbed and undisturbed states were taken and analysed for physical and chemical analysis and soil moisture.

According to the national soil classification system, the examined soil is classified as *Eutric cambisol on phlich*. This soil subtype occupies around 35000 to 40000 hectares of the Montenegrin territory, mainly in the coastal, southern part of the country. Terrains of the Montenegrin coast, where *Eutric cambisol on phlich* is mainly present, are usually mountainous, ranging between the coast and the surrounding carbonate hills, up to the 800 to 900 meters a.s.l. Moreover, those terrains are known for the sloppy relief with numerous torrential streams. These conditions led to the development of shallow, erodible soils with alluvium-colluvium properties. Therefore, most of the cultivated landscapes classified as *Eutric cambisol on phlich* are terraced with dry-stone walls.

The content of the plant available P_2O_5 and K_2O significantly decreases within the depth and soil is poor in P_2O_5 and medium supplied with K_2O . At the horizons deeper than 30 cm, the soil is characterized with poor availability of the both elements. This situation may be explained by seldom and shallow fertilizer application, due to the specific terrain configuration, parcels fragmentation, soil erosion and olive trees age as some of the

strong limitations. Therefore, it is recommended to add essential nutrients by injecting and micro-elements through foliar feeding. More detailed characteristics of the soil profile are presented in the following tables and figures.



Figure 6: Soil profile sampling

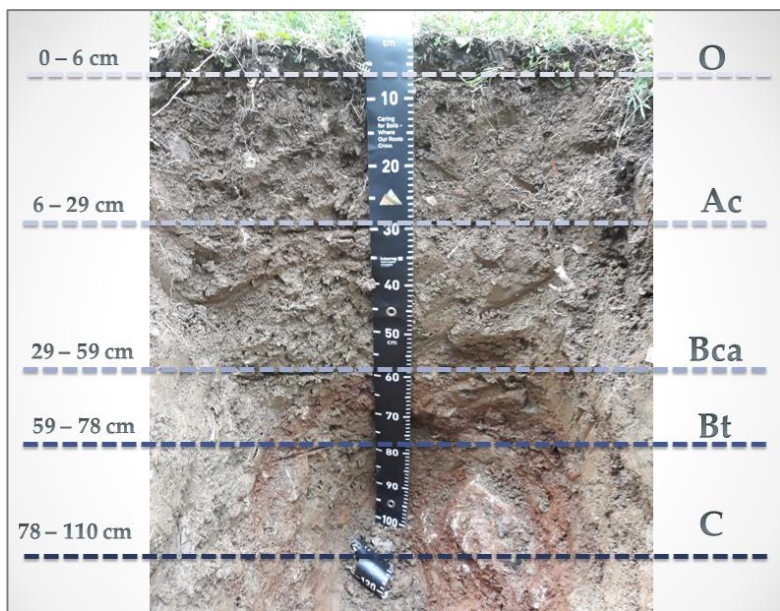


Figure 7: Experimental soil profile with distinguished horizons

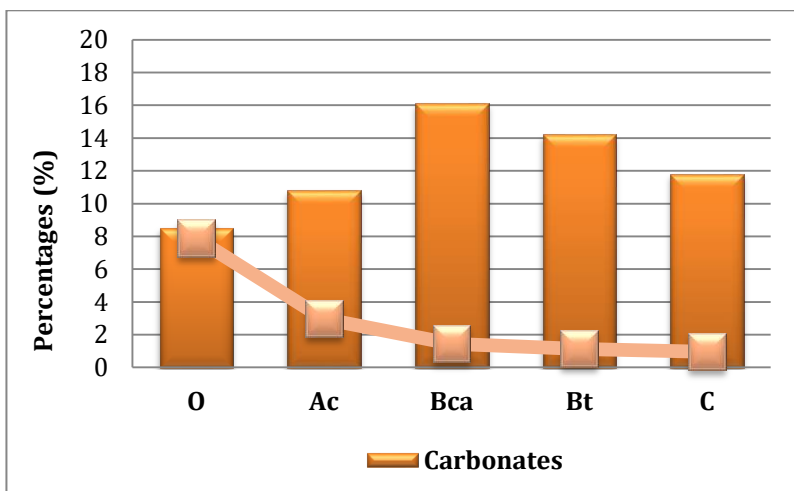


Figure 8: Variation of the calcium-carbonate and humus content at the experimental soil profile

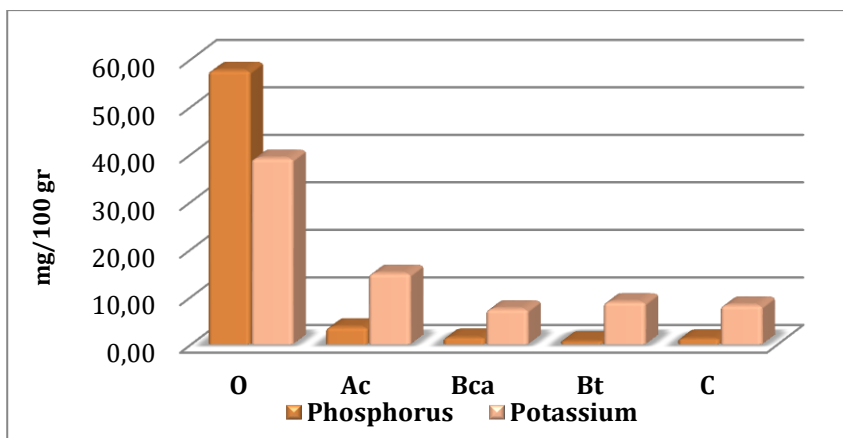


Figure 9: Variation of available phosphorous and potassium at the experimental soil profile

Table 2: Agro-chemical analysis of the examined soil

| Depth | pH | | CaCO ₃ | Humus | P ₂ O ₅ | K ₂ O |
|--------|---------------------|-----------|-------------------|-------|-------------------------------|------------------|
| cm | in H ₂ O | in 1M KCl | % | % | mg/100g | mg/100g |
| 0-6 | 7.65 | 7.08 | 8.5 | 7.87 | 57.6 | 39.1 |
| 6-29 | 7.7 | 7.16 | 10.8 | 2.96 | 3.6 | 14.9 |
| 29-59 | 7.48 | 6.9 | 16.1 | 1.45 | 1.4 | 7.4 |
| 59-78 | 7.61 | 6.99 | 14.2 | 1.13 | 0.7 | 8.9 |
| 78-100 | 7.58 | 6.95 | 11.8 | 0.96 | 1.2 | 8.2 |

Table 3. Soil mechanical properties analysis at the examined soil

| Mechanical fraction content (%mas) | | | | | | |
|------------------------------------|-----------------|--------------|--------------|-----------|-----------|--------------------------------------|
| Sample no. | Depth <i>cm</i> | Sand (mm) | | Silt (mm) | Clay (mm) | Textural classes (USDA/FAO) |
| | | <i>large</i> | <i>small</i> | | | |
| | | 2.00–0.20 | 0.20–0.05 | | | |
| 1 | 0–6 | 8.2 | 5.7 | 69.6 | 16.5 | silt loam <i>poorly skeletoid</i> |
| 2 | 6–29 | 4.6 | 4.1 | 55.3 | 36.0 | silty clay loam skeletoid |

| | | | | | | |
|---|------------|-----|-----|------|------|-------------------------------------|
| 3 | 29–59 | 3.5 | 3.4 | 56.9 | 36.2 | silty clay loam <i>skeletoid</i> |
| 4 | 59–78 | 2.2 | 2.1 | 48.1 | 47.6 | silty clay <i>skeletoid</i> |
| 5 | 78– 100 | 2.1 | 3.0 | 48.7 | 46.2 | silty clay <i>skeletoid</i> |

After conducting the irrigation experiment, it was concluded that it would be difficult to introduce regular irrigation at the experimental site, from both infrastructure and economic aspect. This conclusion is made according to the complex configuration of the terrain. However, certain contemporary irrigation systems should be taken into consideration.

Full surface irrigation from the nearby water source was carried out with in August (Figure 11). Except for the experimental purposes, surface irrigation supply would not be recommended for this site, while certain traditional water harvesting techniques may be taken into consideration. However, it was noted that irrigation has a positive impact on the olive yield (Figure 10). Yield obtained at the rainfed parcel equalled 9.85 t/ha, while in the case of irrigation introduction, it was expected yield to increase by 0.2 t/ha (10.05 t/ha).

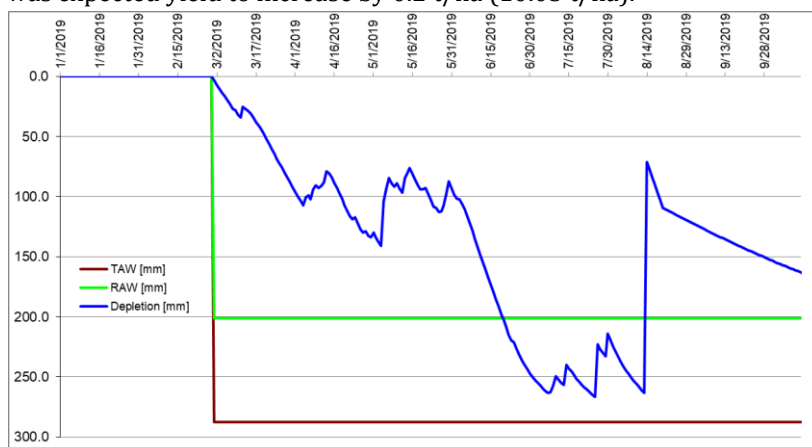


Figure 10: Soil water balance at the irrigated olive parcel



Figure 11: Experimental irrigation of ancient olive trees in *Džidžarin*

Džidžarin olive orchard is the complex plantation of more than 70% of old olive trees. Most of the olives may be considered as ancient or even monumental. Each olive tree has a story attached to it, unique appearance and certain peculiarity. However, from tourist point of view, it would not be interesting to map all the trees. Therefore, the project team decided to identify, describe and geo-reference olive trees that are easily or almost easily approachable (located near the road and trails and visible from the road, since most of the parcels are in the private ownership).

The measurements on the field included manual determination of the canopy half-radius and circum-reference (Figure 13) on 1.3 meters from the ground. This methodology has been proposed by CIHEAM Bari experts.

Half-radius of the 23 canopies ranges between 3.4 to 8.3 meters, while the average value is 5.13m. Circum-reference, measured at 1.3m above the ground, ranges between 3 and 5.6m, while the average value equals to 4.03m.

Location of the each ancient olive tree is presented through its geographic coordinates, determined with GPRS tool (Figure 14). All the data are presented in the following table and available in GIS.

Table 4: Census of the ancient olive trees

| No. | Variety | Latitude | Longitude | Canopy half-radius | Circum-reference at 1.30 m |
|-----|---------------|----------------|----------------|--------------------|----------------------------|
| 1. | <i>Žutica</i> | 42°05'19.646"N | 19°08'19.983"E | 3,4 | 4,6 |
| 2. | <i>Žutica</i> | 42°05'18.907"N | 19°08'20.989"E | 4,5 | 3,7 |
| 3. | <i>Žutica</i> | 42°05'17.469"N | 19°08'19.074"E | 4,35 | 4,55 |
| 4. | <i>Žutica</i> | 42°05'17.041"N | 19°08'18.803"E | 4,9 | 3,56 |
| 5. | <i>Žutica</i> | 42°05'16.129"N | 19°08'19.258"E | 3,75 | 4,26 |
| 6. | <i>Žutica</i> | 42°05'16.472"N | 19°08'20.888"E | 4,8 | 4,65 |
| 7. | <i>Žutica</i> | 42°05'12.165"N | 19°08'33.259"E | 4,7 | 3,93 |
| 8. | <i>Žutica</i> | 42°05'13.143"N | 19°08'33.388"E | 5,1 | 3,75 |
| 9. | <i>Žutica</i> | 42°05'13.511"N | 19°08'25.753"E | 7,15 | 3,95 |
| 10. | <i>Žutica</i> | 42°05'13.455"N | 19°08'25.325"E | 5,8 | 4,76 |
| 11. | <i>Žutica</i> | 42°05'15.182"N | 19°08'20.535"E | 3,9 | 3,7 |
| 12. | <i>Žutica</i> | 42°05'19.383"N | 19°08'16.236"E | 5,27 | 3,05 |
| 13. | <i>Žutica</i> | 42°05'18.999"N | 19°08'16.426"E | 4,6 | 3,4 |
| 14. | <i>Žutica</i> | 42°05'19.207"N | 19°08'15.351"E | 5,2 | 3,2 |
| 15. | <i>Žutica</i> | 42°05'22.437"N | 19°08'15.304"E | 8,3 | 3 |
| 16. | <i>Žutica</i> | 42°05'23.459"N | 19°08'15.346"E | 5,1 | 5,6 |
| 17. | <i>Žutica</i> | 42°05'24.196"N | 19°08'15.954"E | 5,6 | 5,3 |
| 18. | <i>Žutica</i> | 42°05'24.342"N | 19°08'16.701"E | 5,4 | 3,78 |
| 19. | <i>Žutica</i> | 42°05'25.050"N | 19°08'16.833"E | 6 | 3,25 |
| 20. | <i>Žutica</i> | 42°05'25.472"N | 19°08'16.100"E | 4,7 | 4,1 |
| 21. | <i>Žutica</i> | 42°05'25.783"N | 19°08'16.660"E | 4,5 | 4,9 |
| 22. | <i>Žutica</i> | 42°05'26.341"N | 19°08'16.672"E | 6 | 4,1 |
| 23. | <i>Žutica</i> | 42°05'26.739"N | 19°08'16.153"E | 4,5 | 3,45 |

In order to estimate age of the ancient (monumental) olive trees, methodology proposed by *Arnan et al. (2011)* was followed. This research was conducted in north-eastern Spain in order to assess the age of large olive trees considered to be millenarian and classified as monumental. Proposed linear relationship between olive tree diameter and age of the olive trees (in years) is: **Age=2.11 x diameter (cm)+ 88.93.**

The following table includes results of the estimation, following the methodology proposed by Arnan et al. (2011). The average age of the 23 mapped ancient olive trees is 359 years, while the oldest mapped tree is 465 years old. Furthermore, there are more than a thousand years old olive trees in Džidžarin; however these 23 were included in the research according to their potentials for agri-tourism vaporisation.

Table 5: Estimation of the ancient olive trees age and year of plantation

| No. | Circum-reference (m) | Diameter (cm) | Age | Average age | Lower limit | Upper limit | Estimated year of plantation | Lower limit | Upper limit |
|-----|----------------------|---------------|-----|-------------|-------------|-------------|------------------------------|-------------|-------------|
| 1 | 4,6 | 146,4 | 398 | 398 | 342 | 454 | 1622 | 1678 | 1566 |
| 2 | 3,7 | 117,8 | 337 | 337 | 290 | 385 | 1683 | 1730 | 1635 |
| 3 | 4,55 | 144,8 | 395 | 395 | 339 | 450 | 1625 | 1681 | 1570 |
| 4 | 3,56 | 113,3 | 328 | 328 | 282 | 374 | 1692 | 1738 | 1646 |
| 5 | 4,26 | 135,6 | 375 | 375 | 323 | 428 | 1645 | 1697 | 1592 |
| 6 | 4,65 | 148,0 | 401 | 401 | 345 | 457 | 1619 | 1675 | 1563 |
| 7 | 3,93 | 125,1 | 353 | 353 | 303 | 402 | 1667 | 1717 | 1618 |
| 8 | 3,75 | 119,4 | 341 | 341 | 293 | 388 | 1679 | 1727 | 1632 |
| 9 | 3,95 | 125,7 | 354 | 354 | 305 | 404 | 1666 | 1715 | 1616 |

| | | | | | | | | | |
|---------|------|-------|-----|-----|-----|-----|------|------|------|
| 10 | 4,76 | 151,5 | 409 | 409 | 351 | 466 | 1611 | 1669 | 1554 |
| 11 | 3,7 | 117,8 | 337 | 337 | 290 | 385 | 1683 | 1730 | 1635 |
| 12 | 3,05 | 97,1 | 294 | 294 | 253 | 335 | 1726 | 1767 | 1685 |
| 13 | 3,4 | 108,2 | 317 | 317 | 273 | 362 | 1703 | 1747 | 1658 |
| 14 | 3,2 | 101,9 | 304 | 304 | 261 | 346 | 1716 | 1759 | 1674 |
| 15 | 3 | 95,5 | 290 | 290 | 250 | 331 | 1730 | 1770 | 1689 |
| 16 | 5,6 | 178,2 | 465 | 465 | 400 | 530 | 1555 | 1620 | 1490 |
| 17 | 5,3 | 168,7 | 445 | 445 | 383 | 507 | 1575 | 1637 | 1513 |
| 18 | 3,78 | 120,3 | 343 | 343 | 295 | 391 | 1677 | 1725 | 1629 |
| 19 | 3,25 | 103,4 | 307 | 307 | 264 | 350 | 1713 | 1756 | 1670 |
| 20 | 4,1 | 130,5 | 364 | 364 | 313 | 415 | 1656 | 1707 | 1605 |
| 21 | 4,9 | 156,0 | 418 | 418 | 359 | 477 | 1602 | 1661 | 1543 |
| 22 | 4,1 | 130,5 | 364 | 364 | 313 | 415 | 1656 | 1707 | 1605 |
| 23 | 3,45 | 109,8 | 321 | 321 | 276 | 366 | 1699 | 1744 | 1654 |
| AVERAGE | | | | 359 | 309 | 409 | 1661 | 1711 | 1611 |
| MAX | | | | 465 | 400 | 530 | 1730 | 1770 | 1689 |
| MIN | | | | 290 | 250 | 331 | 1555 | 1620 | 1490 |

The following maps show ancient olive trees in *Džidžarin* that have high agri-tourism potential and should be included in tourist offer of the area. Blue, orange and red colours show different canopy radius, while the transparent, grey and black tetragons represent various circum-references.

It is advisable to create informative boards for each of the ancient olive tree selected within this research. Therefore, each table should contain the exact coordinates and variety of the olive tree, position on the map, estimation of the age and other relevant information.

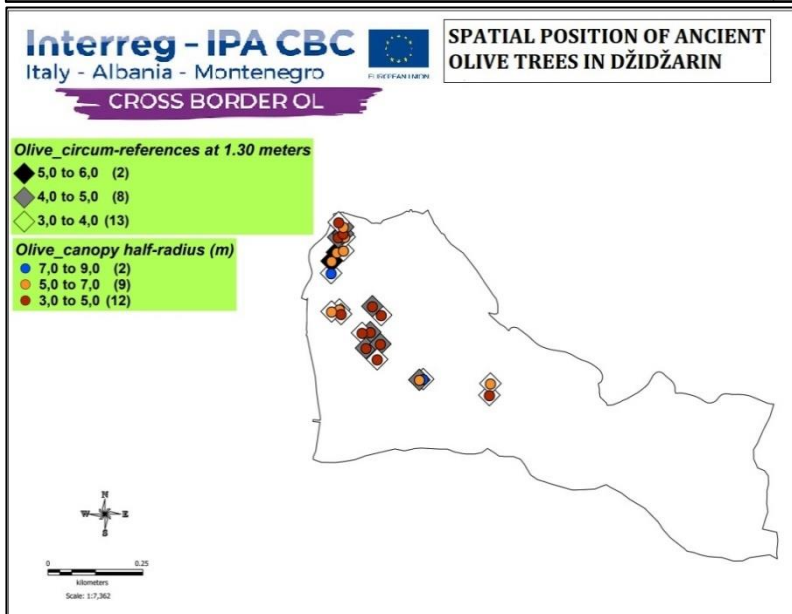
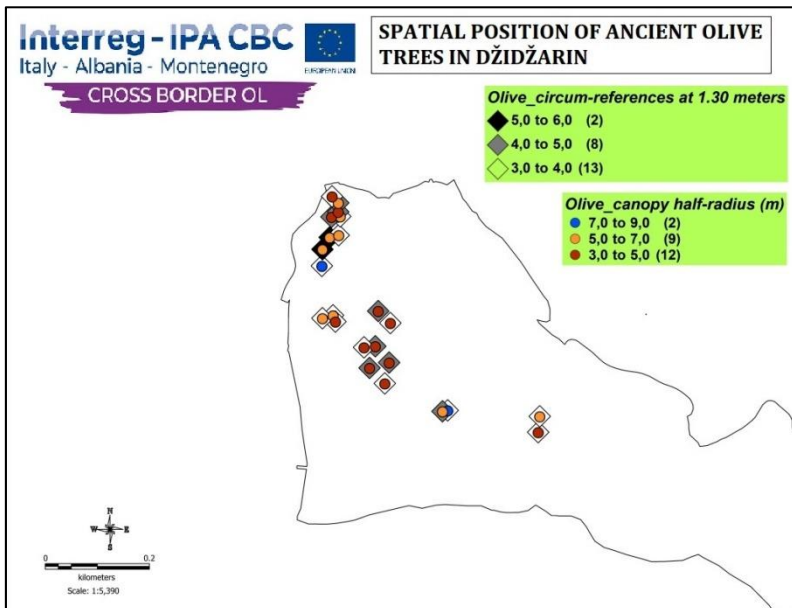


Figure 12: Spatial position of ancient olive trees in Džidžarin



Figure 14: Determination of the trunk circum-reference



Figure 13



Figure 15: Georeferenced ancient olive trees 1-9

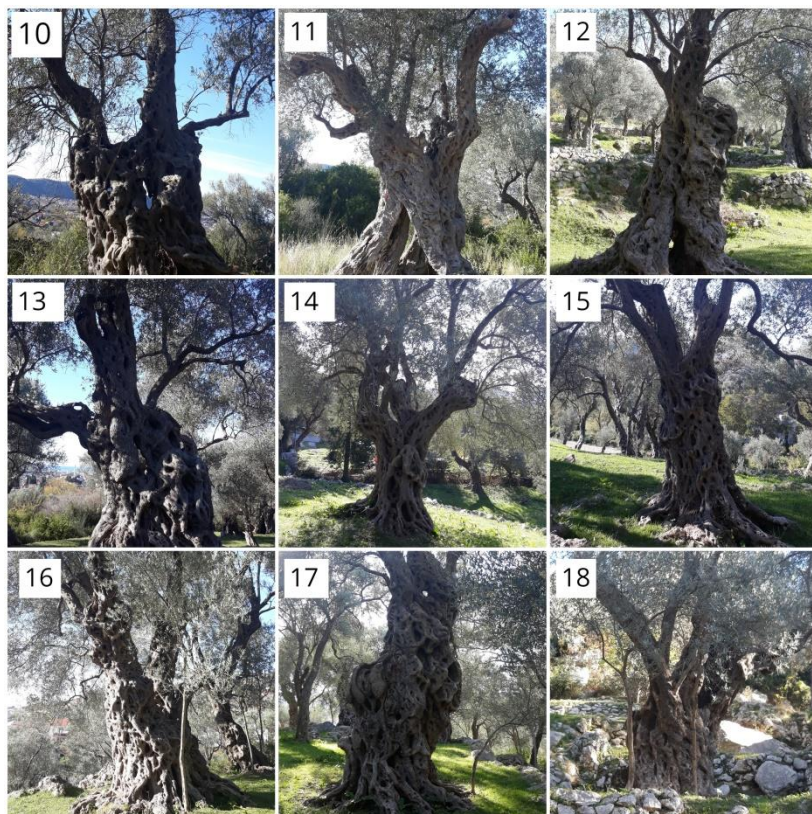


Figure 16: Georeferenced ancient olive trees 10-19

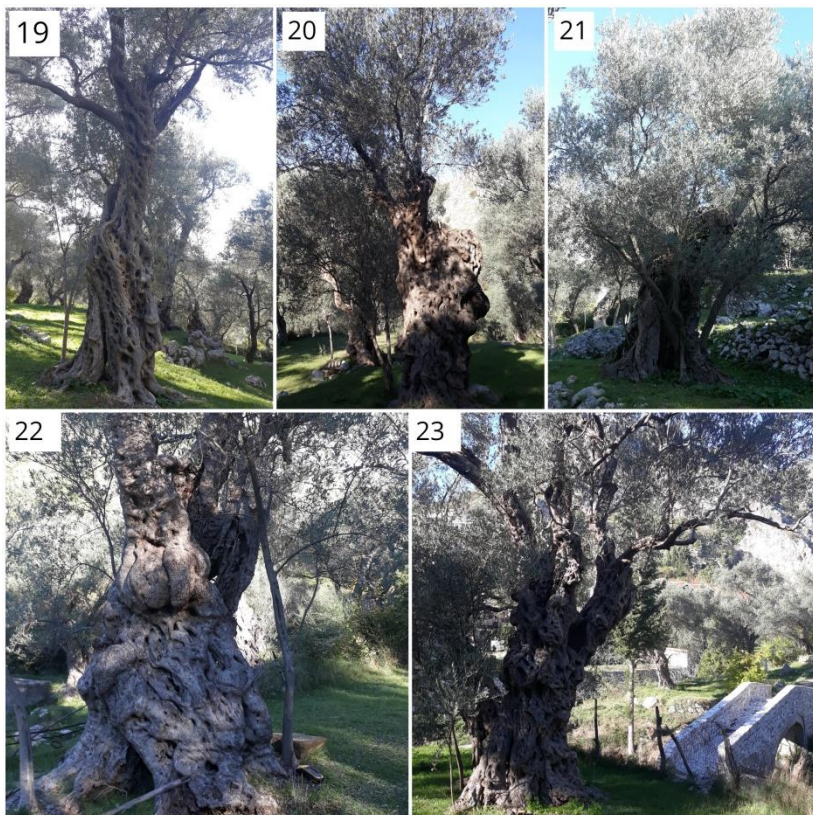


Figure 17: Georeferenced ancient olive trees 19-23

Census of the cultural-historical objects

VII

In order to develop sustainable tourism that relies on the local agricultural products and crafts, it is important to include historical sites situated in the surrounding area into tourist offer. These assets “add story to the place” and expand the possibilities for development of the landscape.

Overview of the most important cultural assets is presented in the following map and available in GIS for further upgrade.

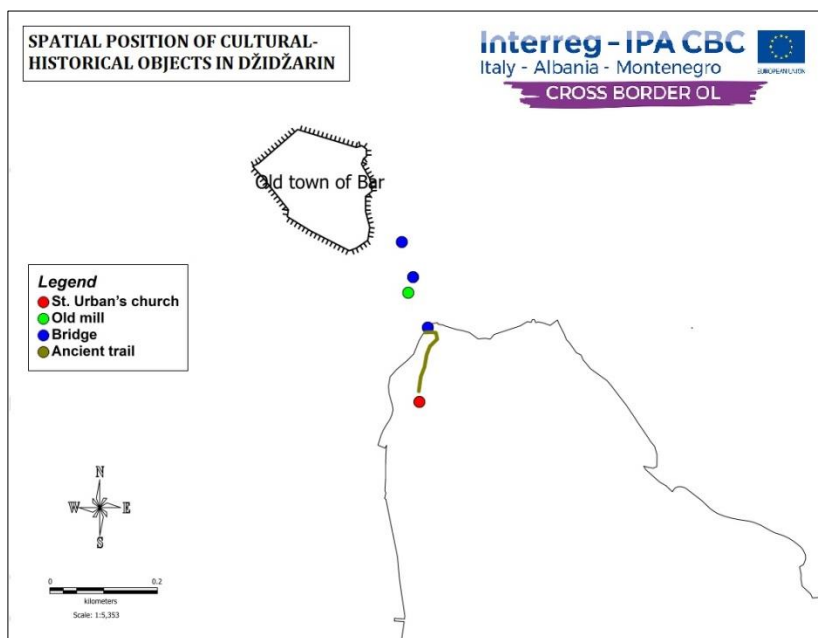


Figure 18: Spatial position of cultural-historical objects in Džidžarin

ANCIENT BRIDGES

There are four bridges in the project area. Those are stone arch footbridges. Their most severe devastation was recorded in April 1979, when tremendous earthquake occurred.

The oldest and the most authentic bridge is the most upstream one, situated nearby the remains of the olive mill. However, this part of the area should not be included in regular tours (only for adventurers). Also, the secret cave passage is situated nearby. These assets have high potential for valorisation; however, adaptation and conservation projects should be implemented.



Figure 19: Part of the area that should be valorized in the future

One of the bridges is located next to the water source “Kajnak” and it is not accessible to tourists and local visitors.

The ancient stone bridge situated next to the mill is the most attractive from the tourist point of view. It is part of the hiking trail and relates Kajnak with Džidžarin olive orchard. Standing on this bridge, tourists can enjoy the river canyon, grandiose hills and mountains, stone walls of the Old town, the olive groves and mills as well as the other cultural treasures and natural pearls of the area.



Figure 20: The bridges situated next to the water source “Kajnak” and Old mill – Hostel “The grove”

The most downstream bridge is the smallest, but the most interesting as well. According to the documentation obtained by the relevant institutions, this bridge was built in 1886, during the period of Ottoman occupation. It was renovated in 2017, as a result of fruitful collaboration between the Association of olive growers of Bar and Tourist organisation of Bar.



Figure 21: Recently renovated ancient bridge in Džidžarin

OLIVE MILLS

Due to the suitable environmental aspects of the area, traditional olive growing and olive processing has always been an ingrained agronomic practice in the project area. Back in 1932, four oil mills were situated in this area, well-known for the production of high-quality extra virgin oil. The most representative symbol of that time is the facility of Old mill of Duke Mašo Vrbica (1833-1989), adapted to a hostel ("The Grove"). Furthermore, this area preserves a memory to Marić brothers, owners of the first and only olive oil refinery in Montenegro.



Figure 22: Old mill of Duke Mašo Vrbica - Hostel "The Grove"



RELIGIOUS OBJECTS

During the infrastructure work through the olive complex in 2016 and 2017, the remains of the old church were found. Remains of the foundation of this middle-aged church have been found in the form of stone structures which are circa 20 cm high. This archaeological finding was identified as the remains of the catholic church of Saint Urban from the XIII century. Conservation activities were performed by the local archaeologist, according to the supervision of The National Administration for the Protection of Cultural Properties and Roman Catholic Archdiocese of Bar.



Figure 23: Conserved remains of St Urban's Church

Very important religious aspects of the area are olive trees in the ownership of Islamic community ("Vakuuf"), marked with the red letter V.

SKIN TANNERY

Nearby the secret cave passage, there are remains of the skin tannery. Skin tanneries were built as simple stone structures and used for treating animal skins in order to produce leather. The animal skins were degreased, desalted and soaked into water. After that, an acidic compound (tannin) was used in order to gain the final shine. It is important to include this easily approachable spot into tour guiding, since it reveals great commercial character of the people that used to live here.



Figure 24: Remains of the skin tannery in the foothill of Old City of Bar

TERRACES AND DRY STONE WALLS

Due to the complexity of the terrain, olive growers used to build terraces and dry stone walls in order to combat soil erosion processes. The most common terraces are elongated; however, there are moon-shaped terraces in the groves as well. It is recommended to repair all the terraces within the grove that are not in good condition, but to preserve their initial appearance. Also, technique of making dry stone walls should be promoted as a typical Mediterranean practice that must not be forgotten.



Figure 25: Repaired and collapsed stone walls

FOUNTAINS

Additional cultural-historical asset of the area are the fountains from Roman and Ottoman period. Unfortunately, both fountains are not in function and their repair should be taken into consideration.



Figure 26: Old fountains in *Džidžarin* from Roman and Ottoman period

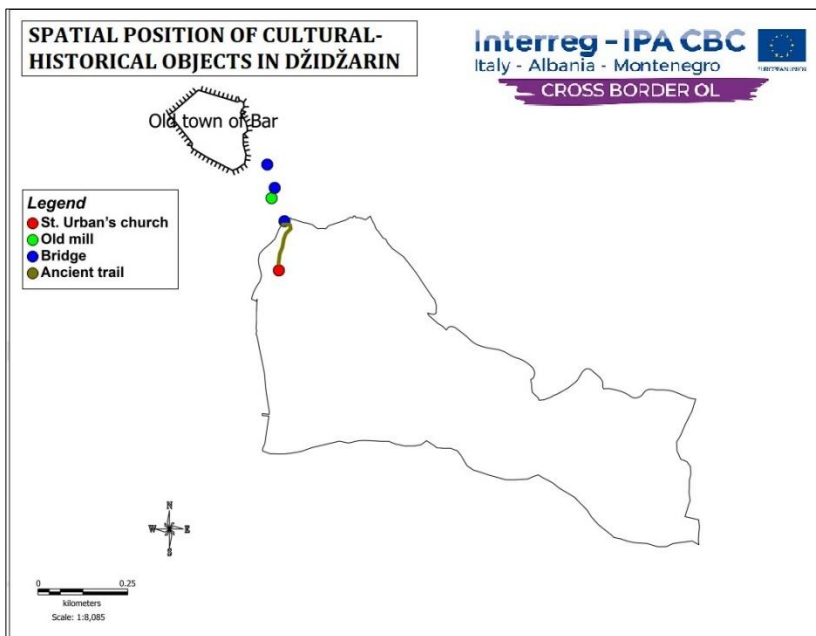


Figure 27: Spatial position of cultural-historical objects in Džidžarin (full view)

The most important road in this area is the ancient, narrow walking trail that leads to the villages situated in the slopes of Rumija Mountain (Menke and Mikulići). This old macadam road had an important commercial character throughout the history. Nowadays, it is one of the most attractive walking trails at the territory of Bar municipality.

The following figure, Figure 28, shows a road map. Public roads are classified as passable (dark red) and impassable (light green). At the middle of the passable public road with the parcel, an attractive viewpoint is located. Also, one of the main roads through Džidžarin that leads to the higher altitudes is private. There are also walking and hiking trails, previously mentioned.

All these features stand out *Džidžarin* region as undiscovered natural pearl of our part of the coast, with huge tourist, ecological and sustainable potential, recognized by local visitors and various categories of tourists.

Figure 29 represents the final GIS map composed of the three combined layers:

- Spatial position of mapped ancient olive trees
- Spatial position of cultural-historical assets
- Spatial position of roads and trails

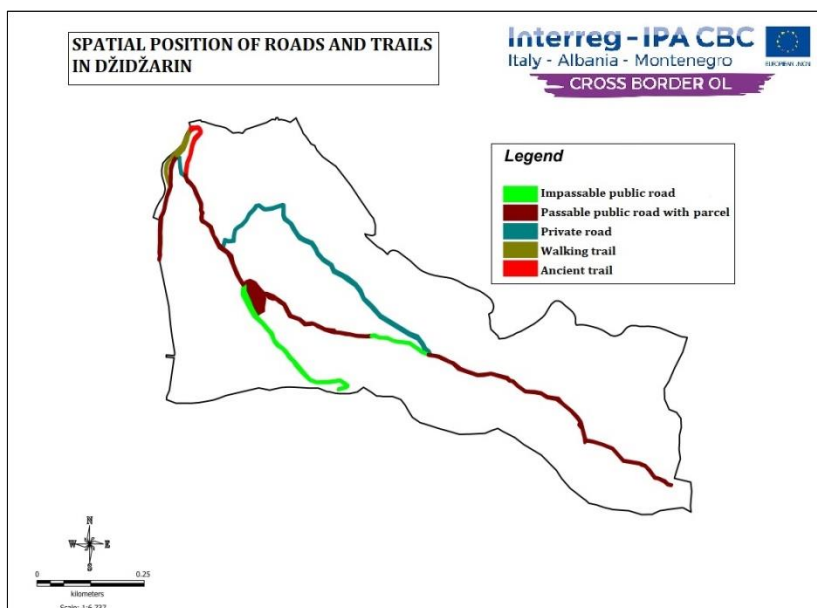


Figure 28: Spatial position of roads and trails in Džidžarin

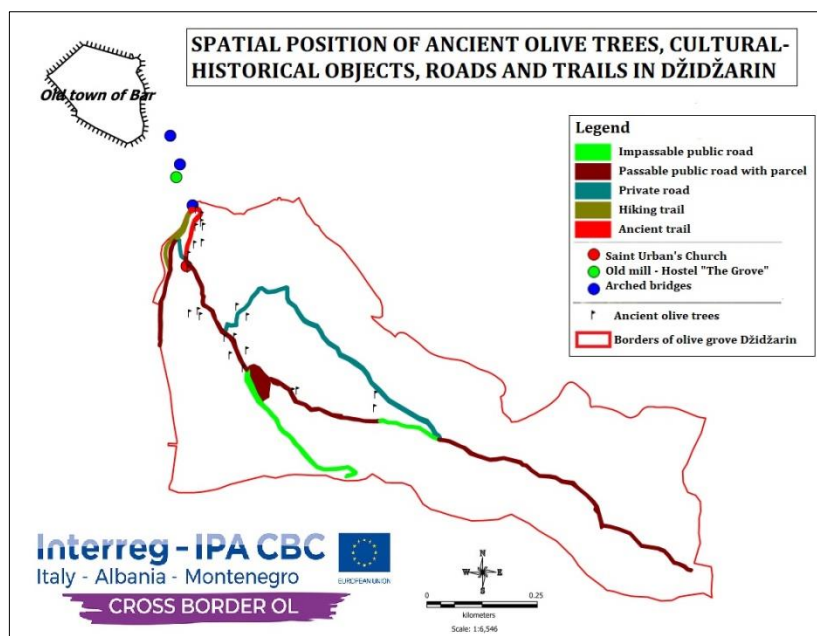


Figure 29: Spatial position of ancient olive trees, cultural-historical objects, roads and trails in Džidžarin

Džidžarin olive orchard has one of the greatest potentials for the development of local agri-tourism in the south of Montenegro, given its magnificent landscapes and numerous cultural assets of great historical importance.

Immeasurable agronomic, tourist and cultural treasures of the area reveal the importance of further valorisation of this area, inseparable part of the sustainable tourism offer of Bar.

Identification of the most attractive ancient olive trees, estimation of their age, climate and soil research, survey of the farmers, collection of the best agronomic practices in the area, production of maps in GIS, recommendations for further valorisation of the area etc. are some of the activities implemented within this comprehensive research.

Collection of the data in this report, together with compiled photo collages and maps should be used in further implementation for development of local plans of development and community maps. All the maps are also available in GIS, ready for further upgrade.

In order to develop sustainable tourism in this area, certain weaknesses should be overcome: eliminate landfill, repair fountains, set labels and guideposts, include local

crafts and souvenir offer, remove bushes and clean the roads etc.

“CROSS BORDER OL” project will certainly create a new tourist route in order to make the area more approachable and interesting for both local visitors and tourists. Furthermore, this project produced valuable input data that remain available for further upgrade and various analyses.

Annex 1 – LECRCM and Informative boards

In accordance of recommendations in chapter VII - Census of the ancient olives, (page 26), Project Management Team of Municipality of Bar created informative boards for each of the ancient olive tree selected within this research. Each table contains the exact coordinates and variety of the olive tree, position on the map, estimation of the age and estimated year of plantation.

Ancient olive trees are numerated also on LECRCM:







| 19 | 20 | 21 |
|---|--|--|
|  |  |  |
| 22 | 23 | |
|  |  | |

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