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EVALUATION OF THE EFFECTS OF VARIOUS FACTORS ON ABOVEGROUND AND BELOWGROUND BIOMASS STORAGE CAPACITY OF EASTERN MEDITERRANEAN MAQUIS VEGETATION

PROCJENA UČINKA RAZLIČITIH ČIMBENIKA NA KAPACITET ZA SKLADIŠTENJE NADZEMNE I PODZEMNE BIOMASE ISTOČNOMEDITERANSKE VEGETACIJE MAKIJE

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Summary

This study was carried out on the data obtained from 35 plot areas selected among the vertical distribution regions of maquis in study area located in Eastern Mediterranean region. The data were grouped in terms of altitude, dominant exposure, vegetation height, and mean age factors, and it is tried to reveal the change of maquis biomass depending on these factors. The data obtained shown significant variation and, for this reason, the mass values are expressed as mean values. The potential relationship between the mentioned factors and the amounts of stored biomass was examined by using t-test and variation analysis. The mean aboveground biomass amount was found to be 24,183 ton/ha, while mean belowground biomass that doesn't contain fine root was found to be 41,062 ton/ha. According to these results obtained from mean values, the root/shoot ratio was calculated to be 1.7.

KEY WORDS: Biomass, maquis, root/shoot ratio, altitude, exposure

INTRODUCTION
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Maquis is a concept that has entered into vegetation science from the word „maquis" in Corsican language. The „shrubs, which are generally always-green and dominated by hard-leaved species, that are 2-5m in length in Mediterranean Basin" are named maquis (Özalp 2000). Scrub populations called maquis have significant role in agro-silvo-pastoral systems having limited water potential, and they have also potential to reduce the effects of climate change by acting as a carbon pool because of their high portion within the vegetation in places, where they spread over (Ruiz-Peinado et al. 2013). Besides being a carbon sink and containing high-level of biodiversity within their structures, maquis populations also serve for many traditional purposes such as providing feed in animal husbandry, firewood, and hunting (Nair et al. 2009, Canteiro et al. 2011, Varol and Ertugrul 2015).

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Maquis-like scrub populations covering significant portion on earth spread over locations, where the climate conditions like Mediterranean climate are dominant. These regions, where the precipitation restrains the plant development, are climatic stress regions, and are located between the semi-arid regions of tropics and deserts and the temperate zone. The debates on defining, classifying, and utilization of the vegetation type covering these large areas still continue (Özalp 2000).

The maquis regions are seen in Turkey's regions, where the Mediterranean climate is dominant. In a study of Uslu (1985), it has been reported that there are maquis regions larger than 1 million ha in Aegean and Mediterranean regions. But, there is no sufficient information about the total area that they cover and the characteristics of maquis populations in different regions. In order for maquis vegetation to take its place in ecosystem management plans, and in order to establish the conditions and methods for sustainable and optimum use of maquis populations, it is required to reveal their economic, ecologic, and biologic values. But, the number of scientific studies on this topic in Turkey is very limited.

Besides understanding the carbon storage and carbon cycle among the global benefits, the data regarding the woody biomass are necessary for many purposes such as determining the productivity of vegetation, management of bioenergy sources, and estimating the flammable materials in forest fires (De-Miguel et al. 2014). Measuring the carbon is also an obligation because of the undertakings of United Nations Framework Convention on Climate Change (UNFCCC) and the obligations originating from Kyoto Protocol (Brown 2002). The UNFCCC obliges all the participant parties for preparing, publishing, and regularly updating the national inventories about gas emissions having greenhouse effect and removals from land use change and forestry by using comparable methods (Houghton et al. 1997, Joosten et al 2004). Although it is possible to determine the aboveground biomass through remote sensing methods (Arıcak et al, 2015), forest inventory data is considered as important resource since they offer more accurate C and biomass data via local measurements and they also better represent the regional heterogeneity (Birdsey, 1992; Brown and Schroeder, 1999). On the other hand; estimating the amount of carbon stored in growing trees and harvested wood is also important, because carbon is becoming a valued product on the global market (McKinley et al. 2011).

As specified in 25th article of Kyoto Protocol, Turkey has become a party on 26th of August, 2009. Throughout the processes of both of mentioned protocol and REDD +(Reducing emissions from deforestation and forest degradation in developing countries; and the role of forest conservation enhancement of forest carbon stocks in developing countries), it is required to accurately determine the forest carbon stocks (UNFCCC 2012). Hence, there is a necessity regarding the studies on determining the biomass and carbon amounts stored in maquis.

The aim of our study is to determine the aboveground and belowground biomass storage capacities of maquis spreading over Eastern Mediterranean region and to reveal the change in amount of biomass stored depending on certain vegetation and habitat conditions. Thus, it was aimed to understand the biomass of maquis populations and to provide useful data.

MATERIAL AND METHOD
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Study area – *Područje istraživanja*

This study was carried out on the data obtained from 35 plot areas located within the borders of Çamalan Forest Sub-District Directorate in Tarsus Forestry Department of Mersin Regional Forest Directorate in eastern region of Mediterranean basin. Çamalan Forest Sub-District Directorate is located between 34° 59' 09" – 34° 40' 10" E and 37° 01' 53" – 37° 25' 32" N.

Climate data – *Podaci o klimi*

Study area is located within a typical Mediterranean climate region. Annual mean temperature was 16.2 °C. The lowest mean temperature in vegetation season was 13.8 °C in April, while the highest mean temperature was 33 °C in July, and the mean temperature was 19.1 °C. Annual mean precipitation level was 525 mm, and majority of this amount was received in vegetation season. Mean relative humidity was 60%.

Experimental data – statistical evaluation – *Podaci o eksperimentu – Statistička procjena*

At the beginning of this study, the natural factors that have potential to affect the biomass storage capacity of maquis vegetation were determined, and the study was designed in this parallel. These factors were divided into 4 groups, and then the subgroups were established. The sampling procedure was executed in the way covering these groups and subgroups, and the data were clustered in this parallel. The groups and sub-groups established are listed below:

1. Exposure: Sunny exposure, shadowy exposure;
2. Altitude:
   400–600, 601–800, 801–1.000, 1.001–1.200 m;
3. Mean height of vegetation:
   up to 1.5 m, 1.51–2 m, 2.1–2.5 m and 2.51-3 m;
4. Mean age: 10-20, 21-30, 31-40 and 41-50 years.

In determining the plot areas, in order to ensure the standard firstly, the regions, where the maquis flora covers 70%

or more, were selected. In order to reduce the slope-related errors, the study was started on the lands with 5-10% slope, and the study areas were distributed in accordance with the aim of this study (in dimensions of 10m x 10m) to various altitude, exposure and vegetation height levels. Since the factor of slope is not a factor that affects the biomass storage capacity of maquis vegetation, it wasn't involved in experimental design. In studies on sloping lands, it is required to determine a correction factor and recalculate the edge lengths in order to accurately find the limits of sample plots. In order to prevent the error possibility and time loss that these calculations for each of 4 edges would lead, the sampling procedure was executed on the lands having up to 10% slope. By examining the actual statuses of the lands, firstly the alive, healthy and robust individual populations were considered.

In order to determine the aboveground biomass, all of the individuals within the each plot area were clear-cut at the closest point to the soil level and the branches were weighed. Besides that, the stem sections were taken from 3-5 individuals at the closest point to the soil level in order to determine the age.

In order to determine the belowground biomass, the distribution of individuals within the plot areas; in every sampling point, a 2mx2m section was dug down to the bedrock, and then the roots were taken out and weighed. Fine root (thinner than 2 mm) sampling was not performed, and they were excluded from assessment.

Samples were taken from every component. Wood samples were peeled from barks, and fresh wood and bark weights were measured. In order to determine the weight of leaves, the sample branches were taken and, by separating the leaves, the weights of leaves and branches were measured, and then compared in order to estimate the ratio. And then, the samples were taken to the laboratory and completely dried at 65±3°C temperature and their dry weights were found. Using fresh/dry weight ratios, the fresh weight values were translated into dry weight values. Although the most widely accepted method for determining the moisture content of wood is to dry in an oven at 105°C, the removal of volatile content at this temperature may lead to errors in estimating the moisture content (Rodriguez et.al. 1998, Granstrom 2003). Plant biologists generally dry the leaves and fruits at 60-70 °C, because high temperatures cause decreases in organic compounds (Westerman, 1990). Cornelissen et al. (2003) have recommended drying the herbaceous stems at 60 °C for 72 hours or at s 80 °C for 48-72 hours, and extended this recommendation to woody stems. Since maquis societies consists of high-level of leaves and thin material, the temperature of drying was set to 65°C in order to prevent any failures due to high temperature.

The analyses of data were performed in accordance with the design of study. While designing, in order to reveal the maquis' biomass, 4 groups of samples, which were believed to have effect on the biomass, were established, and then they were divided into sub-groups. And then, by using t-test and variance analysis, it was examined if there are differences between these sub-groups.

RESULTS
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Firstly, the variation of among the altitude steps of study area, where the maquis spreads, and the ratio of participation into composition were determined. It was observed that there were significant difference between the species and the ratio of participation into composition of the components constituting the maquis as the altitude changed. While *Quercus coccifera* L. individuals were observed at all the altitudes between 488m and 1115m, *Quercus coccifera* L.'s ratio of participation into composition increased as the altitude increased, and it became a maquis population consisting of a single species at the highest altitude level. Moreover, in and around every plot area, the *Juniperus drupacea* (Labill.) individuals were separately observed. While *Phillyrea latifolia* L. species was found to be the species that was most frequently observed up to 1000m altitude, it was replaced by *Quercus coccifera* L. at higher altitudes. In Table 1, the change of species can be seen in 250m of altitude intervals.

Although the maquis vegetation varies between 0m and 1250m altitudes throughout the study area, the populations, where the sampling could be performed, were found at 488-1155m of altitudes. 35 sample plots taken among those altitudes were divided into 4 sub-groups, 200m each, and the amounts of biomass they stored are presented in Table 2 in mean values.

As a result of the evaluation by considering the biomass storage capacities of the groups, the most significant difference was observed in root wood and root bark. While the portion of aboveground biomass is higher between 400m and 600m altitudes, belowground biomass was observed to be higher than aboveground biomass in all the resting sub-groups. While no altitude-related difference was observed in maquis populations constituting the aboveground biomass,

Table 1. Change in species with 250m altitude interval
Tablica 1. Promjena vrste s obzirom na interval od 250 m nadmorske visine

Altitude (m) / Visina (m)	
1001–1250	*Quercus coccifera* L.
751–1000	*Phillyrea latifolia* L., *Quercus coccifera* L., *Laurus nobilis* L., *Juniperus oxycedrus* L
501–750	*Phillyrea latifolia* L., *Quercus coccifera* L., *Laurus nobilis* L., *Paliurus spina-christii* Mill.
251–500	*Phillyrea latifolia* L., *Quercus coccifera* L., *Styrax officinalis* L., *Myrtus communis* L.
0–250	*Phillyrea latifolia* L., *Myrtus communis* L., *Quercus coccifera* L.

Table 2. Mean oven-dried biomass by altitudes (ton/ha)
Tablica 2. Prosječna apsolutno suha biomasa (tona / ha)

Altitude (m) / Visina (m)	Stem wood / Drvo debla	Stem bark / Kora debla	Foliage / Lišće	Root / Korijenje	Root bark / Kora korijena	Total / Ukupno
400–600	19.15	3.69	6.52	15.56	4.86	49.79
601–800	14.11	3.43	3.20	34.21	10.93	65.90
801–1000	17.09	4.80	3.79	29.35	9.24	64.29
1001–1200	14.37	3.33	2.50	49.79	17.30	87.30

a significant increase was observed in belowground biomass of maquis populations between 1001m and 1200 m.

The factor „exposure" was taken into consideration, and the exposures were divided into sunny and shadowy exposures (northwestern, northern, northeastern, and eastern exposures were shadowy ones, while others were sunny exposures) groups, and the differences and similarities were examined. 24 maquis sampling areas were clustered in sunny exposure group, while 11 areas were clustered in shadowy exposure group. In Table 3, the amounts of biomass were presented in relation with the exposure.

As seen in table and graph, given the mean values, it can be easily seen that the biomass capacity of sunny exposures were higher than that of shadowy exposures. The difference reached at 7.32 ton/ha in total.

The mean vegetation height values measured in sampling areas were divided into 4 sub-groups. The mean vegetation height was cascaded from 1.5m with 50cm interval. The sampling areas, where the mean height was lower than 1.5m, were not cascaded since the vegetation heights there were too close to1.5m. There are 4 areas in 0-1.5m range, 11 areas in 1.51-2m range, 8 areas in 2.1-2.5 m range, and 12 areas in 2.51-3 m range. Biomass storage capacities of sub-groups are presented in Table 4 in relation with maquis components.

The total mean value was found to be 50.13 ton/ha in 0-1.5 m sub-group, 58.50 ton/ha in 1.51-2m sub-group, 69.98 ton/ha in 2.01-2.50m sub-group and 74.95 ton/ha 2.51-3m sub-group. The maquis component having the highest value in total was found to be root amount. It can be concluded that the total mean biomass amount linearly increases as the length of maquis components increases.

3-5 individuals cut at the ground level on the plot areas were utilized in order to determine the ages. From these ages, the arithmetic mean value of the ages was calculated for each of the areas. From the aspect of mean age, the maquis areas were clustered under 4 groups as 10-20, 21-30, 31-40 and 41-50 ages, and the aboveground and belowground biomass amounts and changes were examined. There were 7 plots in 10-20 age group, 5 plots in 21-30 age group, 11 plots in 31-40 age group, and 12 plots in 41-50 age group. Arithmetic mean biomass amounts of sampling areas are presented in Table 5.

As seen in Table 5, the evaluations based on the mean age indicated that no sufficiently accurate relationship could be established between the mean vegetation age and biomass.

In order to reveal the maquis biomass, 4 groups that are thought to have effect on biomass were established, and those groups were divided into sub-groups. Then, it has

Table 3. Mean oven-dried biomass amounts by the exposures
Tablica 3. Srednja apsolutno suha količina biomase prema izloženosti

Mean oven-dried biomass amounts by the exposures (ton/ha) / Srednja apsolutno suha količina biomase prema izloženosti (tona/ha)						
Exposure / Izloženost	Stem wood / Drvo debla	Stem bark / Kora debla	Foliage / Lišće	Root / Korjenje	Root bark / Kora korijena	Total / Ukupno
Sunny / sunce	16.58	4.63	3.81	32.23	10.28	67.54
Shadowy / sjena	15.368	3.46	3.49	28.70	9.18	60.22

Table 4. Mean biomass amounts by the vegetation height levels (ton/ha)
Tablica 4. Prosječne količine biomase prema visini vegetacije (tona / ha)

Height (m) / Visina (m)	Stem wood / Drvo debla	Stem bark / Kora debla	Foliage / Lišće	Root / Korjenje	Root bark / Kora korijena	Total / Ukupno
0–1.5	12.98	3.68	3.55	22.74	7.17	50.13
1.51–2	11.69	2.74	3.36	31.01	9.68	58.50
2.1–2.5	19.72	5.30	3.63	30.47	10.84	69.98
2.51–3	18.72	5.11	4.37	36.43	10.31	74.95

Table 5. Oven-dried maquis biomass by the age factor (ton/ha)
Tablica 5. Apsolutno suha biomasa makije prema faktoru starosti (tona / ha)

Age(years) / Starost (godine)	Stem wood / Drvo debla	Stem bark / Kora debla	Foliage / Lišće	Root / Korjenje	Root bark / Kora korijena	Total / Ukupno
10–20	12.00	2.44	3.75	34.09	10.19	62.49
21–30	12.16	2.69	2.92	24.45	6.70	48.96
31–40	17.90	4.97	3.53	36.85	11.99	75.25
41–50	18.77	5.34	4.17	26.90	9.25	64.45

been examined, by using t-test in exposure and variance analysis, if there is any difference between these sub-groups.

t-test results for exposure factor are presented in Table 6. As it can be seen, since the Sig. (p) values of t-test were $p>0.05$, H_0 hypothesis is accepted. In other words, „there is no statistically significant difference between 2 different exposure groups and aboveground, belowground, and total amount of biomass."

The plot areas having different altitudes were clustered into 4 groups as 400-600m, 601-800m, 801-1000m and 1001-1200m. The similarities and differences between altitude groups and aboveground, belowground, and total biomass were examined by using independent sample one-way variance analysis (ANOVA). Since the significance value (Sig. p) of the table presenting the results obtained from analyses was higher than 0.05, it was concluded that there was no statistically significant difference between altitude level and mentioned variables (Table 7).

The similarities and differences between the subgroups created based on mean vegetation height and the aboveground, belowground, and total biomass were examined by using independent sample one-way variance analysis (ANOVA). Since the significance value (Sig. p) of the table presenting the results obtained from analyses was higher than 0.05, it was concluded that there was no statistically significant difference between top height and relevant variables (Table 8).

By calculating the mean ages from the stem sections of maquis components cut at the ground level in sampling areas, 4 groups (10-20, 21-30, 31-40 and 41-50 ages) were established. Since the significance value (Sig. p) of the table presenting the results obtained from analyses was higher than 0.05, it was concluded that there was no statistically significant difference between age groups and mentioned variables (Table 9).

Table 6. t-test (Independent Samples Test) results for exposure factor
Tablica 6. Rezultati t-testa (test za nezavisne uzorke) za faktor izloženosti

Variable / Varijabla	Variance distribution / Distribucija varijance	Levene's Test for Variance Equality / Levenov test za homogenost varijance		t-test for Variance Equality / t-test za homogenost varijance
		F	Sig.	t
Aboveground / Nadzemna	Equal variance distribution / Jednolika distribucija varijance	2.015	0.165	0.687
	Non-equal variance distribution / Nejednolika distribucija varijance			0.744
Belowground / Podzemna	Equal variance distribution / Jednolika distribucija varijance	0.566	0.457	0.681
	Non-equal variance distribution / Nejednolika distribucija varijance			0.761
Total / Ukupno	Equal variance distribution / Jednolika distribucija varijance	2.082	0.158	0.926
	Non-equal variance distribution / Nejednolika distribucija varijance			1.050

Table 7. ANOVA results for altitude groups
Tablica 7. Rezultati programa ANOVA za skupne prema visini

Variable / Varijabla	Source of Variance / Izvor varijance	(Sum of Squares) / (Zbroj kvadrata)	(df)	(Mean Square) / (Prosječna vrijednost kvadrata)	F	p
Aboveground / Nadzemna	Intergroup / Međugrupni	250.533	3	83.511	0.707	0.555
	Intragroup / Unutargrupni	3659.922	31	118.062		
	Total / Ukupno	3910.455	34			
Belowground / Podzemna	Intergroup / Međugrupni	2501.036	3	833.679	2.826	0.055
	Intragroup / Unutargrupni	9144.901	31	294.997		
	Total / Ukupno	11645.937	34			
Total / Ukupno	Intergroup / Međugrupni	1474.298	3	491.433	1.050	0.385
	Intragroup / Unutargrupni	14515.311	31	468.236		
	Total / Ukupno	15989.609	34			

Table 8. ANOVA results for mean vegetation heights
Tablica 8. Rezultati programa ANOVA za prosječne visine vegetacije

Variable / Varijabla	Source of Variance / Izvor varijance	(Sum of Squares) / (Zbroj kvadrata)	(df)	(Mean Square) / (Prosječna vrijednost kvadrata)	F	p
Aboveground / Nadzemna	Intergroup / Međugrupni	881.746	3	293.915	3.008	0.045
	Intragroup / Unutargrupni	3028.710	31	97.700		
	Total / Ukupno	3910.455	34			
Belowground / Podzemna	Intergroup / Međugrupni	757.866	3	252.622	0.719	0.548
	Intragroup / Unutargrupni	10888.071	31	351.228		
	Total / Ukupno	11645.937	34			
Total / Ukupno	Intergroup / Međugrupni	2438.448	3	812.816	1.859	0.157
	Intragroup / Unutargrupni	13551.161	31	437.134	3.008	0.045
	Total / Ukupno	15989.609	34			

Table 9. ANOVA results for mean vegetation age
Tablica 9. Rezultati programa ANOVA za prosječnu starost vegetacije

Variable / Varijabla	Source of Variance / Izvor varijance	(Sum of Squares) / (Zbroj kvadrata)	(df)	(Mean Square) / (Prosječna vrijednost kvadrata)	F	p
Aboveground / Nadzemna	Intergroup / Međugrupni	711.364	3	237.121	2.298	0.097
	Intragroup / Unutargrupni	3199.091	31	103.196		
	Total / Ukupno	3910.455	34			
Belowground / Podzemna	Intergroup	1516.496	3	505.499	1.547	0.222
	Intragroup	10129.442	31	326.756		
	Total / Ukupno	11645.937	34			
Total / Ukupno	Intergroup / Međugrupni	2489.087	3	829.696	1.905	0.149
	Intragroup / Unutargrupni	13500.522	31	435.501		
	Total / Ukupno	15989.609	34			

DISCUSSION
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In this study, which was carried out in order to determine the aboveground and belowground biomass amounts of maquis lands within the borders of Çamalan Forest Sub-District Directorate in Tarsus Forestry Department of Mersin Regional Forest Directorate in eastern region of Mediterranean basin, the evaluations were performed based on the data obtained from 35 sampling areas in terms of the factors of altitude, exposure, mean vegetation height, and mean age. Moreover, it was also statistically examined if there is a relation between stored biomass and relevant factors. As it can be seen in results and graphs presented in „Findings" section, maquis biomass values have a very wide variation and no high-grade statistically significant relationship can be established between the maquis biomass values.

According to the data obtained in our study, the mean aboveground biomass amount was found to be 24,183 ton/ha. Moreover, it was determined that the belowground biomass contains approximately 41,062 ton/ha of root. Of the total fresh biomass amount, approximately 63.98% consists of dry matter. This value is higher than that of Taurus cedar (0.51) and Calabrian pine (0.61) sharing the same habitat (Durkaya et al, 2013, Durkaya et al., 2015). McPherson et al. (1994), by reviewing the literature, have found it appropriate to converse the fresh biomass into dry biomass by multiplying with 0.56 for broadleaved species and with 0.48 for coniferous species. As it can be seen, the maquis components conversion coefficient is also higher than 7.98%, which has been projected for the broadleaved species.

In accordance with the obtained results, the root/shoot ratio was found to be 1.7. The interesting point here is the redundancy of belowground biomass amount. As well as this situation can be explained with the harmony with habitat having low humidity, it can also be correlated with the use of aboveground portion for purposes of feeding animals and using as energy source by humans.

While the mean aboveground biomass in maquis scrubland dominated by *Quercus coccifera* was found to be 20.21 ton/ha in our study, Sağlam et al. (2008) have determined the total flammable matter biomass in maquis population in Aegean region, where *Quercus coccifera* L., the dominant species, have mean vegetation height of 0.53-1.30 m, to vary between 7 and 67.4 ton/ha. Canadel and Roda (1991) have found the aboveground and belowground biomass of *Quercus ilex* populations to be 160 ton/ha and 63 ton/ha, respectively. It can be seen that there are significant differences between the biomass amounts of not only the different maquis populations but also the similar maquis populations. These differences can be attributed to the genetic factors, crown closure, the species in composition and their portions, habitat conditions, and human interventions.

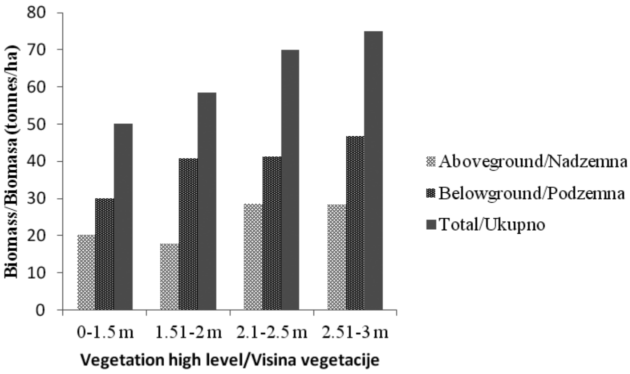

Figure 1. Mean biomass amounts by the vegetation height levels
Slika 1. Srednje količine biomase prema visini vegetacije

Marziliano et al. (2015) have reported, for *Phillyrea latifolia* individuals, that9.15% of biomass is stored in leaves, 50.24% in aboveground, and 40.6% in belowground. Mean root/ shoot ratio was found to be 0.68. In a study that has been carried out in Portugal, the root/shoot ratio of Mediterranean woody plants has been determined (40 scrubs from 18 species) to vary between 3.7 (*Arbutus unedo*) and 0.1 (*Cystus multiflorus*) (Silva and Rego, 2004). In our study, the root/ shoot ratio was found to be 1.698. In our study, while the dominant species up to 1000 m altitude was *Phillyrea latifolia* L., it is attention-grabbing that the root/shoot ratios differed significantly from those found by Marziliano et al. (2015).

In studies on determining the portion of foliage within the aboveground biomass of *Phillyrea latifolia*; Armand et al. (1993) have found that ratio to be 27% in France, Marziliano et al. (2015) found it to be 15% in Italy and Topic et al. (2009) found it to be 7% in Croatia. In our study, this value varied between 12.6% and 18.9%. The studies that have been carried out on areas, where the *P. latifolia* is the dominant species, revealed that even the same species shows wide variation in different habitats.

In general, it was observed that the sunny exposures had more biomass. A linear relation was observed between the mean vegetation height and mean biomass. It can be concluded that the mean age and altitude values are independent from biomass. The graphical relation observed between exposure and vegetation height levels and biomass values were found to be nonsignificant in statistical assessments (figure 1).

The reason of that is the wide variation shown by the data obtained from plot areas. On the other hand, correlating the subsequent studies on determining the maquis biomass with the mean vegetation heights is the most acceptable approach.

CONCLUSIONS
ZAKLJUČCI

In Eastern Mediterranean region, which is our study area, maquis constitutes 2.7% of the vegetation as of the year 2007, while it is expected to increase to 14% in 2070s due to the climate change (Tamai et al., 2007). Despite its important potential, there is not enough study on maquis populations. Considering the habitats, where the maquis vegetation spreads over, it is seen that those lands are stony-rocky, where the absolute soil depth is very low. It is very difficult to establish any production forests on these lands, and it is even impossible on some locations. The maquis populations grown under these conditions retain significant amount of biomass and also carbon in their aboveground and belowground organs. When compared, the Taurus cedar, which is one of the main dominant species of the region, retains 136-326 ton/ha aboveground biomass at 100th age according to site classes, while Calabrian pine retains 89-169 ton/ha (Durkaya et al, 2013, Durkaya et al., 2015). In our study, the mean aboveground biomass storage was found to be 24.183 ton/ ha at relatively less ages in maquis scrubland. The biomass storage capacity of maquis at locations, where it is very difficult and even impossible to establish effective production forests, is attention-grabbing.

Besides being a carbon sink and containing high-level of biodiversity within their structures, maquis populations also serve for many traditional purposes such as providing feed in animal husbandry, firewood, and hunting. It is very likely that these utilizations will continue in future. In order to sustain the maquis, which are exposed to multidirectional and even excessive use, and to maintain their benefits, it is necessary to know the maquis scrublands and to establish the protection-usage balance via the obtained data. In establishing the protection-utilization balance, especially replacing the rural population's use for energy purposes with the use of logging residues would be an efficient solution (Eker, 2014, Alkan et al. 2014). The most important problem here is that the maquis scrublands involve significant variations even in short distances. For this reason, carrying out the studies on maquis vegetation should be within narrow areas in order to achieve more reliable results.

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Sažetak

Ovo je istraživanje provedeno pomoću podataka dobivenih iz 35 područja određenih vertikalnom distribucijom prostora makije na istraživanom području smještenom u regiji istočnog Sredozemlja. Podaci su grupirani prema visini, dominantnoj izloženosti, visini vegetacije I prosječnoj starosti, te su se promatrale promjene na biomasi makije ovisno o tim faktorima. Dobiveni podaci pokazuju značajne varijacije te su iz tog razloga ukupne vrijednosti prikazane kao prosječne vrijednosti. Potencijalni odnos između spomenutih čimbenika i količine skladištene biomase provjeren je pomoću t-testa i analize varijacije. Prosječna vrijednost količine nadzemne biomase bila je 24.183 tona/ha, dok je prosječna vrijednost podzemne biomase, bez finog korijenja, bila je 41.062 tona/ha. S obzirom na rezultate dobivene iz prosječnih vrijednosti, omjer suhe mase nadzemnih organa i korijena iznosio je 1,7.

KLJUČNE RIJEČI: Biomasa, makija, omjer suhe mase nadzemnih organa i korijena, visina, izloženost