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ANALYSIS OF SOILS SPATIAL DIFFERENTIATION AND PRODUCTIVITY IN FOREST MANAGEMENT UNIT MUZLJANSKI RIT

PROSTORNA ANALIZA TALA I UTJECAJ NA PRODUKTIVNOST U GOSPODARSKOJ JEDINICI MUŽLJANSKI RIT

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SUMMARY

The paper presents analysis of soil spatial distribution and productivity of *Populus* x *euramericana* I-214 forest cultures in forest management unit (hereinafter: FMU) Muzljanski rit. Soil cover in the FMU is heterogeneous in relation to position and altitude in floodplain. Analysis were conducted on eugley and humogley soil types. Eugley, soil type, was delineated according to physiologically active soil depth as α, β or β/γ gley soils and humogley was delineated as one soil unit. Cultures of the poplar clones *Populus* x *euramericana* I-214 are found on at least two but usually more different site types within the same forest management section (18.43 %). Single forest management section is a by definition a single forest spatial unit having similar ecologic factors. Aim of our research was to enable consistent forest section delineation, based on the interaction of soil productivity properties and distribution as well as *Populus x euramericana* I-214 productivity dataset. Based on our anaysis (spatial analysis of raster layers of soil systematic unit distribution-soil subunit, digital elevation model and productivity according to inner delineation of FMU Muzljanski rit), the resuts show eugley share in lower systematic soil unit. The results show contribution of lower systematic units of eugley in forest managemet section/culture. We found a raising trend of α and β-gley, as well as humogley. On one side the higher contribution of this sistematic units indicates reduction in the forest culture yield. On the other side higher contribution of *β/γ gley indicates an increase of culture yeald.* The *Populus* x *euramericana* I-214 cultures are spatialy concentrated, extending over soil units with different characteristics, pointing in alternative economicaly justified section delineation, based on the soil types.

KEY WORDS: Muzljanski rit, analysis, GIS, soil, productivity

INTRODUCTION
UVOD

Interest in growing poplars has fluctuated, and objectives have shifted between producing saw log, pulpwood, or more densely spaced 'wood grass' or biofuels (Stantruf et al., 2001, Fuhrer et al., 2009). Actual trends in society deliberately direct the elevating utilization of forest functions, considered by increasing number of authors as ecosystem services (Hassan et. al., 2005, Vuletić et al., 2010, Ferre et al., 2014). The target in poplar cultures management is improvement in timber production. In the contextual man-

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ner, writing about productivity among different poplar cultivars is often unpopular, due to the only one considered - productive function. Nevertheless, from wider perspective an optimal utilisation of soil productive capacities in forest cultures/plantations can contribute in lessening the pressures in natural forests (Silva, 2016) and could be a very important project on national level as in China (Sheng, 2008) which could be increase timber production in forest plantation (Zhang et al., 2000). According to McCarthy et al., (2017) interest of planting poplar on forest land has increasing in north European countries in the past period.

Contemporary GIS-based analysis and software enabled in detail analyzing of more parameters in space (Valjarević and Živković, 2016). Implementation of GIS analyze in forestry would be manifested in substitution of traditional methods in analyze with geospatial one (De Mers, 2005, Galić et al., 2018). Spatial analysis of the soil conditions can be done at different levels (Mc Bratney et al., 2003, Galić et al., 2019, Galić et al., 2020a). Soil maps for practical use in general, are insufficiently precise to optimize land use management and to help practical land management (Sanchez et al., 2009). The practical importance of the soil and the silviculture productivity data management can be recognized particularly at a local area. Precise maps of local soils might be produced following to detail edaphic research, aiming at site map as final output.

Data gathering on tree species occurrence is consisted in local forest surveys. The surveys encompass data on tree species distribution, productivity and threatening factors, within approximately same site conditions (at forest section level). Regionalizing of poplar cultivation with key planting clones and productivities of poplar plantations has been studied in economically most developed countries as the USA (Zalesny et al., 2012) and China (Sheng, 2008). In contrast to this research on small area the research may mark off micro depressions and on micro elevations. Micro-relief is the basis of determination of soil systematic units in alluvial plain and had not been followed solely in the internal forest management unit (FMU) delineation into forest sections (stands), in terms of optimal soil management. Research based only micro-relief basis can lead to insufficiently adequate spatial distribution of proposed tree species (Anić, 2018, Galić et al., 2020a). In our case the digital elevation model (DEM) was a basis for defining micro relief and after that for precise soil map. In the part near the riparian zones we can found mixture of different soil types with unequal productivity in poplar plantations (Živanov and Ivanišević, 1986). For that reason, a soil type within a section can occur exclusively, or in a complex with the other soil types.

The first objective of this paper was to assess which soil subunits (soil systematic unit) condition the highest productivity for poplar plantations. Thereafter, the aim was to enable consistent forest section delineation, based on the interaction of productivity properties of soil type and the *Populus* x *euramericana* I-214 productivity dataset. These directions are important in the better space use in sparsely forested area as Vojvodina.

MATERIAL AND METHODS
MATERIJALI I METODE

Forest MU Muzljanski rit is located in Autonomus Province Vojvodina, northern part of Republic of Serbia (Figure 1) and occupy area without flooding. According to EUNIS habitat classification (2012) the described area could be conducted in G1.1141 - Pannonic willow and poplar-willow galleries; and in G1.223 – Southeast European *Fraxinus – Quercus – Alnus* **forests (https://eunis.eea.europa.eu/habitats.jsp).** Pannonic willow and poplar-willow galleries habitat is described as riverine woods of the Pannonic basin formed by *Salix alba*, *Salix fragilis* and often *Populus alba* or *Populus nigra*, which may at times dominate, in particular, in Vojvodina. Southeast European *Fraxinus - Quercus – Alnus* **forests** is described as mixed riverine forests of Ponto-Pannonic and sub-Mediterranean regions of southeastern Europe, usually dominated by *Quercus robur* and/or *Fraxinus angustifolia*, with varying admixtures of *Ulmus minor*, *Ulmus laevis*, *Carpinus betulus*, *Acer campestre*, *Alnus glutinosa*, *Fraxinus excelsior*, *Salix alba*, *Populus alba*.

The following raster layers have been used: soil systematic unit distribution, DEM and the tree species distribution (according forest management plan data – FMP for period from 2010 to 2019) and productivity according to inner delineation of FMU Muzljanski rit.

Soil systematic units which were observed are shown in Figure 2. Soil features of the observed soils were determined in previous research (Galić et al., 2017). The site determination was preceded by DEM drawing and testing theoretical models in soil mapping. The terrain model is based on state topological map (R 1:5000) for micro-relief defining. All the mapped points in addition to X and Y axis value have been determined in Z axis value on the whole area of FMU Muzljanski rit (cca. 1820 ha). The map source allows a product with equidistance of up to 10 cm, quite adequate for modeling spatial soil differentiation. ArcGIS 10.5. Package was used for interpolation, resulting in 3D terrain model (Figure 3.).

Interpolation analyses (ARC toolbox → Spatial Analist Tools → Interpolation → Spline) based on one pixel for 0.1 m. After the topography tasks, soil distribution research was performed, using the Classification of soils in Yugoslavia (Škorić et al., 1985) and compared with WRB classification (FAO 2014). The key presumption was that soil cover pat-

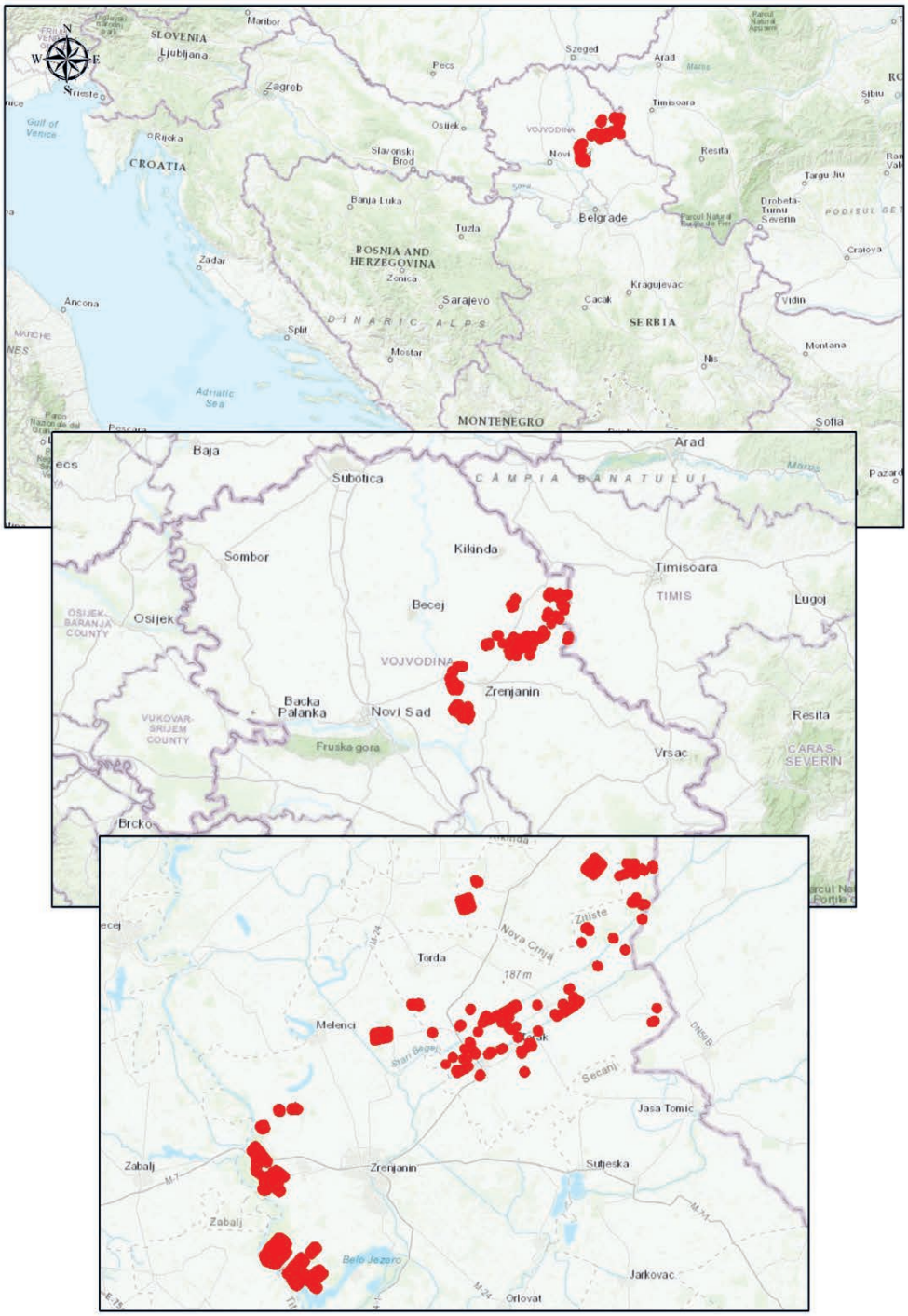

Figure 1. Overview of Forest Management Unit Muzljanski rit
Slika 1. Zemljopisni položaj Gospodarske jedinice Muzljanski rit

tern is related with type of relief (in this case altitude). Soil profiles are covered in the whole area of management unit depending on micro-relief. Several soil types were determined in the FMU, followed by analysis for eugley and humogley soil types (Škorić et al.,1985). According to WRB classification (2014) all the soils in study belong to gleysols. Humogley (Škorić et al.,1985) in WRB classification is described as humic gleysoil (Pavlović et al. 2017) and eugley as a haplic gleysoil. Neither of these two classifications takes into account physiological active soil depth. The eugley soils were delineated according to physiologically active soil depth in a soil profile consequently referred to as α, β or γ gley soils (Wilde, 1940), in further readings given by the following expressions of soil systematic unit. Physiological active soil depth in Wilde (1940) classification are determined by the level of groundwater and soil texture. Small changes in physiological active depth leads to consequential changes in productivity of the tree species. In particular,

these differences in productivity are more significant to poplars (Živanov and Ivanišević, 1986, Ivanišević et al., 2010, Galić et al., 2019, Galić et al., 2020b).

Analysis of inner delineation into forest sections was based on inputs of site survey; forest management plan data (FMP) for period 2010 - 2019; and spatial soil distribution according to tree species productivity (in our case *Populus* x *euramricana* I-214). In site survey of soil profile network on the management unit level we collected data of: relief (meso and micro), vegetation (trees, shrubs and ground floor), groundwater level, soil morphology with horizon description, soil physiologically depth. Forest management

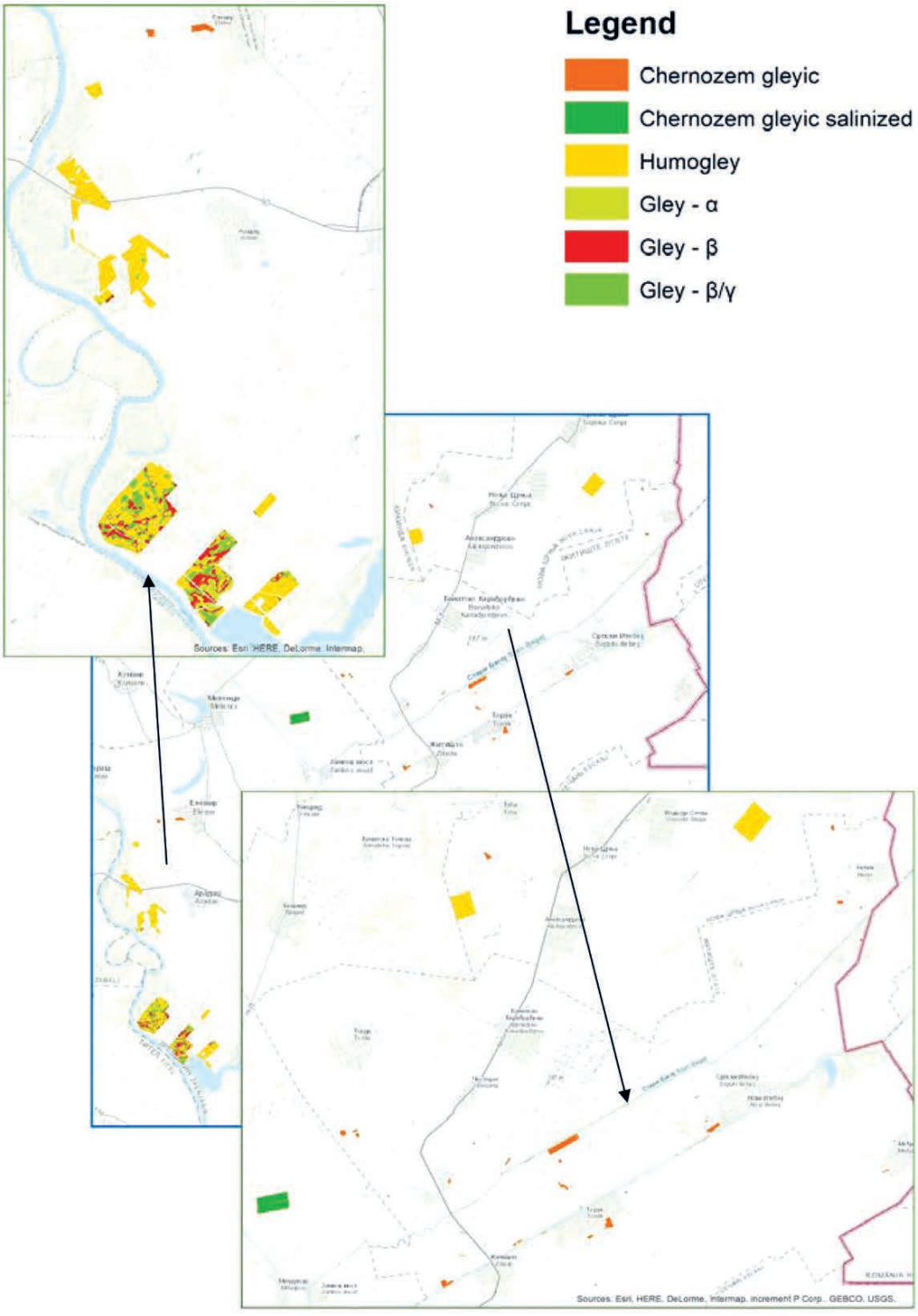

Figure 2. Systematic soil units - according Galić et al., 2014
Slika 2. Sistematske jedinice tala – Galić i sur., 2014

plan data include data for diameter, basal area, volume, increment, diameter class, causes of damage.

This analysis was based on the forest sections as the smallest spatial delineation. The essential assumption was that a section area must be consistent with the type of soil. Analysis of productive characteristic was evaluated based on the data gathered in the survey and FMP of the most widespread tree species represented as black poplar clone – *Populus x euramericana* I-214. Regarding this analysis we used the average value of stand characteristics (diameter, basal area, volume, increment),and share of soil systematic unit (subunit) at the level of forest section within V age class. The cluster analysis

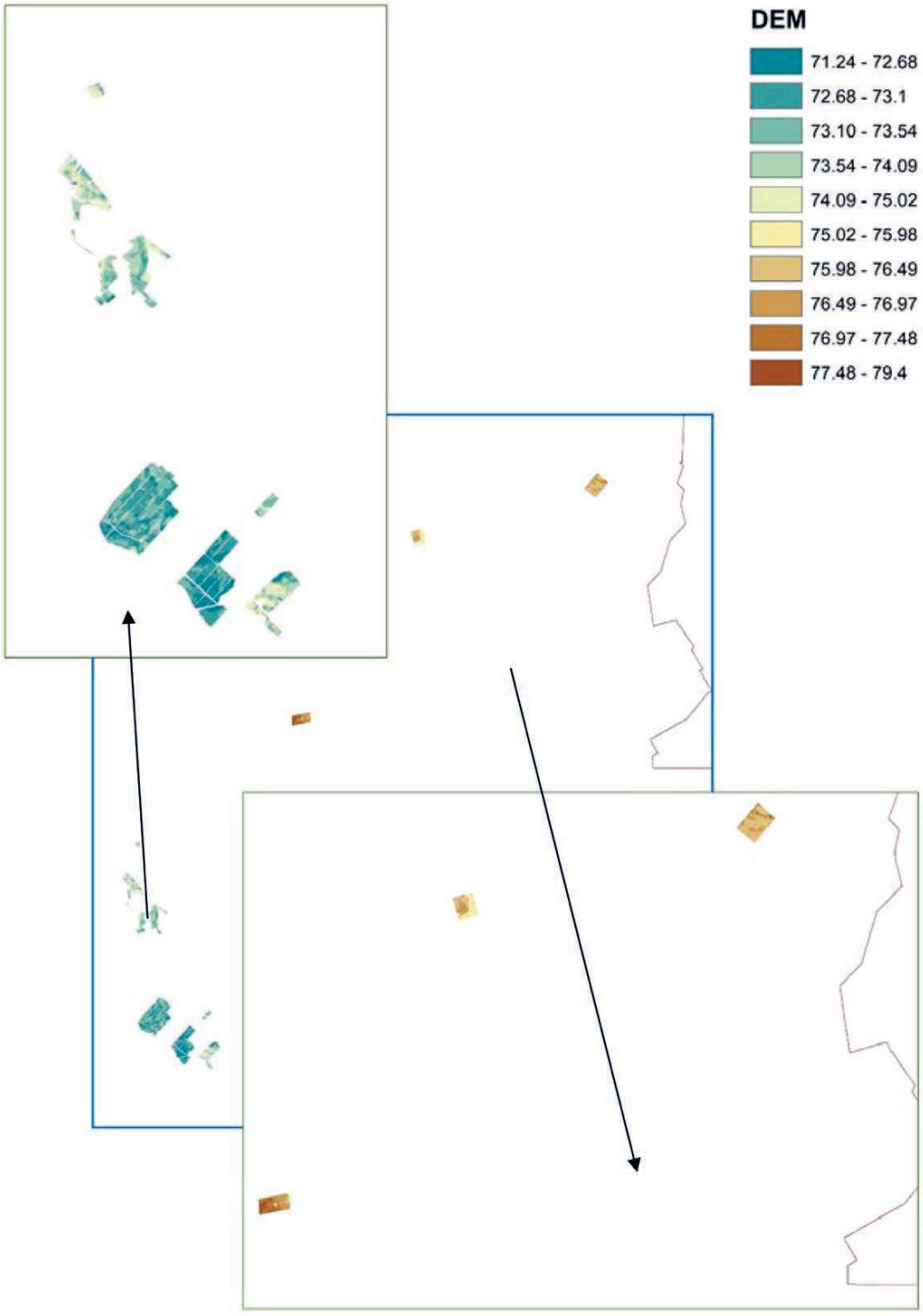

Figure 3. 3D terrain model
Slika 3. 3D model terena

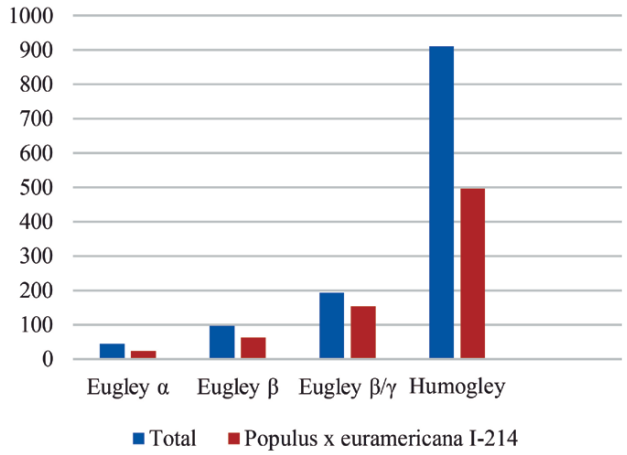

Figure 4. Determined soil types in FMU Muzljanski rit
Slika 4. Determinirani tipovi tala

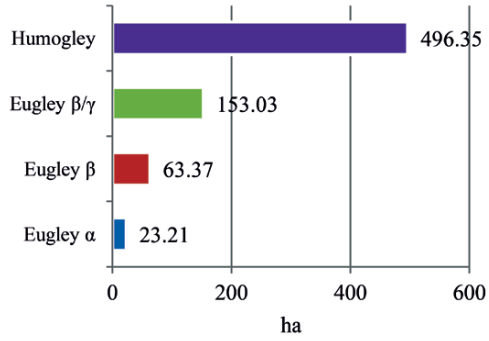

Figure 5. Proportional share of soil types under cultures of *Populus x euramericana* I-214
Slika 5. Udio tipova tala pod nasadima topola

(CA) we used to show the separation of the soil subunit. PCA analysis was used to show the power of each soil systematic unit (subunit). Correlation analysis was used to show connection between single dataset of stand characteristics and soil systematic unit (subunit) share. All statistical analyses were performed in program Statistica 12.

RESULTS AND DISCUSSION
REZULTATI I RASPRAVA

The site productivity of poplar plantation was discussed, in order to assess which soil subunits (soil systematic unit) condition were with the highest productivity for poplar plantations. Thereafter, the aim was to enable consistent forest section delineation, based on the interaction of productivity properties of soil type distribution and the *Populus x euramericana* I-214 productivity dataset.

In FMU Muzljanski rit humogley is the most common soil type, covering a total area of 910.99 ha (Figure 4). The three systematic soil units of the eugley soils (α, β, β / γ) occupy 380.89 ha, whereas other soil types are present on 86.17 ha.

Cultures of *Populus* x *euramericana* I-214 are grown on humogley soil and on the three systematic units of eugley soil on the total area of 741.17 ha. On humogley the cultures occupied 496,35 ha, while on other three units 239,61 ha. The most productive systemic unit (referred to the β/γ gley) occupies an area of 23,21 ha (Figure 5).

Forest stand delineation into sections pointed to the fact that, a single section, *Populus x euramericana* I-214 was cultivated on the same soil type (humogley) on the 120.39 ha. The spatial analysis also showed that other systematic units of the soil can only be found in a variety of combinations within a section. Area related to the cultivation of *Populus x euramericana* I-214 is 167.95 ha (figure 6 and table 1). Sections which consisted of two and more systematic soil units, where each of those units covered more than 1 ha (taken for rationalizing the use of space), extend on 133.96 ha (79.76%). The highest average share in the sections is related to the humogley (45.89%) and β/γ gley. The surface of these two soil systematic units within the sections, covering the surface over 1 ha, calculated in the areal units, is 70.63 or 63.34 ha respectively (a total of 133.97 ha).

In MU Muzljanski rit *Populus x euamericana* I-214 plantation was found in a section just on section on single soil type - humogley and section on multiple soil types. In the part near the riparian zones spatial soil distribution represent a mixture of humogley, semigley and eugley soil (Živanov and Ivanišević, 1986). Change in soil systematic units can lead to differences in the productivity (Fuhrer et al., 2009). In this case final quantity of value net yield of main stand is decisive according to the volume (Petraš et al., 2008a). Differences in productivity of *Populus* x *euamericana* I-214 plantation on humogley, compared to section on multiple soil types conducted further discussion. In another direction, research based only micro-relief basis can lead to conclusion for replace or substitute poplar plantations under changed site conditions towards a stand (Anić, 2018, Galić et al., 2020a) without spatial distribution of proposed tree species. In spatial analysis any systematic soil unit (site) has certain properties. The results of different productivity of plantations

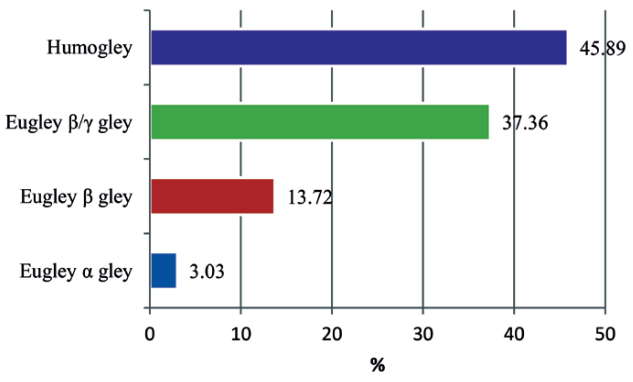

Figure 6. Average participation in section with two or more soil unit
Slika 6. Prosječni udio po odsjecima sa dva ili više tipova tala

Table 1. The minimum, maximum and the total area over than 1 ha in section with two or more soil unit
Tablica 1. Minimalna, maksimalna i ukupna površina veća od 1 ha sa dvije ili više sistematske jedinice tala u odsjeku

Soil unit *Sistematska jedinica tla*	Average participation – in section *Prosječni udio u odsjeku*	Minimum detected area *Minimalna determinirana površina*	Maximum detected area *Maksimalna determinirana površina*	Total area over 1 ha *Ukupna površina iznad 1 ha*
	%	Ha	ha	ha
α gley	3,03	0,0052	5,0485	5,05
β gley	13,72	0,0017	9,9235	23,93
β/γ gley	37,36	0,2264	9,9848	63,34
Humogley	45,89	0,8166	9,2568	70,63

could be explained by significant influences of site (McCarty et al., 2017, Maissupova et al., 2017).

Actually, plantations in MU Muzljanski rit being managed on the more soil systematic units within a same section, occupy 18.43% of the area. According to previous research (Klašnja et al., 2008, Galić et al., 2011, Klašnja et al., 2012, Galić et al., 2020b) of the detected systematic units classified in eugley, the best one for growing the poplars is the β/γ gley. The systematic units of the other two eugley units (α and β gley) are unfavorable for growing the *Populus* x *euamericana* I-214, due to the reduced depth of physiologically active soil. The normal development of the root system of *Populus* x *euamericana* I-214 need physiologically active soil depth of at least 70 cm. Systematic units α and β gley can not provide sufficient physiologically active soil depth. Systematic unit area β/γ gley provide the threshold of the necessary physiologically active profile depth, allowing cultivation of *Populus* x *euamericana* I-214. Humogley in the FMU "Muzljanski rit" is characterized in enhanced soil clay (Galić et al., 2016) throughout the profile, consequently being less suitable for cultivation of the Euramerican poplar (Ivanišević et al., 2010), furthermore indicated by portion of the total sand fraction at microsites (Fuhrer et al., 2009, Bradley Pinno et al., 2010, Galić, 2010, Galić et al., 2018).

Tree diameter structures (diameter at breast height) is the first parameter indicating productivity of the plantations. At the less productive sites they reach the smaller thoracic diameters, and in the study area those were concentrated in the diameter degree of 22.5 cm (β-gley and humogley – containing silt+clay fraction). Some more favorable soil conditions at β/γ gley resulted in the largest number of trees grouped in the 27.5 cm diameter degree. A special case represents the humogley as the only soil type in the section. The largest number of trees in average was reached in diameter degree 27.5, but this was due to the small number of trees (Figure 7).

The highest quality classes are intended mainly for the production of industrial veneers, while class II has slightly lower requirements for the quality of wood than highest quality classes and it is reflected in money mainly the timber utility value (Màrkus et Mészàros, 2000, Petraš et al., 2008a). The most valuable assortments are those of 35 cm mean diameter (F logs) and 30 cm (L logs). However, the diameter structure in FMU Muzljanski rit points to the fact that the largest number of trees at the end of the rotation can be found on β gley in class I of sawlogs, whereas on the β/γ gley and humogley in L class. The minimum average volume in age from 21 to 25 years was found on humogley, 95.58 m^3ha^-

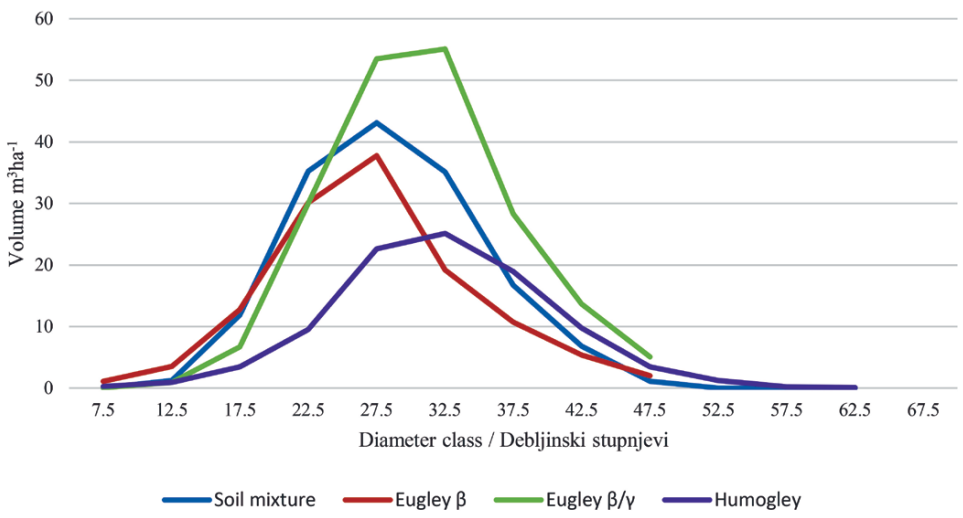

Figure 7. Influence of soil type on soil productivity in diameter classes
Slika 7. Utjecaj sistematske jedinice tla na produktivnost nasada

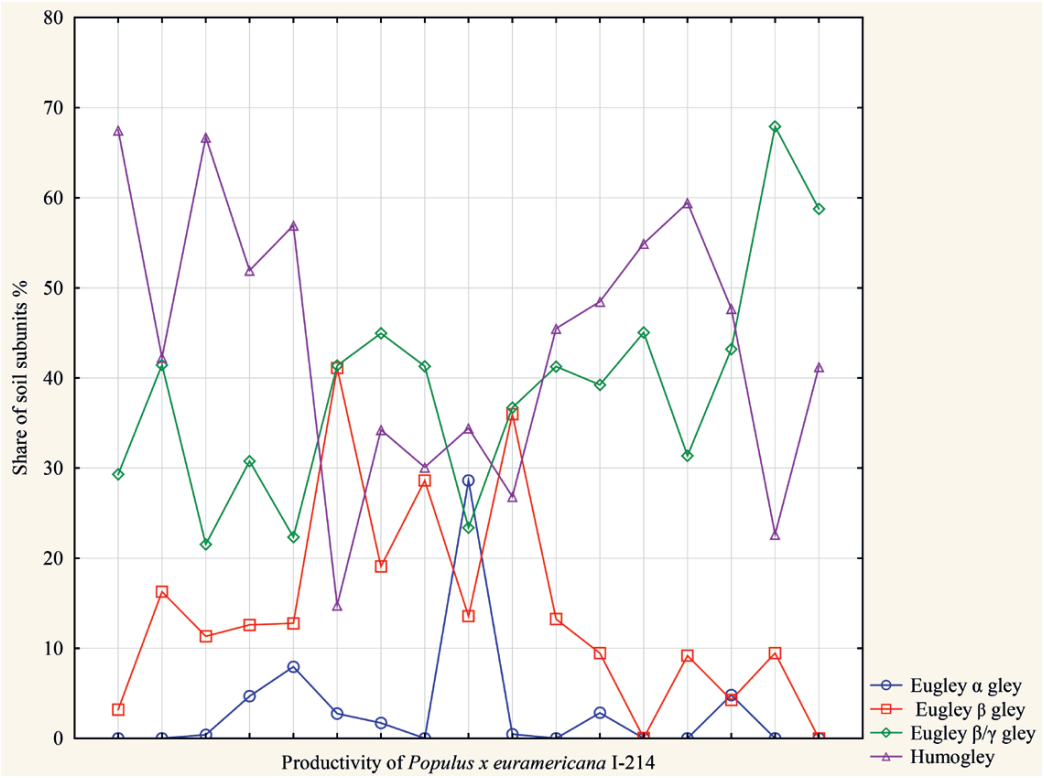

Figure 8. Participation of soil systeamtic units in soil mixtue and productivity of *Populus x euramericana* I-214 plantation – V age class
Slika 8 Udio sistematskih jedinica tala i produktivnost *Populus x euramericana* I-214 u V dobnom razredu

[1]. On β gley the average volume was 122.52 m^3ha^{-1}, while the most productive was the β / γ gley with average volume of 193.3 m^3ha^{-1} (Figure 7, as sum of all diameter class). Volume on the β / γ of the aforementioned most valuable assortments was 102.11 m^3ha^{-1} (52.82% of the total volume). On the β gley was found 37.36 m^3ha^{-1} in average. Plantations of *Populus* x *euamericana* I 214 on the humogley in the complex with the other soil types as well as on the humogley as the only soil type within a section, have reached similar timber volume of the most valuable timber assortments (59.7 and 58.8 m^3ha^{-1} respectively). However, the larger share of other soil types in a section, the better productivity was confirmed as well as higher-quality of wood which has the higher utility value and price (Petraš, 2008b).

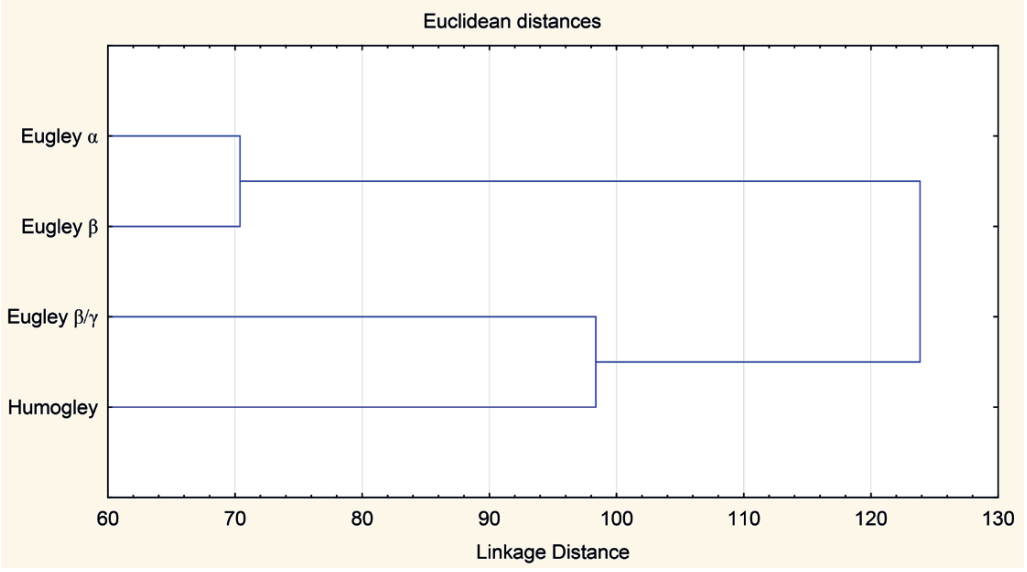

Figure 9. Cluster analysis of soil systematic units on productivity of *Populus* x *euramericana* I-214 plantation
Slika 9. Klaster analiza utjecaja sistematskih jedinica tala na produktivnost *Populus* x *euramericana* I-214

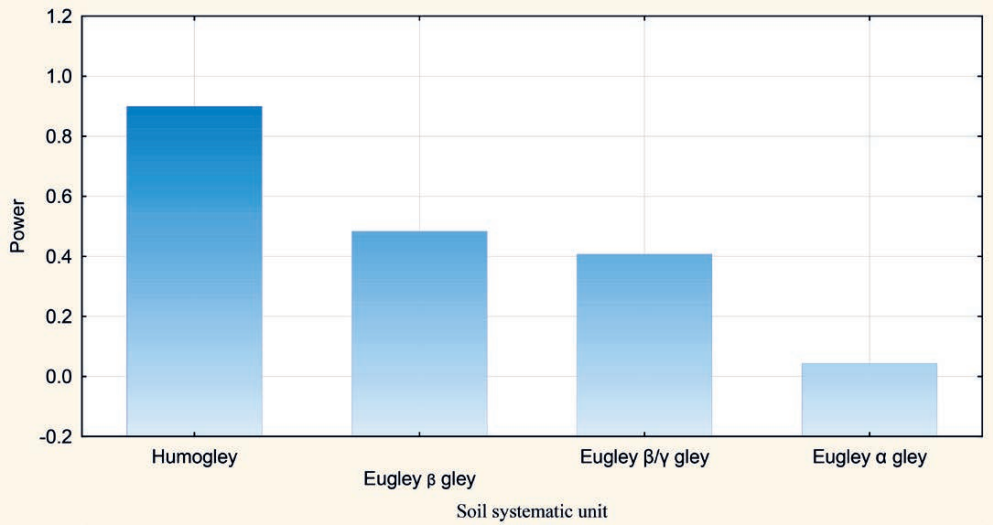

Figure 10. PCA analysis of soil systematic units on productivity of *Populus* x *euramericana* I-214 plantation
Slika 10. PCA analiza utjecaja sistematskih jedinica tala na produktivnost *Populus* x *euramericana* I-214

Increasing participation of α and β gley, as humogley have influence on reduction in the productivity of *Populus* x *euramericana* I-214 plantation. With increase of partipitation of β/γ gley in soil mixture we can see the increase of volume in *Populus* x *euramericana* I-214 plantation (Figure 8).

The increasing trend of α and β gley, likewise humogley, indicated a decrease in productivity of the Euramerican poplar. An exception to this was discovered at the share of β/γ gley, the latter being positively correlated in those two phenomena. Increasing in participation of β/γ gley increases the average timber volume per section. Statistical significance indicates a weak statistical relationship (r^2 0.3745). Cluster analysis shows two groups (Figure 9). In the one group we find α and β gley and in the second group β/γ gley and humogley. Grouping into these two groups is probably a consequence of physiological active soil depth. First group (α and β gley) is characterized by smaller depth. PCA's analysis shows the importance of soil systematic units (Figure 10), and shows that humogley have the greatest strength and α gley lowest strenght. According to this anal-

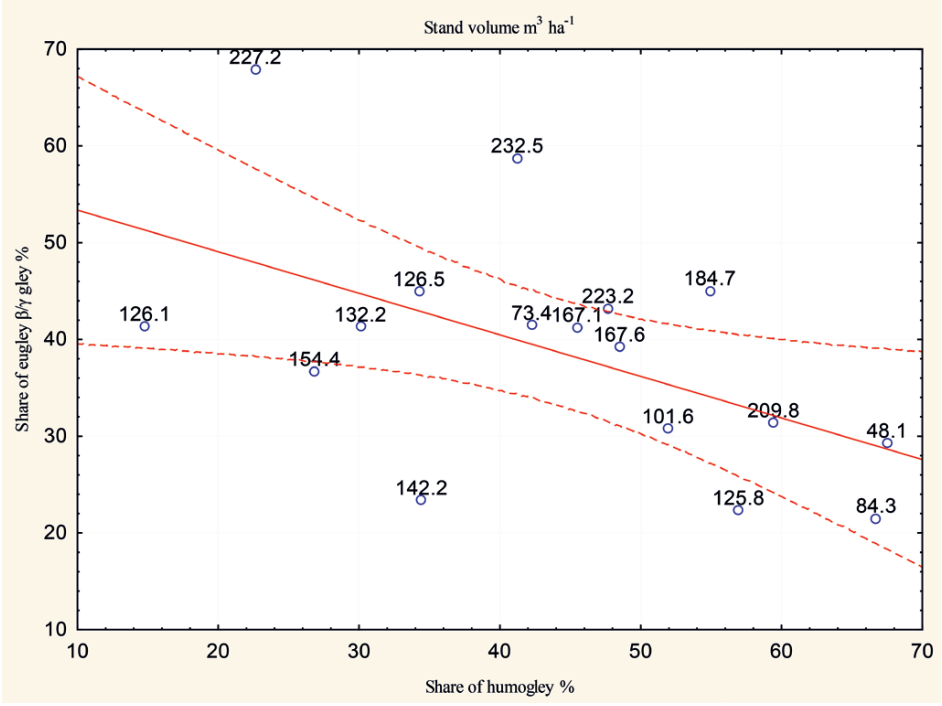

Figure 11. Correlation analysis of share of eugley β/γ and humogley with plantation productivity
Slika 11. Korelacijska analiza udjela močvarno glejnog β/γ i ritske crnice sa produktivnošću nasada

ysis major influence is connected to soil type – humogley. In both case it was shown on the decrease of productivity with increase of portion of eugley (physiological α and β). Correlation analyses shows that the increase of eugley β/γ gley in relation to humogley leads to increase of plantation productivity (Figure 10). However, if we consider that the average volume refers to the entire section and all the soil systematic units within it, the statistical connection must be explained in more details.

Total area of the α and β gley under *Populus* x *euamericana* I 214 plantations is 86.58 ha. The total area of these two systematic units in plots larger than 1 hectare is 28.98 ha, indicating that the eventual delineation would be reasonable. At the surface, 10 % share of α gley, as well as 20% share of β gley, witnih a section, substantially reduces the productivity of *Populus* x *euamericana* I 214 plantations. Significant reduction of the productivity on humogley is already noticeable if its portion is 30% or larger of the sec-

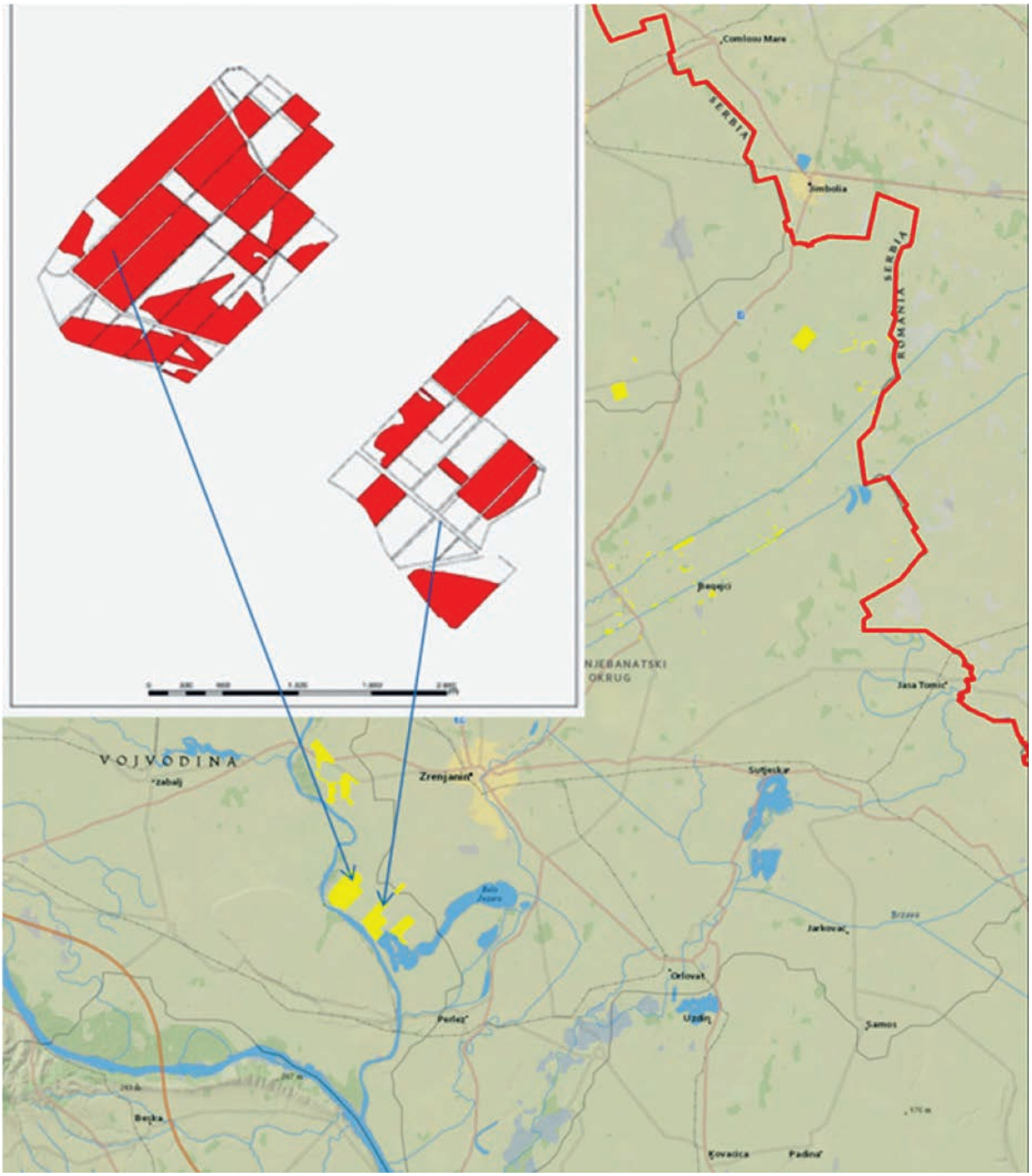

Figure 12. Soil mixture in *Populus x euamericana* I-214 plantation
Slika 12. Kompleks tipova tala pod nasadima *Populus x euamericana* I-214

tion area. To the contrary, increase in 30% or more of β / γ gley share increases the productivity.

Plantations of *Populus* x *euramericana* I-214 on the two or more soil systematic units in a section larger than 1 hectare are concentrated in the FMU (Figure 12). The spatial pattern in relatively small space enables spatial separation of the soils. The separation would enable optimization of the land use. On the FMU surface differentiation of eugley soils to α, β and β/γ gley would be carried out. A special category would be represented in humogley. Optimizing the land use would result in reasonable substitution of tree species or its cultivars, heading to an increase in production characteristics in the researched area. Potential stable and vital species are represented as pedunculated oak on researched area on humogley and shallower systematic units of eugley soils.

Increasing in the production characteristics would improve more easily fulfillment of other forest functions/services as reducing the pressure of natural forests and climate change mitigation (Sheng 2008, Zalesny et al., 2012).

CONCLUSIONS
ZAKLJUČCI

Site conditions in FMU "Muzljanski rit" are heterogeneous and it was necessary to investigate the productivity of *Poplar x euramericana* I-214 plantations.

Increase of α and β gley and humogley in soil mixture indicate a decrease in productivity of *Populus x euramericana* I-214 plantation. Decrease of productivity in *Populus* x *euramericana* I-214 plantations are observed on α gley with 10%, and the β gley with 20% of share. Increasing participation of β/γ gley causes increase of plantation (share more than 30%) and it was a slightly positive correlation (r^2 0.3745). Although this correlation is statistically weak, in terms of studying the properties of the soil is an important value - because productivity analysis was performed based on the average volume.

Optimizing the land use would result in reasonable substitution of tree species or its cultivars, heading to an increase in production characteristics in the researched area. Increasing in the production characteristics would improve more easily fulfillment of other forest functions/services.

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SAŽETAK

Razumijevanje produktivnosti drveća u gospodarskim jedinicama vezano je za poznavanje više stanišnih čimbenika. U radu se prikazuju istraživanja s obzirom na rasprostranjenost tala, dajući im veću važnost u odnosu na izbor klona, vodni režim, klimatske ekstreme, kao i postupak obnove nasada. Opravdanost navedenog pristupa je vezana za više provedenih istraživanja, u kojima je jedan od osnovnih čimbenika tip tla, a s njime i odgovarajuća vrsta drveća.

Pregled prostorne rasprostranjenosti tala omogućeno je razvojem programskih paketa za prostornu analizu geoinformacijskih podataka. U radu je prikazana analiza prostorne raspodjele tala i produktivnosti nasada *Populus* x *euramericana* I-214 gospodarske jedinice (GJ) Mužljanski Rit. Definiranju rasprostranjenosti tala u GJ Mužljanski rit prethodila je izrada modela terena. Model terena napravljen je na bazi osnovne državne karte (R 1:5000) za definiranje mikroreljefa. Svaka poznata točka je osim vrijednosti na *x* i *y* osi, dobila vrijednost i na *z* osi. U programskom paketu ArcGIS je izvršena interpolacija, a rezultat je 3D model terena u GJ Mužljanski rit na površini od približno 1820 ha. Na ovaj način je omogućena analizirati ekvidistance na 10 cm na prostoru gospodarske jedinice. Prostornom analizom su prema Klasifikaciji zemljišta Jugoslavije (Škorić i sur., 1985) determinirani različiti tipovi i niže sistematske jedinice tala. Prethodno navedena klasifikacija je nadopunjena podjelom na fiziološki aktivnu dubinu profila prema Wildeu (1940), zbog pretpostavljene različite produktivnosti tala ovisno o vrsti stabala koja će se tamo uzgajati. Postupak je na ovaj način definirao područja niza i greda na prostoru čitave GJ, te je poslužio kao osnova za daljnje analize. Mrežom pedoloških profila su definirani tipovi tala. Rezultati istraživanja ukazuju da je pokrov tla u istraživanoj GJ heterogen, te su kao tipovi tla determinirani euglej i humoglej. Podjela na niže sistematske jedinice kod eugleja je vezana za fiziološki aktivnu dubinu profila i to na α, β ili β/γ glej (ograničavajući čimbenik je stagnacija podzemne vode u profilu). Posljedica je 18,43% nasada *Populus* x *euramericana* I-214 koji se nalazi na dvije ili više različitih vrsta sustavnih jedinica tala, unutar istog odsjeka, u dijelu šume koja tvori glavnu prostornu jedinicu sa sličnom ekologijom. Povećanje ili smanjenje udjela sustavne jedinice tla dovodi do postizanja različite produktivnosti. U radu je utvrđena potreba podjele eugleja kao tipa tla na niže sistematske jedinice. Rezultati istraživanja ukazuju da trendovi povećanja udjela α i β-gleja u tlu, kao

i humogleja, utječu na smanjenje prinosa nasada *Populus* x *euramericana* I-214, dok udio β/γ-gleja (u statističkoj značajnosti od 0,3745) pozitivno korelira s volumenom nasada *Populus* x *euramericana* I-214. Iz rezultata je također vidljivo da je mali udio α gleja (do 10%) dovoljan po površini odsjeka da bi doveo do smanjenja produktivnosti nasada *Populus x euramericana* I-214, dok je taj udio kod β-gleja nešto većite ne bi trebao prelaziti 20%, odnosno najviše 30%.

Nasadi *Populus* x *euramericana* I-214 prostorno su koncentrirani, što ukazuje na alternativnu ekonomski održivu podjelu na temelju karakteristika tala uz izbor odgovarajuće vrste drveća. Na području niza je u najvećoj mjeri zastupljen euglej (fiziološki α i β glej) i potrebno ih je izbjegavati, budući da i mali udio navedenih sustavnih jedinica zemljišta bitno utječe na produktivnost, a posljedično i na sortimentne strukture nasada *Populus* x *euramericana* I-214. U najvećem broju slučajeva, kao zamjenska vrsta na humoglejevima i fiziološki plićim sustavnim jedinicama bio bi hrast lužnjak kao stabilna i vitalna vrsta. Na osnovi prostornog rasprostranjenja tala to se vrlo jasno može definirati, a u konačnici se i ispunjavaju ostale funkcije šuma.