

Wood forest products quantity and quality in relation to tree crown defoliation

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Continuous changes in forest ecosystems necessitate the ongoing validation and improvement of the existing models for assessing the quantity and quality of wood forest products. Understanding how these changes affect forest ecosystems and, consequently, forest products are highly important for the quality and sustainable management of forest ecosystems.

This research aimed to determine the relationships between the quantity and quality of wood forest products and tree crown defoliation degree (TCDD). The research included four economically important tree species in Croatia: pedunculate oak (*Quercus robur* L.), narrow-leaved ash (*Fraxinus angustifolia* Vahl), silver fir (*Abies alba* Mill) and Norway spruce (*Picea abies* (L.) Karst.). The destructive method was applied to determine the quantity and quality of wood forest products, followed by sampling and laboratory analyses of energy wood. The sampled trees were selected based on the TCDD as follows: healthy tree – if TCDD was lower than 25%; 3A tree – if TCDD was between 61% and 80%; 3B tree – if TCDD was between 81% and 99%; and dead tree – if TCDD was 100%.

The results of this study revealed differences between the expected and actual gross volume in the interval of $\pm 10\%$ for pedunculate oak, silver fir, and Norway spruce, while for narrow-leaved ash, the deviation went up to almost 46%. Furthermore, a significant reduction in branch biomass by increasing the TCDD class was observed for silver fir and Norway spruce. The results of laboratory analyses of energy wood did not reveal an unequivocal trend in decreased quality of energy wood by increasing TCDD class. The analysis of present wood defects revealed that wood defects related to biological degradation (rot, insect attack) were more common reasons for log declassification in the case of dead trees compared to healthy trees. For silver fir and Norway spruce trees, a continuous decrease in average tree value with increasing TCDD class was determined. In the case of pedunculate oak and narrow-leaved ash, dead trees had a lower average tree value compared to healthy trees, while 3A and 3B trees did not show a continuous decrease in average tree value across all DBH classes.

Based on the results of this doctoral dissertation, it can be concluded that TCDD can be used as a helpful indicator of the quantity and quality of wood forest products. Therefore, it is justified to develop new models for assessing the quantity and quality of wood forest products, including TCDD as an additional variable.

(160 pages, 4 supplements, 226 references, original in English)

Key words: narrow-leaved ash; pedunculate oak; silver fir; Norway spruce; tree dieback; timber grading; assortment table; wood defects; average tree value; aboveground biomass; wood chips; energy wood quality

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Količina i kakvoća drvnih šumskih proizvoda u ovisnosti o osutosti krošnje stabla

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Kontinuirane promjene u šumskim ekosustavima nameću nužnost kontinuirane kontrole i unaprjeđenja postojećih modela procjene količine i kakvoće drvnih šumskih proizvoda. Poznavanje na koji način te promjene utječu na šumske ekosustave, odnosno šumske proizvode od iznimnog je značaja za kvalitetno i održivo gospodarenje šumskim ekosustavima.

Istraživanje je provedeno s ciljem utvrđivanja ovisnosti između količine i kakvoće drvnih šumskih proizvoda i stupnja osutosti krošnje stabla. Istraživanjem su obuhvaćene četiri gospodarski važne vrste drveća: hrast lužnjak (*Quercus robur* L.), poljski jasen (*Fraxinus angustifolia* Vahl), obična jela (*Abies alba* Mill) i obična smreka (*Picea abies* (L.) Karst.). Korištena je destruktivna metoda utvrđivanja količine i kakvoće drvnih šumskih proizvoda te uzorkovanje i laboratorijske analize energijskog drva. Odabir stabala uzorka temeljio se na stupnju osutosti krošnje stabla kako slijedi: zdravo stablo – osutost krošnje stabla do 25 %; 3A stablo – osutost krošnje stabla 61–80 %; 3B stablo – osutost krošnje stabla 81–99%; odumrlo stablo – 100 % osuta krošnja stabla.

Rezultatima istraživanja utvrđena su odstupanja između planskog i stvarnog bruto obujma na razini ± 10 % za hrast lužnjak, običnu jelu i običnu smreku dok su kod poljskog jasena utvrđene razlike i do skoro 46%. Nadalje, za običnu jelu i običnu smreku utvrđeno je značajno smanjenje biomase grana porastom stupnja osutosti krošnje. Rezultati laboratorijskih analiza za energijsko drvo nisu bili jednoznačni, odnosno nije utvrđen kontinuirani trend smanjenja kakvoće povećanjem stupnja osutosti krošnje. Analizom prisutnih grešaka drva utvrđeno je da su greške biološke prirode (trulež, oštećenja od insekata) bile češći razlog deklasifikaciji trupaca kod odumrlih stabala nego li kod zdravih. Za stabla obične jele i obične smreke utvrđen je kontinuirani pad prosječne vrijednosti stabla s porastom stupnja osutosti krošnje. Kod hrasta lužnjaka i poljskog jasena odumrla stabla su imala manju prosječnu

vrijednost u odnosu na zdrava stabla dok stabla u kategoriji 3A i 3B nisu imala kontinuirani pad vrijednosti za sve debljinske stupnjeve.

Na temelju rezultata ovog istraživanja može se zaključiti da stupanj osutosti krošnje može poslužiti kao dobar indikator količine i kakvoće drvnih šumskih proizvoda te bi razvoj novih modela procjene količine i kakvoće drvnih šumskih proizvoda koji bi uključili stupanj osutosti krošnje bio potpuno opravdan.

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Ključne riječi: poljski jasen; hrast lužnjak, obična jela; obična smreka; odumiranje stabla; klasifikacija oblovine; sortimentne tablice; greške drva; prosječna vrijednost stabla; nadzemna biomasa; drvena sječka; kakvoća energijskog drva

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