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A stepwise approach for deriving timber assortment of trees from Terrestrial Laser Scanning data

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Forest ecosystems represent an important source of income for landowners and at the same time an important source of ecosystem services for the society. Quantitative and qualitative information about timber assortments are particularly important to support sustainable forest management, representing a crucial prerequisite for active forest management. To date, the most accurate methods for assessing the timber assortments availability within forest stands are destructives, and the development of an effective method for deriving these estimates on standing trees is highly needed. This is particularly more evident for mixed forests, which are often subject of the conflict between conservation and productive functions.

This study aims to introduce a stepwise approach for timber assortment estimation and classification using TLS data. The approach consists of four steps: a) timber-leave discrimination, b) tree detection, c) stem reconstruction, and d) timber assortment estimation and classification. The study was carried out in a mixed tree-species and multi-layered Mediterranean forests, observing 178 trees of twelve different species, wherein 66 out of 178 were large trees, with a diameter at breast height higher than 20 cm.

Results indicate that the discrimination between timber and leaves reached 0.98 for accuracy using Random Forest algorithm. All trees with a diameter at breast height higher than 30 cm were correctly identified. The overall detection accuracy was 84.40 % (SD± = 4.7%). Best detection accuracy was found for A. lobelii, S. torminalis, F. excelsior, Q. cerris, A. campestre and F. sylvatica (higher than 84.3%) tree species. 47 out of 66 detected large stems were correctly reconstructed. The stepwise approach allows to classify 168 logs (134 merchantable logs and 34 non-merchantable) extracted from 47 stems through the automatic functions (i.e. cylinder-fitting approach), with an accuracy ranging between 75% (134 out of 179 reference merchantable logs) and 85% (34 out of 40 reference merchantable logs). The overall reconstruction accuracy was

71.40 % (SD± = 17.1%). Best reconstruction accuracy was found for Q. cerris, A. opalus and F. excelsior (higher than 43.5%). Concerning the timber assortment 134 out of 179 merchantable logs were classified in one of the 15 assortment types (i.e. A+, A0, A-). The whole predicted logs were classified in 11 assortment types, so eleven out of 15 assortment types were correctly matched between predicted and reference data. The classification of merchantable logs was more accurate for eight assortment types (A-, B-, B0, B+, C-, D-, D+ and Fuelwood-), which was ±2 merchantable logs. The abovementioned results support the feasibility of this stepwise approach for calculating the timber assortment of standing trees, ensuring the valorisation of the productivity of forest characterized by tree species richness and heterogeneous stand structure.