Fuel Types Mapping Using Airborne LiDAR Data

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Abstract: A spatial representation of vegetation structure, like provided by fuel maps, is probably the fastest way to get a first quick idea of forest fires behavior. Data from passive sensors on board of satellites have been extensively used to build these maps. However, these sensors are not able to show the vertical structure of the canopy. Over the last few years, this problem has been improved using active sensors as LiDAR, which are able to penetrate the canopy, gathering information about the vertical structure. In this work we analyze the suitability of airborne LiDAR data for mapping fuel types in a forested area of Tenerife (Canary Islands, Spain). LiDAR data (provided by GRAFCAN) were acquired between June and August 2010. These data are discrete and unclassified, with an average density of 2.1 points/m^2. They were classified using LAStools software, due to its speed, robustness and reliability when classifying and generating the different layers of information derived from LiDAR point cloud data. The fuel types were classified according to the PROMETHEUS project. This classification is based primarily on the height of the vegetation cover. It considers seven fuel types: one for grasslands, three for shrubs and finally three for trees, with and without understory. The main difficulty arises on the discrimination of points belonging to the tree cover classes (leaves, branches and slash) or to the understory. In order to differentiate among the three models with woody fuel, a cluster analysis (k-means) was carried out, analyzing the vertical distribution of LiDAR points within 33 plots, evenly divided among the three fuel types that present more difficulties to be identified. For this analysis, the heights of the points were normalized, obtaining the height of the vegetation cover above the ground. A Digital Terrain Model was also necessary, being built using the different LIDAR scenes. Once we identified the vertical behavior of the points in the plots, we proceeded to the classification of the seven fuel types using a tree classifier, demonstrating the potential of LiDAR to classify fuel types based on the vegetation vertical structure. The map reliability was evaluated by analyzing the error due to quantity disagreement and allocation disagreement, giving an 8% error in quantity and 6% by allocation. Quantity disagreement was due to the low density of points per m^2 having LiDAR data.

Keywords: LiDAR, fuel types, k-means, decision tree