Project II: Forest Structure and Tree Competition

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Outset and Goal

During the first work period which aimed in a crown segmentation of Marburg Open Forest a dataset containing detailed information on several crown properties such as height and area was created. The further working steps in the second project base on this dataset and a comprehensive dataset consisting of spectral and structural properties. The goal of this second project is to provide several statistical measures in order to analyse forest structure and tree competition.

Forest structure

For the purpose of describing the forest structure four indicators were derived. They focus on the forest density and the ratio of crown area to soil area regarding either the forest departments or the different tree species in the area of interest. On the one hand, the forest density was calculated by trees per ha as a mean of all sections of the same tree species or as a value for each forest section (Fig. 1 and 4). On the other hand , the soil/crown area ratio was calculated dividing the crown area by the soil area as a mean of all sections of the same tree secies or as a value for each forest department (Fig. 2 and 3).

The values of density per tree species range between 218 trees/ha and 239 trees/ha for the whole forest. In contrast, the density values for each single departments without considering their dominating tree species the density range from 33 to 440 trees/ha. The soil/crown area ratio values ranges differ for the mean of each tree species and the seperate values for each single section. This indicates differences between the individual forest departments of the same dominating tree species.

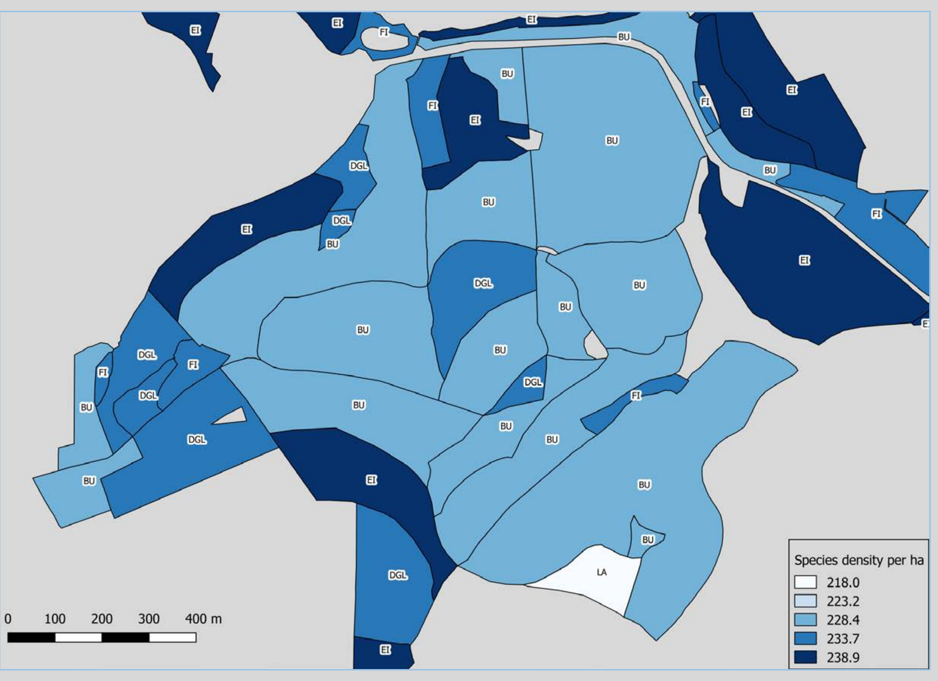

Figure 1: Density in trees/hectar for tree species

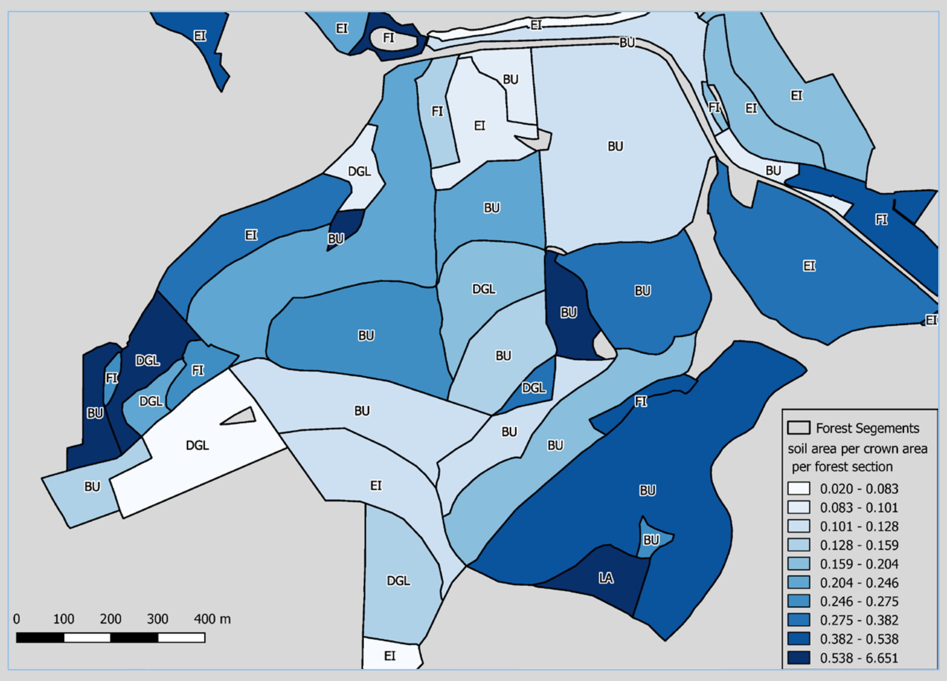

Figure 2: Ratio of soil area to crown area per forest section

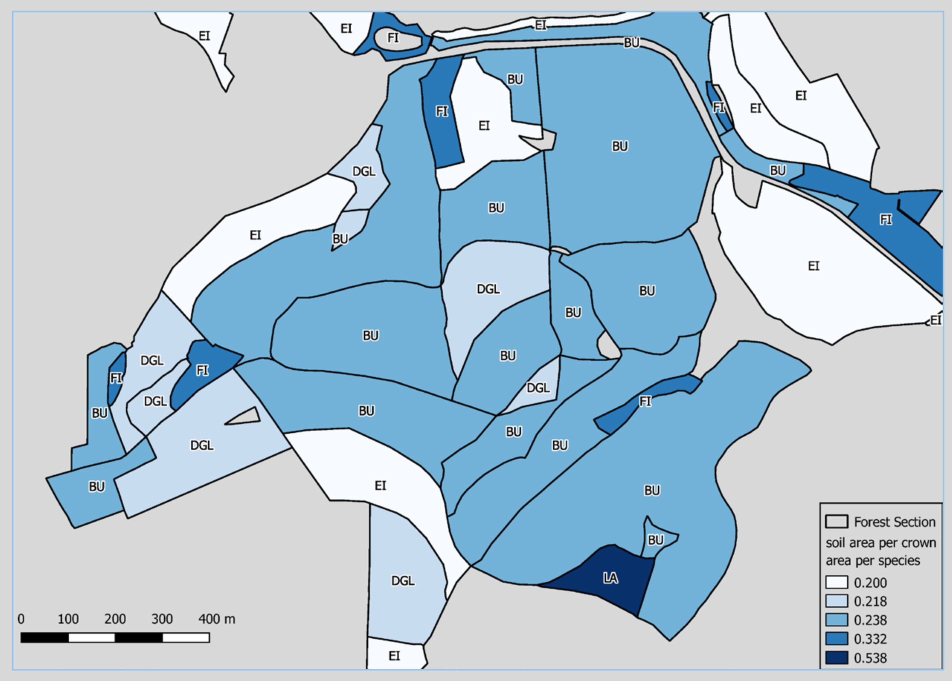

Figure 3: Ratio of soil area to crown area per species

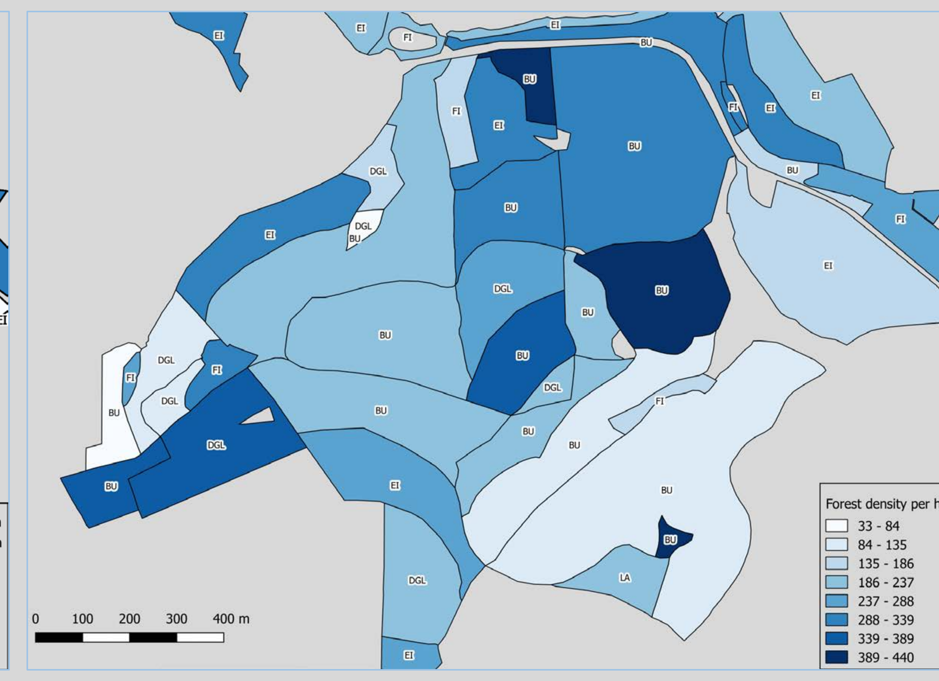

Figure 4: Density in trees/hectar for forest sections

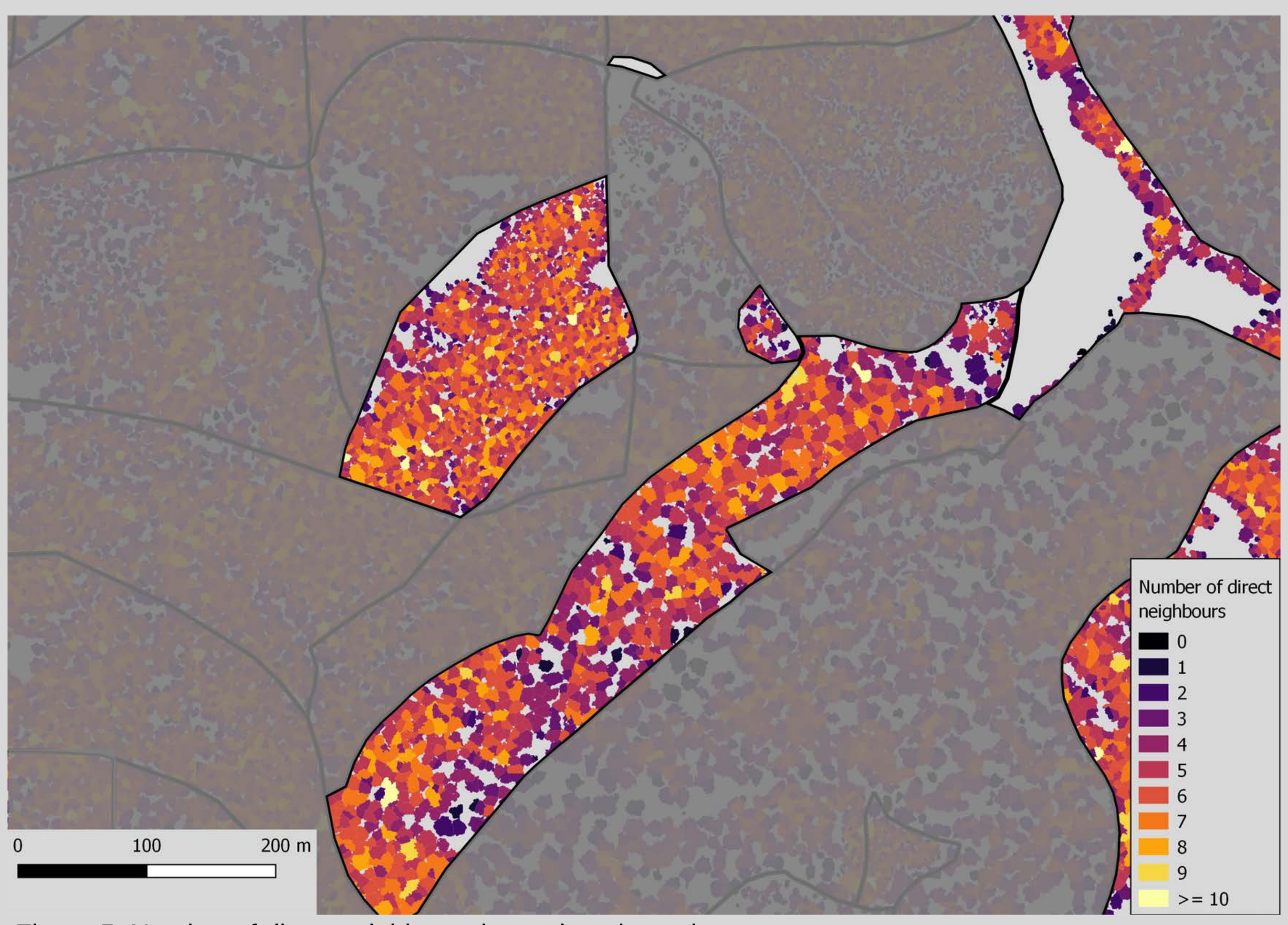

Figure 5: Number of direct neighbours in two beech sections

Direct Neighbours

Two beech sections within the study area were chosen to expand on the statements and a detailed look at different indicators. The tree height, the number of direct neighbours and the entropy were generated from LiDar and RGB data. Figure 5 shows the amount of direct neighbours for each tree polygon. A buffer of 10 cm size was placed around each polygon. Then the amount of touched on polygons within the buffer was counted.

At first glance there seems to be no significant difference between both sections. On closer inspection though it becomes apparent that trees in the lower section tend to stand more separately. In comparison with the forest density per ha (Fig. 4) there is a connection between the density and the number of direct neighbours by tree. According to that the indicators density (tree/ha) and number of direct neighbours point to similar patterns within the forest.

Maximum Height

Figure 6 shows the maximum height of each polygon with a range between maximum of 43.9 m and a minimum of 7.8 m. The height was derived from the canopy height model (chm) by extracting the maximum height for each polygon.

As one can see there is a difference in tree height between the two considered sections. The tree sizes in the upper section are much smaller then the sizes in the lower section. It is noticeable that the higher trees have less direct neighbours than the smaller ones. The density in trees/ha is also higher for the lower department while the soil/crown area ratio only differs slightly between the observed sections. These indicators point to differences in the age composition of the departments. This assumption is supported by the metadata which states an age of 49 years for the upper and 140 years for the lower section.

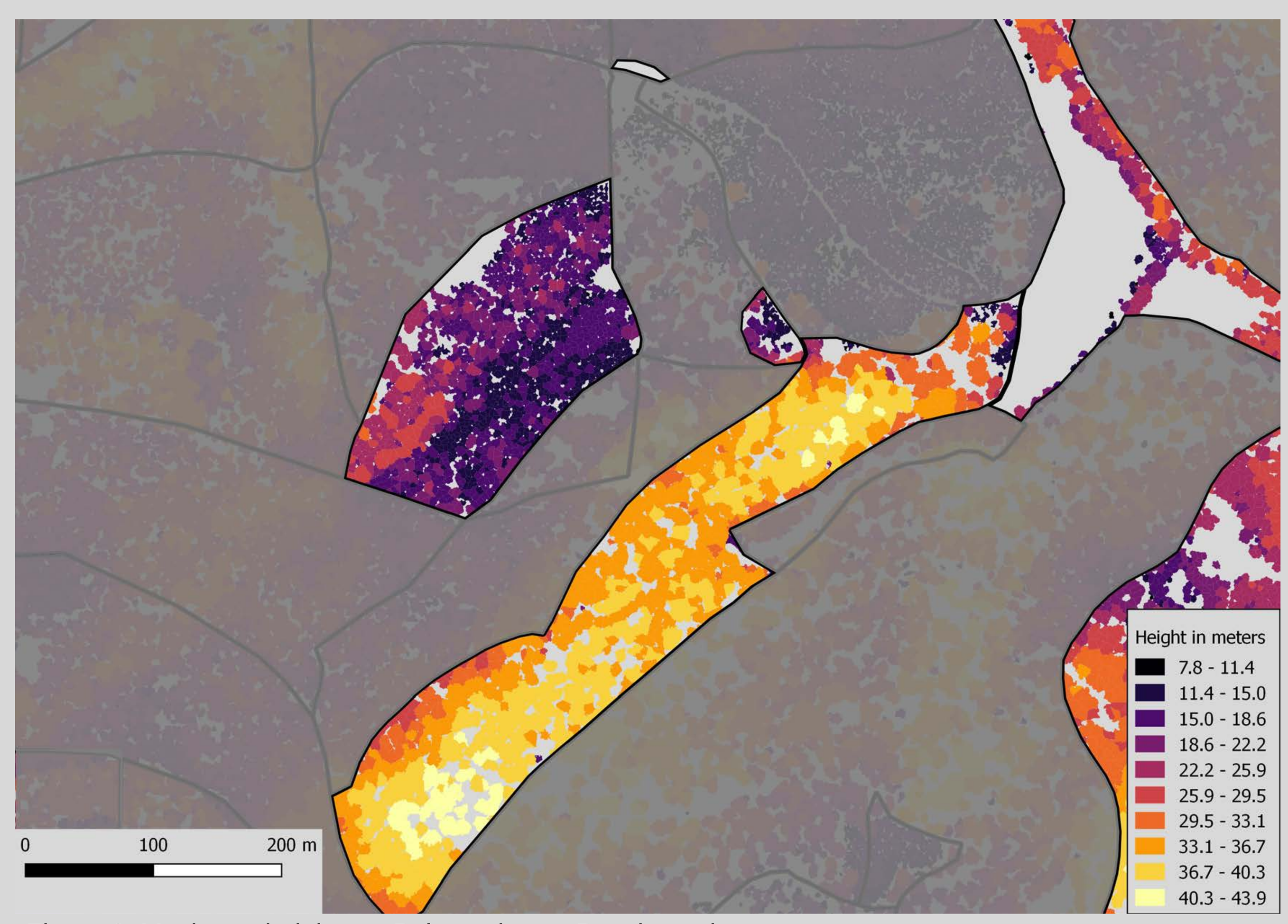

Figure 6: Maximum height per Polygon in two Beech sections

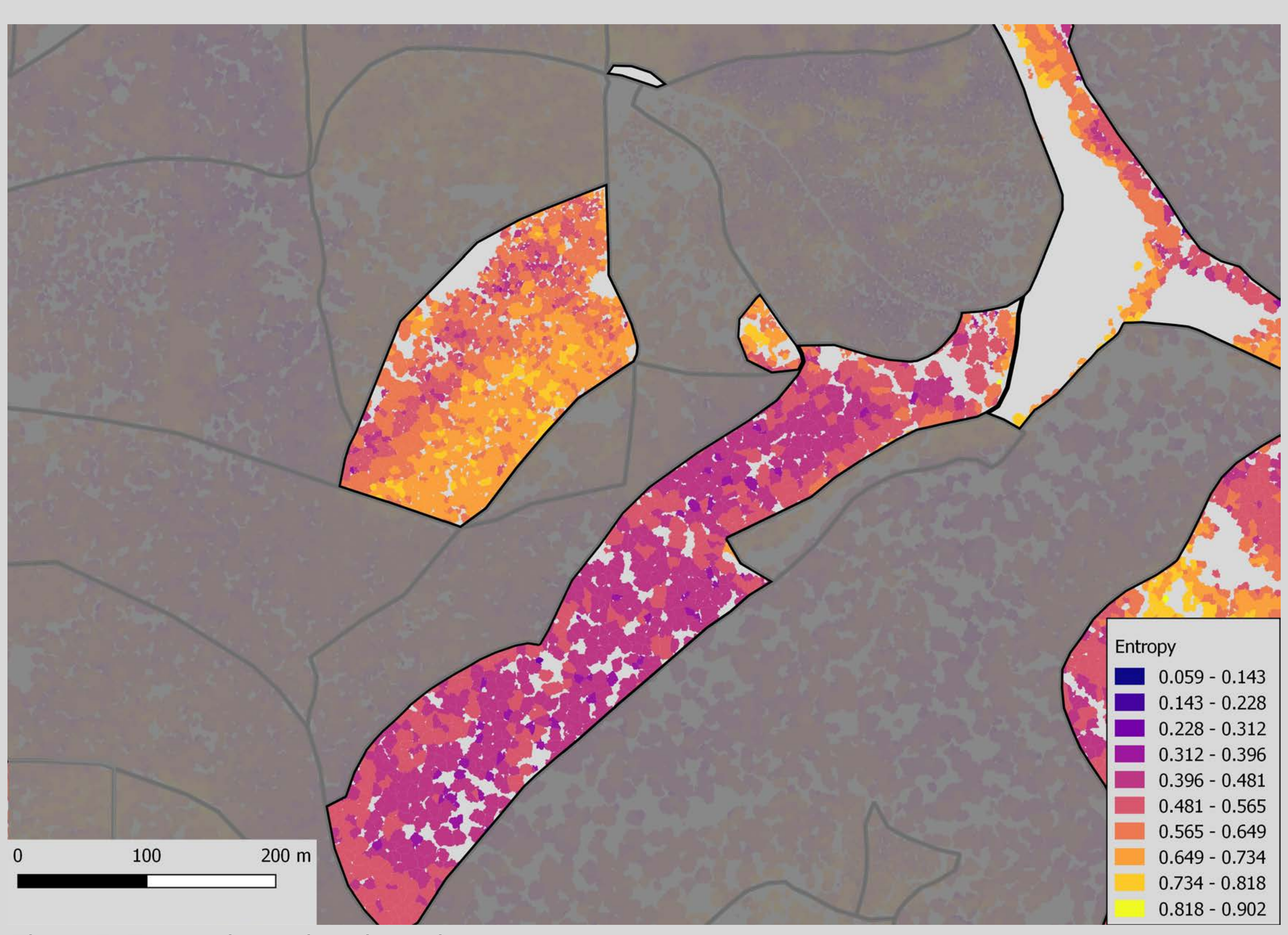

Figure 7: Entropy in two beech sections

Entropy

The entropy as generated for this example as shown in figure 7 represents the diversity and evenness of LiDaR returns per altitude level. Lower values indicate an even vertical structure per polygon while higher values imply a more diverse vertical structure per polygon.

Concerning the considered beech departments the indicator suggests a more diverse vertical structure for the trees in the upper section while the structure for the trees in the lower section appears to be more even. It is noticeable that polygons with low entropy and thus a lower vertical diversity simultaneously have a higher height and vice versa. This leads to the presumption that a more even vertical structure points to a higher age of the inventory. In contrast, a lower age of tree department is indicated by a diverse vertical structure.