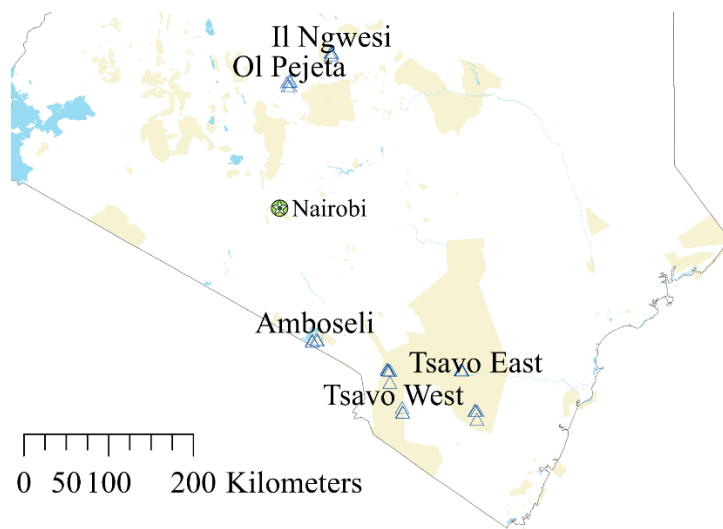


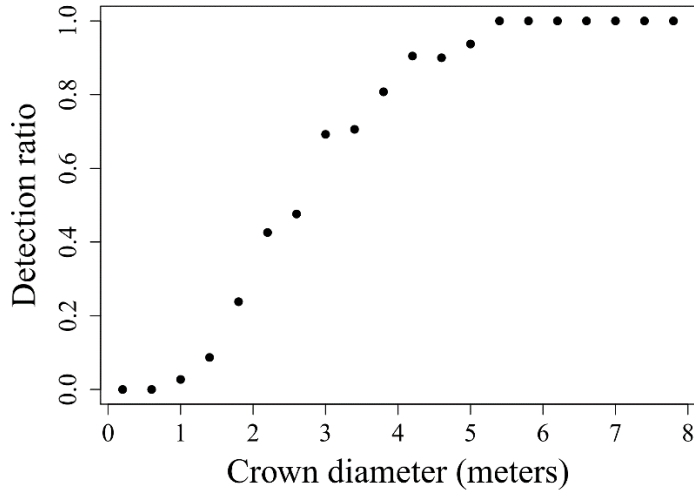
## Appendix A

This chapter describes a validation analysis of estimated mean crown size, crown density, and woody cover using field data collected in southern Kenya during September-October 2015. Plots were established in five protected areas: Tsavo West NP, Tsavo East NP, Amboseli NP, Ol Pejeta wildlife conservancy, and Il Ngwesi group ranch (Figure A1). In total, we established 28 plots with at least four plots in each protected area. The size of plots varied with the density of trees and shrubs, ranging from 350m<sup>2</sup> to 8000m<sup>2</sup> with a median at 1450m<sup>2</sup> (38x38m). The position of plot corners were determined with a GPS and the position of trees and shrubs within each plot were measured with a laser rangefinder from the plot corners. Using measuring tape, we determined the diameter of crowns along the longest axis and on the perpendicular. From these two measurements, we later calculated crown sizes assuming elliptic crown shapes. We acquired the best available high resolution imagery covering the sites from 2012 or later. In some cases, this resulted in imagery of lower quality (few green leaves on the trees) than the imagery used in the continental analysis.



**Figure A1: Map of the five protected areas in southern Kenya where field work was conducted. The positions of individual plots are marked with blue triangles.**

Our analysis of detection ratios (Figure A2) indicates a detection threshold of ~ 2 m below which smaller trees and shrubs were not reliably detected, while most individuals with crown diameter > 3 m were detected. The detection ratios were likely negatively influenced by the sometimes low quality of the imagery and the time difference between image acquisition and field work (often 2-3 years).



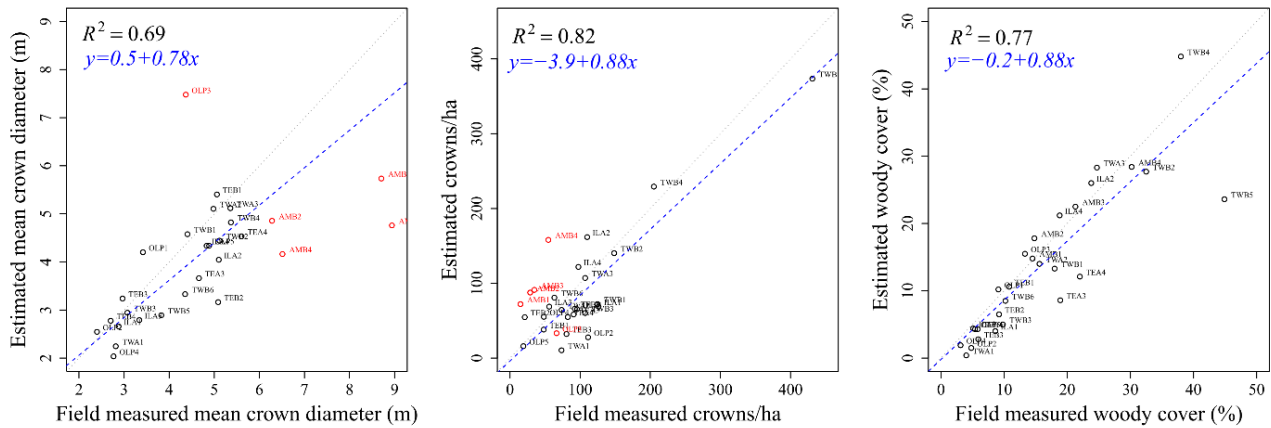
20

**Figure A2: Detection ratios of woody plants in classified imagery at field work sites. The values were calculated as mean detection ratios for trees divided into bins with width 40cm.**

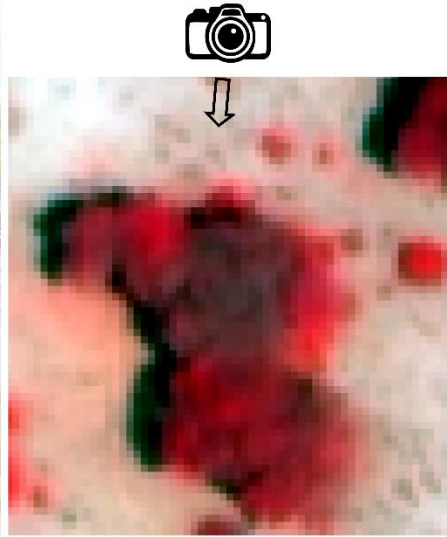
25

Figure A3 shows validation results for mean crown sizes, crown density, and woody cover. Here, we excluded all field measured trees and shrubs with a diameter less than the 2 m detection threshold. Estimates of the woody properties then fall relatively close to the one-to-one line. The four sites in Amboseli were dominated by large umbrella thorn acacias (*Vachellia tortilis*) with heterogeneous crowns (Figure A4). The spread-out architecture of these tree crowns make them appear as several distinct crowns from above and the delineation algorithm did not identify them as single trees. While these trees are not rare, they were overrepresented in our field data set and we therefore chose to exclude the Amboseli sites when calculating  $R^2$  for mean crown size and crown density. We also excluded one site in Ol Pejeta (OLP3) where the smaller trees lacked green leaves in the imagery and could not be detected.

30



**Figure A3: Validation of estimated mean crown size, crown density, and woody cover. The Amboseli sites and one site in Ol Pejeta were excluded when calculating  $R^2$  for mean crown size and crown density. These sites are shown in red color.**



35

**Figure A4. *Vachellia tortilis* at a field work site in Amboseli NP, Kenya. The left image shows two trees with overlapping crowns, with the second being further back on the left. The right image shows the same trees in false color satellite imagery. The branched-out architecture of the canopy make them appear as several distinct crowns. The camera symbol roughly indicates the position from which the ground photo was taken.**

40