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The form factors of South African trees: is it possible to classify them easily using field measurements and photographs?

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Abstract

Modern tree biomass allometry makes use of "form factor", which is the ratio of the true volume to the apparent volume. However, there is no database of form factors of South African trees, hence this study was undertaken to assess the possibility of assigning form factors to trees in a quick and easy way, either by visual assessment of an image of the tree or by simple field measurements. Stem diameter, taper and node length data for 112 trees was collected using both *in situ* and in-lab measurements from photos taken of the same trees in the field. The data were used to model tree volume using the fractal properties of branching architecture. The estimated tree volume was then used along with basal diameter and tree height to calculate the form factor.

Results showed that measurements taken off images underestimated stem diameter and node length by 4% and 5% respectively, but the fractal allometry relationships developed using either the manual in-field or image analysis approach were not statistically different. This proves that dry season photography is sufficiently accurate for establishing relationships needed to construct a fractal model of tree volume. The image analysis approach requires a clear unobstructed view of the sample tree. This requirement made the approach less effective as when trees were in close proximity and when branches overlapped. The time taken using the photographic approach was twice the amount taken for the manual in-field.

Form factor varied between species, but the variation was not statistically significant ($p=0.579$). The mean form factor per species ranged from 0.43 to 0.69. Form factors were negatively correlated with wood density (-0.177), basal diameter (-0.547) and height (-0.649). Due to the unavailability of an independent tree biomass dataset, it was impossible to validate the allometric equations based on estimated form factors and wood density. The inclusion of form factor was shown to improve the accuracy of biomass estimation by 11%.

Principal component analysis showed that form factors can be assigned using tree height and the form quotient.