

## A SAMPLE OF BIAS, THE BIAS IN SAMPLING

Hijbeek Renske<sup>1</sup>, Farid Dahdouh-Guebas<sup>1</sup>, Gitundu Kairo James<sup>2</sup>, Johan Schoukens<sup>1</sup> and Nico Koedam<sup>1</sup>

<sup>1</sup> Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium  
E-mail: [renskehijbeek@gmail.com](mailto:renskehijbeek@gmail.com)

<sup>2</sup> Kenya Marine and Fisheries Research Institute, PO Box 81651 Mombasa, Kenya

Forest inventories for either commercial or scientific purposes require accurate data on density and basal area. Mangrove forests grow worldwide on (sub) tropical seashores in saline environments. Within these forests, plotless sampling methods are typically used for density and basal area estimations. A methodological study was conducted to verify the accuracy of several plotless sampling methods, among which the Point Centered Quarter Method (PCQM). Two approaches were used: one fieldwork approach in which the spatial coordinates of all trees in 4 sites in a mangrove forest near Gazi Bay- Kenya were recorded. One modeling approach in which 6 vegetation dispersion patterns were generated based on the literature. Both approaches resulted in datasets on which the plotless sampling methods were applied in silico (MATLAB 7.7.0) and the estimations compared with the true densities.

The results show strong bias for each method, depending on the site and pattern. Overestimations and underestimations were found of more than 80%, which gives density estimations with 5 times fewer trees per area than the real value. In general the results correspond with previous findings from for example Engeman et al. (1994), Steinke and Hennenberg (2006) or White et al. (2008). Additionally in this study an emphasis is placed on PCQM, which is the most often used method within mangrove research, and the zonation pattern occurring in some mangrove forests. Overall, PCQM is in the group of worst performing methods. Zonation gives a larger underestimation in every method.

One argument given for using PCQM is the assumed comparison benefit, as other researchers also use this method. This study however shows that both underestimations and overestimations do occur when using PCQM, which gives a double bias when comparing two sites.

Care should be taken when using plotless sampling methods. Deviant estimations of resources can generate large errors when valuing ecosystem services. Especially with the potential of the Reducing Emissions and from Deforestation and forest Degradation (REDD) situations can come in which communities receive too little or societies pay too much for carbon sequestration.

This study argues for a change in the research methodologies. When plotless sampling methods are a necessity because the forest is difficultly accessible or very sparse, it is recommended to measure the distance to the second individual when using PCQM. Preferably however the Variable Area Transect (VAT) method should be used.

### References

- Engeman R.M., R.T. Sugihara, L.F. Pank and W.E. Dusenberry. 1994. A comparison of plotless density estimators using Monte Carlo simulation. *Ecology* Vol 75:1769-1779.
- Steinke I. and K.J. Hennenberg. 2006. On the power of plotless density estimators for statistical comparisons of plant populations. *Canadian Journal of Botany* 84: 421-432.
- White N.A., R.M. Engeman, R.T. Siguhara and H.W. Krupa. 2008. A comparison of plotless density estimators using Monte Carlo simulation on totally enumerated field data sets, *BMC Ecology*.