Mapping edaphic characteristics in tropical rainforests based on floristic inventory and remote sensing

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The objective of this study was to develop a method to map environmental heterogeneity in *tierra firme* tropical rainforest based on floristic inventory and remote sensing. First we recorded the presence or absence of pteridophytes (ferns and lycophytes) in 36 transects. These were 2×500 meters in size and spread over a 1300 km^2 tropical rainforest area in Ecuadorian Amazonia. Then we estimated the soil cation content for each transect using calibration, i.e. by taking an average of the known soil cation content optima of those pteridophyte species that were observed in the transect. The soil optima were obtained from a pre-existing dataset consisting of floristic and soil data for 134 transects situated in Ecuador, Colombia and northern Peru[1]. We then collected spectral signatures from the Landsat image using 200×600 meter rectangles centered on the transects. We modeled the estimated soil cation content at each transect as a function of the DN values of the six visible and infra-red bands of the image using linear multiple regression.. This we repeated for a number of different pre-processing treatments. The best model was achieved when the image had been first atmospherically corrected by doing a Dark Object Subtraction after having masked away all water pixels, and subsequentally topographically corrected by doing an equal area normalization, which scales the DN values so that all pixels get the same total brightness. Backward elimination was applied to remove from the multiple regression model those bands that were not statistically significant. The final model was used to estimate soil cation contents for the transects on the basis of their DN values. Leave-one-out cross-validation showed that the soil cation contents estimated using floristic composition and spectral signatures were highly correlated ($r=0.88$, $p<0.001$) (Fig. 1). We finally applied the regression equation to the image data in order to produce a continuous map of estimated soil cation content for the entire study area (Fig. 2).

[1] H. Tuomisto, K. Ruokolainen, and M. Yli-Halla, "Dispersal, environment, and floristic variation of western Amazonian forests" *Science* 299, pp. 241-244; and unpublished data.

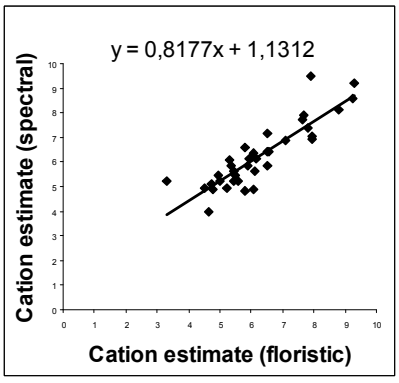

Fig. 1. Linear regression between cation estimates based on spectral signatures and cation estimates based on floristic composition.

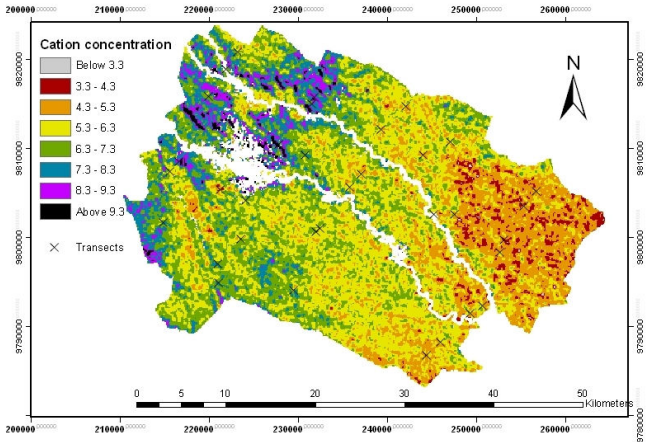

Fig. 2. The final map of estimated soil cation content in the study area.