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Links between soil composition and podoconiosis occurrence and prevalence in Cameroon

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Introduction: Podoconiosis, a form of non-filarial elephantiasis, is a geochemical disease associated with individuals exposed to red clay soil from alkalic volcanic rock. It is estimated that globally 4 million people suffer from the disease, though the exact causal agent is unknown. This study is the first analysis in Cameroon to compare high resolution ground-sampled geochemical soil variables and remote sensing data in relation to podoconiosis prevalence and occurrence.

Aim: To investigate the associations of soil mineralogical and element variables in relation to podoconiosis prevalence and occurrence in Cameroon.

Methods: In this study, exploratory statistical and spatial data analysis were conducted on soil and spatial epidemiology data associated with podoconiosis. The studied soil data was comprised of 194 samples from an area of 65 by 45 km, containing 19 minerals and 55 elements. Initial proximal analysis included a spatial join between the prevalence data points and the closest ground-sampled soil variables. In addition, the soil variables were interpolated to create a continuous surface. At each prevalence data point, soil values from the interpolated surfaces were extracted. Correlation and logistic regression analysis were carried out on both the proximal analysis data set and the interpolated soil variables. The interpolated soil variables were also analysed using principal component analysis, to identify any patterns or clusters, regarding podoconiosis occurrence.

Results: Bivariate analysis of the proximal and interpolated data set identified several statistically significant soil variables associated with podoconiosis. Correlation analysis identified several soil variables with a statistically significant positive Spearman rho value in relation to podoconiosis prevalence. Logistic regression analysis identified several statistically significant soil variables with odds ratio values greater than 1, with respect to the podoconiosis occurrence data. The significant variables included barium, beryllium, potassium, sodium, rubidium, strontium, thallium, potassium feldspar, mica and quartz. Barium, beryllium, potassium, sodium, quartz, mica and

potassium feldspar have been previously identified in the literature in relation to podoconiosis occurrence. The PCA biplots showed no definite groupings of soil compositions with respect to podoconiosis occurrence. However, the envelope of the 95% confidence ellipse, representing prevalence data with at least one case of podoconiosis, does begin to separate as the soil variables suggested to be associated with podoconiosis occurrence increase and reach maximal values.

Conclusion: The findings suggest that the key minerals and elements identified in this study may play a role in the pathogenesis of podoconiosis or could be disease covariates. These significant results have led to ongoing research within this project to examine the utilisation of medium and high-resolution hyperspectral methods to identify if podoconiosis-associated soil variables, such as quartz, are detectable remotely. Data can then be used to predict areas at risk using multivariate machine learning techniques theorising a link between prevalence, presence and combinations of multiple soil related variables.

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