A global predictive model of soil selenium

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Selenium (Se) is a vital trace element for human health, and because Se intake occurs primarily through dietary consumption (e.g., grain), the human health risk of inadequate Se intake is governed in part by soil Se concentrations. Soil Se is highly variable and typically ranges from ~0.01-2 mg/kg but can be >1,000 mg/kg in seleniferous soils. Standardized broad scale soil geochemical surveys have been conducted in few countries including China, Western Europe, and the United States, but for much of the globe, broad scale Se distributions are virtually unknown. Therefore, the health risks associated with Se deficiency/toxicity are also unknown. The goals of this research were to 1) identify the dominant climatic, geologic, and soil physicochemical properties that govern spatial Se distributions in the soil, and 2) using data from previously conducted broad-scale soil geochemical surveys, use statistical models to predict soil Se on a global scale.

Soil Se data were obtained from ~38,000 data points in China, Western Europe, and the USA from various geochemical surveys. In order to identify the dominant variables governing Se distributions, 18 global datasets describing climatic (e.g., aridity, temperature, evapotranspiration), soil (e.g., pH, clay content, bulk density), and other variables (e.g., geology, land use) were collected, imported into ArcMAP, and extracted for each data point. The relative importance of each of these datasets in terms of governing soil Se distributions was evaluated using several linear and nonlinear statistical models. Artificial neural network models were then used to predict the spatial distribution of Se on a global scale. The results of the statistical analyses indicate that climate variables were the most important for governing soil Se concentrations followed by soil chemical properties. Of the variables analyzed, categorical variables (e.g., geology, soil type, land use, etc.) were the least important in terms of governing the broad scale distribution of Se. Soil Se concentrations were predicted on a global scale with ~70% accuracy. Such predictions could be used to evaluate the current status of Se in agricultural soils where no previous measurements have been made. Given that the most important variables are comparatively dynamic (e.g., climate vs. geology), these results suggest that the spatial distribution of Se in soils is likely to change through time.