A NOVEL USE OF DATA TRANSLATION ALLOWS 3-D PREDICTION OF SOIL FERTILITY LANDSCAPES

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Soil fertility managers need better estimates of the subsoil contribution to the nutrient pool. This need could be achieved through 3-D predictions of subsoil fertility using a novel method of soil-profile data translation in relation to a controlling genetic horizon. For this translation, the depth of a controlling pedogenic feature is used as the origin and the rest of the profile is linearly scaled to it. When applied to a group of soils, from across a local or regional landscape, with varying depth to the controlling feature, a coherent dataset results. Three advantages of this method are: 1) sparse profile data can be linked by the translation allowing confident functional fits, 2) rather than interpolation, spatial predictions are based on the link provided by the soil genetic model, 3) high resolution sensor data such as bulk soil apparent electrical conductivity (ECa) or remote sensing can be used as a proxy of the genetic feature of interest. In summary, this translation procedure allows landscape trends in soil fertility - caused by the controlling feature - to be represented by relatively simple functions. The resulting functions can be combined with a soil genetic model to make 3-D predictions of subsoil fertility.
To illustrate the method, we used soil profile and ECa data from several previous studies on a 36-ha study field. This field is located in NRCS-Major Land Resource Area 113 - the Central Claypan Region. In this soil region, profile clay distribution exhibits pedogenic control of soil profile fertility. A prominent argillic horizon contains the profile maximum clay (clay-max) content of 45-65%. The soil profiles from the study field were translated separately with depth to clay-max as the translation origin. The translations were composited and functions were fit to soil texture, cation exchange capacity (CEC). P. K, Ca, Mg, Na, Al, organic matter, and buffer pH.

We used the profile fertility functions to produce 3-D maps of landscape fertility. First, the origin of the translation. depth to clay-max, was related to measurements of (ECa) via a best-fitting exponential model. Next, data from an ECa survey of the study field were used in this exponential model to calculate spatial maps of depth to clay-max. This result was a map of the translation. Finally, at each map node, the fertility functions were back-translated by matching the origin of the functions to the depth to clay-max, resulting in 3-D predictions of profile fertility.

The functions and resulting 3-D maps reflect the genesis of these soils and are useful for estimating the subsoil contribution to the nutrient pool. Soil above the clay-max had low CEC, P. and buffer pH. This soil material was highly weathered and therefore leached of primary minerals and fertility. Soils in the Central Claypan Region having a deep clay-max are largely composed of this material and may respond well to fertilizer and lime additions. Argillic horizons near the clay-max were rich in secondary clay minerals with high CEC, but were very low in pH and P. Relatively unweathered loess parent material below the argillic horizons had increased P and pH. Soils in this region with shallow clay-max have relatively high subsoil fertility and may not respond to fertilizer additions. The 3-D models show differential distribution of subsoil fertility that could have implications for plant response, and may interact with surface additions of fertilizers.

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Our cover: To world food security and agricultural production, the Haber-Bosch process has been the most economical means for fixation of nitrogen for fertilizer. Fritz Haber won the Nobel Prize for Chemistry in 1918 and Carl Bosch shared the prize in 1931.