



Soils and public health: the vital nexus

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Soils sustain life. They affect human health via quantity, quality, and safety of available food and water, and via direct exposure of individuals to soils. Throughout the history of civilization, soil-health relationships have inspired spiritual movements, philosophical systems, cultural exchanges, and interdisciplinary interactions, and provided medicinal substances of paramount impact. Given the climate, resource, and population pressures, understanding and managing the soil-health interactions becomes a modern imperative.

We are witnessing a paradigm shift from recognizing and yet disregarding the 'soil-health' nexus complexity to parameterizing this complexity and identifying reliable controls. This becomes possible with the advent of modern research tools as a source of 'big data' on multivariate nonlinear soil systems and the multiplicity of health metrics. The phenomenon of suppression of human pathogens in soils and plants presents a recent example of these developments. Evidence is growing about the dependence of pathogen suppression on the soil microbial community structure which, in turn, is affected by the soil-plant system management. Soil eutrophication appears to create favorable conditions for pathogen survival. Another example of promising information-rich research considers links and feedbacks between the soil microbial community structure and structure of soil physical pore space. The two structures are intertwined and involved in the intricate self-organization that controls soil services to public health. This, in particular, affects functioning of soils as a powerful water filter and the capacity of this filter with respect to emerging contaminants in both 'green' and 'blue' waters.

To evaluate effects of soil services to public health, upscaling procedures are needed for relating the fine-scale mechanistic knowledge to available coarse-scale information on soil properties and management. More needs to be learned about health effects of soils in organic agriculture that are often used for soil quality comparison and benchmarking. The influence of soil degradation and rehabilitation on public health has to be assessed in quantitative terms. Some links between soils and public health regarding, for example, immune maturation, antibiotic resistance development, and mental well-being, have been long hypothesized but remain to be examined. The data on soil-health relationships are scarce and very much disjointed, and a concerted international effort appears to be needed to encompass various economic and geographical settings. Current definitions of healthy soil broadly include aspects that are conducive for human health, and functional evaluation of soil quality with a focus on public health will have useful applications in public policies and perception. The 'soil-health' connection is complex in character, global in manifestation, and applicable to every human being.