Chemists Without Borders and the water sampling volunteers

Chemists Without Borders intends to develop and introduce a Well Sharing Program (WSP), which will allow those whose wells are contaminated with arsenic to take water from a neighbor's safe well. Well sharing presents its own difficulties such as social, cultural, and economic considerations, which we hope to overcome in part through stakeholder outreach and education. With the development of logistics and policies that make the program acceptable to the community, we believe that the model may then be replicated across Bangladesh.

The WSP has the potential to be the most cost-effective, sustainable solution for drinking water in Bangladesh compared to other options such as installing treatment systems or drilling deep wells. For example, a water treatment system can cost more than $20,000 and require frequent operation and maintenance and specialized parts, which if not properly maintained make them susceptible to break down, which is often the case, and why many water projects fail after about one year.

If we demonstrate success of the WSP, the model may be implemented across Bangladesh, and to other countries that are experiencing similar problems. The solution isn't limited to arsenic – we can use this method to address other types of contaminants.

Chemists Without Borders is seeking technical and program management support to assist with the WSP. If you have experience with water quality and quantity evaluation and project management, please contact me at robert@environmentalstrategies.org.

The Formation and Importance of Soil Organic Matter in Ecosystem Health

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Carbon (C) is the fourth most abundant element in the universe and is the foundation of all life. All living tissues contain C in forms of organic compounds made of C rings or chains with other essential nutrients. The recycling of these tissues (e.g. plant litterfall, decomposition) is a fundamental process involved in global C cycling and the formation of soil organic matter. For thousands of years, humans have appreciated the fact that 'dark soils' are commonly productive soils and the dark color is often associated the amount of organic matter incorporated into the mineral soil. As world population increased, the demand for agricultural production increased resulting in increased land exploitation. Under intensive agricultural production even the most productive soils may gradually become less productive - a consequence driven in part by the degradation of soil organic matter quantity and/or quality. Land clearing for row crop agricultural production encouraged net mineralization of organic matter, soil erosion, increased acidity, (or accumulation of alkali in arid lands), leading to a decline in soil productivity over time.

Soil organic matter is a complex and dynamic component of the soil ecosystem and one of the key soil attributes that is directly influenced by management decisions. Soil organic matter primarily consists of residual compounds from the decomposition of plant, fauna, and microbial input, and it exerts a major influence on soil structure and function. For example, soil organic matter provides much of the cation exchange and water holding capacity of surface soils; it increases soil aggregate stability and reduces the potential for surface runoff and soil erosion; it also acts as the primary energy source and nutrient source for soil organisms thereby influencing soil microbial diversity and activity. It is also important to note that globally, soil organic matter contains about twice as much C as all terrestrial vegetation (yes, including trees!) and the atmosphere combined. Therefore, it is essential to understand how to effectively manage soil organic matter to ensure a healthy and productive ecosystem.

Soil organic matter slowly accumulates over time in natural ecosystems and the rate at which soil organic matter either increases or decreases depends on the balance between gains and losses of C. The C gains mainly are on-site plant residues (root and shoot production and turnover); applied organic materials (natural or anthropogenic). The C losses commonly come from soil respiration (mineralization or conversion of reduced C to CO_2), plant biomass removals, and/or processes that directly remove soil, such as erosion. Temperature and moisture constraints dictate decomposition rates, with anaerobic conditions associated with wetlands (commonly also in a depositional position in the landscape) resulting in exceptionally slow C loss rates and high C accumulation rates. Management practices need to maximize C gains while minimizing C losses in order to conserve or build soil organic matter. Healthy soil ecosystems contain a diversity of organic compounds and classes of compounds that make up fast, slow and passive pools of soil organic matter.

For agroecosystems, there are a multitude of practices that can help build soil organic matter including: 1) Seeking to maintain continuous vegetative cover; 2) returning all plant residues rather than harvesting straw or stover; 3) Applying composts, manures, and/or biochar to promote C gains; 4) Minimizing intensive tillage and synthetic fertilizer applications; 5) avoiding whole plant harvest and overgrazing to reduce C losses. For natural ecosystems such as forest or prairie, the rates of soil organic matter turnover are lower than that in croplands. In forests, the secondary metabolites in tree and understory litter can slow the decomposition of soil organic matter and the absence of tillage or intensive physical disturbance greatly reduces C losses to increased soil respiration. Large disturbance such as a forest fire may have the capacity to rapidly remove a significant amount of soil organic matter depending on the fire regime. As a legacy of fire and a passive form of C, charcoal or pyrogenic organic matter (Fig 1) can directly contribute to the passive component of the soil organic matter pool, although the low density may facilitate lateral transportation and a redistribution of C across a landscape. Nevertheless, careful management to promote soil organic matter accumulation is essential to improve soil health and productivity across ecosystems. Elimination of fire from forest or grassland ecosystems reduces the inputs of pyrogenic C. Rebuilding soil organic matter pools to pre-Anthropocene levels will best be accomplished by reducing soil disturbance, increasing biomass returns to soil and incorporating pyrogenic C into management systems.

Figure 1. Soil organic matter formation and the "short-cut" for charcoal or pyrogenic C as a passive form of soil carbon (DeLuca and Aplet. 2008. Frontiers in Ecology and the Environment 6, 18–24. http://dx.doi.org/10.1890/070070).

Below are some additional resources to learn about soil organic matter:

- Soil organic matter in agricultural ecosystem (Cornell University): http://franklin.cce.cornell.edu/resources/soil-organic-matter-fact-sheet
- Soil organic matter helps maintain a healthy forest ecosystem (Michigan State University): https://www.canr.msu.edu/news/organic_matter_in_soils_helps_maintain_a_healthy_forest_ecosystem
- Interpretation of soil organic matter testing result (Oregon State University): https://catalog.extension.oregonstate.edu/em9251
- Soil organic C reservoir, dynamic, and response to global change (1997 article): https://doi.org/10.1073/pnas.94.16.8284
- Persistence of soil organic matter as an ecosystem property (2011 article): https://doi.org/10.1038/nature10386
- Land use, management, and global change on soil organic matter dynamics (2011 article): https://doi.org/10.1007/s11104-010-0617-6
- A updated view on the components and persistence of soil organic matter (2015 article): https://doi.org/10.1038/nature16069