Landmark Papers: No. 3


Reflections by N.H. Batjes

I was pleasantly surprised, and honoured, by the Editor-in-Chief’s request to provide some reflections on my paper published in the European Journal of Soil Science in 1996. During my early career as a land evaluation expert, I largely considered sound soil organic matter management as being essential to safeguarding the fertility and physical properties of soils. However, it was when I joined ISRIC - World Soil Information, then known as the International Soil Reference and Information Centre, in 1990 that I became more aware of, and interested in, the role of soils (and the soil organic matter they hold) in regulating ecosystem functions and processes. Under the stimulating Directorship of the late Dr Wim Sombroek, ISRIC had just organized an international conference that led to the widely cited book on ‘Soils and the Greenhouse Effect’ (edited by Dr Lex Bouwman, 1990). Interestingly, one of the outcomes of the conference was the identification of research gaps with respect to the geographical distribution and characterization of the world soils and land cover types as required for improved, quantitative model-based studies of land use and climate change-induced changes in biogenic greenhouse gas (CO₂, N₂O and CH₄) fluxes, and the associated changes in carbon stocks held in vegetation and soil at various spatial and temporal scales. Such information is needed to inform land-use policies and to propose interventions that promote a reduction in biogenic greenhouse gas emissions at a global scale while ensuring food security, biodiversity and human well-being and livelihood at the local scale.

One direct spin-off of the conference on ‘Soils and the Greenhouse Effect’ was the methodological development and subsequent compilation of a harmonized, quantified soil profile database, now known by its acronym ISRIC-WISE, which has been linked to the soil mapping units shown on the broad-scale digital FAO-UNESCO Soil Map of the World. Key site and soil attributes to be considered in the global database were identified from an extensive review of soil factors and processes that control fluxes of heat, moisture and greenhouse gases (with my esteemed former colleague Dr Mike Bridges). By its nature, the database drew heavily on the essential and voluntary contributions from a wide range of soil institutes and experts contacted across the various continents; each contributed a selection of soil profiles considered best to represent soil conditions (defined in terms of the unifying Soil Map of the World Legend; FAO-UNESCO, 1974) in their respective countries. These materials were supplemented with site, soil morphological and soil analytical data derived from the vast collection of survey reports and paper maps safeguarded in ISRIC’s soil reference library.

Because of this concerted effort, WISE soon provided a larger consistent profile dataset for the world than previously available, albeit still with recognized soil geographical and soil taxonomic gaps, that is freely accessible through the ICSU World Data Centre for Soils (http://www.isric.org). The WISE soil profiles and suite of spatial GIS databases derived from them have been used for a diverse range of studies by numerous research groups and organizations throughout the world. They have been cited, for example, in research on pedotransfer function development, global agro-ecological zoning, assessments of crop production potential and yield gap analyses, soil vulnerability to pollution, soil gaseous emission potentials, and mathematical modelling of soil organic carbon stock changes at national scale.

One of my first studies using the initial WISE dataset was to present estimates for global stocks of soil carbon, organic as well as inorganic, held in the various soil types of the world to a depth of 2 m; earlier global assessments only considered the top 1 m of soil and were based on datasets that are more limited. The ‘1996 estimates’ implied that the soil organic carbon pool to 1-m depth is about twice the size of the atmospheric carbon pool and about three times the amount of carbon in vegetation; hence, the overall size of the soil carbon reservoir is large when compared with the gross annual fluxes of carbon. My paper thereby pointed to the importance of soils in sequestering atmospheric CO₂ and in emitting biogenic trace gases that are radiatively active and enhance the ‘greenhouse’ effect. Changes in land use and management as well as predicted global warming and climate change, through their effects on net primary productivity, the plant community and soil conditions, have important effects on the size and composition of the organic matter pool in the soil and directly affect the atmospheric concentration of these trace gases.

In retrospect, the still widely cited paper was arguably among the first to draw attention to world-scale carbon in soil in relation to the importance of soils in sequestering atmospheric CO₂ and in emitting biogenic trace gases. It is encouraging for soil scientists and other stakeholders to see that managing soils for multiple economic, societal and environmental benefits now figures prominently on the international agenda (UNEP, 2012).
fundamental issue remains on how to ensure food security and improve livelihoods in the face of increasing land degradation, dwindling fresh water supplies, environmental pollution and loss of biodiversity, while combating or adapting to climate change. This requires new policies and innovative approaches to land management that consider the possible mismatch of the private and social benefits and costs of soil carbon management across the spatial and temporal scales (SCOPE - Benefits of Soil Carbon Project; http://www.soilcarbon.org.uk/). These are challenging issues that need to be tackled by experts from a broad range of disciplines.

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References