

# Amounts, dynamics and sequestering of carbon in tropical and subtropical soils: A memory

*This article belongs to Ambio's 50th Anniversary Collection. Theme: Agricultural land use*

Freddy Nachtergaele

Published online: 13 March 2021

When our article was published (Sombroek et al. 1993) it was in the relative early days of concern about global warming (the IPCC had only been established a couple of years before in 1989). The Food and Agriculture Organization (FAO) of the United Nations had other priorities at the time, focusing on food security and technical and policy assistance to Ministries of Agriculture in developing nations. Wim Sombroek, who had a keen interest in environmental issues had just been appointed as new director for the Land and Water Division at FAO's Headquarters in Rome, Italy.

Before his arrival, the Land and Water Division had been known for their activities at field level in developing countries in assisting in soil surveys, establishing irrigation schemes and giving fertilizer advice. The division had also built up a solid reputation in applied research (crop water requirements), pure methodology development (the Framework for Land Evaluation), and global information products in the field of soils (The FAO/UNESCO Soil Map of the World). The previous director, Graham Higgins, had inspired the Agro-ecological Zones methodology that determined agricultural production potentials in the developing world.

Wim Sombroek had started his career in FAO as a junior expert in a FAO/UNESCO team for forestry research and animal husbandry, based in Belem, Brazil. On the basis of this experience he prepared a PhD-thesis on "Amazon soils", a subject that would remain near his heart throughout his career. Afterwards he worked in several UNDP/FAO supported soil projects, notably in Uruguay and Nigeria. He had gone on from there to become the project manager of the Kenya Soil Survey between 1972 and 1978 where he laid the basis for the SOTER (Soil and Terrain Database) approach to soil mapping. In 1978 he became the Secretary General of the International Society

of Soil Science (ISSS, now IUSS) and the director of the International Soil Information Center (ISRIC) until 1991.

In a discussion with the Editor of *Ambio* just after his appointment, Wim saw an opportunity to further his research findings in the highly fertile Terra Preta de Indio soils of the Amazon Basin. The high carbon content in this region was attributed to the deliberate addition of charcoal-like materials over thousands of years by the prehistoric local inhabitants as well as by long-term mulching and frequent burning practices. To place the research in a wider global warming context, I was called in to use the FAO/UNESCO Soil Map of the World as a basis for the calculation of the global soil organic carbon pool. At the time I had only recently joined FAO's headquarter after having worked in FAO soil survey projects in Sudan, the Philippines, Algeria, Tanzania and Botswana (where our project had finalized the soil map, scale 1:1 000 000). As a FAO technical officer I had always been fascinated in global soil studies and at the time I was working on the digitizing the world soil map (a product that would be released in 1995) and associated interpretations. The third scientist to assist with the article was Axel Hebel, a German soil scientist who had also recently joined FAO as an associate expert.

The rapid evolution of GIS technology proved to be a great assistance for the estimation of soil properties, but the limited availability of readily available soil profile data (in particular soil carbon) proved to be a significant obstacle. In the end, we estimated the soil carbon content of the 26 FAO soil groups based on analytical data for only 400 soil profiles. We were well aware that this is a very low statistical basis to extrapolate results for about 6000 soil mapping units. In comparison more than 21 000 soil profiles were analyzed recently by International Soil Reference and Information Centre (ISRIC) for the Harmonized World Soil Database. Nevertheless, the results were

informative, and more important than the absolute figures, the distribution over the various units allowed later to make first estimates of soil carbon country stocks.

The organic carbon pool in the upper 1 m of the world's soils was estimated at 1220 Gt organic carbon (the present day estimate is about 1500 Gt) and 1.5 times the total for standing biomass (now estimated to be the double). In the widespread deep soils in the tropics, the carbon stored below 1 m may add about 50 Gt C. The contributions of charcoal, roots and soil fauna should be added to these totals. The much less dynamic carbonate-carbon pool amounts to 720 Gt C. Changes in land use, particularly by clearing of forests, reduce organic carbon by 20 to 50% in the upper soil layers, but little in deeper layers. On the other hand, there are indications that a human-induced enrichment of soil organic matter can be maintained over centuries. Research on the causative soil processes should be supported, because an improved understanding of this phenomenon might lead to better management strategies and sound programs to stimulate organic carbon storage and fertility levels in tropical and subtropical soils. The article contributed to the later research in biochar that

promotes the replacement of slash and burn techniques using low-intensity burning fires covered with dirt and straw, which sequester carbon and reduce methane and nitrous oxides emissions from the soil.

We really did enjoy writing the article and would discuss after working hours how to best present the results. Such a pity Wim passed away.

## REFERENCE

Sombroek, W.G., F.O. Nachtergaele, and A. Hebel. 1993. Amounts, dynamics and sequestering of carbon in tropical and subtropical soils. *Ambio* 22: 417–426.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

**Freddy Nachtergaele** (✉)

Address: FAO, Rome, Italy.

e-mail: [freddy\\_nachtergaele@hotmail.it](mailto:freddy_nachtergaele@hotmail.it)