ASSESSMENT OF SOIL ORGANIC CARBON STOCKS AND CHANGES AT NATIONAL SCALE

The GEFSOC Project Team

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WHY ASSESS SOIL ORGANIC CARBON STOCKS AND CHANGES?

Soils hold about 3 times more C than terrestrial vegetation and twice as much as the atmosphere. Land use change, inappropriate agricultural practices and climate change can all lead to a net release of C from soils to the atmosphere, enhancing the problems of greenhouse gas release.

Carbon in the soil can be held in organic and inorganic (as carbonates) form. Soil organic carbon (SOC) generally predominates in the wetter regions. It is vital for ecosystem functions — a major determinant of soil fertility, structural stability, and water holding capacity; but it is highly sensitive to changes in land use and management (Fig. 1).

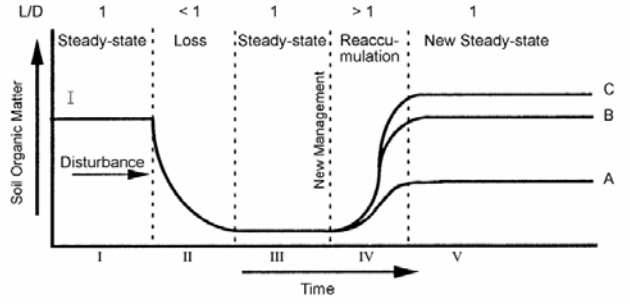

Fig. 1. Conceptual model of soil organic matter decomposition/accumulation following disturbance or improved management: A – stabilization at lower than initial level; B – stabilization at original level; C – stabilization at above-original level

National estimates of SOC stocks and changes are needed to: a) develop appropriate land management policies, b) safeguard soil resources and biodiversity (UNCCD and UNCBD), and c) take actions to mitigate climate change and take advantage of the emerging carbon market (Kyoto Protocol to UNFCCC).

The GEFSOC Project has developed a generic system which can quantify the potential impact of land use/management and climate scenarios on sequestration of organic carbon in soils at national and sub-national level. It has been tested in Amazon-Brazil, Jordan, the Indo-Gangetic Plains of India, and Kenya.

METHODOLOGY

Stage 1 – Model evaluation: Identify long-term experimental, SOC datasets. Evaluate and modify existing carbon models (Roth-C and Century), until they are able to simulate these long-term experimental data

Stage 2 – Model input data: Collate and format national-scale soils, climate and land-use datasets to act as model input data

Stage 3 – SOC model/GIS linkage: Couple the C-models with GIS to estimate soil carbon stocks and changes at national scale

Stage 4 – Assess SOC stocks: Estimate SOC stocks for 1990, the Kyoto baseline year

Stage 5 – Assess changes in SOC stocks: Develop plausible land use change scenarios; quantify the impact of these changes on carbon sequestration 2000 and 2030

Deforestation in Amazon-Brazil causes C losses (see Fig. 1-II)

RESULTS

Results from the GEFSOC Modelling System© proved comparable to estimates made using conventional map-based approaches.

In general, the models predict overall losses of soil C for all case study areas. This reflects both continued land use change in Amazon-Brazil and Kenya as well as current and projected land management changes, within a specific land use. Results will be detailed in a special volume of *Agriculture, Ecosystems & Environment*.

The GEFSOC system and datasets can be downloaded from the project website (http://www.reading.ac.uk/GEFSOC).

To our knowledge, the GEFSOC system is unique:

- Applicable to a wide range of soil types, climates, and land uses; it has been developed using data sets from four contrasting regions
- Provides multiple approaches for computing SOC stocks and changes for national greenhouse gas inventories. Estimations use three methods: two process-based models (Roth-C and Century) and an empirical method (IPCC)
- Model output can be used to improve national-scale estimates of land use-related C emission/sequestration. Results can support land-use policy formulation
- The GEFSOC system can be used at finer scales where complex systems are involved; the primary limitation at any scale is the availability of data
- It can be expanded to give net emissions of major greenhouse gases.

PARTNERS

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The GEFSOC Project Team (Nairobi workshop, October 2003)