4. Evaluation of soil carbon monitoring methods

There is a timely need for soil carbon monitoring in developing countries, and the monitoring system to be applied needs to agree with instructions given by the Intergovernmental Panel on Climate Change (IPCC). UNFCCC decision 2/CP.13 encourages Parties not included in Annex I to the UNFCCC (i.e. non-industrialized countries) to use the most recent reporting guidelines as set out in UNFCCC decision 17/CP.8 as a basis for reporting GHG emissions from deforestation and to apply the IPCC guidelines for land use, land-use change and forestry (GPG LULUCF).

Currently, the majority of the non-Annex I Parties uses the IPCC default assumption that there are no changes in soil carbon. Given that soil carbon is a significant carbon pool, it is critical to estimate stocks and changes, using higher tier methods in line with IPCC GPG LULUCF. Both the repeated soil surveys and the model-based method described in this report are considered higher tier methods as described in GPG LULUCF. The use of a higher tier method improves estimates of carbon emissions and removals, following the principles of transparency, accuracy, completeness, consistency and comparability compared with the default method.

Given that reductions in emissions or increases resulting from the demonstration activity should be based on historical emissions, taking into account national circumstances (UNFCCC decision 2/CP.13), there is an urgent need in developing countries to establish a national monitoring system to facilitate the development of a historical emission reference scenario and future emission levels. The principles of completeness and accuracy are particularly challenging since the applicability of the model-based method has not yet been thoroughly tested in the majority of tropical countries and repeated soil carbon measurements are almost non-existent.

Both the soil survey method and the model-based method have advantages and disadvantages when applied to soil carbon monitoring.

Soil survey method

Advantages

- Improve estimates of changes in carbon stocks of soil and estimates of emissions/removals associated with these changes in line with IPCC GPG LULUCF and UNFCCC reporting requirements compared with the default method.
- Produce transparent estimates that can be reported consistently over time.
- Sampling design and soil measurements can be coordinated with inventories of land-use and biomass resources.

- There are well-established statistical procedures to estimate uncertainties.
- Trend estimates can be verified with model-based estimates.
- Other soil properties can also be determined from the samples collected.

Disadvantages

- Laborious and expensive to conduct.
- Large uncertainties because of high spatial variation of soil carbon.
- Sample size needed for monitoring purposes difficult to determine without earlier information on variation of soil carbon.
- Feasible sampling interval is relatively long (e.g. ten years).
- Annual emissions/removals can only be estimated by interpolation.
- Uncertainty associated with the annual estimates, obtained by interpolation, is relatively high, especially when disturbances, such as fires or logging leading to deforestation and forest degradation, change from year to year.
- Future scenarios difficult to develop.
- QC/QA activities difficult to implement.

Model-based method

Advantages

- Improve estimates of changes in carbon stocks in soil and estimates of emissions/removals associated with these changes in line with IPCC GPG LULUCF and UNFCCC reporting requirements compared with the default method.
- Improve scientific understanding of carbon dynamics in soils.
- Can provide time-series annual estimates without interpolation.
- Makes use of measurements taken elsewhere.
- An increasing amount of measurements and further development continuously improve the system.
- Application in one country benefits from all previous developments of the system in other countries.
- Results of validity tests in one country may be relevant for other countries.
- Gives the possibility of improving the model using measurements.
- Can be used for estimating soil carbon pool in the past, present and future if input data are available.
- Can be used to estimate scenarios.
- Links elementally to forest inventory, changes in forest inventory data reflected in the results of soil carbon monitoring.
- Lower costs compared with soil survey.

Disadvantages

- Determination of the initial carbon stock may be difficult; problem with the steady state assumption, input data from the past may not be available.
- Soil carbon cycle may be inadequately described in the model: effects of factors that have an effect on soil carbon but not included in the model.
- Reliable uncertainty estimates may be difficult or impossible to obtain.

- All input data needed may not be available locally, necessary to complement using information from elsewhere.
- Potential bias of the model difficult to estimate.