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Empirical estimation of organic carbon stocks for agricultural soils in the Republic of Ireland

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Agriculture is considered to be a major source of greenhouse gases (GHGs) but may in part act as a sink by adopting proper management options. As an Annex-I country, Ireland submits annual estimates of all anthropogenic GHG emissions and sinks to the United Nations Framework Convention on Climate Change. Within agricultural systems, N2O emissions are estimated using Tier 1 methodologies consistent with the Intergovernmental Panel on Climate Change revised 1996 guidelines. Carbon stocks within Land Use, Land Use Change and Forestry are also reported using Tier 1 approaches. This is due to limited country-specific data for emission factors and land management activity. There is a necessity of a more precise estimation of baseline soil organic carbon (SOC) stocks following Tiers 2 and 3 using country-specific activity data. Data were collated for major land cover (LC) types from Co-ordination of Information on the Environment, the General Soil Map and an Indicative Soil Map. Higher resolution spatial data is also available for land use (LU) from the Land Parcel Information System available in Ireland, which complements the official national agricultural data from the Central Statistics Office. Measurement data of SOC and bulk density are available nationally and have been used to develop non-linear empirical models to estimate the SOC content in disaggregated agricultural LU to 100 cm soil depths from which total SOC stocks can be inferred. Soil type specific models have been developed, with predictive levels between 64 and 99%, representing well the amount of estimated SOC content for a particular soil type when compared to the land cover specific models. The empirical equations derived from all soil data (both mineral and peat) showed large variations in SOC stocks under a LC/LU. This variability is reduced substantially by separating peats from other soil types. Relative to grassland (factor of 1) the SOC references at 0-30 cm depth for arable and rough grazing are 0.76 and 1.65, respectively. The arable value is consistent with IPCC default factors. The factor for rough grazing is higher than "natural reference" but proably reflects the poor quality, high peat content of these low productivity soils. Using both base data for soil types (Great Soil Group or Indicative Soil Type), the estimated SOC stocks(t C ha-1 $\pm$ se) on mineral soils at the 0-10, 0-30 and 0-100 cm depths were 59.8 $\pm$ 0.9, 134.9 $\pm$ 1.7 and 204.9 $\pm$ 2.7 for grassland, and 34.4 $\pm$ 0.3, 94.8 $\pm$ 1.0 and 166.2 $\pm$ 1.5 for arable land, respectively. Upscaling to national level, a SOC stock of 912 and 1758 Tg was found at 0-30 and 0-100 cm soil depths, respectively, which are higher than estimates from previous studies. For the complete soil profile that includes peats > 100 cm depth, using values from other works, the total SOC stock was estimated at 2726 Tg. Results imply that the empirical models developed can provide more robust estimate of SOC stocks than earlier estimates and signify well the variations within vegetation and soil types. Further works are necessary to resolve anomalies such as misplaced LU areas and inappropriate soil type.