Abstract

In the context of ongoing climate change, more attention is being given to soil and its organic carbon pool. This is because soil could partially compensate for the increasing amount of carbon dioxide in the atmosphere or, on the other hand, be a vast pool of carbon dioxide if organic matter stored in soil mineralizes. Therefore, the precision of soil organic carbon pool estimation, development of monitoring methods, and revelation of factors controlling the pool have been more and more focused on by soil scientists. Conventional soil sampling for soil organic carbon pool estimation and modelling includes manual sampling, measuring forest floor depth and bulk density, and taking soil samples for carbon concentration analysis. These are time and labour demanding. Therefore, there is an effort to develop precise models predicting the carbon pool based on its driving factors that would limit the amount of fieldwork. The models often use remote sensing data, and, in addition, there is an effort to estimate soil organic carbon concentration from soil spectral characteristics.

Nevertheless, another variable needed to estimate the organic carbon pool is the thickness of the soil profile or individual soil horizons. The thickness can hardly be determined from remote sensing data, so it has to be measured in the field. However, some geophysical methods look promising and could provide thickness information in greater detail and with less effort than manual sampling; in particular there is ground-penetrating radar, which is being engaged to estimate the horizon depths non-destructively.

This doctoral thesis aims to bring new knowledge about the soil organic carbon pool, factors controlling the pool, and methods for estimating it in temperate forests. It examines the variability of the soil organic carbon pool and its driving factors and, subsequently, the variability of forest floor and topsoil thicknesses and their driving factors. However, the main objective was to test the usability of ground-penetrating radar to estimate forest floor and topsoil thicknesses.

The soil organic carbon pool was analyzed along several gradients across the Czech Republic. The forest floor and topsoil thicknesses were studied at a finer scale at a site of 1 km^2. Both studies examined the effect of climatic conditions, vegetation, anthropogenic acid deposition, and other factors on the soil organic carbon pool and the forest floor and topsoil thicknesses. The potential of ground-penetrating radar for soil survey was reviewed, based on 130 articles published on the Web of Science and SCOPUS between 1995 and 2018. The review summarizes approaches, purposes, and conditions of ground-penetrating radar use in

soil surveying. The fieldwork comprises ground-penetrating radar surveys of organic layer depths, repeatedly run on the same transects on two study sites with contrasting soil types under different moisture conditions. Ground-penetrating radar outputs were verified with the actual depth measured manually at the field.

The study of the driving factors of soil organic carbon pool and forest floor and topsoil thicknesses found that climatic conditions, vegetation, and acid deposition controlled the soil organic carbon pool and the forest floor and topsoil thicknesses at both scales (regional acrros the Czech Rpublic and local at 1 km^2 site). The best predictors, however, differed between scales. An approach to data processing was proposed to estimate forest floor and topsoil thicknesses using ground-penetrating radar. The approach did not detect the boundary between the forest floor and topsoil, but it was successful for the topsoil/mineral soil boundary. The average error of thickness estimation was about 25%. However, the mean thickness at the transects applicable for soil organic mass estimation showed a mean measurement error of only up to about 9%. Average measurement errors were slightly lower under wetter conditions, but the mean thickness estimation was more accurate under the driest conditions.