Operationalizing digital soil mapping for nationwide updating of the 1:50,000 soil map of the Netherlands

Bas Kempen[a], Dick J. Brus[b], Folkert de Vries[b]

[a]*ISRIC - World Soil Information, P.O. Box 353, 6700AJ Wageningen, The Netherlands, bas.kempen@wur.nl, tel: +31 317 483793, fax: +31 317 419000*
[b]*Alterra, Wageningen University and Research Centre, P.O. Box 47, 6700AA Wageningen, The Netherlands*

The national soil map at scale 1:50,000 is the main source of soil information in the Netherlands. Organic soils cover over half a million ha. Intensive use and deep drainage have resulted in an extensive decrease in the acreage of these soils. The national government has therefore commissioned an update of the 1:50,000 soil map for the peatlands. A pedometric approach was developed for updating the map for two areas in the peatlands that jointly cover 187,525 ha area: the till plateau (subarea 1) and the northern fen peat area (subarea 2). This is the first time that digital soil mapping replaces conventional soil mapping in a nationwide, government-funded soil survey programme. The subareas were modelled separately.

Soil classes were updated indirectly through mapping quantitative diagnostic soil properties that were subject to change. These were the thickness and the starting depth of the peat layer. Because the point data were zero-inflated for both properties, a two-step simulation approach was implemented. First, 1,000 peat presence/absence indicators were simulated from probabilities of peat occurrence that were predicted with a generalized linear model. Second, 1,000 conditional peat thickness values were simulated from predictive distributions obtained by kriging with external drift. The indicator and peat thickness simulations were combined to obtain 1,000 simulations of the unconditional peat thickness. The mean and the 5%-, 50%- and 90%-quantiles as a measure of uncertainty, were computed for each node of the 50-m resolution prediction grid. A similar approach was followed for the starting depth. At each prediction node, a probability distributions of three major soil classes (mineral soils, thin peat soils [<40 cm peat], thick peat soils [>40 cm peat]) was derived from the simulated peat thickness and starting depth values. These classes were augmented with information about (static) soil properties derived from the 1:50,000 map to obtain classes according to the 1:50,000 legend. The updated map was then incorporated in the 1:50,000 map with an expert knowledge approach.

The prediction models were calibrated with point data from two data sources. New data was collected at 322 sites in subarea 1 and 2,045 sites in subarea 2 using a spatial coverage sampling design. In addition, over 26,000 legacy soil point data from the Dutch soil information system were used. The legacy dataset with observations on peat thickness (which can be 0 cm) distinguishes hard data, censored data and interval data. For the censored and interval data points the peat thickness at the time of observation is unknown. At these data points possible peat thickness values were simulated from a beta (in case of censored observations) or a uniform (in case of interval data) distribution. All legacy data points with peat thickness greater than 0 cm, both hard data and simulated values, were updated with a statistical model before being used for the calibration of the prediction models that included quantification of the uncertainty of the updated peat thickness values. This uncertainty was taking into account when predicting the peat thickness with the kriging model.

The linear regression models explained 34% of the variance of the conditional peat thickness in subarea 1, and 59% in subarea 2. The average predicted peat thickness is 34 cm for subarea 1, 82 cm for subarea 2, and 65 cm for the joint area. In subarea 1, approximately 50% of the area originally mapped as thin peat soil is now classified as mineral soil. In subarea 2, predicted changes are somewhat less extensive. The original extent of peaty soils has decreased by 15%. This area is now made of up mineral soils.

The peat thickness map and a map with three major soil classes were validated with independent probability sample data. The overall purity of the major soil class map was 65% for both subareas. For subarea 1, the root median squared error was 12 cm and the R^2-value, 0.50. For subarea 2, the root median squared error was 18 cm and the R^2-value, 0.65.

We conclude that nationwide updating the 1:50,000 map with pedometric techniques is feasible. The added value of using legacy point data in addition to newly acquired data was not assessed and merits further exploring. In order to increase the value and usability of the large set of newly acquired field observations and the updated 1:50,000 map, we recommend installation of a soil monitoring network in the Dutch peatlands.