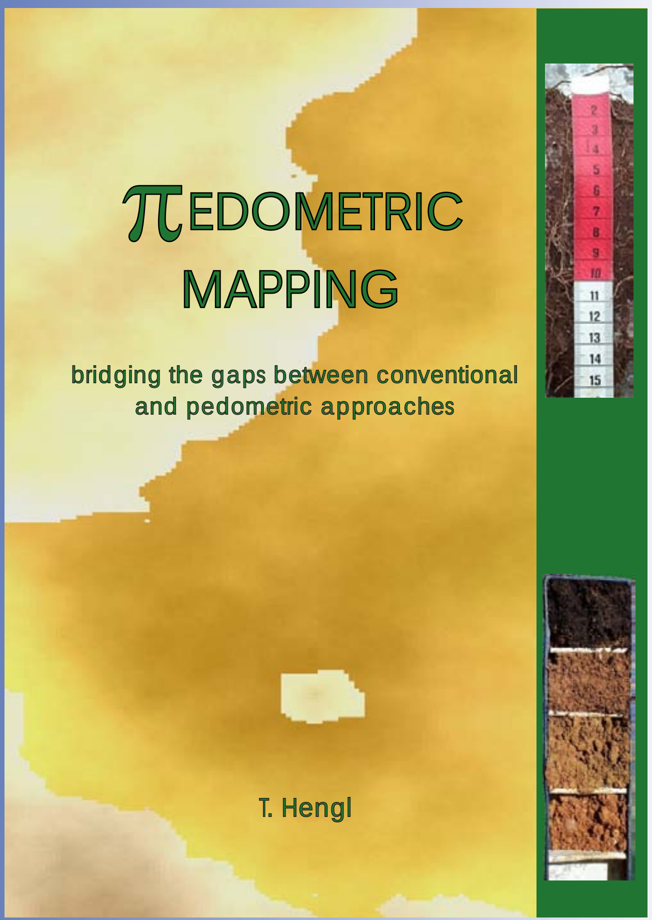
Pedometric mapping

bridging the gaps between conventional and pedometric approaches



The technological and theoretical advances in the last 20 years have lead to a number of new methodological improvements in the field of soil mapping. Most of these belong to the domain of the new emerging discipline – pedometrics. Pedometric mapping is generally characterised as a quantitative, (geo)statistical production of soil geoinformation, also referred to as the predictive or digital soil mapping.

Many new pedometric techniques such as sampling optimisation algorithms, new interpolation techniques, fuzzy or continuous soil maps are, however, still not fully applied in soil mapping at smaller, i.e. regional scales. The polygon-based soil maps with crisp definition of soil classes are still used as the 'state of the art' methodology. For a long time, the term pedometrics has been used as a challenge or contradiction of soil taxonomies, i.e. traditional systems. This thesis is an attempt to bridge the gaps between the empirical and automated methods and improve the practice of soil mapping by designing an integrative pedometric methodology. The thesis covers seven research papers/topics.

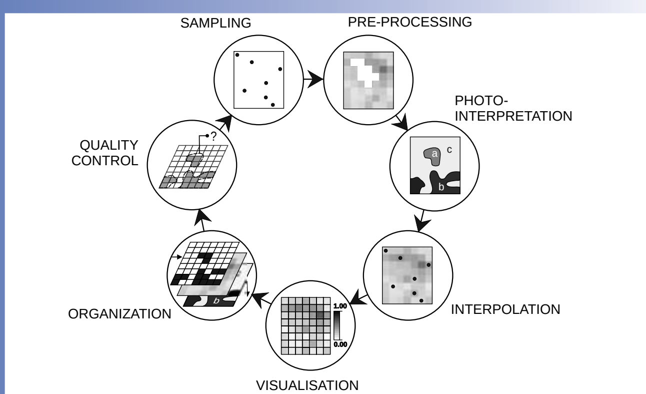


Fig. 1. Schematic outline of the topics discussed in the thesis. Note the circular structure, which symbolizes that the soil maps need to be periodically updated.

SAMPLING - The chapter demonstrates how allocation of points in the feature space influences the efficiency of prediction. It suggests how to represent spatial multivariate soil forming environment; how to optimise sampling design for environmental correlation and which sampling strategies should be used for a general soil survey purposes.

PRE-PROCESSING - In this chapter, systematic methods for reduction of errors (artefacts and outliers) in digital terrain parameters are suggested. These methods ensure more natural and more complete representation of the terrain morphology, which then also reflects on the success of spatial prediction.

PHOTO-INTERPRETATION - This chapter suggests a semi-automated method for extrapolating photo-interpretation from a limited number of study sub-areas to the whole area. The intention was to enhance and not to replace the mapper's knowledge and expertise.

INTERPOLATION - This chapter considers the development of a flexible statistical framework for spatial prediction that should be able to adopt both continuous and categorical soil variables. It suggests methods for dealing with non-normality of input data and multicollinearity of predictors.

VISUALISATION - In this chapter, an algorithm is suggested to visualize multiple memberships and to analyse geographical and thematic confusion. Multiple memberships are visualized using the Hue-Saturation-Intensity model and GIS calculations on colours.

ORGANIZATION - This chapter collates methods from previous chapters and describes organizational structure of a hybrid grid-based soil information system (SIS). It shows how to select a suitable grid size, how to aggregate and disaggregate soil information and what are the advantages and disadvantages of a grid-based SIS. The prediction maps were produced using both photo-interpretation and auxiliary maps, which ensures both continuous and crisp transitions.

QUALITY CONTROL - In this chapter, systematic steps are suggested to assess the effective scale, accuracy of soil boundaries, accuracy of map legends, thematic purity of mapped entities and overlap among the adjacent entities. This assessment was based on a number of control surveys including control profile observations and photo-interpretations.

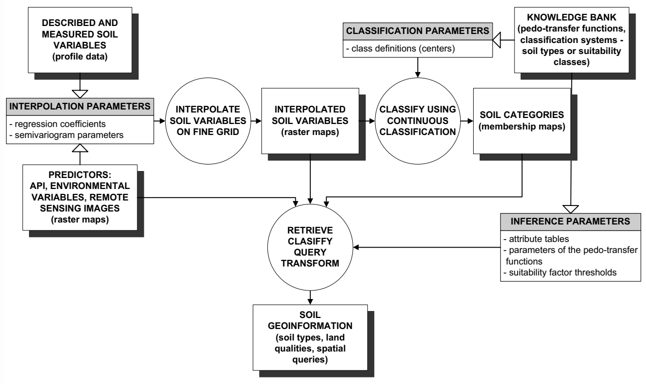


Fig. 2. Schematic flow of methodological steps used within the hybrid grid-based Soil Information System.

The proposed pedometric mapping methodology can be used to enhance the practice of soil mapping making the soil maps more objective, detailed and more compatible for integration with other environmental geo-data. There is no need to use the concept of soil mapping units or use double-crisp soil maps anymore. On the other hand, instead of abandoning photo-interpretation, soil classification or empirical knowledge on soils, these methods can be successfully integrated with pedometric techniques.

Hengl, T. 2003. Pedometric mapping: bridging the gaps between the conventional and pedometric approaches. PhD thesis, Wageningen University.

ITC Dissertation number 101, ITC, P.O. Box 6, 7500 AA Enschede, The Netherlands. Parts of the thesis are available on-line via the ITC's library website www.itc.nl/library/

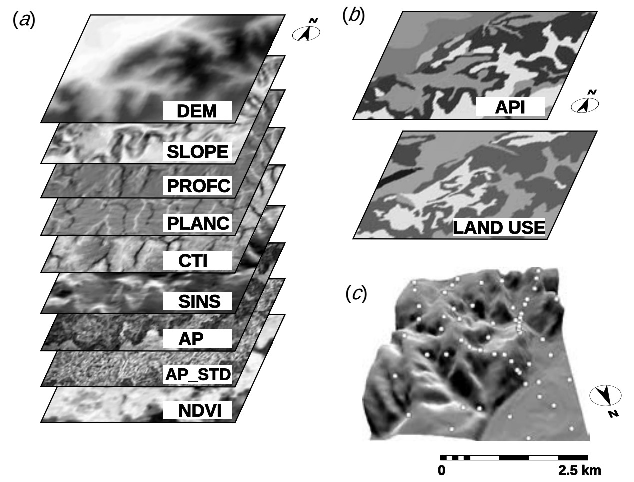


Fig. 3. Multi-source predictors: (a) auxiliary predictors terrain parameters and remote sensing data; (b) aerial photo-interpretation map (API) and land use map and (c) location of the 59 soil profile observations. DEM – elevation; SLOPE – slope gradient in %; PROFC – profile curvature; PLANC – plan curvature; CTI – wetness index; SINS – slope insolation; AP – intensity of the aerial photo; AP_STD – standard deviation of the AP map and NDVI map derived from the Landsat 7 image.

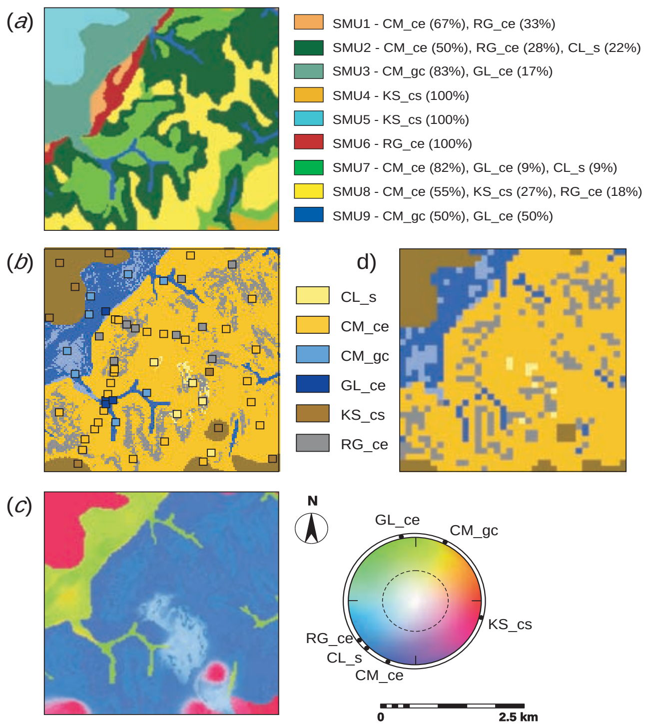


Fig. 4. Comparison of (a) the conventional soil map with compound composition of mapping units, (b) defuzzified (highest) membership map from the supervised fuzzy k-means classification with freely selected colours; (c) the continuous soil map with a circular legend and (d) down-scaled map to 100 m grid. CL_s – Siltic, Calcisols; CM_ce – Calcari-Eutric Cambisols; CM_gc – Gleyi-Calcaric Cambisols; GL_ce – Calcari-Eutric Gleysols; KS_cs – Calci-Siltic Kastanozems and RG_ce – Calcari-Eutric Regosols.

> *"A richly illustrated enthusiastic exposition of digital soil mapping... The author suffuses pedometrics in every syllable... Some of the non-idiomatic uses of English are very creative.*
> *The particular strength of this thesis is that it defines most or all of the aspects of pedometric mapping that require attention... and tackles them!"*
>
> Alex B. McBratney, University of Sydney

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