Concept for pointing out vulnerable sandy areas in relation to the leaching of pesticides to the groundwater: Testing the validity of a soil property map

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Introduction

A concept for pointing out vulnerable sandy areas in relation to the leaching of pesticides to the groundwater has been developed in Denmark (Nygaard, 2004). The concept focuses on the inherent volumetric content of clay and silt and the amount of organic matter in the upper meter of the soil (Fig. 1). Based on a developed raster-based soil property map of Denmark with a resolution of 250 to 500 m (Greve et al. 2007) it is possible to implement the concept in relation to a national screening.

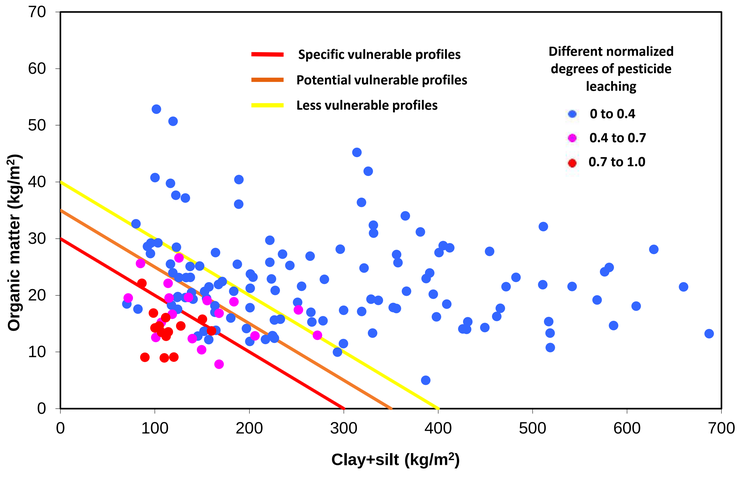

Fig. 1. Simulated leaching of a compound similar to MCPA on 175 sandy profiles (Nygaard, 2004). The area under the three colored lines classifies the profiles according to a graduated vulnerability.

Objectives

- To test the validity of the soil property map in a selected sandy area in Denmark.
- To give recommendations for how the soil property map can be used by local authorities to point out areas vulnerable to leaching of pesticides to the groundwater based on the developed concept.

Materials & Methods

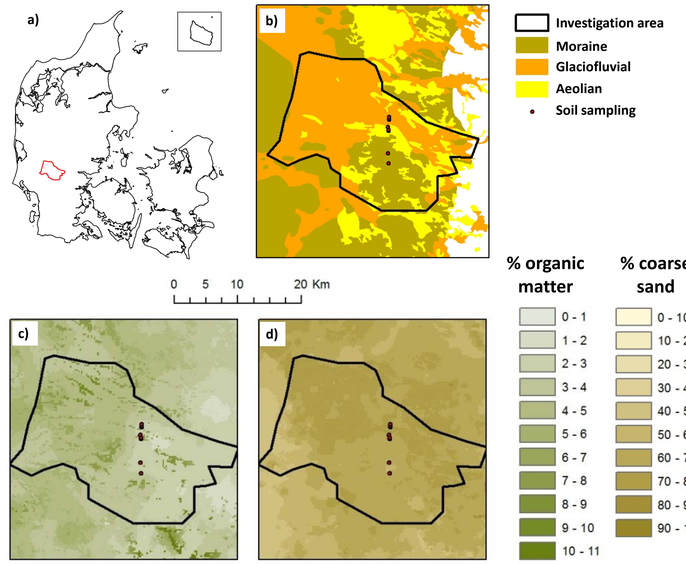

Fig. 2. a) investigation area, b) landscape types, c) variation of organic matter (A horizon), d) variation of coarse sand (>200 μm, A horizon).

The soil property map was tested in selected areas in three different landscape types (Saale moraine, glaciofluvial, and aeolian deposits, Fig. 2). Soil samples were excavated from nine points at two depths (A and B horizon). At each point, samples were taken in a 20 by 20 m^2 grid sampling design giving a total of 16 soil samples in each depth. In the laboratory, the samples were analyzed with the respect to bulk density and the content of sand, silt, and organic matter.

Results

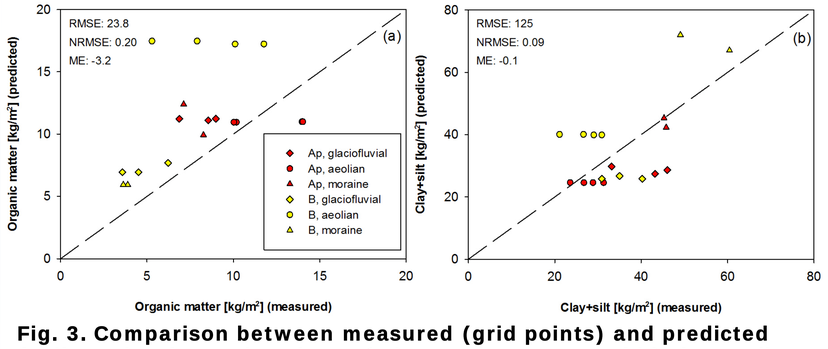

Fig. 3. Comparison between measured (grid points) and predicted (soil map) volumetric values of a) organic matter and b) clay + silt.

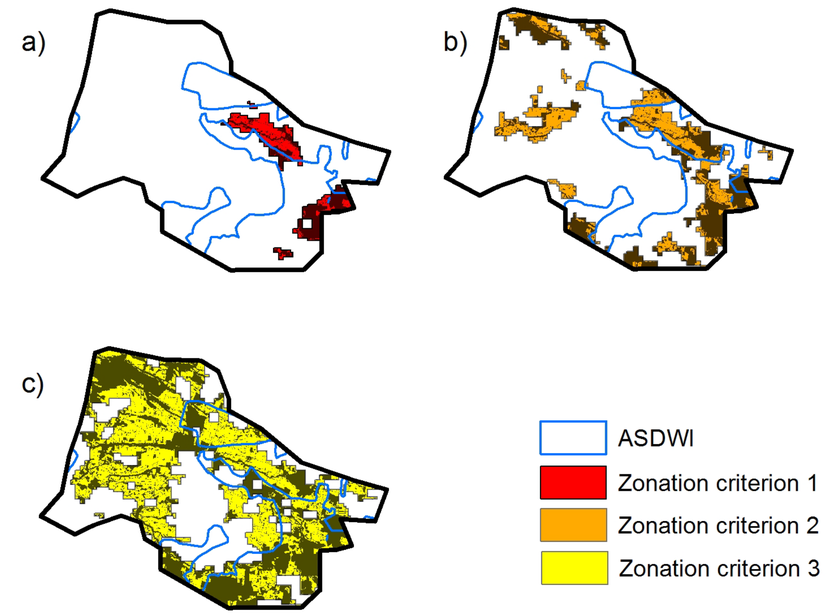

Fig. 4. Graduated aggregated zonation criteria using a specific image segmentation technique (Baatz et al. 2008). Zonation criteria are based on Fig. 1. a) Zonation criterion 1: Includes specific vulnerable areas, b) Zonation criterion 2: Includes zonation criterion 1 + potential vulnerable soils, and c) Zonation criterion 3: Includes Zonation criterion 2 + less vulnerable soils. Shown also: Areas with specific drinking water interests (ASDWI, blue outlined areas), non-cultivated soils (dark areas).

Conclusions

Comparison between predicted values (from the soil map) and measured values showed that a good relation between the total content of clay and silt exists (Fig. 3a). Total amount of organic matter was overestimated by the soil map (Fig. 3b).

Aggregated areas were pointed out having different levels of vulnerability. Most vulnerable areas were found in areas with glaciofluvial and aeolian deposits outside areas with drinking water interests (Fig. 4).

It is possible to use the Danish soil map to point out areas with the risk a pesticide leaching in combination with other maps related to the agricultural practice. However, the map of organic matter needs to be improved.

References:

Baatz, M., C. Hoffmann, G. Willhauck 2008. Progressing from object-based to object-oriented image analysis. I: T. Blaschke, S. Lang, G.J. Hay (red.), Object-Based Image Analysis. Springer, Berlin, pp. 29-42.

Greve, M.H., M.B. Greve, P.K. Bøcher, T. Balstrom, H. Breuning-Madsen, and L. Krogh. 2007. Generating a Danish raster-based topsoil property map combining choropleth maps and point information. Dan. J. Geogr. 107:1–12.

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