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Classification and mapping of morphological features associated to important soil thicknenings within cultivated hillslopes - Example from southwestern Parisian Basin, France

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The quality of soils strongly depends on their thickness resulting from equilibrium between soil development and erosion. Soils water and organic carbon contents are examples of properties which are sensitive to thickness variation, and then has a direct impact on crop quality and yields in cultivated areas. So, the assessment of soil thickness variability in landscapes appears of major interest to quantify soil quality indicators and for soil mapping.
This work aims to characterize linear morphological features of decametric width, identified within cultivated hillslopes, and their connection with soil thickness variability. The 16 ha study area is located on the southwestern Parisian Basin (cretaceous chalks) and has a general rolling topography. Two types of linear morphological features were observed within the area: the well-known lynchets and what we called "undulations". Accurate elevation records were carried out in parallel to an intensive campaign of soil thickness measures within the features and over the whole study area. An accurate DEM and a soil thickness map were computed. An expert method based on the observation of slope gradient variation at each sample neighbourhood was then developped in order to classify the sampling locations into three classes (lynchets, undulations and areas outside features influence). The spatial variability of soil thickness appears more important within lynchets and undulations than within others areas, especially towards the main slope direction. These features show local soil thickenings of different intensity: mean thickness values are about 1.10 m, 0.62 m and 0.45 m within lynchets, undulations and other areas respectively. Moreover, the shape of soil thickenings within a lynchet and within an undulation has different specific characteristics.
We used then the classification tree (CT) algorithm to assess whether the features can be discriminated through their respective landform attributes and soil thickness (CTsoil), and through their respective landform attributes only (CTtopo), e.g. slope, curvature, profile curvature and planform curvature. The CT approach has the advantages to be a non-parametric analysis method and to allow the establishment of predictive classification models to map the different types of features all over the study area. The validation results of CTsoil and CTtopo models showed respectively an 83 % and 67 % model efficiency. The two models performed well for lynchets mapping. These features present statistical differences with the two other classes for all the predictor variables. The most encountered errors in models application are confusions between areas outside features influence and undulations. These confusions tended to increase when soil thickness is not involved as predictor variable because undulations are statistically distinguishable from areas without features influence by curvature, profile curvature and soil thickness only.
The mapping all over the study area of the features lynchets and undulations reveals that undulations are associated to former field limits that disappeared mainly during the last important land consolidation, in comparison to lynchets which are associated to present field limits. 39 % of the study area are constitued by lynchets and undulations which then constitute morphological indicators of human-induced soil accumulations.
The method developed here confers new possibilities regarding soil thickness and dependant properties quantification and mapping.