DOCTORAL THESIS

Digital soil mapping and its application for assessing the effects of urbanization on soil properties and agricultural soil quality in Hong Kong

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Digital Soil Mapping and its Application for Assessing the Effects of Urbanization on Soil Properties and Agricultural Soil Quality in Hong Kong

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Abstract

The soil information in Hong Kong is far from sufficient in meeting the demands needed to resolve the detrimental ecological, agricultural and environmental effects caused by the urbanization period of the last half century. This study, therefore, aimed to bridge this gap by determining the soil information of Hong Kong, using digital soil mapping techniques and attempted to apply this information in addressing the problems.

Firstly, the soil orders on mountainous areas of Hong Kong were mapped based on legacy soil data, where both decision tree and linear discriminant analyses were employed along with several techniques for soil covariates selection. The results show that the constructed discriminant model based on the results from analysis of variance (ANOVA) performed the best and then in the following order of: the constructed discriminant model using a stepwise procedure; the constructed tree model based upon a backward removal procedure; the tree model constructed according to knowledge and experience of soil mapping surveyors; and the automatically constructed tree model. A soil order map was subsequently constructed using the best performing model.

The soils of major agricultural areas in Hong Kong were investigated through a soil survey, which revealed that the soils were generally of sandy loam texture and had moderately acidic, heavy and fertile properties. The soils varied considerably and complexly in the areas, where half of the 18 measured soil properties exhibited moderate spatial dependence, e.g., three particle sizes, while 4 had weak spatial dependence, e.g., soil organic matter (SOM), and the other 5 had no spatial dependence, e.g., bulk density (BD). The spatial variations of the soils were dominated by geological and continuous variations, indicated by results from robust geostatistical analysis and spatial outlier identification. The 13 soil properties with spatial dependences and the other 5 without spatial dependences were mapped with

the techniques of kriging and inverse distance weighted combined with soil map-delineation, respectively.

The temporal variations of the soils were investigated by performing a comparison between the produced maps of the main agricultural areas with the soil survey of the 1950s. The effects of urbanization on the soils were then quantitatively assessed using sequential Gaussian simulation, with the results implying that the local urbanization affected soil pH very slightly, SOM slightly, total phosphorous (TP) moderately, available phosphorous (AP) strongly and particle sizes very strongly.

The produced soil property maps were finally applied to evaluate soil quality for the major agricultural areas, which showed that the soil quality was between 0.43 and 0.87, with 81% of the areas being deemed suitable for crop growth. However, the evaluated soil quality information contained high uncertainty, inferred from the results of the Monte Carlo simulation, with the critical probability that soil quality was overestimated generally increasing with the soil quality value. The stochastic analysis results demonstrated that BD and heavily weighted soil properties contributed the most to the uncertainty of the evaluated soil quality information.

For future work, a greater number of samples are needed in providing more detailed and reliable soil information for the mountainous areas of Hong Kong, thus, enhancing the level of accuracy of the soil property maps of the agricultural areas. Meanwhile, the newest digital soil mapping approaches have also proved useful in enhancing and updating the produced maps of this study.

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