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Application of airborne gamma-ray imagery to assist soil survey in the upper Pasak basin, Thailand

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ABSTRACT

Gamma-ray radioelements are a potential information source for soil mapping, since their abundance is related to soil geochemistry, specifically the chemical composition of parent materials and their weathering products resulting from geomorphic and pedogenic processes (IAEA 2003). Soils have been developed over sedimentation landscapes such as in alluvium and flood plain are uncertain due to the sedimentation process, which is difficult to characterize by field soil survey. Thailand has advantage of Airborne Gamma-ray Imagery (AGRI) covering whole country, for mineral survey but not yet for soil survey. Fuzzy classification method has been recommended as the potential techniue for digital soil mapping (McBratney et al. 2003).

The aim of this study was to evaluate the potential of AGRI for improving digital soil survey process in two phases: (1) a preliminary phase, where hypotheses of soil-geological unit relationships where soils are developed, and (2) a phase where soil map unit boundaries are generated using AGRI and DEM covariables.

The study was conducted in a well-characterized complex in flood plain and river terraces soil landscape: the 300 km^2 upper Pa Sak Valley in Petchaboon province, Thailand.

The relationship between AGRI data and geological units were examined by the distribution of radioelement response to selected soil sediment characteristics, based on a review of literature and supported by observation samples. The potential of AGRI to map sediment soils were examined by interpolate soil observation points applying fuzzy classification over the alluvium and flood plain. Where, soil map was produced from four covariables; three from gamma-ray radio element (%K, eTh and eU) and DEM using fuzzy classification.

To interpret the relation of gamma-ray radioelement with sediment geological units, the results show that, the Pleistocene sediments (Qt), consisting of mixed old alluvial materials on terraces, shows three different radioelement compositions. The Holocene sediments, indicated by Qa, area cover a relatively large area and they are high in all three radioelements.

Figure 1. (left) Airborne Gamma-Ray Imager (AGRI), with geologic units and (right) predicted soil map from AGRI based on fuzzy classification with 92 observation points (black dots).

In the producing soil map, with a soil family level, the best result map was produced and four soil mapping units were interpolated as: 1) Fine silty, mixed, Aeric Vertic Endoqualfs, 2) Fine, mixed, Typic Endoaqualfs, 3) Loamy-skeleton, kaolinitic, Typic Paleustults and 4) Loamy-skeletal over fragmental, kalionitic, Petroferric kalionitic, Petroferric Haplustults. The result map was assessed the accuracy using 92 observation point data, the accuracy result are overall classification accuracy = 67.85% and 2 overall Kappa statistics is 0.6419.

In the hypotheses-generating stage, AGRI provided useful information in three forms (single signal, ratio, and lithology, material transport, and internal pedogenetic processes). In the mapping stage, AGRI showed deficiencies in the soil map production over alluvium terraces and flood plains, which provided a basis for future field sampling to correct these deficiencies.

AGRI suggested new boundaries, differentiating topsoil properties and the presence of plinthite. Further study, AGRI can be recommend for mapping some top soil properties together with other suitable covariables according to soil forming factors.

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