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Geomorphology-based methods of generating soil thickness map in a section of Wanzhou County, Three Gorges reservoir

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Soil thickness has a great importance in many processes such as slope stability, seismic local effects, landscape evolution, soil moisture distribution. It is a fundamental parameter in many environmental models. In local scale applications, direct or indirect measurements can be easily used to accurately measure soil thickness. Nevertheless, in large scale applications, it is often difficult to obtain a reliable distributed soil thickness map and existing methods have been applied only to test sites with shallow soil depth. In this research, we cope with this limitation showing a first attempt to test the applicability of some state-of-the-art soil thickness models in a test site characterized by a complex geological setting and soil thickness values extending from zero to forty meters. Two different approaches were used to derive distributed soil thickness maps: a modified version of the Geomorphologically Indexed Soil Thickness (GIST) model, purposely customized to better take into account the peculiar setting of the test site, and a regression performed with a machine learning algorithm, the Random Forest (RF), combined with the geomorphological parameters of GIST. The proposed models are implemented in a geographic information system environment on a pixel-by-pixel basis. Finally, validation quantifies errors of the two models and a comparison with geophysical data is carried out. The results showed that the GIST model is not able to fully grasp the high spatial variability of soil thickness of the study area: mean absolute error was is 10.68 m with 7.94 m standard deviation, and the frequency distribution of residuals showed a proneness to underestimation. In contrast, RF returned a better performance (mean absolute error is 3.52 m with 2.92 m standard deviation), and the derived map could be considered to be used in further analyses to feed models that require a distributed soil thickness map as a spatially distributed input parameter.

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