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Simplified Regolith Model (SRM) – A GIS approach to estimate regolith thickness using outcrop slopes and distance to outcrops

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Knowledge about regolith thickness is important in various engineering fields; for instance in hydrology where regolith thickness and stratigraphy influence the hydrological processes. The information about the regolith thickness can also be used to quantify aquifer recharge, analyze physical processes such as landslides, erosion and liquefaction or to calculate costs in various infrastructural projects; such as in the field of transportation planning (road and railway).

Problems could arise when needed documentation regarding the regolith thickness is lacking; especially information regarding regolith thickness for a large scale area. Interpolation using Inverse distance weighted (IDW) is one method that can be used in geographic information systems (GIS) to estimate regolith thickness at a larger scale; if drillings containing information of actual regolith thickness are available. IDW is however a data-driven method. This study was aimed to develop, test and compare a non-data driven regolith thickness estimation model called simplified regolith model (SRM) for three previously glaciated study areas in Stockholm, Sweden. The SRM is based on rock outcrops, digital elevation model (DEM) and an optimized outcrop search algorithm.

A script was programmed in an ArcGIS environment to calculate the distance to the closest outcrop cells, as well as their slope values within eight, 45° angle, directions. Three multi-directional search radii were used and compared for the regolith thickness estimations. The regolith thickness was later extrapolated and interpolated based on linear projection from the found slope, and weighting of the distances to the outcrops using IDW.

Results for SRM performance evaluation were presented inform of a root mean square error (RMSE) and percentage of error within ± 2 m (the deviation from known thickness within 2 m). For a better model performance, the latter criterion should have high percentage value, i.e. high percentage of low deviation. Results indicated a tendency towards underestimation of the regolith thickness with increased slope values. The error also increased as distance between the outcrops increased. However, the overall performance of the SRM for the three study areas showed promising results as the percentage of error within ± 2 m for the three study areas was between 50 and 61%. In areas where well data is sparse or lacking the SRM could be an alternative option for preliminary regolith thickness modeling at larger scales.