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PERMACLIM model implementation in QuantumGIS software: a new open source tool to simulate the spatial distribution of alpine permafrost

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ABSTRACT

Permafrost is defined as ground that remains at or below 0 °C for at least two consecutive years, for natural climatic forcing. It is very common in high latitude areas but it is also present in the mid-latitudes mountain range, such as the Alps. The detection of alpine permafrost is difficult due to complex geology and morphology. Measurement campaigns and the installation of monitoring stations are often not easily carried out, and the interpretation and spazialization of punctual data are very problematic. Therefore, an approach based on modeling allows the evaluation of permafrost distribution in mountain regions, in order to address more accurate direct or indirect analyses.
Many empirical and physical models already exist for estimating the spatial distribution of mountain permafrost, often requiring many complex input data. However none of these models have been implemented in open Geographic Information System (GIS) software yet.
In this work, the simplified physical-based model PERMACLIM (Guglielmin et al., 2003) has been implemented and developed as a plug-in for the QuantumGIS application (QGIS), an open source GIS environment. PERMACLIM model uses the energy balance equations and it needs as input data a Digital Elevation Model (DEM), climatic data (air temperature and snow thickness) and physical data (snow thermal conductivity and sensible heat flux). As output, PERMACLIM provides a permafrost map based on mean biennial ground surface temperature for each cell point of the DEM.
The PERMACLIM plug-in (implemented in collaboration with Faunalia) is an extremely versatile open source cross-platform application, using the Python language. It consists of four modules finalized to the calculation of: the distribution of snow based on slope, the ground surface temperature (GST) and the monthly and annual means of GST.
To sum it up, the PERMACLIM is a physical model with a simplified approach that is well suited for a regional application and that requires essentially two variables (air temperature and snow depth) which are often available in spatialized form. Moreover, the plug-in for an open source GIS is a free and open tool, to be freely used and developed by the scientific community.

Keywords: Geographic Information System, Open source, QuantumGIS, Permafrost.