Object Segmentation for Identification of Soil Erosion Sites in Swiss Alpine Grasslands with Neural Networks

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Soil erosion is a significant environmental issue which is of severe ecological impact and has a relevant influence on agricultural land usage. Susceptibility to soil erosion is mainly due to geological, morphological or anthropogenic aspects and often caused by strong precipitation events, avalanches, and snow gliding. With a changing climate, altering land use and their effects on the driving factors of soil erosion, an increase of soil erosion sites in the alpine region is expected.

The assessment of the spatial extent of soil erosion sites in the alpine region over the years requires advanced methods. In the last years, convolutional neural networks achieved remarkable results on objection recognition task. In our work, we employ recent Deep Learning architectures to identify and segment different types of soil erosion on high-resolution aerial images (with a spatial resolution of 0.5 to 0.25 m).

The neural networks are trained with manually mapped erosion sites within a study region (Urseren Valley, Canton Uri, Swiss Central Alps). In addition, further information from digital elevation models (DEM) as for example the slope and other thematic information (mapped objects as buildings, forests etc.) are used for training. We compare neural network architectures such as ResNet, U-Net, and Mask R-CNN and highlight differences and advantages. Our results show that classification and segmentation of soil erosion sites with these neural networks yield satisfying results. Probabilities on a pixel basis are provided which allow for an examination of different confidence levels. Further, it is possible to improve potentially imprecise labels (the manually mapped objects used for training) so that the predictions of the neural networks exhibit a more appropriate delineation. The results suggest, that it is feasible to perform large scale segmentation of soil erosion sites in an automated fashion, since typically the prediction of the segments is fast once the neural network is trained properly.