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Quantification of erosion rate in crop field gullies from point clouds with two different methods : the case study of Savigny crop field (North of Lausanne, Switzerland)

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The spreading use of remote techniques is in our daily life benefits to ease and/or speed up the acquisition and analysis of geographical data that can be meaningful for risk assessment or for taking decisions for prevention measures.

Here is presented one of the possible applications for the Unmanned Aerial Vehicle (UAV) acquisition, to evaluate the volume of eroded soils in a crop field due to washout after heavy rains. The case study is located North of Lausanne (Switzerland), in the village of Savigny. It is a crop field with a gentle slope where we can clearly see washout gullies appearing after rainfalls. A great number of small water streams disappeared for more intense agriculture which is the case here : According to topographical maps, a small stream was flowing in the past but disappeared after 2004. It is interesting to see that after important rainfalls, gullies appear that could correspond to old small stream patterns.

The data acquisition survey of October 30th, 2020 was done by means of a DJI Phantom 4 RTK flying at an altitude of about 20m and the Pix4d Capture planning mission application. To process the obtained 800 images, the new Pix4D Matic software was tested to get a fast dense point cloud with GSD ~1 cm accuracy, a DEM and an orthophoto. The dense point cloud was then analyzed with two compared methods to estimate the washout volumes, which are (1) inverse Sloping Local Base Level; and (2) Point cloud segmentation based on normal vectors and curvatures.

As a result, these two methods gave a first estimation of the eroded volume of around 15m3 over a surface of 9 hectares which corresponds to an erosion rate of 1,7m3/hectare. These remote and non-destructive techniques are fast and easy compared to conventional field surveys, and the data acquisition and processing could be automated. In conclusion, these techniques provide a relatively low-cost time-series datasets processing to monitor and quantify the ongoing gully erosion.

Further investigation would be to keep recording the volume and erosion rate estimations after important rainfalls, when clear new gullies appear and to record in the meanwhile the rainfall intensity. This could help assess in a second step the relationship between the erosion rate and the rainfall intensity and control if this relation follows a power-law function. Such a study could also give some clues about the possible impact of climate changes on erosions in crop fields.