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Testing the feasibility of webcam-based landslide alert systems

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Landslides in mountainous regions like the Alps frequently pose a threat to infrastructure, settlements, and the people. Regional authorities, infrastructure maintainers and civil protection agencies therefore need up-to-date landslide information for early warning and for alert in order to be better prepared for landslide events. Complementary to early warning systems, an automatic alert system that locates a landslide immediately after it was triggered would be highly valuable. Apart from sufficiently short response times, the key requirement is the size of the region that an alert system is able to cover. While Earth observation (EO) methods are capable to cover large regions, they lack the response time that is necessary for any alert system. Alert systems based on close-range sensing techniques can achieve short response times and therefore are often installed for monitoring landslides on the local scale. However, sensors at a fixed location are limited in their coverage which depends on their effective range and orientation towards a target area. As close-range sensing can also be done with sensors of relatively low cost like webcams, multiple sensors can be combined into a sensor network resulting in the opportunity for a webcam-based alert system with a coverage that goes beyond the local scale. Nevertheless, the feasibility of such an alert system depends on two main issues: the ability to detect landslide events in webcam images and the size of the area that the sensor network can cover.

Testing the feasibility of webcam-based landslide alert systems with object-based image analysis and visibility analysis was performed in two steps. In the first step, the possibility for information extraction from webcam images with (semi-)automated object-based image analysis (OBIA) methods was evaluated. While webcam images have been analysed with autocorrelation methods for detecting ground movement, the OBIA approach focuses on detecting spectral changes between images as they occur when landslides remove the vegetation from the ground surface. The OBIA method has proven to be suitable for the identification of landslides in aerial and optical satellite images at various resolutions. The perspective view as well as weather and daylight conditions of webcam images yield new challenges for OBIA that need to be investigated.

In the second step of our study, we developed a visibility analysis model for optimizing the coverage of webcam constellations for monitoring landslide-prone areas. The first input from the OBIA analysis allows an evaluation of the range and viewing perspectives for estimating the effective coverage that a webcam can achieve. The second input is a landslide susceptibility map that helps to narrow down the area where monitoring is required. Susceptibility maps identify areas with similar conditions of causal factors to those found at known landslide locations. Both inputs feed into a visibility analysis model that optimizes the number and locations of webcams to maximize the coverage within the susceptible areas. Thereby, the feasibility of a webcam network for covering of a target region can be estimated in order to support the planning of landslide alert systems.