Microwave radar monitors sliding slopes

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If entire mountain slopes start to slide, danger threatens. It is not always easy to predict and monitor these mass movements. In an international project, scientists at the Technische Universität Darmstadt, Germany, combined numerical models with microwave radar systems in Northern Tyrol—with promising results.

The "Steinlehnen" slope in Northern Tyrol (Austria) started to move in 2003. Rockfalls threatened people, streets and buildings. Meanwhile, peace has returned; although the slope is merely "creeping", Steinlehnen has become an interesting research object for scientists in recent years.

Professor Andreas Eichhorn of the Geodetic Measurement Systems and Sensors branch in the Department of Civil and Environmental Engineering at the Technical University of Darmstadt initiated the interdisciplinary project KASIP (Knowledge-based Alarm System with Identified Deformation Predictor) together with the Technical University of Vienna and the "alpS" research institute; the goal was to combine metrological observations of the slope with computer models.

"A slope is tremendously complex," says Eichhorn. It can be difficult to determine exactly how a mountain slope is composed and how a failure mechanism works in detail. Therefore, scientists will not be able to rely solely on computer-based models to predict mass movements in the future; they also need efficient and precise surveillance and monitoring systems that are as comprehensive as possible.

To do this, Eichhorn and his team tested different methods at

Steinlehnen. "Installing sensors in highly active areas of the mountain is very dangerous," explains Eichhorn. "We were looking for a method that, among other things, makes non-contact observation possible." In the end, one method proved to be particularly suitable; although its basic physical principle has been used in geodesy for a long time, it was never used for the monitoring of slopes. This method uses a microwave radar of the Department of Physical Geodesy and Satellite Geodesy of the TU Darmstadt (Professor Matthias Becker), which was applied prototypically by Eichhorn's team of Darmstadt scientists .

Here, the entire surface of a slope is "shot" with microwaves that are reflected back from the surface and can then be analyzed. By comparing different measurements, the scientists can document changes of just a few millimeters. Accumulations or erosion of rock material, or even the beginning of a major landslide, can thus be recorded, Eichhorn says. In contrast to methods that scan the surface with laser light, for example, microwaves deliver much less disturbance. "A laser has too much noise," says Eichhorn. In her dissertation, doctoral candidate Sabine Rödelsperger developed an evaluation strategy for interpreting the measured data; among other things, this also makes it possible to remove meteorological disturbances and to arrive at meaningful 3D images of the slope.

During the KASIP experiments, the geodesists from Darmstadt, together with their colleagues from the field of geophysics, achieved many important insights for the more accurate interpretation of observed geophysical phenomena and the correlation between the weather and the sliding behavior of the slope. But the research also has practical benefits, as Eichhorn explains: "Solely in terms of technology, it is possible to continuously monitor a large-scale critical slope in high-resolution. Accelerations – early indicators of the possible slipping of large masses – can be detected, and it can be determined when the slope stops moving."

Microwave radar devices are still very expensive, but the method already has potential as a good early warning system: "If you would observe critical slopes with them, you could reliably determine exactly where something is happening," says Eichhorn. "Then less expensive measurement systems and their sensors could be specifically applied there."

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