



ROCYX® ROCKFALL RADAR



Automatic rockfall detection with radar technology in all-weather and at any time of the day. Reliable real-time detection with alarm option for automatic traffic control or construction site evacuation.



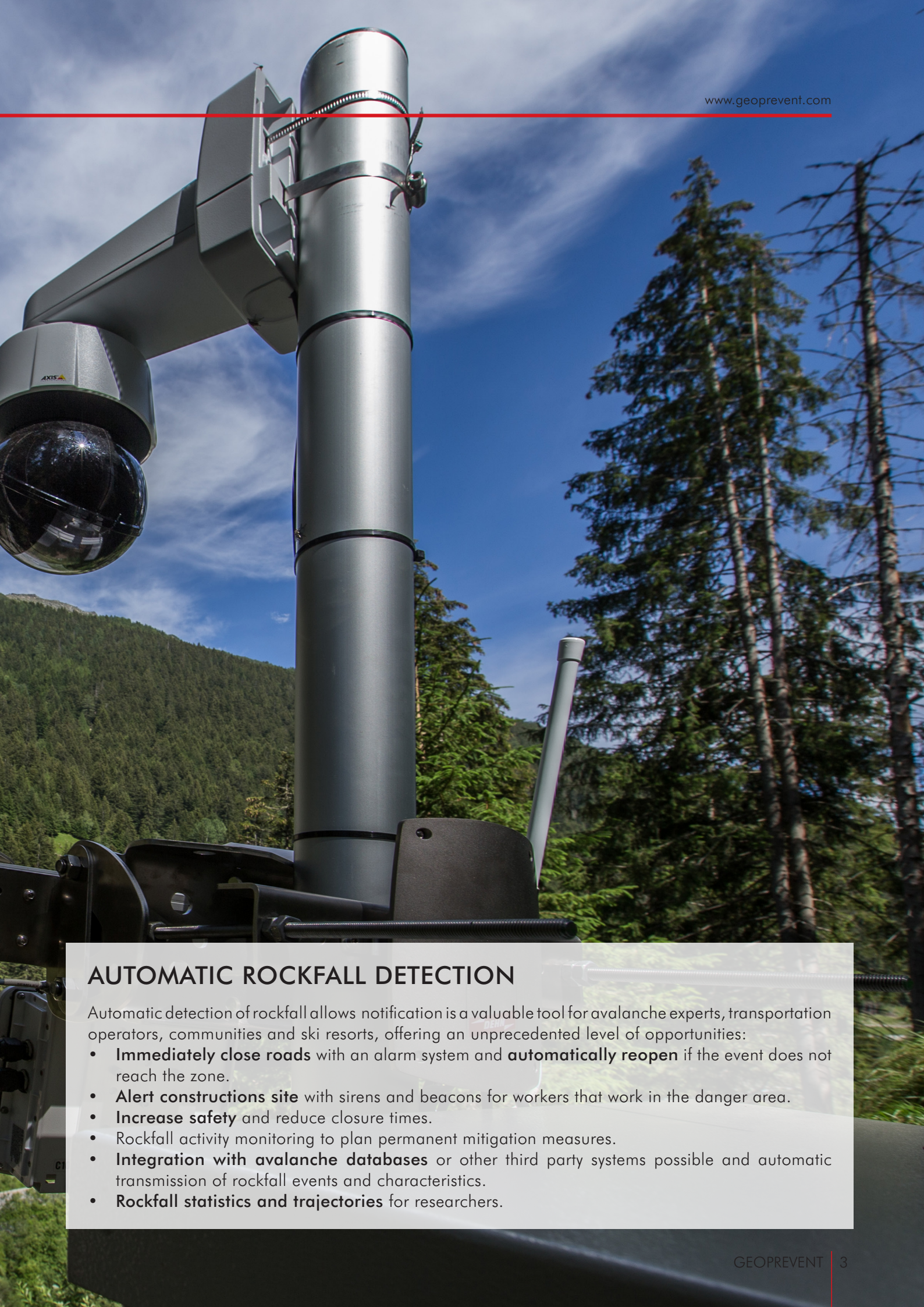
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WHY RADAR?

ROCYX® rockfall radar is a Doppler radar that makes use of the Doppler effect of a moving mass, such as rock boulders, snow or ice in an avalanche. It offers the following benefits:

- **Real-time detection** of rockfall at safe distance.
- **All-weather application** (fog, rain or snowfall) and day and night.
- Monitoring of **large areas** at a distance of up to 1.5 km.
- Coverage of **multiple rockfall channels** simultaneously.
- Opening angles of up to **30° horizontally** and **30° vertically** or at distances below 1 km **90° horizontally** and **20° vertically** (other opening angles on request).
- Dedicated **GEOPREVENT algorithms** for reliable rockfall detection of varying sizes independent of visibility conditions.
- **Rockfall mapping** of avalanches on GRAVX data portal.
- Combination of radars for even larger coverage, redundancy or different functionality e.g. people detection.



AUTOMATIC ROCKFALL DETECTION

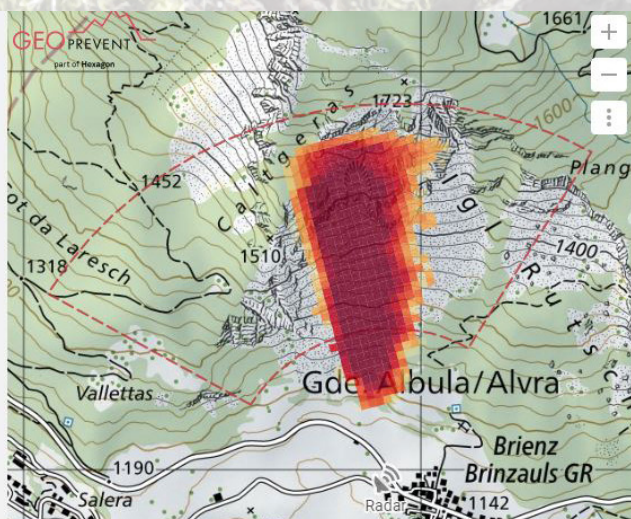
Automatic detection of rockfall allows notification is a valuable tool for avalanche experts, transportation operators, communities and ski resorts, offering an unprecedented level of opportunities:

- **Immediately close roads** with an alarm system and **automatically reopen** if the event does not reach the zone.
- **Alert constructions site** with sirens and beacons for workers that work in the danger area.
- **Increase safety** and reduce closure times.
- Rockfall activity monitoring to plan permanent mitigation measures.
- **Integration with avalanche databases** or other third party systems possible and automatic transmission of rockfall events and characteristics.
- **Rockfall statistics and trajectories** for researchers.



ROCKFALL MAP AND NOTIFICATIONS

Once the radar detects a rockfall event, it triggers the system-integrated camera to take a series of pictures or record a video of the event and triggers an alarm, if an alarm system is attached. The radar tracks the event until it comes to a stop or leaves the field of view. All event data is then transmitted to GRAVX data portal for online display. Rockfall parameters such as start time, duration, size and average front speed are also provided. SMS and email notifications allow for immediate awareness when a rockfall occurs.



Radar Radar

Duration 2min 31s

Size 3.9

Start 2:19:34 PM

Affected regions ROI 1, DZ 1

Speed 85 km/h



Brinzauls_PTZCam

Recorded at 2:20:20 PM (13/20)



LARGE COVERAGE AND HIGH SENSITIVITY

The rockfall radar allows to monitor large areas and several rockfall channels simultaneously.

- Opening angles: 30° horizontal, 30° vertical.
- Opening angles for short-distance (<1 km): 90° horizontal, 20° vertical.
- Other opening angles on request.
- Maximum range (in operation): 1.5 km.
- Detectable size at 100 m: approx. 10 cm in diameter.
- Detectable size at 1 km: approx. 25 cm in diameter.
- Combination of radars for even larger coverage, redundancy and different application e.g. people detection.
- Sensor-fusion with other sensors and technologies, e.g. seismic sensors, to minimize false alarm rate and shorten alert time.

AUTOMATIC ALERTING

The rockfall radar system can be upgraded to an alarm system that triggers automatic actions, such as the closure of a road or railway or the evacuation of a construction site. Common alerting devices are traffic signs, audio-visual sirens or beacons for workers. We usually also implement automatic reopening in case the avalanche event did not reach the road. By doing so, the closure times remain short and road users can continue their journey a few minutes after the alarm.

SEISMIC SENSORS

The rockfall radar can be extended with seismic sensors for event verification within a very short time. In case the warning time is very short, we recommend to use a sensor fusion approach and combine the radar with seismic sensors. Both signals are analyzed simultaneously and verify an event: If the seismic signal confirms the sensor, an alarm is triggered.

DEFORMATION CAMERA

The deformation camera is applied for long-term and area-wide monitoring of instabilities in rock and ice. Fully automated deformation analysis based on the comparison of high-resolution images allows to detect displacements of a few centimeters quickly and easily.

INTERFEROMETRIC RADAR

The interferometric radar is used for large-scale monitoring of unstable slopes independent of visibility and allows to detect surface deformations in the range of sub-millimeters. We often combine the rockfall radar with the interferometric radar to measure both, slow surface movements (mm/day to mm/month) and fast movements (several m/s) with automatic alerting.



COMPREHENSIVE SOLUTIONS

Rockfall radar systems come as a complete system and include the radar hardware, cameras, communication devices and a self-sufficient power supply, if required. We tailor our systems to local requirements and design for long-term fully automated operation. For this, we use high quality components that are suitable for harsh winter conditions and provide an energy-efficient solution.

INTEGRATED CAMERAS

The ROCYX® system includes an integrated camera for event images and videos. We use remote-controlled cameras with pan-tilt-zoom functionality (PTZ) or high-resolution, very energy-efficient camera systems. Thermal imaging cameras or other models may also be added. Besides event images, the camera generates regular status images and if desired, closeups of predefined zones (e.g. avalanche release areas). The user can control PTZ cameras directly via the data portal and gain a live view of the situation on site through smartphone, tablet or PC.

POWER SUPPLY

As power source, we use grid power or, if not available, a sophisticated combination of solar panels and a methanol fuel cell. The solar array is dimensioned based on solar simulations at the radar site and the station's power consumption. Solar power is used when available, whereas the fuel cell takes over during periods of poor weather. The fuel cell and methanol tanks are integrated in the electronics cabinet and the setup is designed for one service visit per year to replenish the tanks, usually in spring/summer. The mobile setup comes in several units for easy transport by a vehicle or a helicopter.

COMMUNICATION

All rockfall data and images are transmitted to the GEOPREVENT cloud for storage and display. In addition, the system sends status and health data for functionality monitoring and the GEOPREVENT operations team can access the system remotely to troubleshoot, if necessary. Data communication is possible through different channels, either through existing networks such as GSM, ethernet, or fiber, or we set up dedicated radio links with repeater stations or satellite communication.

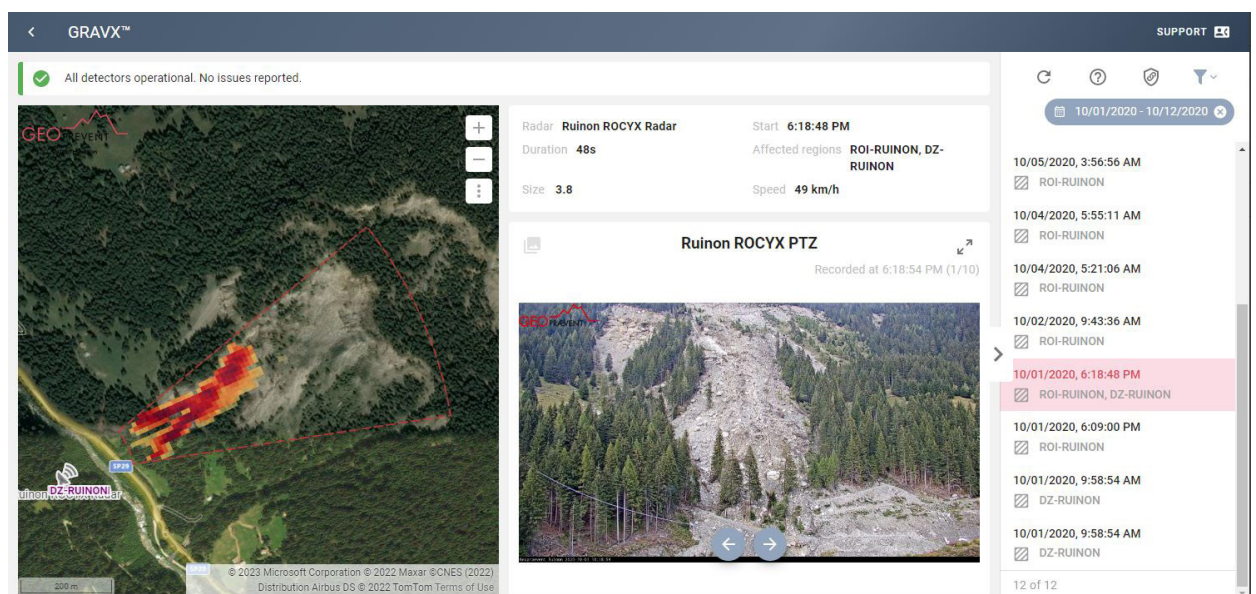
24/7 MONITORING INCLUDED

We continuously monitor all our systems around the world to ensure they are functioning properly. Automated health checks verify critical system parameters and notify the GEOPREVENT team in case of irregularities. Our operations team can access all systems and verify settings, fine tune radar, and perform upgrades.

GRAVX® ONLINE DATA PORTAL

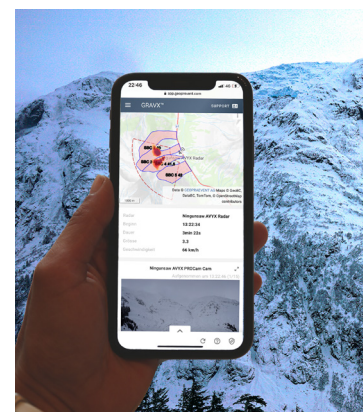
GRAVX online data portal connects, visualises and archives avalanche and status data and provides you with the relevant information conveniently via your preferred devices, i.e. smartphone, tablet or PC. GRAVX online data portal is based on state-of-the-art technology and offers secure storage of your measurement data with password-protected user access. The user only needs to log on to the browser-based portal, there is no need to install any software on any devices.

GRAVX allows for easy navigation and provides an overview of all system data. Rockfall events are displayed georeferenced on a map with an intensity heatmap or event trajectories. According event imagery and avalanche characteristics are shown in the same view. All lists can be filtered by time or image type. The image viewer function is a convenient tool to inspect and compare image details, such as avalanche release zones or crevasses. Other features include remote camera control or the alarm system control center for reopening transport ways.



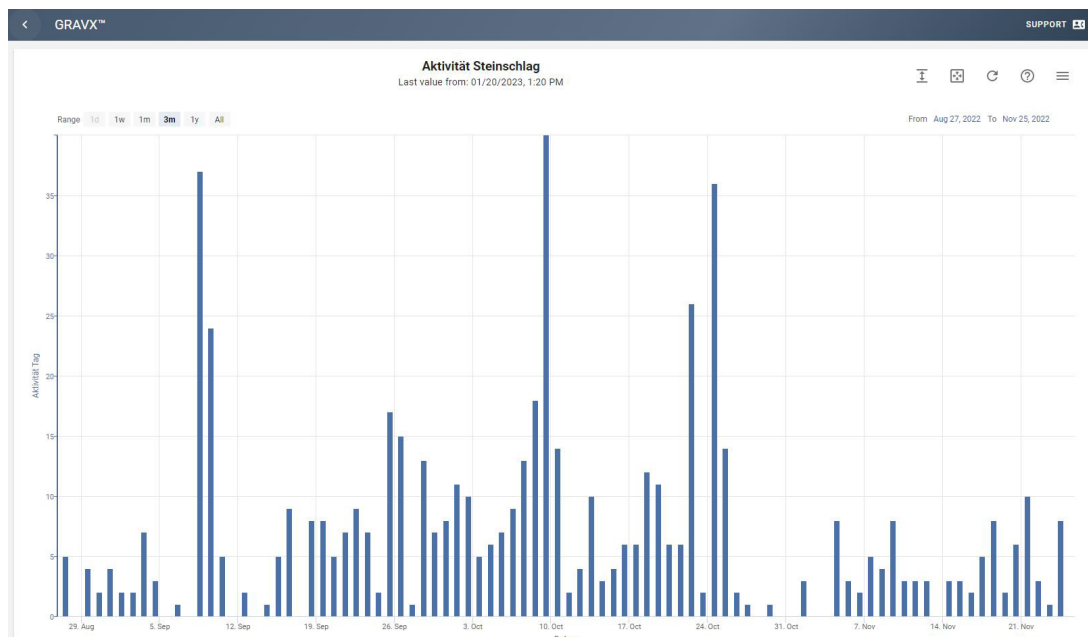
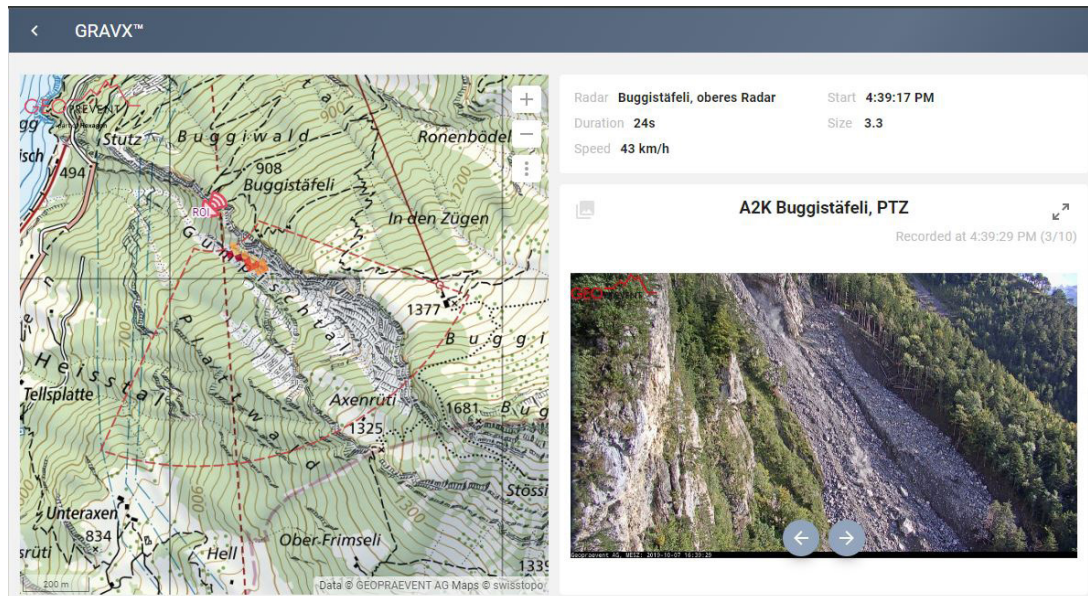
ANYTIME – ANYWHERE

GRAVX online data portal can be accessed anytime from anywhere, be it by smartphone, tablet or PC. Avalanche data is available already in the field. SMS and emails can be sent at event start, end or upon reaching certain areas. Different user levels allow the delimitation of certain functions, such as traffic light control. GRAVX also offers a message board to communicate with the project team and the GEOPREVENT staff.



DATA INTEGRATION

GRAVX online data portal also displays data from other sensors, for example the deformation camera or the interferometric radar. External data can also be integrated and displayed (e.g. measurements from total stations or crack meters). In addition, other calculations and displays are possible, such as the activity plot as shown below.



REFERENCE PROJECTS

To date, GEOPREVENT has operated several complex rockfall monitoring systems internationally since 2019. The following customer projects provide insights into the application of our ROCYX® rockfall radar technology. Please find more information and reference projects on www.geoprevent.com.

GUMPISCH VALLEY, SWITZERLAND

The failure of a mountain face released 120'000 m³ sediment into the Gumpisch valley about 1000 m above the Axenstrasse, a highway of strategic importance in Switzerland, and the railway. Heavy rainfall causes repeating mudflows and rockfall which is monitored by a tailored surveillance system consisting of various sensors and cameras at different locations. The key elements of the system are two ROCYX® rockfall radars at about 400 metres above the road. A high-resolution camera with DEFOX™ methodology permanently analyses the debris accumulations and the radars automatically detect moving rock masses in real time. Simultaneously, three seismic sensors at the same location measure ground vibrations and detect rockfall or a debris flow through the generated ground movement. Our algorithms detect an event by a combination of sensor signals in real-time and automatically switch the traffic lights at the road below to red. If the motion sensors on the rockfall barriers at the road do not detect an impact, the Axenstrasse is opened to traffic again after 2 minutes.



BRINZAULS, SWITZERLAND

The ROCYX® rockfall radar monitors the active landslide area above Brienz/Brinzauls from a distance of about 1 km. Since the road passes through the runout zone of the rockfall zone, it takes between 30 and 60 seconds for a boulder to reach the road depending on boulder size and track. This warning time is sufficient to close the road in time. Upon rockfall detection, the radar automatically switches the traffic lights to red and notifies the responsible safety managers. When the alarm is triggered, there is enough time to leave for vehicles within the road section at risk, assuming normal travel speed.



RUINON, ITALY

The road to Santa Caterina in the Province of Sondrio was a notorious landslide that frequently affected the road. A ROCYX® rockfall radar was deployed for real-time alerting of the road in 2020. The system was setup with automatic reopening if the event did not reach the vicinity of the road. The landslide slowed down significantly after a drainage was implemented.



TECHNICAL DATA ROCYX® ROCKFALL RADAR

Range:	600 m to 2 km (depending highly on the minimum rock size for detection)
Coverage:	0,3 km ² to 3 km ²
Frequency:	10–10.6 GHz
Bandwidth:	10–50 MHz
Antenna vertical opening angle:	20°
Antenna horizontal opening angle:	15°–90°
Weight (without mast):	Approx. 2,3 kg
Power consumption:	Approx. 50 W
Power supply:	Grid power, solar panel, fuel cell
Software:	Rockfall-detection-algorithm (GEOPREVENT development)
Integration:	Online data portal, smartphone, tablet
Alarm:	Automatic alert option, other alarm-functions
Installation:	Quick, few hours

ALARM AND MONITORING SYSTEMS FOR NATURAL HAZARDS

GEOPREVENT provides alarm and monitoring solutions for a wide range of natural hazards. We either monitor the hazard zone to measure precursors of an event or we detect the event itself and automatically trigger alarms.

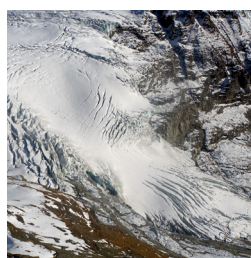
GEOPREVENT also provides technology to detect people in the hazard zone (e.g. prior to avalanche blastings).



ROCKFALL



FLOODS



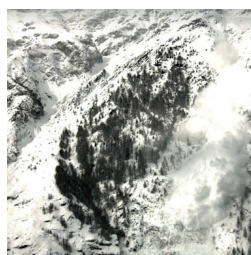
GLACIERS



LANDSLIDES



GLACIAL LAKES



AVALANCHES



DEBRIS FLOWS



SAFETY NETS



PEOPLE

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