the spring of 2016, the complex and its components were tested in the laboratory, and in the winters of 2016-17, 2017-18 in the field conditions in the Khibiny Mountains. The devices (11 devices were tested in total) were installed in the avalanche runout zones of the Yukspor Mountain, crossed by railway. During the tests all avalanches that have reached poles with devices were registered. In the Hakman's valley was registered slushflow. There was one failure due to a software error in its first variant and damage of the sensor by the power supply unit (due to its weak fastening inside the case, though, the case remained not damaged) at an avalanche impact. The identified defects have been corrected. The detectors showed high reliability and transmitted signals even under snow and in water. Although instead of recommended lithium batteries were used alkaline ones, the failures due to the loss of power were not observed. Various possible system configurations convenient to consumers are discussed.

P3.12

EVALUATION OF THE FIRST AUTOMATIC WARNING SYSTEMS FOR SNOW AVALANCHES IN NORWAY

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Our everyday life is continuously changing to be more and more automatic. Cars drive themselves, airplanes fly autopiloted, kitchen appliances are so complex you do not even have to bake your own bread anymore. Every year, Norwegian roads are closed because of snow avalanches. Is it possible to secure the roads from avalanches automatically?

Some roads are closed on indefinite time because of the danger of avalanches. This is frustrating for the road users, as well as creates economic consequences for the business sector. For example, in remote areas in Norway where people live off farming and there is only one road to the farms, a closed road can lead to dairy farmers being forced to spill thousands of liters of milk because the milk truck does not reach the farm to pick up the milk. Time is money and the road users demand that the roads are open.

The Norwegian Public Road Administration has tested two technologies for detecting and warning road users about snow avalanches in real time; doppler radar and geophones. The radar uses radio waves to measure the direction and distance to an object and can therefore be used to decide that an avalanche is moving in relation to the radar. A geophone measures ground motion and can detect a passing avalanche because of the friction caused by the impact between the avalanche and the ground. The geophones and the radars detect movement when an avalanche is initiated and communicate this to traffic lights which are used to warn the road users.

The aim of this master's thesis was to evaluate the first modern automatic warning systems in Norway. The first three seasons of two radar systems and one geophone system was evaluated thoroughly. This thesis also compares the two technologies and their advantages and limitations. Another aim with the thesis was to look at which technology best could differentiate between avalanche type, size and placement of the avalanches, and also which technology was best at separating false alarms from real ones. The avalanches in all systems are modelled using RAMMS to determine avalanche speed and from that, the time the avalanches spend from they are detected to they reach the road. This is necessary to calculate the distance needed between the traffic lights. For the systems to be completely safe, a car that drives past the first traffic light, must be able to pass the avalanche prone part of the road before the avalanche hits the road.

P3.13

IMPLEMENTATION OF THE LARGE-SCALE AVALANCHE HAZARD MAPPING INTO RUSSIAN PRACTICE

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Avalanche hazard mapping is a well-known and widely applied approach in hazard assessment and management. Hazard maps are used for spatial planning in consistence with hazardous areas, for assessing risks, and for planning of mitigation measures. While avalanche hazard regions in Russia occupy about 18% of the territory, large-scale avalanche hazard mapping is not yet used by land planning authorities for land use planning in the avalanche endangered zones. As a result, buildings are being constructed in avalanche hazard zones without avalanche protection. In this research, the importance and difficulty of the avalanche hazard mapping implementation into Russian practice are discussed on the example of Krasnaya Poliana (West Caucasus), Sochi. Krasnaya Poliana is one of the most popular alpine skiing areas in Russia with well-developed infrastructure partly located in avalanche hazard zones. We applied well-known avalanche hazard mapping approaches for Gorky Gorod ski resort, discuss the technical procedure and the obtained results. Definition of avalanche potential release zones is a key step of the avalanche hazard mapping. Using GIS technologies in combination with DEM (5 m) and remote sensing data as well as field observations, 87 potential avalanche release zones have been indicated and analyzed with respect to topographic characteristics. The avalanche fracture depth in the release zones was calculated according to the 3-day snow cover increase (return period dependent). Field observations

(February and July 2017) together with historical and recent state remote sensing and direct avalanche data analysis were performed for determining the runout distances of avalanches. Numerical simulations of avalanches in three-dimensional terrain using avalanche dynamics program RAMMS were performed for understanding of avalanches dynamics and determine the potential avalanche runout distances, velocities and impact pressures (return period dependent). We simulated 87 avalanches with a 30-year return period and 29 avalanches with a 300-year return period. The numerical simulation results were analyzed and used as a basis for the avalanche hazard mapping because there were not enough evidences of extreme and rare avalanches in the region. First, we applied Swiss avalanche hazard mapping approach when avalanche hazard zones were indicated according to avalanche return periods (30 and 300 years) and impact pressure (30 kPa). Second, we applied the values of typical impact pressures expected for avalanches in relation to their destructive effects for avalanche hazard mapping purposes. As a result, large-scale avalanche hazard maps were developed for Gorky Gorod ski resort. We also analyzed the applied avalanche mitigation measures in the region. The avalanche large-scale hazard mapping approach in Russia is still under the development. It is going to merge a theory accumulated so far in the world with the long-term Russian avalanche hazard assessment practice.

P3.14

HISTORIC SNOW AVALANCHES IN THE PYRENEES: THE DESTRUCTION OF THE SMALL VILLAGE OF ÀRREU (PALLARS SOBIRÀ)

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Snow-avalanche events which cause destruction and loss of human lives stand out in the memory of people. In the Pyrenees several such avalanches are historically known which correspond to the more than 100-years return period category. In the present work we reconstruct one of these events. Our longterm objective is to reconstruct these historical major avalanches to improve the knowledge on major avalanche cycles, their frequency and intensity in this mountain range.
On this occassion we reconstructed the event occurred in 1803 which devastated the small village of Àrreu (ten houses destroyed and seventeen people killed) and caused its people to move location to a safer place. To the present day, after 215 years, there is no evidence of a similar phenomenon in the proximity of the ruins of the old village. The story of the catastrophe remains like something legendary in the valley's collective memory, as a circumstance belonging to the past, unlikely to occur nowadays.
We combined several methodologies to reconstruct the event and the frequency of avalanches along the avalanche path. Search in historical documents rendered most of the information: when and where it occurred, and how many people were killed. Field inspection and dendrochronology allowed us to reconstruct several events of various sizes, and to obtain an estimate of the frequency at different elevations along the avalanche path, but due to the short age of the trees, we did not detect evidence of the most extreme event. Finally, with all the data we modelised the 1803 event and reproduced the most likely trajectory which destroyed the old village.

P3.15

AVALANCHE PROTECTION MEASURES AND THEIR VALIDATION

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Introduction: The question of validation arises as soon as measures for the containment of natural dangers are established for a given catchment area. Major differences are present for the systematics of valuation for the different protection strategies, such as passive and active measures with permanent or temporary effect. This is particularly true when the protection strategy includes an interaction of technical and operational (e.g. artificial avalanche triggering) vs. organizational (blocking, evacuating) measures. In the course of the validation process, two essential queries arise:
1. Does the function of the existing protection measure(s) correspond to the basic protection target?
2. To which extent does the structure live up to the expected impacts?
First, the function and the structure's state for the respective protective measures must be evaluated. Then, a future-fit, suitable catalogue of measures can be established. Systematics for the evaluation of avalanche protection constructions In order to perform an evaluation, one has to focus on the following question: To which extent does the construction correspond to the state-of-the-art? In Austria, the state-of-technology status is defined in Section 12a (1) of the Water Rights Act 1959.

A functionality must be tested and proven so to live up to this status. The procedure used therefore must be based on pertinent, renowned scientific insights.
Two further functional validation categories are possible in addition to the "state-of-the-art" rating. If said functionality is not sufficiently tested yet, however, it is considered theoretically proven, then it belongs to the "state-of-science" category. The other way around, if the procedure was sufficiently tested, however, does no longer live up to latest insights, it still corresponds to "state-of-tried-practice". Thus, methods that most recently still belonged to