

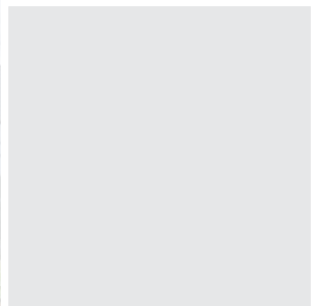
MicroStep - MIS

COMPLEX SOLUTIONS FOR THE REAL WORLD



Success Story

**A COMPREHENSIVE SYSTEM
OF EARLY WARNING AND PREPAREDNESS
FOR THE MOUNTAIN ENVIRONMENT**



Overview

Project

A comprehensive system for early warning, preparedness, and issuing targeted and timely warnings against risks in the mountain environment.

Subject of the Contract

Part I - Ensuring preparedness to handle emergency events caused by sudden snow movements in areas with increased population movement and evaluating the impacts and risks of slope geohazards.

Part II - Software for collecting meteorological data and the meteorological database, software for simulating dangerous natural phenomena threatening infrastructure and people in the mountain environment, and early warning systems against them.

Client

Avalanche Prevention Center, Mountain Rescue Service of Slovakia

Project duration

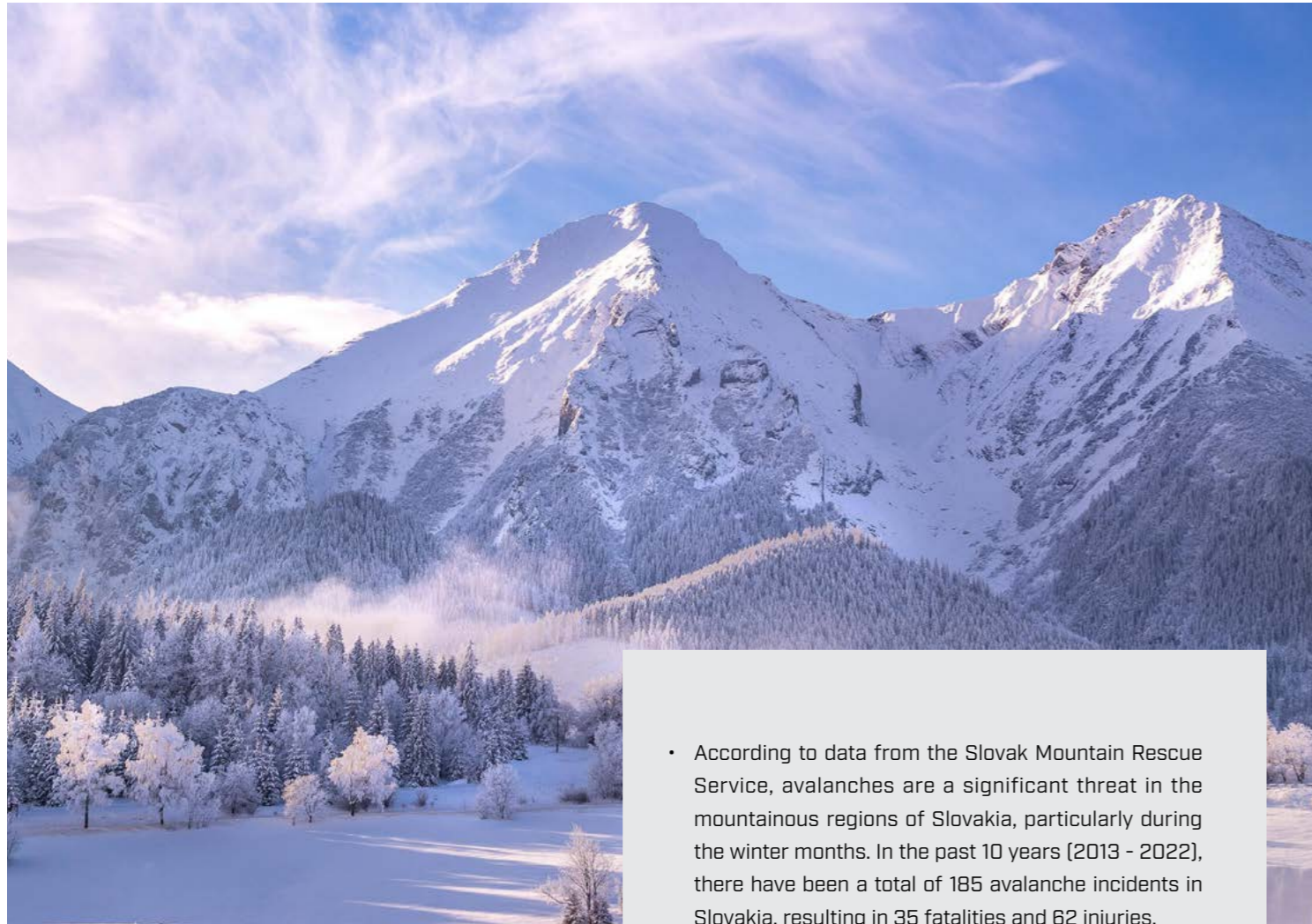
2019 - 2022



Avalanche Prevention Center, Mountain Rescue Service of Slovakia

The Mountain Rescue Service (Horská záchranná služba, HZS) of Slovakia provides nationwide mountain rescue and search and rescue operations in challenging terrains, working closely in cooperation with the Air Rescue Service. It is an integral part of the nationwide integrated rescue system in Slovakia.

The Mountain Rescue Service also operates the national center for avalanche prevention, which monitors conditions in all regions and issues avalanche warnings, along with other countermeasures such as controlled avalanche triggering through explosive detonations. The Avalanche Prevention Center manages its own Avalanche Information System and an online portal where mountain-goers can check the current situation.

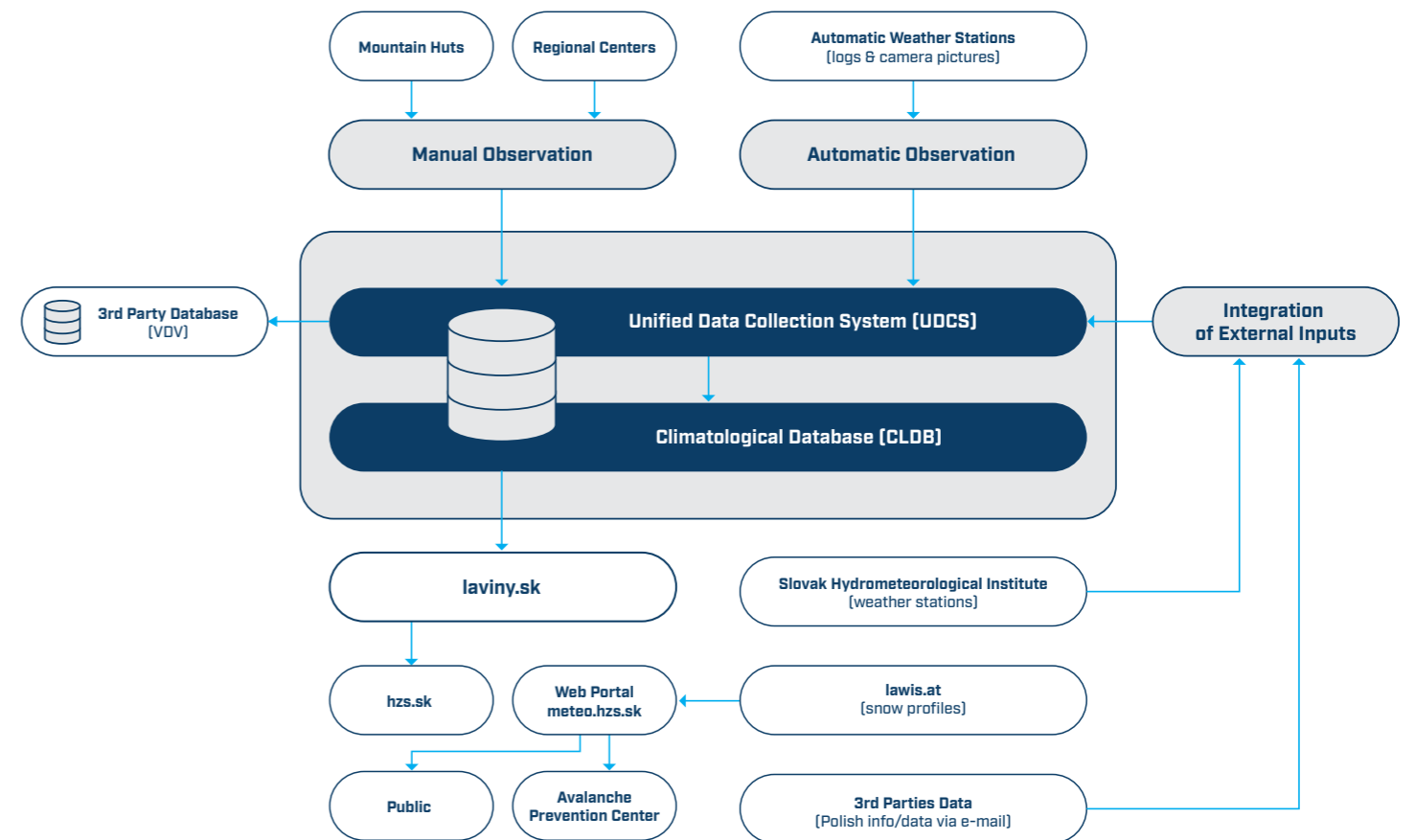


- According to data from the Slovak Mountain Rescue Service, avalanches are a significant threat in the mountainous regions of Slovakia, particularly during the winter months. In the past 10 years (2013 - 2022), there have been a total of 185 avalanche incidents in Slovakia, resulting in 35 fatalities and 62 injuries.

The weather in mountains is constantly changing and can present challenges to even the most experienced travelers. Winters in the mountains can be particularly treacherous, with heavy snowfall and the risk of avalanches. The mountainous regions of Slovakia attract hundreds of thousands of tourists and visitors each year, making safety a top priority. Ensuring the safety of these visitors is the ultimate goal of the Mountain Rescue Service, including the Avalanche Prevention Center, which continually monitors weather conditions and issues warnings to help prevent accidents.

Our partnership with the Mountain Rescue Service dates back to 2008. Over the years, we have worked together on various projects to improve safety and preparedness in the mountain environment. In 2015, we delivered a network of meteorological stations

- The frequency of avalanches varies from year to year, depending on weather conditions, but on average there are approximately 10 - 20 incidents per year in Slovakia. However, it's worth noting that not all of these incidents involve casualties, and many are minor and don't cause any harm.
- The most dangerous areas in Slovakia in terms of avalanches are the High Tatras and the Western Tatras. These areas are popular among tourists and hikers, making safety precautions and awareness of avalanche risks especially important.
- In recent years, there have been several high-profile avalanche incidents in Slovakia, such as the tragic avalanche in the High Tatras in January 2021, which claimed the lives of three people. These incidents serve as a reminder of the dangers of mountain travel and the importance of taking appropriate safety measures.



that had been serving the customer for several years. In 2019 we won the contract to upgrade the existing network and extend it according to requirements of the client.

The project involved the development and implementation of a comprehensive system of early warning, preparedness, and targeted warnings to help mitigate risks in the mountain environment. Our objective was to deliver a system that would enable the Avalanche Prevention Center of the Mountain Rescue Service to handle emergency events caused by sudden movements of snow in areas with increased population movement, while also evaluating the impacts and risks of slope geohazards. Our team was tasked with developing a custom solution that incorporated the latest technology and best practices in the field.

The network of Automatic Weather Stations

We delivered a **network of 46 automatic weather stations**, consisting of three types, to the customer. The first type of station (16) was designed for regional centers of the Mountain Rescue Service, mountain cottages, and dispatchings. The small met station built on a tripod was equipped with a basic set of sensors, including air temperature, relative humidity, wind, and precipitation. These stations are portable, though stable against weather conditions, therefore prove to be incredibly useful in gathering important weather data for the various mountain ranges in the area.

The second type of station (19) was an innovative upgrade of existing stations, which were either fitted with new sensor sets or supplemented with missing parameters. These stations were part of the already existing avalanche protection network implemented in the area as part of the projects dating back to 2008 and 2015. Finally, the third type of station consisted of new and large stations that expanded the existing network to locations chosen by the customer. These stations featured an extended set of sensors, providing even more comprehensive and accurate weather data. Among these sensors were unique instruments designed to measure snow parameters, such as:

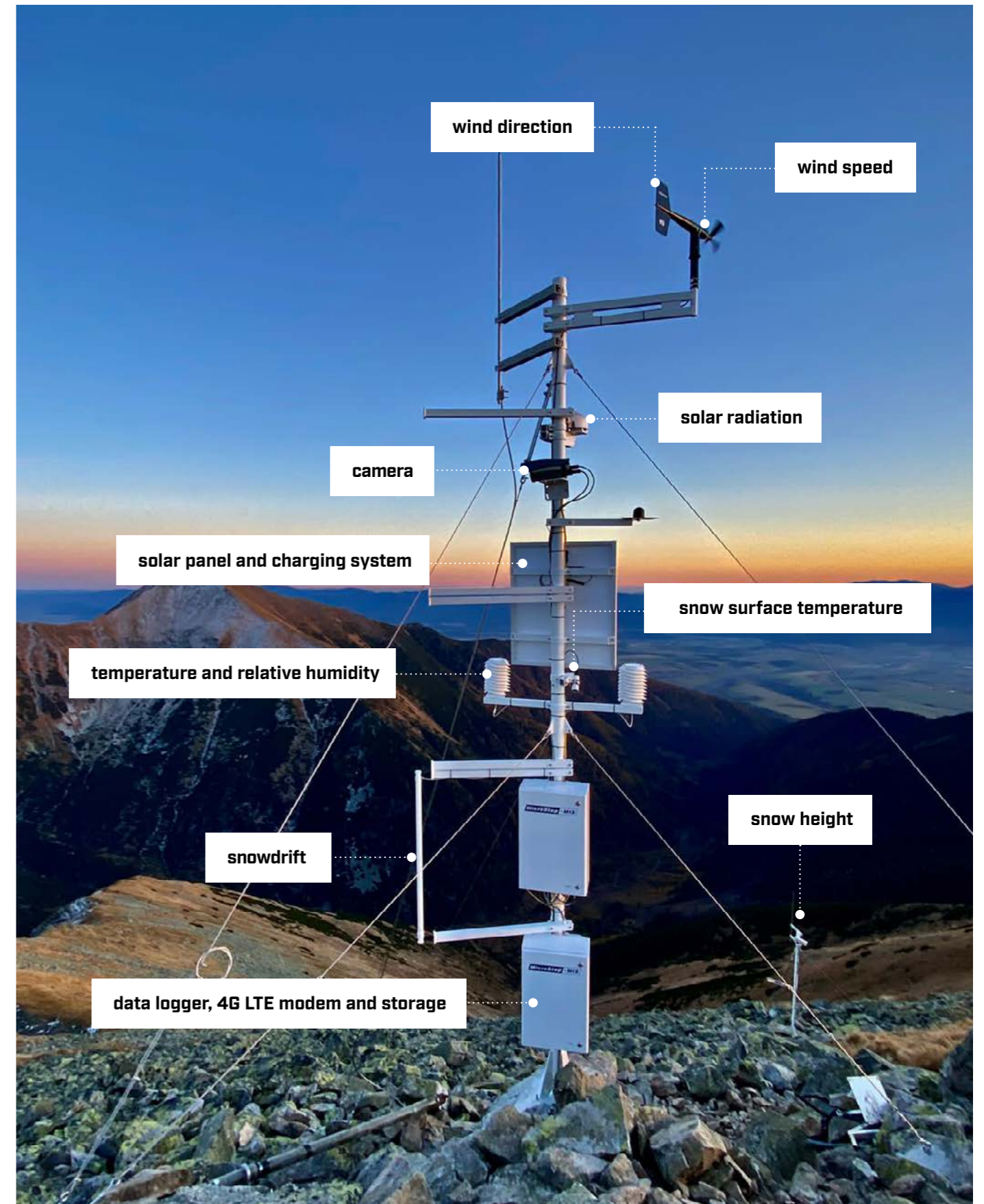
- FlowCapt (snowdrift and snow blowing)
- Laser snow height
- Surface snow temperature
- Snow profile temperature

These specialized sensors allowed for a more in-depth understanding of snow conditions, enhancing the station's ability to provide precise and valuable weather information. With this network of Automatic Weather Stations, the customer can expect to receive crucial weather information for a variety of applications, such as **mountain rescue, avalanche protection, and weather forecasting.**

The summit stations on the ridges, situated at an altitude of approximately 2000 meters, are subjected to significant amounts of snow and frost in the harsh mountain environment of Slovakia. The frost in this region is exceptionally strong, often resulting in frost buildup of

up to 20 cm that cannot be easily removed. As a result, using sensors of the highest quality and those that are best suited for the high mountain environment was a vital requirement for the project.

To ensure the efficient functioning of the stations, a modem and SIM card were incorporated, allowing for the data to be sent to a server for processing and graphical display. This will allow our customer to easily access and analyze the weather data gathered by the stations.

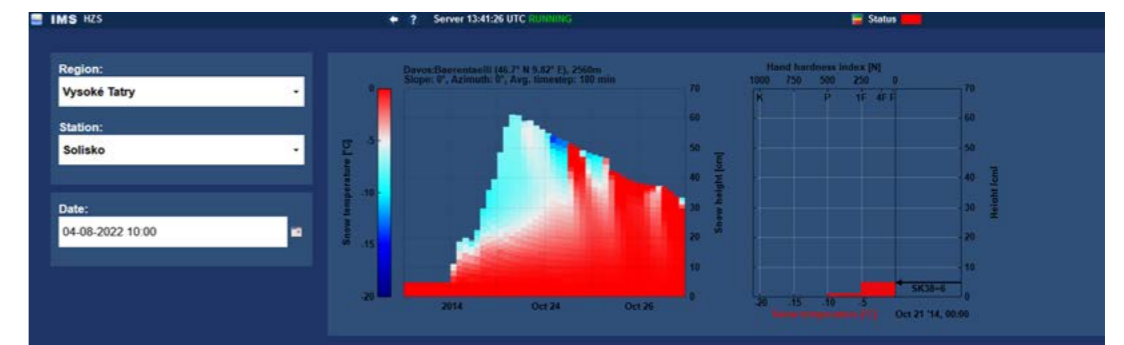


Overcoming obstacles of the mountainous terrain

Due to the challenges presented by the mountainous environment, the installation of the weather stations had to be carried out in several phases. These areas are often covered with snow for most of the year, making it impossible to execute installation works. The late spring and summer months provide a suitable installation window, but they can also be challenging as the weather can be unpredictable. As a result, a great deal of flexibility was required to complete the installation process.

Moreover, many of the chosen spots for the stations were located in difficult terrain, making them hard to access and even harder to bring heavy equipment onto. To overcome this obstacle, the team often had to use helicopters for transport or rely on the services of skilled mountaineers who could carry the necessary equipment to the installation site. Despite the challenges, our team worked tirelessly to ensure the successful installation of each station in the network.





SNOWPACK model

Central Data Collection and Database System

The Unified Data Collection and Database System has been designed to collect and process meteorological data from the Automatic Weather Stations. It enables the operation and maintenance of the meteorological network of the Mountain Rescue Service.

The system processes all meteorological data measured within the network of the stations, with the ability to receive text messages from data loggers and manual

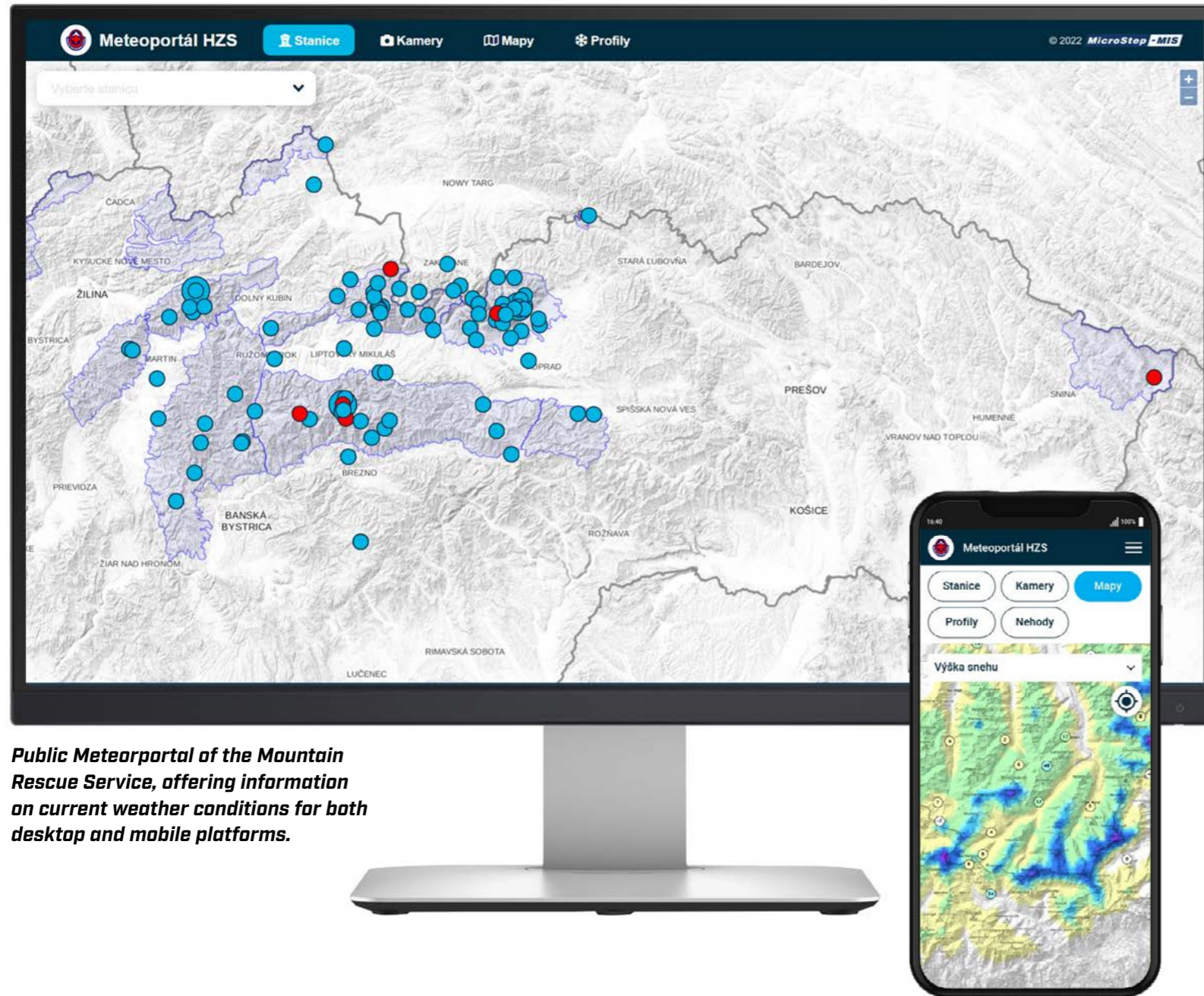
observations online. The system checks and verifies the quality of the received data before entering it into the Mountain Rescue Service method database. This database is used to store all meteorological and environmental data and observations of the MRS and cooperating institutions. The database has a modular architecture, allowing for the addition and expansion of input and output modules. With the system in place, the data collected by the meteorological network can be easily and efficiently

processed, verified, and stored in a single location for easy access and analysis. One of the system's notable features is the generation of station-specific reports, which are utilized as essential inputs for location-based forecasting.

SNOWPACK model

One of the specialties of the system is a unique SNOWPACK model incorporated in the Climatological Database. The

model utilizes weather data to simulate the snowpack's progression throughout the winter season. With the availability of weather data from the Automatic Weather Stations, the snow model can generate snow profiles for each location. By analyzing the microstructure and layering of the snowpack, the model accurately simulates how the snowpack interacts with its environment, including key physical processes such as mass and energy exchange between the atmosphere, snow, and soil.

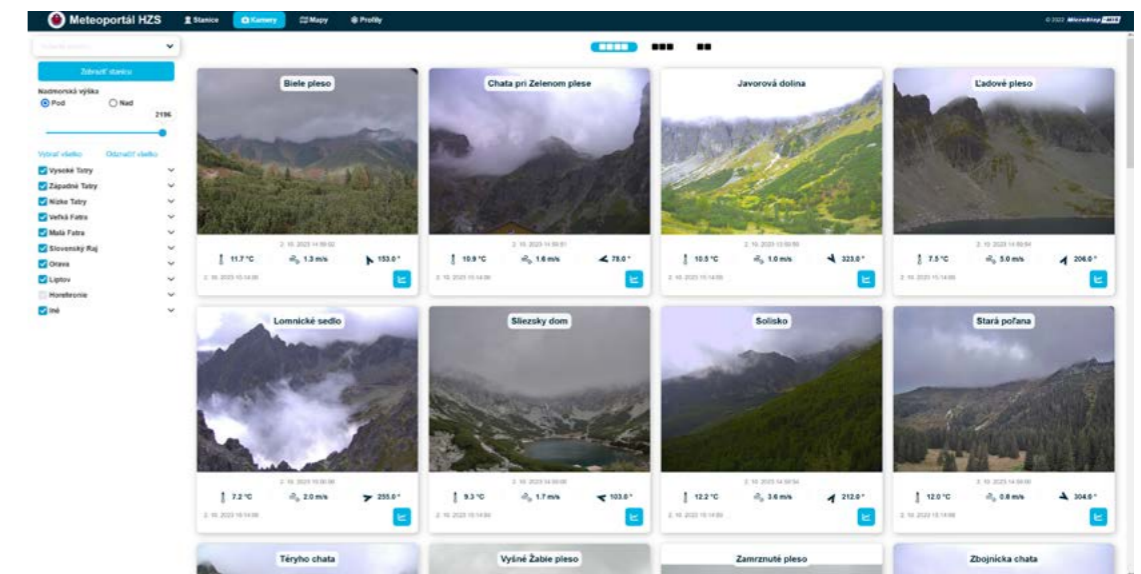
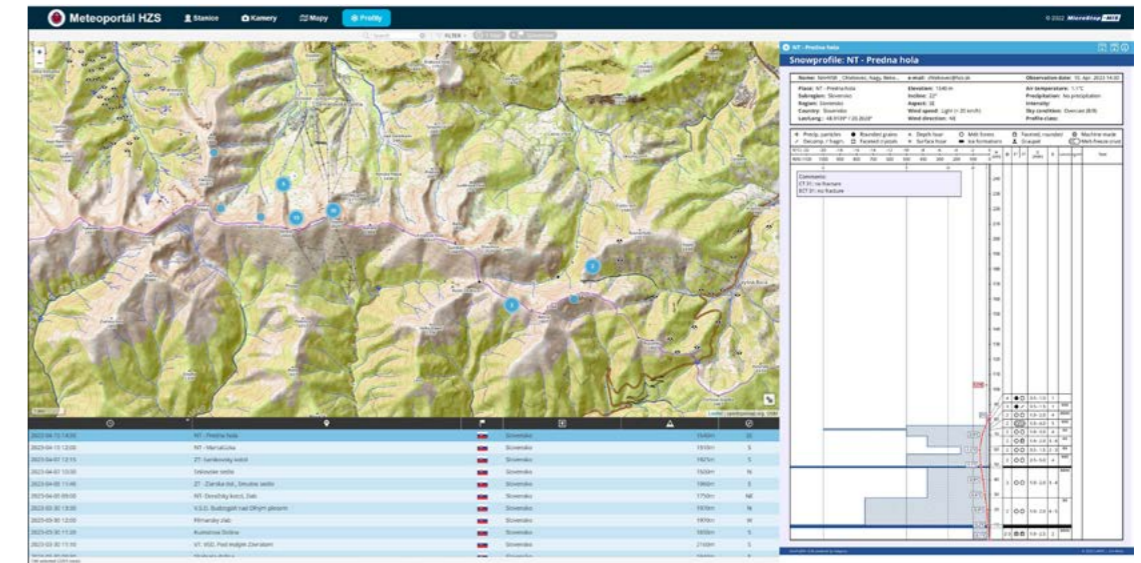
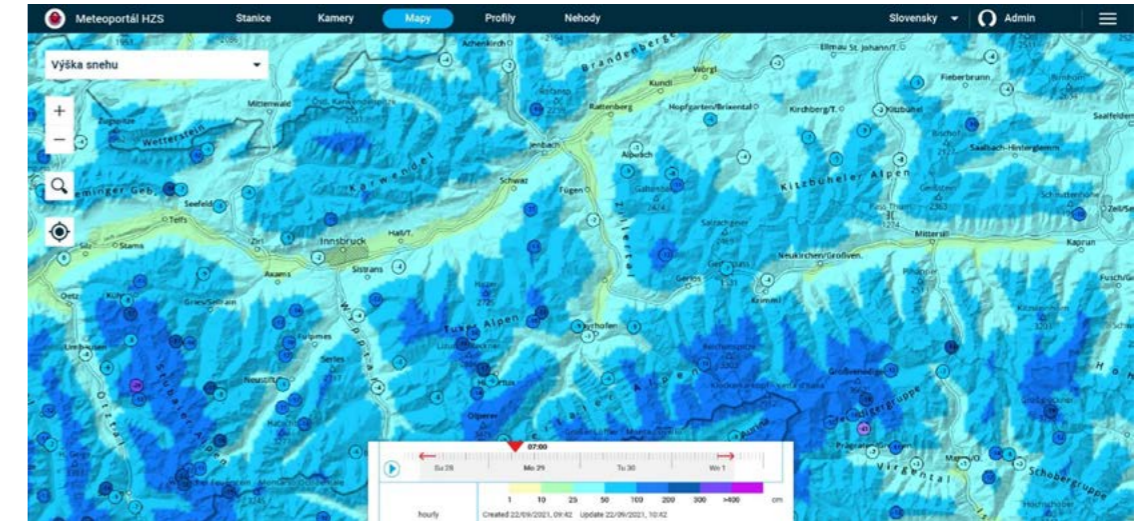


Public Meteorportal of the Mountain Rescue Service, offering information on current weather conditions for both desktop and mobile platforms.

Meteoportál

The stations' collected information not only benefits the Mountain Rescue Service, but also the general public by providing up-to-date weather conditions. This data is easily accessible through the Meteoportál meteo.hzs.sk, which was included in the project's delivery. The portal is user-friendly and offers the most relevant public data. A

map with marked locations of the stations is located on the left-hand side, and users can select locations from a list or filter them by altitude. Additionally, current camera images are updated hourly, and graphs display basic parameters' progression over the past 24, 3, or even 7 days.





Recorded Precipitation at the Automatic Weather Station Sliezsky dom from February 3 to 5, 2023, with the highest precipitation occurring on February 3-4, reaching a total of 104 mm.



The development of wind speed at the Automatic Weather Station Holý vrch from February 3 to 5, 2023, revealed notable conditions. At the Holy vrch station, wind gusts peaked at an impressive 45 m/s [162 km/h] on February 4.

Mitigation of avalanche risk during severe weather conditions

Currently, there are no automated avalanche forecasting systems available. The degree of avalanche danger is calculated manually by an avalanche expert who relies on meteorological data collected by the stations. The accuracy of such data is critical because severe weather increases the risk of avalanches and, therefore, the deadly risk for the visitors of the mountains.

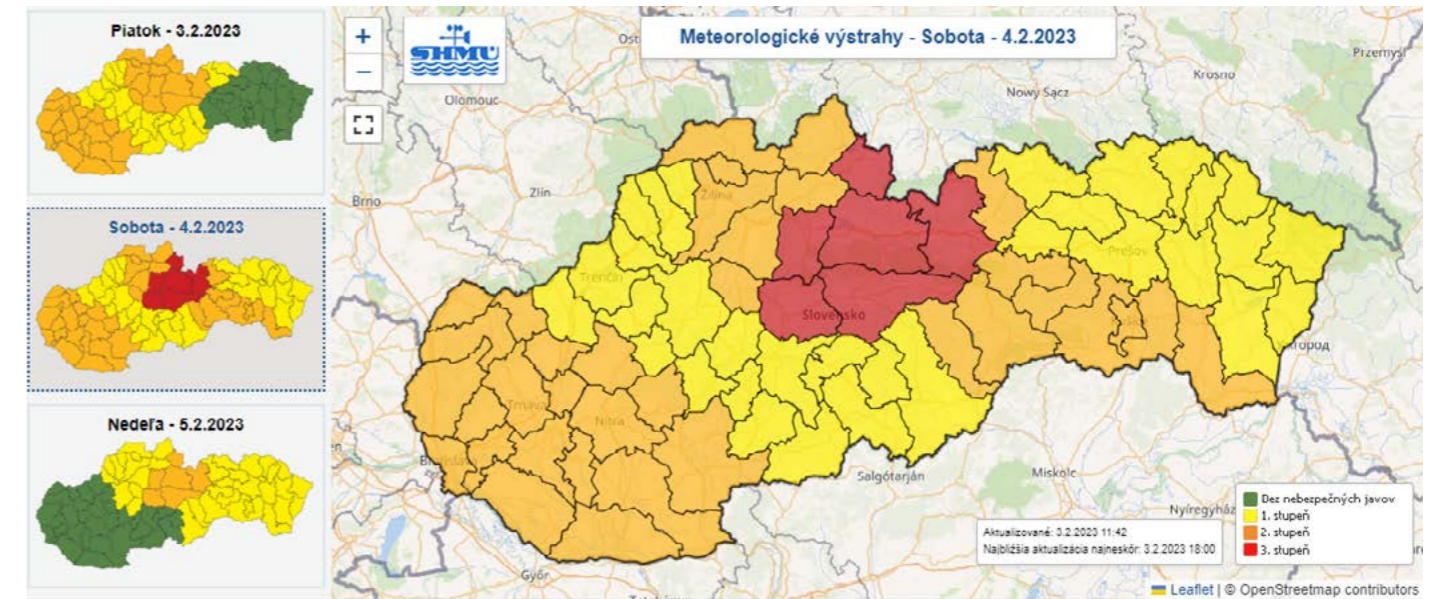
February 2023 proved to be exceptionally challenging for the mountainous regions of Slovakia in terms of weather conditions. Numerous snowstorms, accompanied by strong winds and decreased visibility, affected the eastern and northern regions of Slovakia. On the morning of February 4, a cyclone passed through eastern

Slovakia, causing a complex of phenomena, including heavy snowfall and strong winds reaching hurricane levels in the mountains. These conditions significantly increased avalanche danger, leading to the application of the fourth out of five levels of avalanche danger in the High and Western Tatras, Low Tatras, and Mala Fatra.

The storm had numerous consequences for the country. The Ministry of the Interior of the Slovak Republic recorded more than 80 emergencies due to heavy snow and strong winds, leading to impassable roads and difficulties in accessing shops and clinics. In some areas, power outages left people without electricity. The traffic situation was also critical, with car collisions and road blockages

occurring in several sections under the Tatras, causing problems for vehicles on hills and resulting in long lines. In the High Tatras, several ski resorts had to cease operations due to these severe weather conditions. Operational data from Automatic Weather Stations installed by

MicroStep-MIS enabled the Mountain Rescue Service to issue timely warnings of high levels of avalanche danger. The effectiveness of these warnings, based on actual observational data, helped mitigate potential damage caused by the storm and prevented casualties.



Tabuľkové zobrazenie výstrah

Región	Jav	Stupne v hodinových krokoch																							
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
+ Bratislavský kraj		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
+ Banskobystrický kraj		2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
+ Trenčiansky kraj		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
+ Košický kraj		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
+ Nitriansky kraj		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
+ Trnavský kraj		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
+ Prešovský kraj		2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
+ Žilinský kraj		2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Spatial (above) and tabular (below) representation of weather warnings for the Slovak region on February 4, 2023 [Source: Slovak Hydrometeorological Institute]

Through close collaboration with the client, we were able to successfully deliver a system that met all of their requirements and exceeded their expectations. The results of our work have been significant, with the Centre of Avalanche Prediction of the Mountain Rescue Service now better equipped to manage emergency events in high-risk mountain areas. By providing targeted and timely warnings, we have helped to mitigate risks and protect lives in these challenging environments.

Overall, our project has been a success and has demonstrated our team's expertise in delivering complex, high-value solutions to our clients. Through our collaboration with the Mountain Rescue Service, we have been able to deliver innovative solutions that improve safety and mitigate risks in the mountain environment. This project was yet another successful example of our commitment to delivering high-value solutions that meet the unique needs of our clients.



*Your partners
in any weather*



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