Why monitoring the snow

Why monitoring the snow, it is a **key water source for ecosystems and people**.

Snow cover is one of the most important resources for mountain regions, both economically and ecologically. The mountains act as natural reservoirs, collecting snow in winter and releasing it in spring when temperatures rise. Between 60 and 70% of water reserves comes from melting snow, with high mountain regions at the upper end of this range. Snow is a fundamental water resource that provides water to farms, forests and communities. Knowing how much water will come from the snow on an annual basis is important for short- and long-term planning.

The **water equivalent of snow** (SWE) determines the amount of water contained in the snowpack, helping water managers and hydrologists plan water use.

Measure the SWE

Measuring the amount of water in the snow can be difficult. Monitoring sites are located in locations that are difficult to access while seasonal dynamics often have continuous and sudden changes. In addition, the air temperature controls the amount of water contained in a centimeter of snow. An inch of rain can produce from two centimeters of sleet to 50 or more inches of snow, depending on the air temperature. Different storms bring different types of snow that can contain different amounts of water. Warmer snowstorms can create two inches of sleet for one centimeter of rain, while very cold snowstorms can create more than 50 centimeters of very dry and dusty snow for one centimeter of rain. During winter, different storms bring different types of snow, so the height of the snow does not directly translate into the amount of water retained in the snow. Because of this variability, SWE helps to understand how much water the snow holds.

Hydrologists typically use three metrics to measure and monitor SWE over time. These metrics can help show how snow is changing over time, how it compares to historical conditions, and what impact climate change is having on the snowpack. These tools are not the only ones used by hydrologists, but are some of the most common.

Percentage of normality

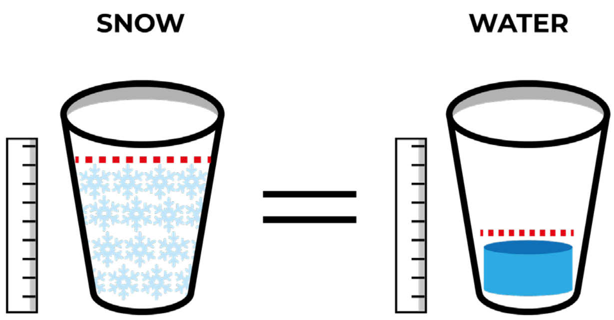
"Normality" is a measure of what is typical for a basin on the day the statistics are reported. This metric shows how the current snow conditions are compared with the historical conditions of a given day.

Graphs rain/snow

Because with climate change more and more snow starts to fall like rain, graphs of water years allow us to compare both forms of precipitation. This metric helps to show the comparison between current snow conditions and historical conditions and total precipitation. It can help to determine drought from snow.

Thirty-year trends

These graphs show the annual observations of the last 30 years, allowing users to compare historical observations with current and previous years.



Snow Water Equivalent is a measure of the amount of water in melted snow. Because 2 cm of precipitation can produce 4 cm of sleet to 40 cm or more of snow, depending on the air temperature, SWE is a more reliable method of measuring water reserves.

Why is snow monitoring essential to understanding the effects of climate change?

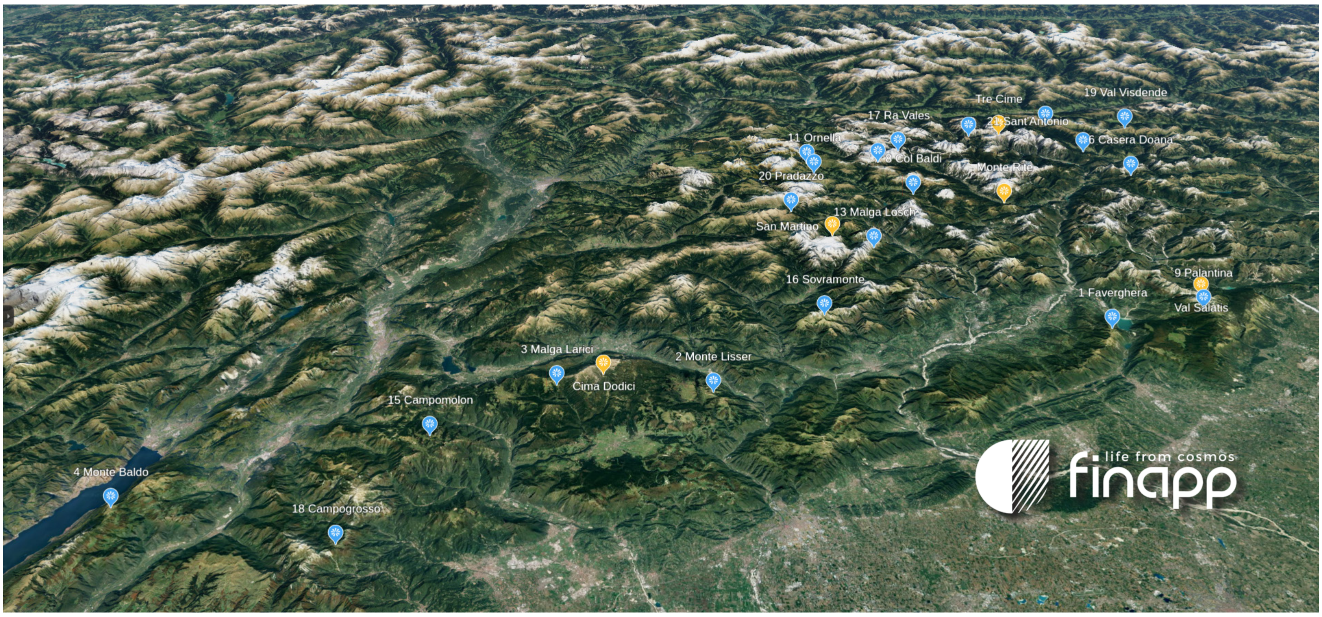
The increase in temperatures due to climate change could lead to a decrease in the snowpack, with a strong impact on water resources.

a) With the shift of regional snow-making at the beginning of the year, one of the most important effects will be the timing of water availability. Water will enter streams and rivers first, meaning it will be less available during the summer months. It is important to note that future changes in rainfall could increase the average flow rate of watercourses during the year, but with a potential decrease in summer flow. Some changes in the flow of streams will be the result of changes in the recharge of groundwater. If we consider the actual flow of streams, models show that snow-dominated ecosystems will have greater variability due to climate change, both from one year to the next (for example, flooding a year and reduced flow the following year) both within the year (for example, higher winter flow and lower summer flow). Most of these streams and rivers will follow the reduced summer flow pattern, but the magnitude of change is influenced by several other factors (e.g., the geology of the bed).

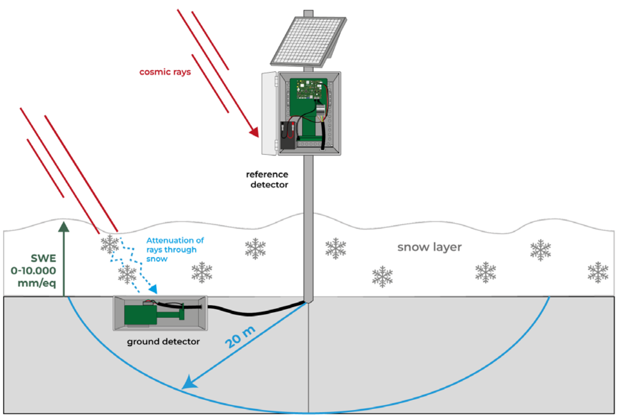
b) Variations in summer flow due to less melting of snow will directly impact water availability for irrigation to support agriculture. This could reduce food availability both regionally and globally; livestock farmers will also be affected, as changes in snowfall will affect the quality, quantity and availability of forage.

c) In the future, more rainfall will fall in the form of rain. Because snow retains water and releases it slowly, this will affect the timing and magnitude of peak flows. This could lead to increased erosion and degradation of certain types of infrastructure such as dams, canals, roads and bridges. In addition, the time of release of water from the reservoirs may be affected by an earlier melting of the snow. Early snow melting and more rain than snow could put these systems to the test and cause more flooding or require dams to release water before the year.

In the image: Network SWE ARPA Veneto - Italy



d) Animals, plants and people who depend on them will also suffer from the decrease in regional snowfall. Freshwater fish depend on fresh, clean water flowing all year round and the reduction in summer flows will lead to an increase in water temperatures. This will create challenges for the fish, forcing them to live in warmer waters or to swim far away to find waters cold enough to survive, especially if air temperatures rise. Snow melting times also affect the plants that animals use to feed and cover themselves, especially those along streams and rivers. A change in timing could affect the ability of plants to settle successfully and could create a more favourable environment for some invasive species.



State of the art SWE monitoring systems

The most innovative method of measuring the water equivalent of snow (SWE) is the use of cosmic ray sensors (CRNS), which can monitor the volume of SWE at the installation site without contact, continuously and completely autonomous, without limits of quantity/height of snow and without maintenance.

ARPAV-Italia has recently equipped 25 sites with CRNS SWE sensors, creating the first Italian network capable of providing continuous and remote monitoring information.

Conclusion

Measuring the water equivalent of snow (SWE) is important for a variety of applications. At the hydrological basin scale, in the management of water resources and hydropower, using the SWE to estimate the reserve of liquid water contained in the snow. On a smaller scale, avalanche risk monitoring or structural health status of large buildings can also benefit from SWE monitoring. Snow and weather research also needs to monitor the snowpack to understand its physical processes. SWE is one of the main macro-properties of snow.

Who is Finapp

The company has developed the latest generation sensor for the non-contact measurement of water content in soil and snow, based on the measurement of environmental neutrons produced by cosmic rays (Cosmic Ray Neutron Sensing).

Finapp solution allows a precise and digitalized water management, with the aim of reducing waste in agriculture, reducing energy cost, increasing productivity, improving the quality of water offering to the professional the value of the available water content at the root of the plants.

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