

# Results for user survey conducted in Germany in 2023

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## 0. Introduction to FPCUP SNOWLOADS in Germany

Snow loads have a significant impact on structures, especially buildings, and can have profound effects, especially during intense or extreme snow events. These loads can cause widespread environmental damage, such as impacts on forests, as well as damage to infrastructure and people. It is therefore crucial to accurately characterize the spatial distribution of expected snow loads in each European country.

The FPCUP initiative, in collaboration with partners such as the German Weather Service (DWD), the Centre national de la recherche scientifique (CNRS), the Finnish Meteorological Institute (FMI), and the Politecnico di Milano (POLIMI), aims to develop a Copernicus Climate Change Service (C3S) app on the Climate Data Store (CDS). This app will provide Europe-wide climatological information on snow loads for civil engineering, hazard mitigation and damage prevention. In three pilot regions - Bavaria (Germany), Uusimaa (Finland), and Lombardia (Italy) - three downstream services will use the C3S App data as a basis and enrich it with up-to-date snow load information.

The heavy snowfall events in southern Germany in 2019 (DWD 2020) highlighted the need for a snow load information service that enables local governmental bodies, communal authorities, and disaster response teams to make decisions in critical situations during intense snow load events. A pilot downstream service for snow load information is developed, tested, and shared in collaboration with local governmental and communal authorities, as well as disaster response teams in the Bavarian region of Germany. This pilot downstream system aims not only to provide current snow load data for responding to potential high snow load events, but also to contextualize it in the context of climate change using the C3S app.

## 1. Introduction to the user survey

Both the C3S app and the downstream pilot services will carefully consider end-user requirements, including design specifications, data use, spatial resolution, and continuous time intervals. The user survey discussed here serves as a tool to identify and understand these specific user needs. It focuses on the pilot regions, but may also provide insights for the C3S

application. This report presents the results of the survey conducted among German, more specifically Bavarian, stakeholders.

The objectives of the survey are:

- Identifying groups of potential end-users for the pilot downstream services;
- Getting a deeper understanding of user requirements on snow parameters and its presentation;
- Further promoting the FPCUP action and informing the stakeholders about the planned user workshop in 2024;
- Collecting contact information of stakeholders to inform them about news from FPCUP SNOWLOADS as well as invite them to the user workshops or further surveys;

## 2. Methodology

The survey was collaboratively developed with input from all the action members, resulting in a final English version with 14 questions (see [SURVEY SNOWLOAD](#)). It is important to note that this survey includes questions intended for all pilot regions in order to increase efficiency; therefore, certain questions may be less relevant to specific pilot regions. The final survey was then translated into both German and Italian.

The survey was conducted using the [EUSurvey](#) online tool, which not only provides tools to collaborate on the survey, but also publishes the surveys in compliance with EU data security laws.

Prior to the survey, each pilot region independently identified stakeholders, which in Bavaria next to the civil protection offices and property management consist of the following:

- [DIN Standards Committee Building and Civil Engineering](#)
- [DKE](#) (German Commission for Electrical, Electronic & Information Technologies)
- [Bavarian State Ministry for Housing, Construction and Transport](#)
- [Institute for Federal Real Estate BlmA](#)
- [Mountain rescue](#) (German Red Cross)

Furthermore, the distribution of the survey through emails, websites or social media was organized autonomously by each pilot region to maximize participation. The survey was also promoted on the FPCUP website as FPCUP news, see [here](#).

In Germany, the survey was promoted on the [DWD website](#), through individual invitations, but also through mailing lists. The German part of the survey was open between 01.08.2023 and 19.11.2023 and had a total of 74 participants.

## 3. Results for Germany

In the following section, we are discussing the results of the survey. For the sake of easy reading, we are condensing the content and also not provide numbers or diagrams for all the survey questions. A whole uncommented list of diagrams and numbers can be requested by contacting the authors.

### 3.1 Results on the stakeholder profiles

Participants in the German survey mainly expressed interest in the pilot region of Bavaria, with a small fraction indicating interest in EU-wide or Alpine regions. The applications of snow load that participants primarily considered were general civil protection, and more specifically, infrastructure protection (refer to Figure 1). This outcome is not very surprising, considering that for the pilot downstream service in Bavaria, we target in particular disaster response team

and plan to provide them with current information on snow loads. Furthermore, it can be seen from Figure 1, that the environmental impact of snow loads is not very much of interest in the Bavarian region.

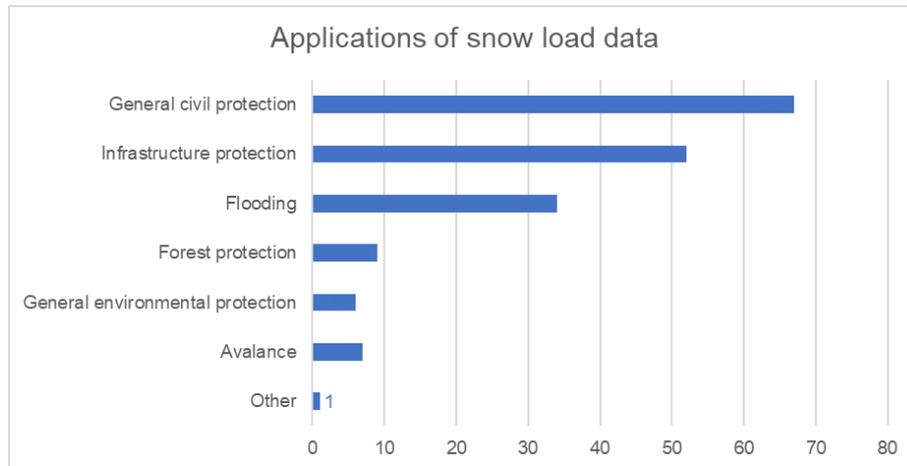


Figure 1: Results of multiple-choice question on desired application of snow load data

### 3.2 Results on user requirements on snow parameters

The second segment of the survey aimed to identify the snow parameters that stakeholders find most relevant and their preferred units for these key snow parameters. The snow parameters listed were:

- Snow loads
- Extreme values of snow loads
- Snow depth
- Snow density
- Liquid water content

For a brief explanation of the snow parameters, see for example (Fierz, Armstrong et al. 2009).

Starting with the preferred snow parameters, participants were asked to assign a priority rating (0-5) to each snow load parameter. Figure 2 shows the distribution of high priority votes, indicating the number of participants who gave a priority of at least 3.

Combining all three high priorities (3, 4, 5), snow load emerges as the most preferred snow parameter, closely followed by snow depth and extreme values. When only priority 5 is considered, extreme values of snow loads take precedence, suggesting that stakeholders are particularly interested in receiving comprehensive information about general snow loads in their region. This underlines the potential high interest in the C3S application. In addition, it's worth noting that interest in snow density and liquid water content is comparatively lower, possibly because these parameters are more relevant to the scientific community and contribute less information to practical applications.

Participants were also asked for their preferred units for snow load, snow depth, and snow density. For snow load and snow depth, the preferred units were  $\text{kN/m}^2$  and  $\text{cm}$ , respectively, each receiving 92% of the votes. As shown in Figure 3, the preferred unit for snow density is  $\text{kg/m}^3$ . Notably, snow density had the highest percentage of participants with no response, possibly reflecting the comparatively lower interest in this parameter.

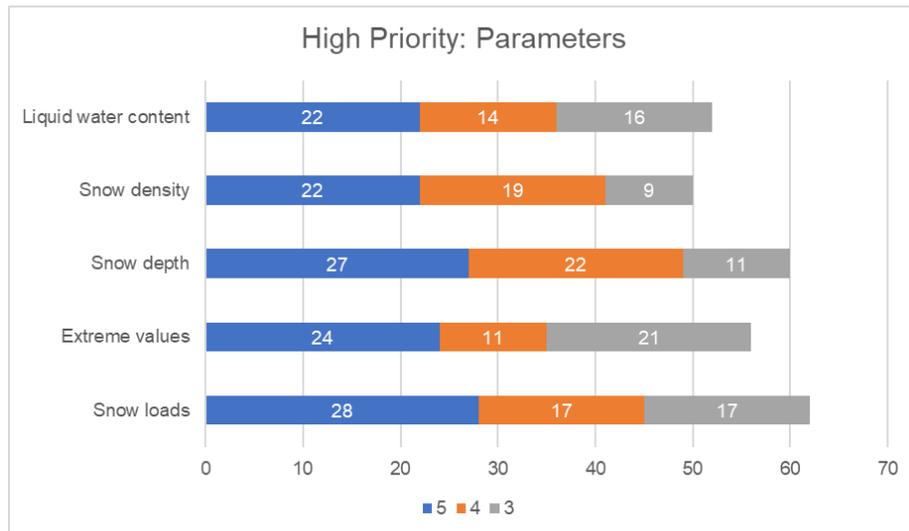


Figure 2: Comparison of high priorities (3,4,5): Snow parameters

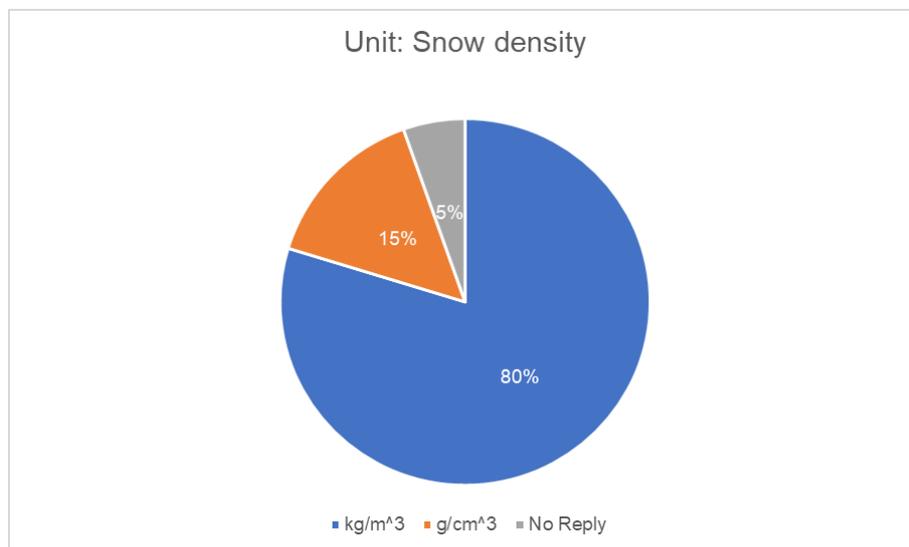


Figure 3: Preferred unit of snow density

### 3.3 Displaying the snow data

The third section of the survey focused on the user requirements on the displaying of the snow data. This includes the data format as well as the graphical presentation of data.

It's important to note that the questions of data format, temporal and spatial resolution are specifically tailored to the snow information system in Bavaria. The focus is on providing current snow loads in this region. In contrast, these questions may be less applicable to the C3S application, which is primarily designed to provide extreme values and climate predictions related to snow loads.

The preferred data format is illustrated in Figure 4, which shows that point data was the top preference, with a grid coming in second. It was somewhat surprising that point data was preferred, considering that a grid would theoretically provide more detailed information. It's important to note that we did not provide explicit explanations for the technical terms "point data" or "grid," which could have led to confusion on the part of participants. For example, participants may have thought of point data as a system where they input a point on the map and receive the corresponding snow load as an output. In this case, we may not have sufficiently considered the participants' knowledge background for this question, and we plan

to explore this aspect further in future investigations. For a brief explanation of grid, see for example (Shekhar and Xiong 2007).

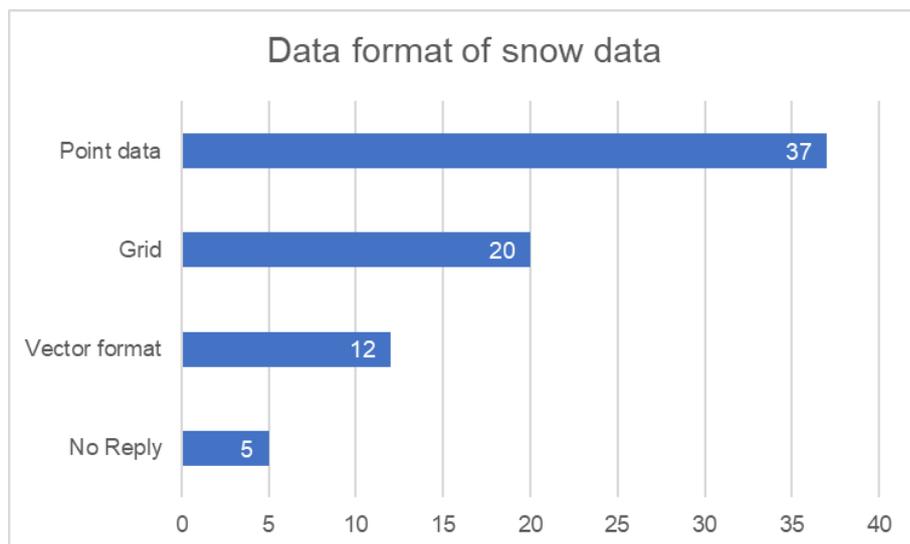


Figure 4: Preferred data format for snow data

In the case of a grid as the data format, the clear choice for resolution was 1km x 1km, as shown in Figure 5. This preference is in line with expectations, considering that such a resolution would provide the most detailed information. Conversely, in terms of time resolution, the preference was not for the finest (hourly), but for the second finest, i. e. subdaily (see Figure 6)

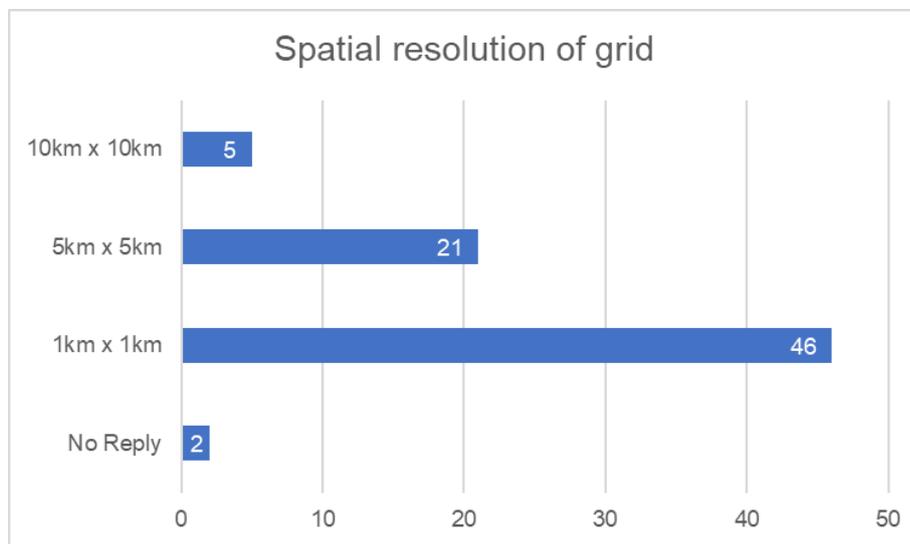


Figure 5: Preferred spatial resolution for grids

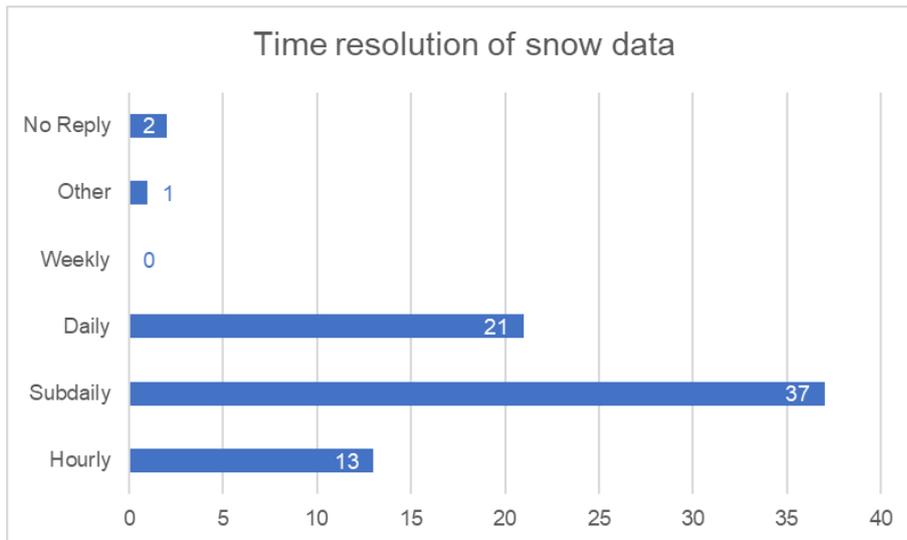


Figure 6: Preferred time resolution of snow data

In relation to time resolution, we asked if participants were interested in snow data from previous days, and if so, what would be their preferred number of days for the snow data offered. As shown in Figure 7, the preferred number of days ranges from 1 to 4, indicating a preference for a short-term view that allows for trend observation without delving into an extended time scale. This preference is logically consistent with the focus of the information system on current snow loads. In practice, understanding how long heavy snow has been present on roofs, for example, is critical, while the climate aspect is secondary. It's important to note that these considerations are not directly applicable to the C3S app.

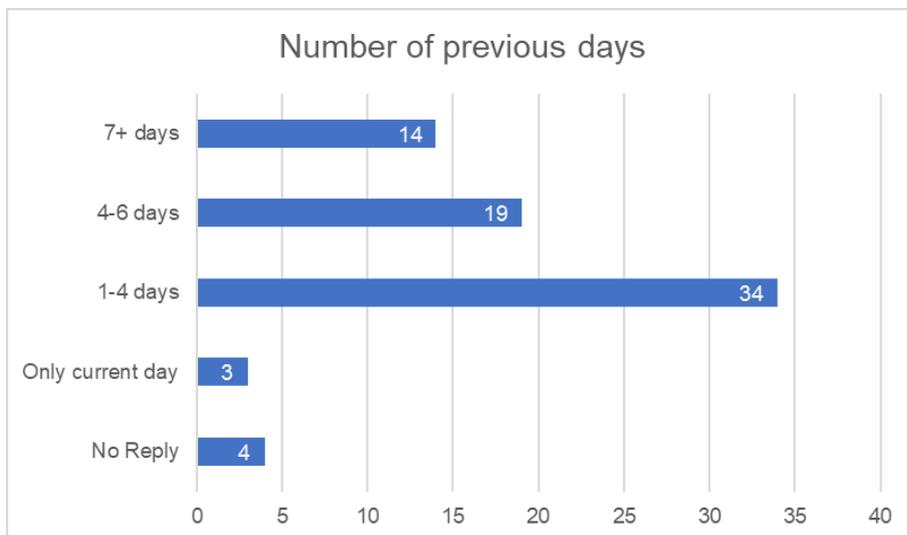


Figure 7: Preferred number of previous days snow data being offered

Now let's look at the presentation of snow load data. Firstly, we asked about the priority of implementing a traffic light system - a graphical tool that uses green below 60%, yellow above 60% and below 80%, and red above 80% - in relation to extreme snow load values. Such a system could serve as a quick visual indicator of high snow load levels, and could also contextualize climate projections of snow load within the snow load norm (i.e., norm relative to extreme snow load values). The former is crucial for the snow load system in Bavaria, as it supports rapid responses to high snow loads. The latter consideration could also be applicable to the C3S app, providing contextual information for climate predictions on snow load.

Figure 8 illustrates that a significant majority of participants consider a traffic light system to be highly valuable. Out of 74 participants, 40 voted for the highest priority (5) and over 66 participants expressed a preference for high priority (3, 4, 5). This indicates strong interest and support among users for implementing a traffic light system.

In addition, we wanted to explore the preferred presentation format for snow load data among stakeholders. We asked participants to assign a priority rating (0-5) to snow load maps, snow load graphs over time (i.e., a graph that shows the variation in snow load over time for a given point on the map), and snow load tables that show the variation in data over time or space. Figure 9 shows that the highest priority is given to snow load maps, with a clear preference over the other two options when considering the sum of all three priorities. However, when looking specifically at Priority 5, snow load tables are most often prioritized.

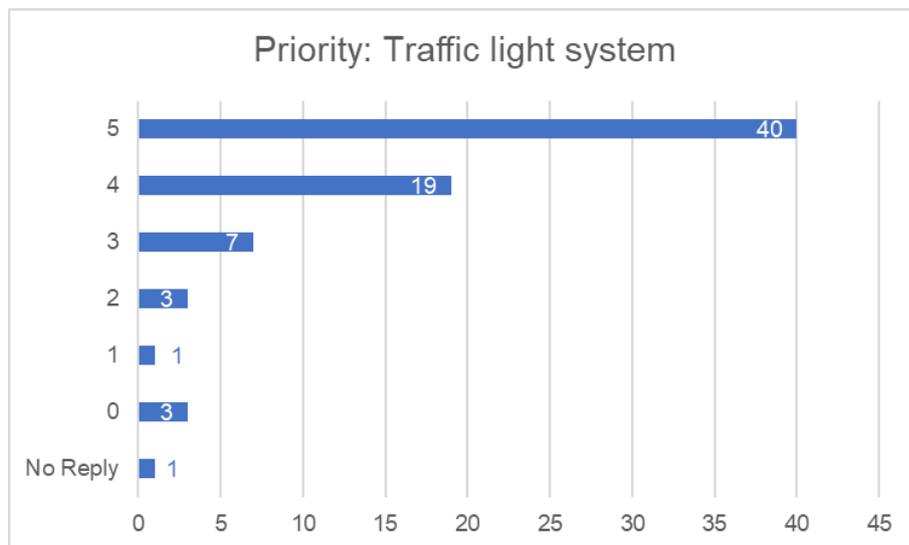


Figure 8: Priority of having a traffic light system for the snow load maps

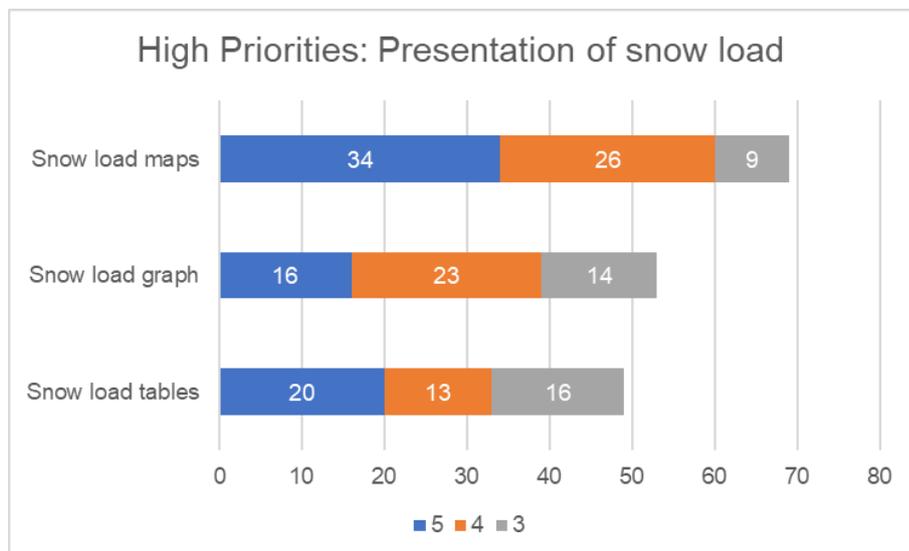


Figure 9: Distribution of high priorities regarding presentation of snow data

This shows that there is a general preference for the graphical presentation of data, but there are also stakeholders who prefer to have the data in tabular form, making it more accessible for further analysis. Additionally, this reiterates that the variation over time, such as a snow load graph, is not as highly prioritized by stakeholders. The emphasis on static representations

such as snow load maps and tables suggest a preference for instantaneous and summarized information rather than detailed temporal evolution.

### 3.4 User friendliness

In the final section of the survey, we looked at usability and explored the types of additional information and services that could enhance the user experience. First, we asked whether stakeholders would be interested in technical background information, such as the quality of the measured data, the models used, or the spatial interpolations. Presented as a multiple-choice question (see Figure 10) shows that all three aspects received similarly high demand, with 43-51 votes from 74 participants. Therefore, there is no specific topic that stands out as being of particular interest; rather, stakeholders express a general interest in having access to information about the technical methods used.

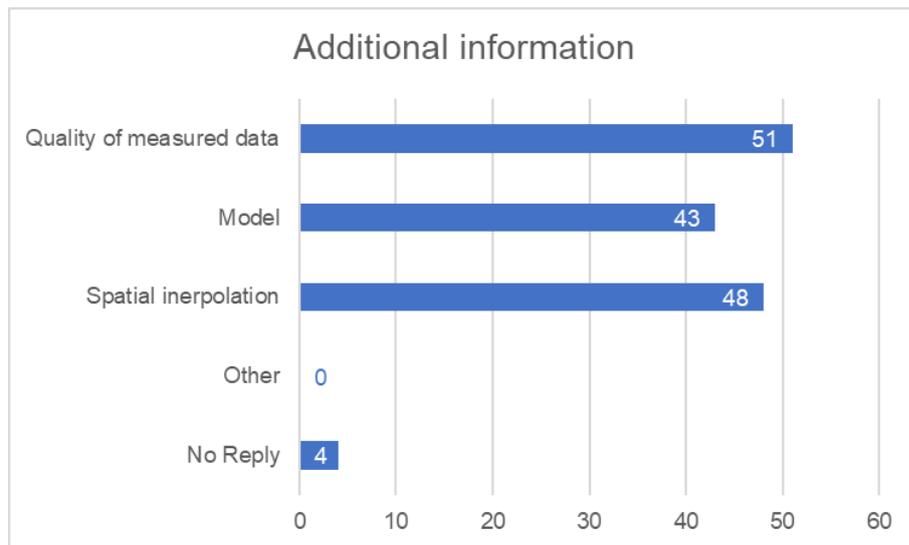


Figure 10: Multiple-choice question on interest in additional information

We also inquired about additional services that might be of interest to stakeholders. Specifically, we suggested introducing the theory of snow load standards and data, and providing (online) training on how to use the snow load information system. Participants were again asked to assign a priority rating (0-5) to these two options

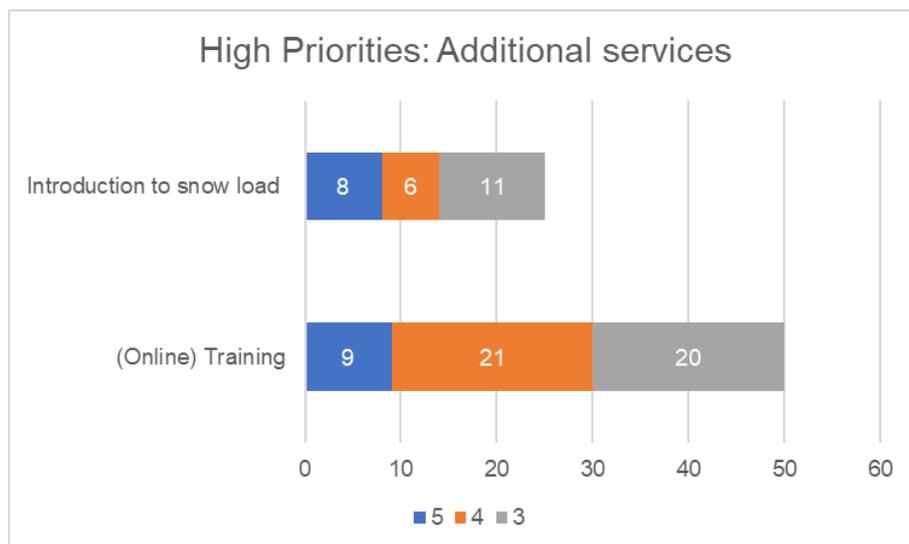


Figure 11: Distribution of high priorities regarding additional services

. As shown in Figure 11, the number of high priority votes (3, 4, 5) clearly indicates that users are interested in the online training, while the theoretical introduction is not as highly prioritized. This observation may be influenced by the fact that a significant portion of the participants are associated with civil protection and may prioritize practical application over an in-depth understanding of the scientific principles behind snow loads.

## 4. Conclusions

The results of the survey provide valuable insights into stakeholders' preferences and priorities for the development of a snow load information system. One of the prominent themes that emerges is the stakeholders' strong interest in practical applications, particularly evident among those involved in civil protection. The emphasis is on obtaining actionable information related to current snow loads, with a focus on rapid response to high snow loads rather than an in-depth understanding of the scientific background.

In terms of data presentation, stakeholders highly express a preference for graphical formats, with snow load maps being the most preferred. This indicates a strong preference for immediate and summarized information. The proposed traffic light system, which provides a visual indication of snow load severity, receives significant support.

Technical background information is another aspect of general interest to stakeholders. This includes details on the quality of measured data, applied models, and spatial interpolations. This indicates a desire for transparency and credibility in the snow load information system.

The idea of providing an online training module for users is well received. This is consistent with the practical orientation of the stakeholders, suggesting that they value training opportunities to enhance their ability to effectively use the Snow Load Information System.

In conclusion, the survey results highlight the need for a snow load information system that prioritizes practical, easily accessible and graphically presented information. Transparency in the technical background, coupled with training opportunities, can improve user experience and utility. Stakeholder preferences provide valuable guidance for the development and implementation of an effective and user-friendly snow load information system.

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