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Emergency managers' perceptions of Early Warning Systems (EWS) products and probabilistic information

Nota Técnica SMN 2023-140

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Abstract

The National Weather Services provide information to the community which needs to be understood in order to make decisions. Through a survey, the emergency managers' perception about the use of both products generated by the Early Warning System (warnings) and probabilistic information present at weather forecasts, was evaluated. It is important to highlight that this kind of information is found in forecasts provided by the National Meteorological Service to indicate the probability of occurrence of precipitation and it is of large interest to investigate how this information contributes to the decision-making process when severe weather is present. For the analysis of the last point, hypothetical situations are presented in order to identify the difficulties that decision-makers would face at the moment of receiving forecasts with uncertainty measures, and to what extent the perception of uncertainty information could influence the actions within the sector.

Keywords: Early warning systems, uncertainty, users.

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1. INTRODUCTION

Early Warning Systems (EWS) are scientific and technical instruments designed to provide warnings. The information provided by EWS allows, through a variety of tools, the planning and coordination of actions to reduce the damage and impact of the most significant hazards (Menalled and D'Amen, 2022). In this way, the accurate dissemination and interpretation of warnings is fundamental, as it enables decision-makers to act in a timely and appropriate manner in situations where society and its assets are potentially at risk.

Studies related to how different sectors receive and react to a warning have become an essential element for the design of these products. The links between National Meteorological and Hydrological Services (NMHSs) and diverse organisms associated with the social sciences tend to get stronger and generate the synergy needed for the development and constant improvement of the EWSs (Golding, 2022). To identify the aspects to be improved in each element that form the EWS, from the determination of which are the most useful products for each user group to the way in which the information is disseminated, received and interpreted, constitute an elementary task that requires the active participation of the users involved.

In a global context of growing interest in the incorporation of probabilistic information in weather forecasting products and severe weather warnings, it is appropriate to address this issue. The incorporation of probabilistic information in weather forecast reports has been the subject of debate for decades at a global level. In search of an accurate interpretation of weather forecasts, multiple studies have been developed both from the meteorological science and from the social sciences (Murphy et. al., 1980, Gigerenzer et. al., 2005, Morss et.al., 2008, Doyle et. al., 2011, Fundel et. al., 2019, among others). Although there is an extensive bibliography on users' perception of probabilistic forecasts, studies are mostly limited to European and North American countries, so it is relevant to make progress in the research of this topic at the local and regional level. Results of a survey aimed at users in European countries discuss the importance of a correct interpretation of the forecast issued and highlight to what extent the users and especially those involved in organizations such as the Civil Defences (DC), act (or would act) when probabilistic forecasts for severe short-term events are issued (Sivle et. al., 2022).

Another aspect to consider in the context of probabilistic forecasts is the presentation format used to communicate the level of uncertainty associated with the event, as a relationship has been observed between the way in which forecast uncertainty is presented and the way in which the recipient of the information makes decisions (Joslyn et. al., 2009, Stephens et. al., 2019, de Elia et. al., 2021). In fact, misunderstanding probabilistic information could have a more negative impact on the decision-making process than omitting this information from the forecast (Joslyn et. al., 2009).

The Faculty of Science of the University of Buenos Aires (FCEN-UBA) together with the National Meteorological Service of Argentina (SMN) collaborate with the World Weather Research Program (WWRP) led by the World Meteorological Organization (WMO). The Nowcasting and Mesoscale Research (NMR) and Societal and Economic Research Applications (SERA) Working Groups from WWRP, lead a project aimed at evaluating the techniques applied to very short-term forecasting (nowcasting) and EWSs available worldwide, with focus on developing countries. The results of this project can be found at: https://wwrp-nowcastingcapabilities.com/. From this initiative, centered on the assessment of the NMHSs across diverse WMO regional associations, there is an interest in identifying how the uncertainty information in probabilistic forecasts associated with meteorological events is understood and identify from which thresholds users take actions or contingency measures.

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This technical note presents the results of a survey aimed at emergency management organizations across diverse towns of Argentina, more precisely in the provinces of Buenos Aires, Chaco, Cordoba and Entre Rios. Results on the use of EWS products and probabilistic information applying ideal scenarios, are discussed. The interest in these questions lies in the fact that the reference studies that allow us to account for the strategies to incorporate probabilities on products provided by the SMN and how users interpret this information, is limited.

2. DATA AND METHODOLOGY: User survey

The methodology applied to collect data consists in the development of a survey using an online tool (Annex). The survey was composed of 29 questions (27 mandatory and 2 optional) distributed across 6 main sections:

1. **About the user**: Respondent information and user group. In this case all respondents belong to municipal and provincial Civil Defence offices.
2. **Weather warnings**: The effects of false alarms and misses are assessed. Adaptation of severe weather alerts to users' needs.
3. **Probabilistic products**: Evaluation of the interpretation of probabilistic information by users.
4. **Communication**: Evaluation of possible communication tools applied to warning dissemination.
5. **Mitigation**: Analysis of actions or possible mitigation measures carried out by users in response to alerts issued.
6. **Training**: Identification of user needs related to warning and EWS products, capacity building activities and specialized courses.

This survey is inspired by the questions formulated in Sivle et. al. (2022), in which information was collected from different groups of users who receive daily meteorological information in European countries.

Through the Risk Management and Emergency Direction, the questionnaire was disseminated between diverse local Civil Defences (CD) during December 2021 and March 2022. During the months of August and September 2022, through the Risk Management and Civil Protection Undersecretariat, CD members from municipalities in Chaco, Córdoba and Entre Ríos were contacted, expanding the region of analysis. It should be noted that this study only considers EWS users belonging to the CD and leaves open the possibility of extending the study to other user groups and covering a greater extension of the national territory.

A total of 26 responses from the provinces of Buenos Aires (22), Entre Ríos (2), Chaco (1) and Córdoba (1) were analysed (figure 1). Among them, 25 belonged to municipal CD and 1 to provincial CD.

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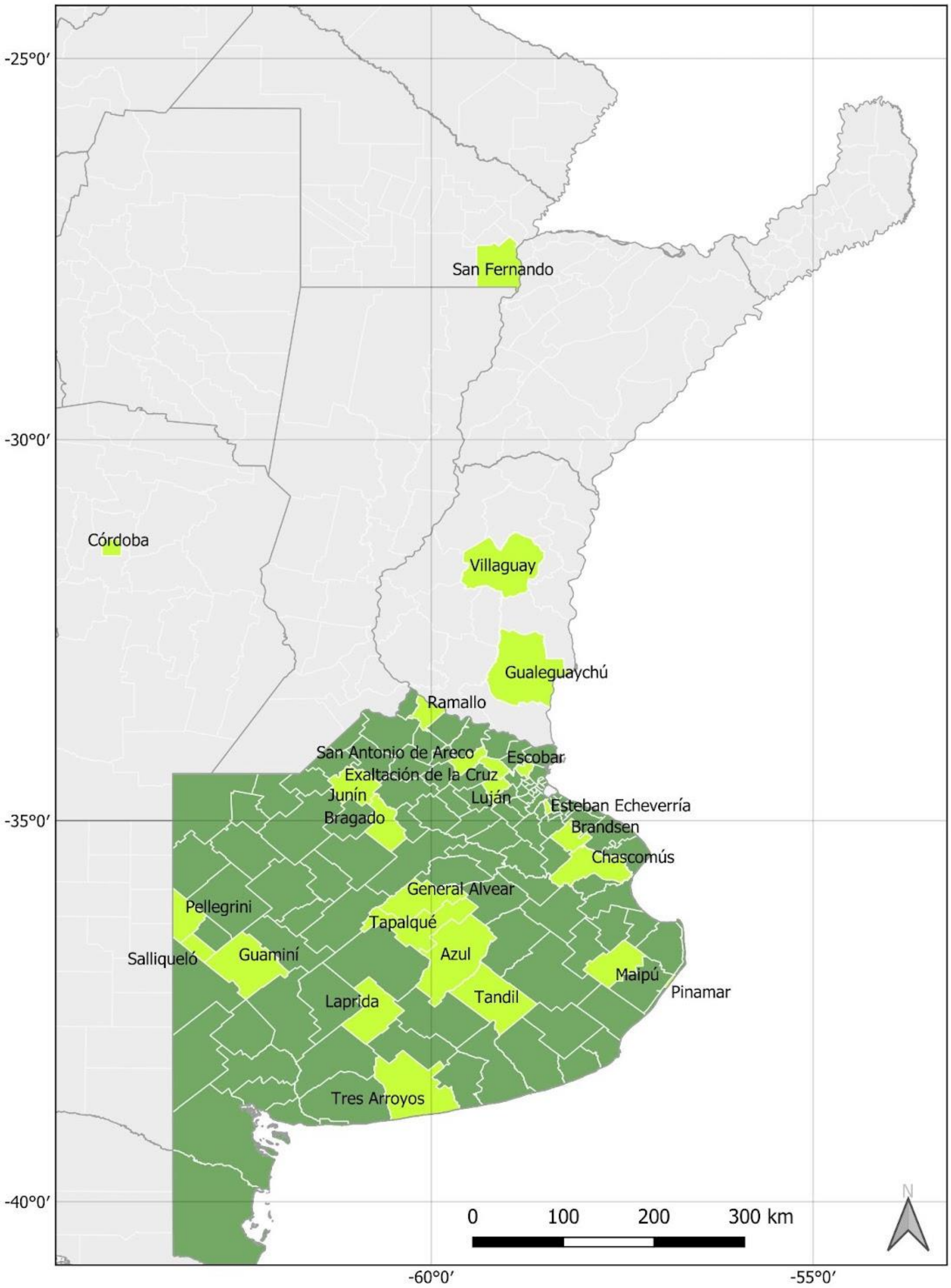

Figure 1: *Location of local emergency managers respondents (light green) and provincial emergency manager respondent (dark green).*

3. RESULTS

3.1 Receiving warnings

This section will analyse the responses generated by the participating provincial and municipal CD members. This first block is aimed at determining what type of information is of most interest to them within the sector, which are the communication channels frequently used to receive warnings, what is the level of confidence they have in the warnings received, which parameters and/or meteorological phenomena trigger decision making in the sector and, finally, what are the limitations they face when receiving a warning or alert message from the EWS.

3.1.1 Information used by users

Respondents were asked which meteorological information they consider of most interest given the level of usefulness it represents in the decision-making process within the sector (question 13).

As presented in figure 2, precipitation and lightning are among the parameters they find most useful (61.5% and 42.3% of respondents, respectively), followed by wind gusts (34.6%), wind speed and temperature (26.9% in both cases), relative humidity (11.5%) and snow (3.8%).

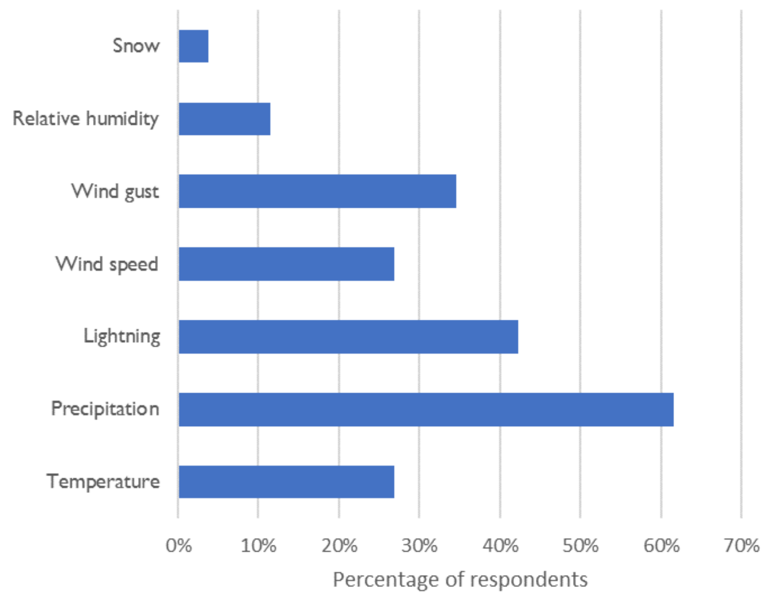

Figure 2: *Distribution of answers to question 13: “Which of the following meteorological parameters do you find more useful for your activities?”.*

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3.1.2 Communication channels for warnings reception

Communication and dissemination are two pillars of EWSs, this is why it is essential to know which are the main channels used by users to receive information about possible severe events within the risk management and emergency sector.

It is possible to identify that the official website of SMN (figure 3) is used by most of the consulted users (more than 80%). Messages via WhatsApp are also often used and placed in the same position as the previous case. This high percentage can be explained by the use of WhatsApp groups that allow emergency managers to share information provided by EWS between different members in a simple and rapid manner. Additionally, the reception of information via email represents 38,5% of respondents and the use of websites (no official) 34,6%, followed by the use of SMS (26,4%). Social media and mobile apps constitute more and more used tools and, in this survey, represent 19,2% and 15,4%, respectively. It is worth mentioning that at the time of collecting the responses, the official SMN mobile application was not yet available, which will be implemented as of January 2023, which could lead to an increase in the percentage of users who use this tool to access EWS products. Media such as radio and television are used less frequently. In the "other" category, telephone calls and direct communication with provincial civil defence authorities are mentioned.

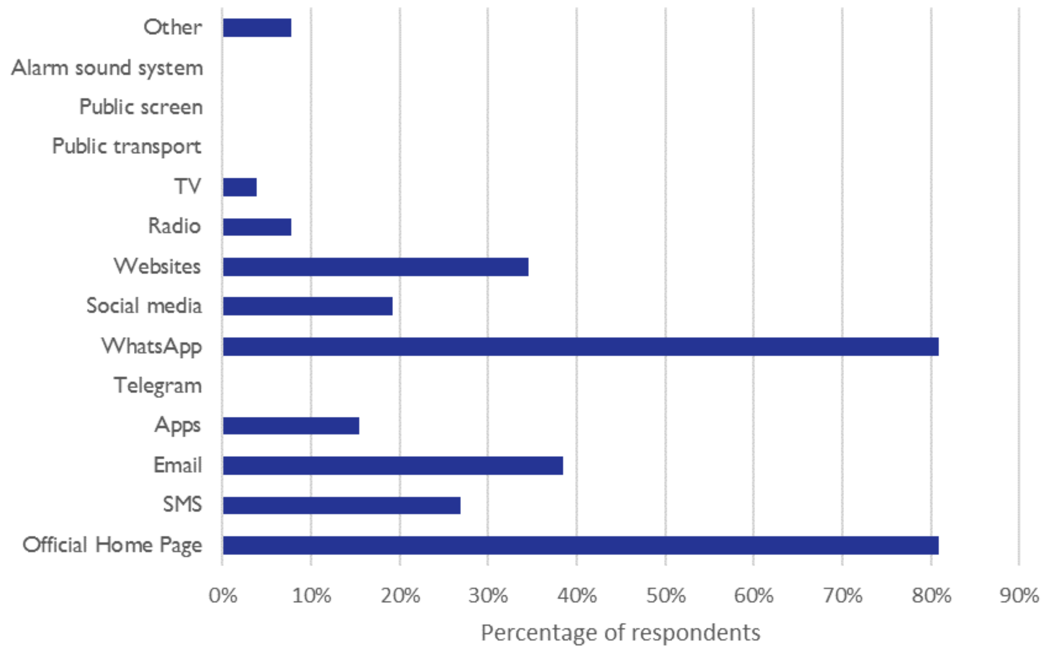

Figure 3: *Distribution of responses to question 20: “Which kind of communication tools do you use to get information about severe weather development?”.*

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3.1.3 Level of confidence in warnings

Questions 14 (“How high is your confidence in the accuracy of a 2-6 hours forecast with respect to each of the following parameters:”) and 15 (How high is your confidence in the accuracy of a 1-day forecast with respect to each of the following parameters:”), propose the analysis of the degree of confidence that users have regarding the accuracy of forecasts for various parameters such as temperature or wind speed, and for phenomena such as thunderstorms or hail among many others. Presented with a list of possible weather parameters and phenomena, respondents were asked to determine for each of the items on the list the level of confidence they have in the forecasts on a scale between 'very low' and 'very high'.

The distribution of responses to question 14 and 15 are shown in figure 4. To simplify the visualization and analysis of the cases, responses in the 'very low' and 'low' categories were grouped as 'low', while responses in the 'high' and 'very high' categories were grouped and represented as 'high'.

According to the results, it is observed that forecasts for possible hail fall up to 6 hours in advance have a low level of confidence among users (60% of them consider that the certainty of this type of forecast is very low or low), however, a slight increase in the level of confidence in 24-hour forecasts is perceived. We understand that the highest level of trust should occur in the shortest timeframes (2 to 6 hours), so we identify this as an aspect to be strengthened in working together with users. In the case of thunderstorm forecasts up to 6 hours in advance, a high percentage of users (72%) consider these to be highly reliable, decreasing this percentage in the case of 24-hour forecasts (down to 52%). In contrast to storm events, precipitation forecasts are considered more 'erratic', with 36% of respondents indicating a very low or low level of confidence in 6-hour forecasts and increasing to 40% in 24-hour forecasts.

The forecast of parameters such as temperature, minimum temperature and maximum temperature have a high reliability by users and this tends to decrease as the forecast time increases.

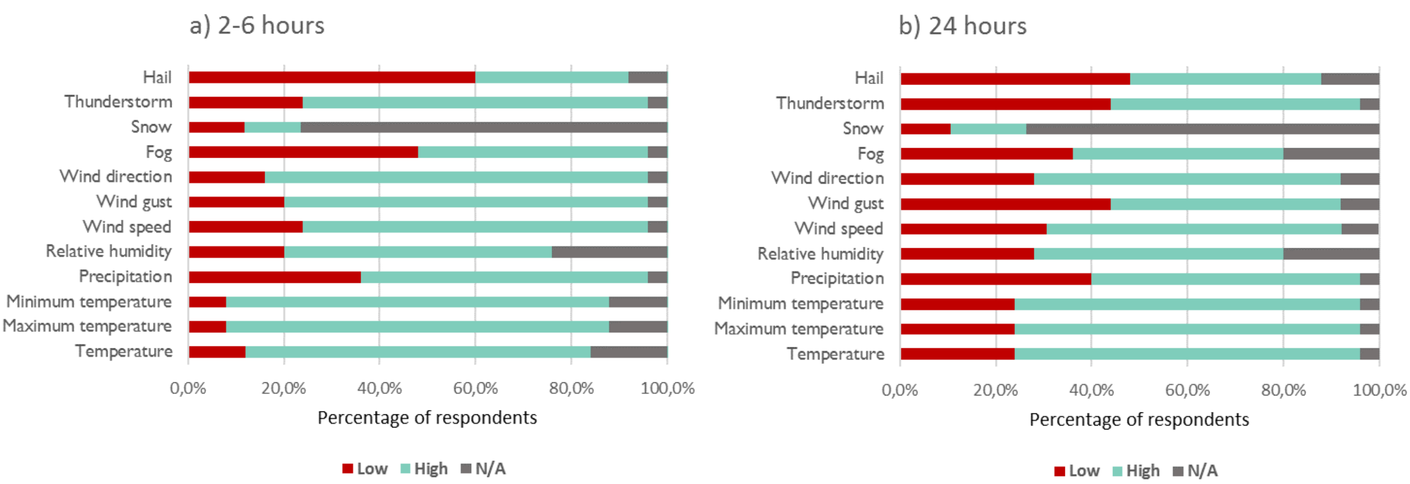

Figure 4: *Distribution of responses to question 14: “How high is your confidence in the accuracy of a 2-6 hours forecast with respect to each of the following parameters:” and question 15: “How high is your confidence in the accuracy of a 1-day forecast with respect to each of the following parameters:”*

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Regarding wind forecasts, there is a high level of confidence in very short-term forecasts (2 to 6 hours) in terms of direction, intensity and presence of gusts. However, these high levels of confidence in the accuracy of the forecasts decrease in case b), as expected.

3.1.4 Relationship between reported phenomena and implementation of preventive measures.

It is of crucial interest to identify which meteorological phenomena affect the different communities and which are the ones that trigger the most prevention actions by the CDs in order to concentrate future efforts on NMHSs. As shown in Figure 5, heavy rainfall and thunderstorms occupy the first places (84.6% and 80.8% of respondents, respectively) given the potential for damage caused by these phenomena, which have various impacts, such as waterlogging, flooding, falling trees, among others. Warnings for strong winds are the next most important and trigger prevention measures in 76.9% of those consulted. Next come severe events such as hail (65.4%), lightning (53.8%) and tornadoes (34.6%). Heat waves (38.5%), fog and low visibility (30.8%), cold waves (23.1%) and snow storms (7.7%) are also important

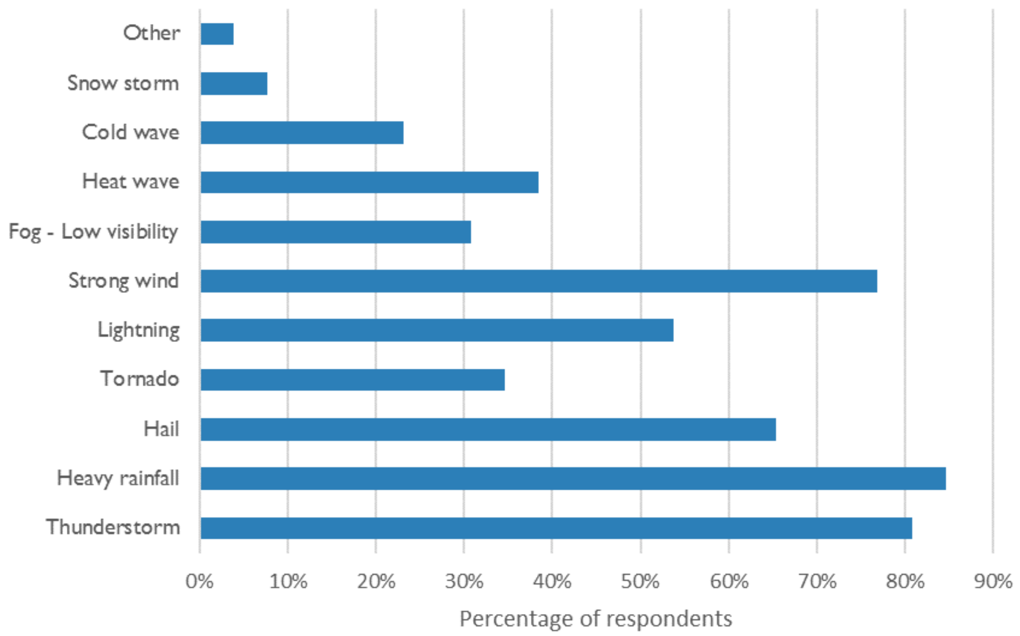

Figure. 5: *Distribution of responses to question 23: "Which severe weather event is triggering most of your "taking action"?".*

3.1.5 Limitations on the use of EWS products

This last section analyses question 21: "What kind of problems do you find in the warnings/alerts issued?", which seeks to evaluate the main limitations that members of municipal and provincial CD experience when

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receiving information on warnings and alerts. One of the most frequently mentioned drawbacks is the lack of geographical precision of the information provided by the EWS (42.3% of the respondents). Despite the updates that have been implemented in recent years in order to improve the products and their visualization, this point continues to cause concern among risk and emergency managers. 23% of those surveyed express some difficulty in sharing or relaying the information provided by the EWS, while nearly 20% of them consider that warnings/alerts are issued at short notice, which could limit the sector's actions in the event of a severe event. On the other hand, about 15% of the surveyed respondents highlighted the lack of incorporation of impact information in the EWS warnings and alerts, which a priori appears to be a low percentage considering the potential of this type of information, mainly for those that make up the National System for Integral Risk Management (SINAGIR, for its Spanish acronym) and taking into consideration the growing trend towards the implementation of impact forecasts at both regional and global levels.

To a lesser extent, there are problems such as the use of technical language in the notices and alerts (15.4% of respondents), which in the first instance, could suggest the need to strengthen the training of CD personnel in the use of EWS products. Other difficulties identified are: lack of spatial coverage of the EWS (7.7%) and inadequate communication channels for the transmission of information (3.8%). On the other hand, a considerable proportion of users consulted (38.5%) assume that there are no limitations in the reception of information provided by EWS products.

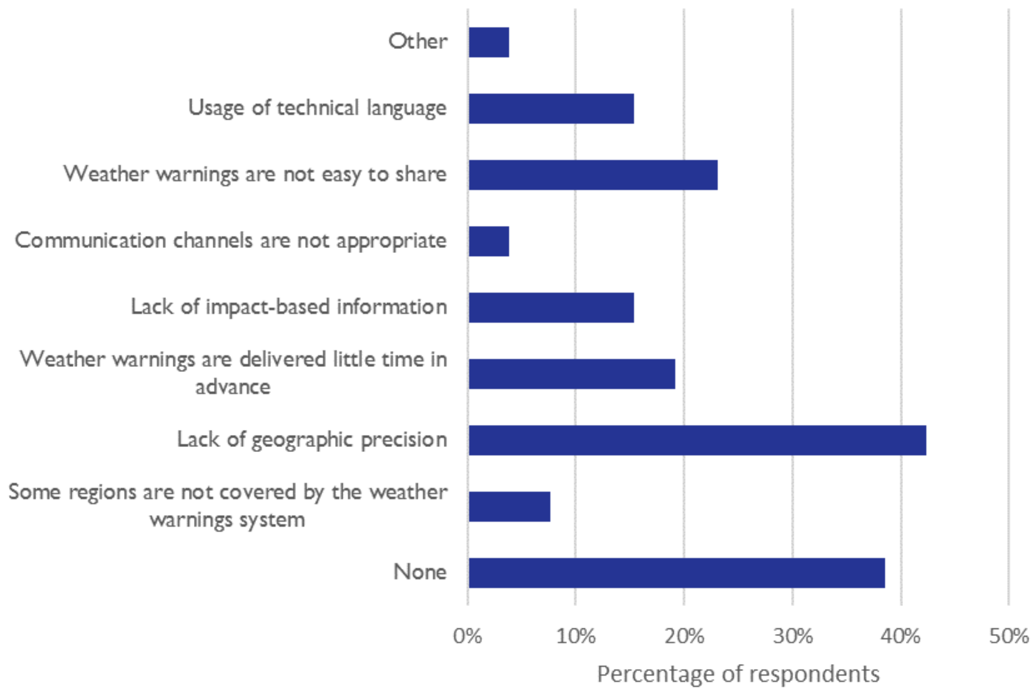

Figure 6: *Distribution of responses to question 21: "Which kind of problems do you find when weather warnings are presented?".*

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3.2 Probabilistic products

This section focuses on probabilistic forecasts, i.e., those that explicitly express a certain degree of uncertainty associated with the forecast. The dissemination and use of this type of probabilistic information is common among different groups of users, especially those involved in decision-making processes to ensure the protection of people and their property, so it is valuable to investigate the use and interpretation of this type of information within the CD sector.

In the following sections, hypothetical situations involving the use of probabilistic information will be addressed. From these ideal scenarios, a series of questions and challenges will be generated based on the treatment applied to the probabilistic products currently available and their understanding by the users.

3.2.1 Perception of the probabilities

In some cases, probabilistic forecasts are presented in text form using terms that represent different degrees of uncertainty of occurrence (or non-occurrence) of the predicted event, also known as "qualitative terms" (discussed in de Elía, 2019). This type of report is not always accompanied by explicit or numerical probability values that express the degree of uncertainty to be considered for such an event (note that in the case of the SMN, 7-day precipitation forecasts include associated probability ranges). The question then arises as to what is the level of interpretation of terms such as possible, probable or very probable, highly used by NMHSs at a global level. In this context, in question 19 (Imagine your meteorological service issues information of an upcoming storm in your region with the indications possible, likely, very likely. Which probabilities would you associate with this forecast?) respondents were presented with a hypothetical situation in which a storm warning is issued in the next few hours using the terms "possible", "probable" and "very probable" (expressing in some way the uncertainty of the forecast) and then asked to associate or identify these terms with probability ranges.

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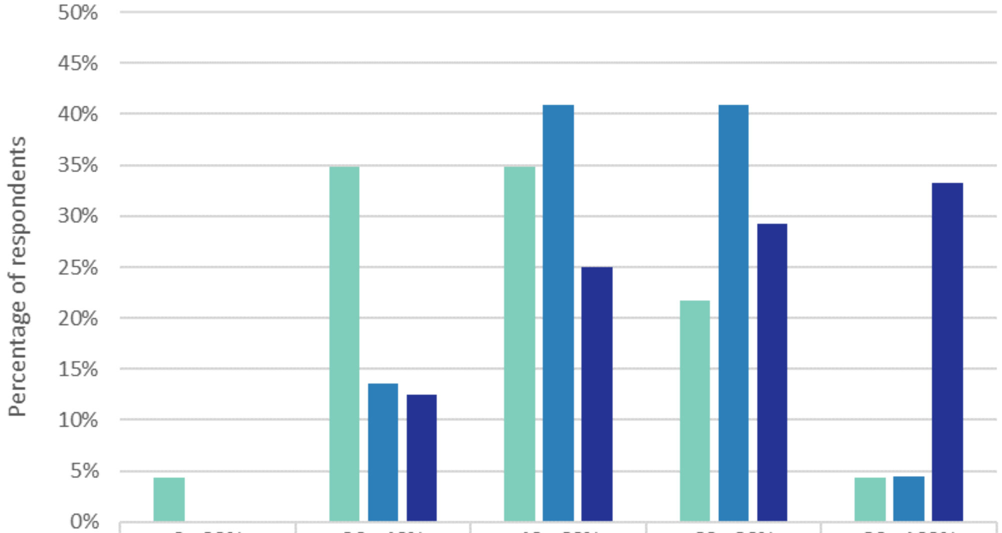

	0 - 20%	20 - 40%	40 - 60%	60 - 80%	80 - 100%
Possible	4,3%	34,8%	34,8%	21,7%	4,3%
Likely	0,0%	13,6%	40,9%	40,9%	4,5%
Very likely	0,0%	12,5%	25,0%	29,2%	33,3%

Range of probabilities

Figure 7: *Association of probabilities to the probabilistic terms "possible", "likely" and "very likely" as perceived by users.*

As a result, the term "possible" is the one with the greatest diversity of interpretations, with the ranges [20-40%] and [40-60%] being the most frequently selected by users (34.8% in both cases). On the other hand, the term "probable" is associated with higher probability ranges compared to the previous case (more than 80% of respondents associate it with probability ranges between 40 and 80%). On the other hand, the category "very likely" was associated to a greater extent with probability ranges between 80 and 100%, although here too there is a large dispersion of responses (figure 7).

These results show that most of the receivers of the message would have a different interpretation, which is conceptually far from what the forecaster is trying to communicate. As stated by Gill (2008), it may be necessary to implement numerical uncertainty scales and to fix the verbal terms associated with these values in order to unify these interpretations so that both forecaster and user communicate in the same language.

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3.2.2 Mitigation measures based on probabilities thresholds

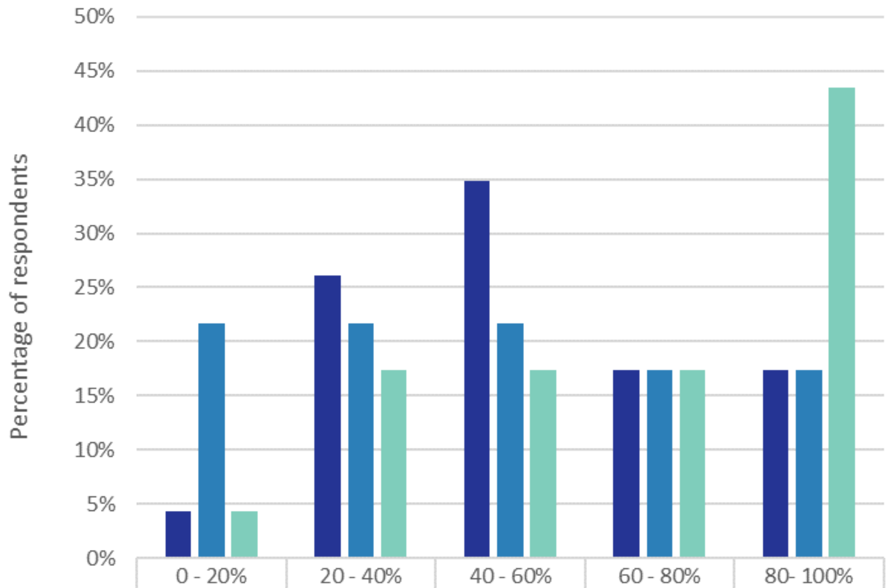
Following the work of Sivle et al. (2022) where a possible relationship between the number of people potentially affected by a severe weather event and the probability ranges from which preventive measures are initiated by decision makers, questions 25, 26 and 27 analyse this aspect where hypothetical situations are discussed.

Question 25: A storm is forecasted for the next day. On which probability would you or your department/agency/organization generally start with preliminary actions?

Question 26: Would your threshold (in the previous question) be different if you would know the event likely happens in the countryside with low density of population. Please, indicate the probability when you would start the action.

Question 27: Would your threshold (in the previous question) be different, if you would know that the event can happen; when many people are travelling/ staying outdoor/ there are many activities/ festivals, etc. If yes, please, indicate the probability when you would start the action.

Figure 8 shows the distribution of responses for the three situations described above: situation I (the volume of people potentially affected - general condition - is not taken into consideration), situation II (the volume of people potentially affected is considered low) and situation III (the volume of people potentially affected is considered high).



	0 - 20%	20 - 40%	40 - 60%	60 - 80%	80- 100%
In general	4,3%	26,1%	34,8%	17,4%	17,4%
Low population density	21,7%	21,7%	21,7%	17,4%	17,4%
Increasing flow of people	4,3%	17,4%	17,4%	17,4%	43,5%

Figure 8: *Range of probabilities from which users would take preventive measures in the event of a severe event, under three possible scenarios.*

In scenario I, it is identified that users would take mitigation actions as soon as the probability of occurrence of the phenomenon exceeds the 40% threshold (about 35% of respondents opt for the 40-60% range).

Another result to highlight is the fact that the probability ranges from which action is taken could have a certain variation according to the number of people that could be affected. It is observed that in the scenario of low flow of people, the minimum probability threshold tends to go down, i.e., action would be taken starting from lower probability values. While the minimum threshold increases in a scenario of large concentrations/ mobilization of people. Possibly, this can be explained by multiple variables associated with contingency measures applied in these cases, such as the impact on the suspension of a massive event or in a context of high flow of people for tourist reasons, among others.

These results contrast, however, with those found by Sivle (2022), where, under the same scenarios, the users consulted would tend to lower the minimum probability threshold as the population density exposed to the phenomenon increases.

3.2.3 Interpretation of a precipitation probabilistic forecast

Previous studies such as that of Gigerenzer et al. (2005) show the difficulties of users in interpreting information from probabilistic forecasts. In that study, users from different cities were surveyed and provided with the statement of a precipitation forecast for the next day with a probability value associated with the event. Similarly, in question 28, respondents were presented with the following statement:

"A 70% chance of precipitation is forecast for tomorrow."

They were then asked to select the interpretation they considered correct from a series of possible interpretations for that forecast (note the possibility of selecting "Don't know/No answer" among the options).

Among the responses collected, several interpretations were identified, the most frequent being that "7 out of 10 forecasts indicate rain somewhere in the area corresponding to my locality" (46% of respondents), which could be conceptually correct as long as the respondent's locality is located within the area affected by the forecast. Referring to the work of Morss et al. (2008), the interpretation that best fits the situation is the one that states that 7 out of 10 forecasts indicate rain in at least one specific point or place in the forecast area, so that only 15% of the surveyed users are able to interpret the predicted weather situation as the forecaster intends to convey it.

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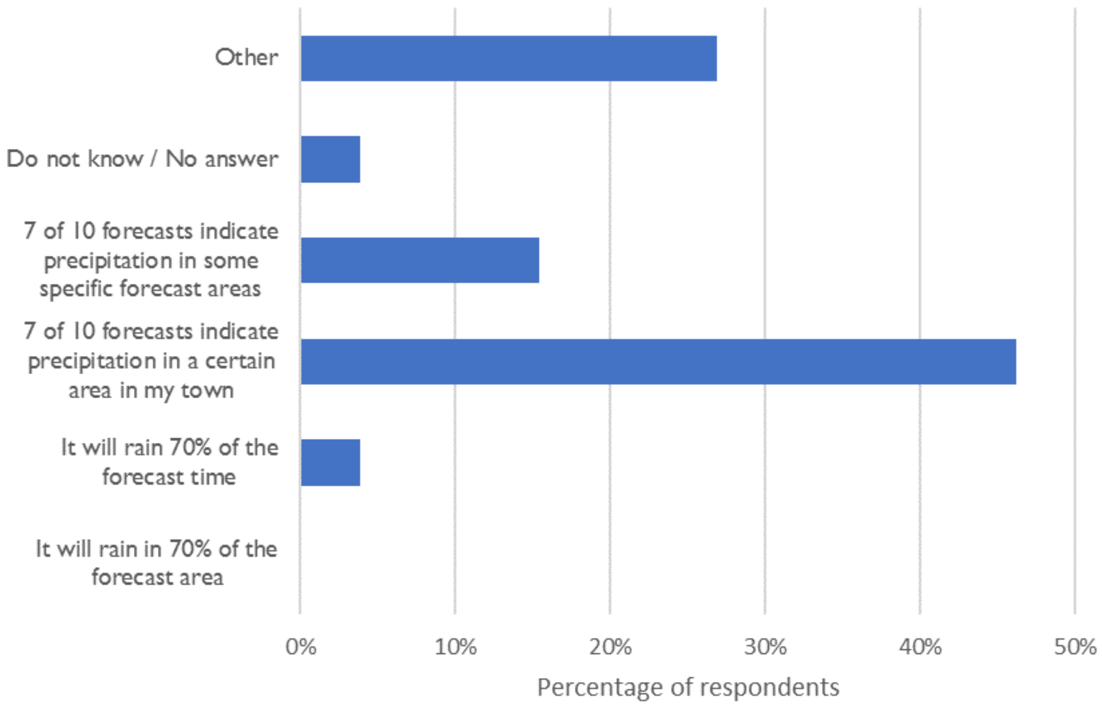

Figure. 9: *Interpretation of a probabilistic precipitation forecast. Distribution of responses to question 28.*

The association of percentage of probabilities with percentage of area that will be affected by the event or the percentage of time in which the event in question will develop are very common interpretation errors (Gigerenzer et al., 2005, Joslyn et al., 2009); however, no cases were recorded in which the probability of precipitation occurrence was associated with the percentage of area affected and low is the frequency of cases in which users interpret probabilities as defined by the time it will rain during the day tomorrow (about 4% of respondents).

In cases where the respondent did not associate the statement with any of the possible interpretations from the list, he/she chose to express in text form his/her own interpretations, among them:

["there is a 70% chance of rainfall somewhere (at one or more locations) within the forecast area"] ***(a)***

[“"we interpret this as a high probability of rainfall in a given area, which encompasses several cities or towns"”] ***(b)***

[“we understand it as a matter of certainty and uncertainty and the percentages represent just that!!!"] ***(c)***

[“if rainfall is recorded during that period”] ***(d)***

[“the probability of rainfall"] ***(e)***

["there is a 7 in 10 chance that it will rain in the morning in the forecast area"] ***(f)***

In some cases, it is difficult to identify the reasoning or conceptual idea behind the answer, which prevents a valid judgment as to whether the user is really making an error of interpretation or not. On the other hand, there is confusion associated with the term 'morning' since it is understood as a specific period of time during the day, which differs from the idea of chance of precipitation that, a priori, could occur in any time slot (morning-afternoon-evening-night) (see case f).

This diversity of interpretations derived from the concept of probability is not only present among users, represented here by emergency managers and the general public, since it has been exposed as a problem even within the scientific community (De Elía and Laprise, 2005).

3.3 Training: users' requirements

In recent years, since the launching of a new EWS, the NMS has been actively working on the survey of information associated with the use and interpretation of warning messages by different national agencies involved in decision making based on the information provided by the EWS. This kind of studies are developed in order to direct future actions that allow possible improvements and strengthening of the current EWS (Menalled and Chasco, 2022, Saucedo et al., 2023).

As discussed in section 3.2, users face certain difficulties when interpreting a forecast or a warning or alert message. Certainly, it is essential to know, from the user's perspective, which are the most required areas of knowledge. For this purpose, respondents were asked about the training areas they consider necessary to implement or reinforce in order to improve the reception of warning and alert messages provided by the EWS and the subsequent adoption of early action measures (Question 29: "In which area do you consider it would be necessary to have more training or education?)

Figure 10 shows a high percentage of respondents who note the need to reinforce training in the interpretation of warnings and alerts issued (69.2% of the total number of respondents). A little more than 42% of them consider it necessary to receive training on possible actions to be implemented given a warning or alert issued. Training in the interpretation of products derived from remote sensing, such as satellite or radar images, was selected by 38% of the users and, to the same extent, training is required in terms of communication tools within the sector.

Only 4% of respondents stated that training activities are not necessary in any of the areas mentioned above.

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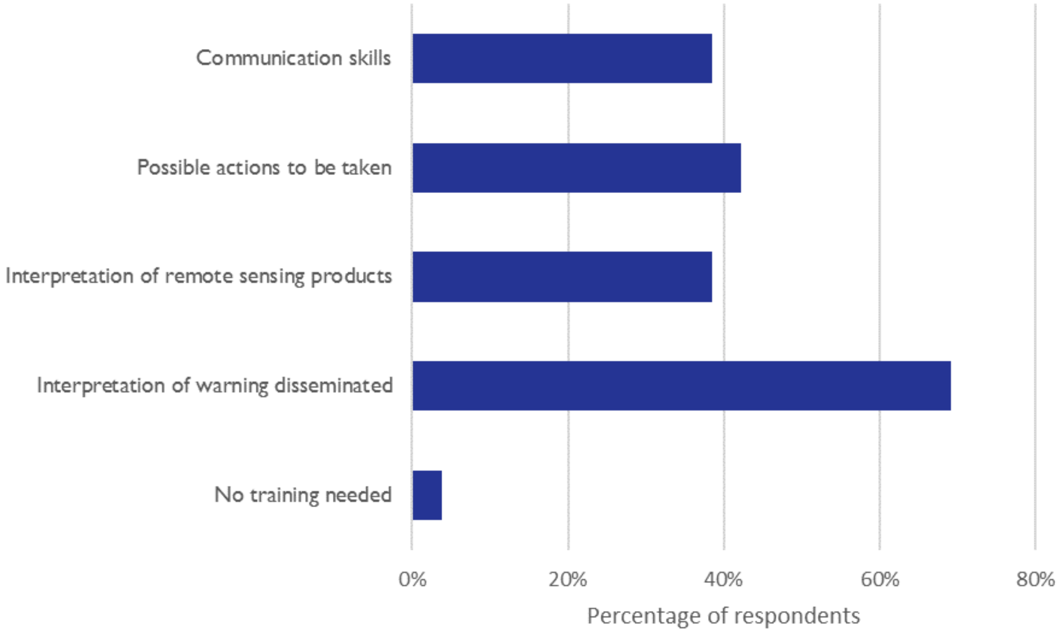

***Figure 10:** Distribution of responses to question 29: "In which field may more training be needed?".*

4. CONCLUSIONS

From a survey disseminated to local and provincial emergency managers, diverse aspects related to the use and interpretation of the information provided by the EWS at the National Weather Service, were evaluated. Most influential variables and meteorological phenomena for the implementation of preventive and mitigation measures, main communication channels used in the reception of warnings for severe weather, level of confidence with respect to products received from the NWS and, finally, limitations perceived by emergency managers at the time of receiving the warning, were the main topics addressed.

Another of the main topics here analysed, is the treatment of uncertainty information, present in weather forecasts. The objective is to know the users' perception on the uncertainty concept (generally involved in warnings) and the manner in which available probabilistic information could influence decision-making processes.

The sample of users taken for the analysis let note firstly the existence of a large heterogeneity of uncertainty perception and interpretation of qualitative terms associated (frequently used by NMHSs in their weather reports) in general, and of interpretation of probabilistic forecasts for precipitation in particular (relevant information for emergency managers at the time of triggering preventive actions). It is noted the existence of diverse interpretations of qualitative terms such as, possible, likely and very likely, used for probabilistic products. The term possible is the most ambiguous, associated with probabilities between 0 and 100%. Similarly, it can be affirmed that the terms likely and very likely are not associated with probabilities in a uniform manner, which could produce users misunderstand forecasts and negatively influence the decision-making process. These results are in line with others derived from studies in the psychology field where it is assumed that past experiences and preconceptions acquired may have influence on the uncertainty perception (Heuer, 1999). Through the study of hypothetical cases in which a thunderstorm is forecasted to occur, it was determined the fundamental role thresholds of probabilities used for forecasts play in the decision of triggering preventive measures. Given three possible scenarios, dependent on the greater or lesser flow of people, evident changes exist in the minimum thresholds from which preventive actions would be triggered when a severe event is expected to occur.

Subsequently, the interpretation made by CDs members of a probabilistic precipitation forecast is analysed. The low percentage of participants (15% of the total) who were able to identify the correct interpretation from a list of possible interpretations stands out. Some of the respondents chose to express their interpretation in writing, which made it possible to identify other difficulties arising from the presence of ambiguous and imprecise terms in the description of the forecast.

Finally, it should be pointed out the need to extend the analysis in order to understand the reasons that entail misinterpretations of weather warnings. For example, studying in more detail the consequences of associating high probabilities scenarios with severity levels of phenomena forecasted seems to be a relevant point, since users could understand a high probability of occurrence is necessarily associated with the severity of an event. Without doubt, one of the main challenges is to notice these possible interpretations that could drive probabilistic information not be usable. As mentioned above, future studies should incorporate a larger sample of users for the analysis in order to obtain better representativity at the national level, and also including other sectors to be evaluated (not only emergency managers).

How does having the responsibility of analysing uncertainty impact the decision-maker? What conclusions can be drawn from probabilistic information? How does this translate into prevention and preparedness actions? These questions require even more focus if these types of products are to be applied in short- and very short-term reporting. The application of strategies that adjust to the needs of the users and an adequate training to those potential recipients of the message are key elements to achieve a correct interpretation of the forecast that translates into the implementation of anticipatory actions.

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ANNEX. Questionnaire

* 1. Name:

* 2. Country/City:

* 3. Organization:

* 4. Position Held:

* 5. Email:

* 6. Which user group do you belong to?

☐ General public with access to the information
☐ Emergency managers
☐ Transport
☐ Energy sector
☐ Agriculture sector
☐ Water management
☐ Public health
☐ Research
☐ Tourism
☐ Other (please specify)

*7. In which tasks do you need weather forecasts/warnings?

*8. Defining false alarms as meteorological phenomena events that were forecast to occur but did not, could you indicate what is the impact of false alarms on weather warnings in your sector?

☐ They do not have an impact on the sector
☐ They could have an impact on the sector
☐ They could have a significant impact on the sector
☐ They could have a very significant impact on the sector

*9. Defining “misses” as those meteorological phenomena occurring despite not being forecast, could you indicate what is the impact of misses in your sector?

☐ They do not have an impact on the sector
☐ They could have an impact on the sector
☐ They could have a significant impact on the sector
☐ They could have a very significant impact on the sector

*10. Do you consider that weather warnings received allow you to take appropriate and anticipatory actions?

☐ Yes
☐ No
☐ Sometimes

*11. What is the time-interval at which you receive nowcasting information updates?

☐ <1 hour
☐ 1 hour
☐ 2 hours
☐ 3 hours
☐ 4 hours
☐ 5 hours
☐ 6 hours
☐ Other (please specify)

*12. According to your needs, what time-interval for updating the nowcasting information (up to 6 hours) would you prefer?

☐ <1 hour
☐ 1 hour
☐ 2 hours
☐ 3 hours
☐ 4 hours
☐ 5 hours
☐ 6 hours
☐ Other (please specify)

*13. Which of the following meteorological parameters do you find more useful for your activities? Multiple answers are allowed.

☐ Temperature
☐ Maximum temperature
☐ Minimum temperature
☐ Precipitation

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☐ Relative Humidity
☐ Wind speed
☐ Wind gust
☐ Wind direction
☐ Fog
☐ Snow
☐ Thunderstorm
☐ Lightning
☐ Hail
☐ Do not know/ No answer
☐ Other (mention any other parameter)

*14. How high is your confidence in the accuracy of a 2-6 hours forecast with respect to each of the following parameters:

	Very low	Low	High	Very high	N/A
Temperature	☐	☐	☐	☐	☐
Maximum temperature	☐	☐	☐	☐	☐
Minimum temperature	☐	☐	☐	☐	☐
Precipitation	☐	☐	☐	☐	☐
Wind speed	☐	☐	☐	☐	☐
Wind direction	☐	☐	☐	☐	☐
Fog	☐	☐	☐	☐	☐
Snow	☐	☐	☐	☐	☐
Thunderstorm	☐	☐	☐	☐	☐
Hail	☐	☐	☐	☐	☐

*15. How high is your confidence in the accuracy of a 1-day forecast with respect to each of the following parameters:

Options: Same question 14.

*16. Are you interested in receiving probabilistic products applied to short-term forecasts?

☐ Yes
☐ No

*17. How do you wish to receive such products? Multiple answers are allowed.

☐ Graphics (e.g. box plots)
☐ Probability maps of weather events over time intervals
☐ Map displaying probabilities for exceeding warning thresholds
☐ Text
☐ Do not know/ No answer
☐ Other (please, mention any other product)

*18. Do you think that probabilistic information makes the forecast more trustworthy?

☐ Yes
☐ No

*19. Imagine your meteorological service issues information of an upcoming storm in your region with the indications possible, likely, very likely. Which probabilities would you associate with this forecast?

	Possible	Likely	Very likely
0-20%	☐	☐	☐
20-40%	☐	☐	☐
40-60%	☐	☐	☐
60-80%	☐	☐	☐
80-100%	☐	☐	☐

*20. Which kind of communication tools do you use to get information about severe weather development? Multiple answers are allowed.

☐ Official Home Page
☐ SMS
☐ Email
☐ Apps
☐ Telegram
☐ WhatsApp
☐ Social media
☐ Websites
☐ Radio
☐ TV
☐ Public transport
☐ Public screen
☐ Alarm sound system
☐ Other (specify)

*21. Which kind of problems do you find when weather warnings are presented? Multiple answers are allowed.

☐ None

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☐ Some regions are not covered by the weather warnings system
☐ Lack of geographic precision
☐ Weather warnings are delivered little time in advance
☐ Lack of impact-based information
☐ Communication channels are not appropriate
☐ Weather warnings are not easy to share
☐ Usage of technical language
☐ Other (specify)

*22. Do you think that an impact-based forecasting (saying, the consequences of heavy rain can be flooding etc., strong wind can cause damages to buildings and infrastructure etc.) will be more useful than a pure meteorological forecast (telling e.g. the amount of rain, the value of gusts) in the future?

☐ Yes
☐ No

*23. Which severe weather event is triggering most of your "taking action"? Multiple answers are allowed.

☐ Thunderstorm
☐ Heavy rainfall
☐ Hail
☐ Tornadoes
☐ Lightning
☐ Strong winds
☐ Fog - Low visibility
☐ Heat wave
☐ Cold wave
☐ Snow storm
☐ Other (please, mention any other event)

24. What are the most important mitigation actions?

*25. A storm is forecasted for the next day. On which probability would you or your department/agency/organization generally start with preliminary actions?

☐ 0-20%
☐ 20-40%
☐ 40-60%
☐ 60-80%
☐ 80-100%

*26. Would your threshold (in the previous question) be different if you would know the event likely happens in the countryside with low density of population. Please, indicate the probability when you would start the action.

☐ 0-20%
☐ 20-40%
☐ 40-60%
☐ 60-80%

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☐ 80-100%

*27. Would your threshold (in the previous question) be different, if you would know that the event can happen; when many people are travelling/ staying outdoor/ there are many activities/ festivals, etc. If yes, please, indicate the probability when you would start the action.

☐ 0-20%
☐ 20-40%
☐ 40-60%
☐ 60-80%
☐ 80-100%

28. What is your interpretation of the following weather report: “forecast of a 70% chance of precipitation for tomorrow”?

☐ It will rain in 70% of the forecast area
☐ It will rain 70% of the forecast time
☐ 7 of 10 forecasts indicate precipitation in a certain area in my town
☐ 7 of 10 forecasts indicate precipitation in some specific forecast areas
☐ Do not know / No answer
☐ Other (specify)

*29. In which field may more training be needed? Multiple answers are allowed.

☐ No training needed
☐ Interpretation of warning disseminated
☐ Interpretation of remote sensing products
☐ Possible actions to be taken
☐ Communication skills
☐ Other (specify)

(*) mandatory question

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