



Weather Forecast and Weather Warning Preferences in Germany

Results of a national representative study

KFS Working Paper Nr. 24

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Background of the study

The presented study is part of the research project "**Weather Warnings: from EXtrem event Information to COMmunication and Action**" (WEXICOM III; for more information, see the box on the right) supported by the Hans Ertel Centre for Weather Research. This network of universities, research institutes, and the Deutscher Wetterdienst is funded by the BMVI (Federal Ministry of Transport and Digital Infrastructures).

In WEXICOM III, the Disaster Research Unit (DRU) aims at improving the coping capacities of the public concerning weather risks through user group-specific warning communication formats. Based on extensive literature review, a theoretical framework (Schulze and Voss 2020), workshops, and several standardised surveys, we will develop warning communication formats tailored to the needs of specific user groups and test them in a final study.

The results presented below are part of one study used to develop the warning communication formats. Using the study design shown in the figure on the right, we wanted to answer the following questions:

1. What are Germans' attitudes towards weather forecasts?
2. How do Germans perceive weather warnings and how do they respond to them?
3. What preferences do Germans have with regard to weather warnings?
4. Can specific user groups be identified?

Project **WEXICOM III** – **Weather warnings: from EXtreme event Information to COMmunication and action**

WEXICOM III is an interdisciplinary research project to improve the use of weather forecasts for society. The focus is on warnings of extreme weather specifically tailored to the needs of the recipients. Special attention will be paid to the communication of the uncertainties of the forecasts as well as the weather impacts at different lead times and for specific user groups.

Website

<https://www.geo.fu-berlin.de/met/wexicom/index.html>

Project duration

01/2019 - 12/2022

Project partners

Institute for Meteorology (FU Berlin)
AG Interdisciplinary Security Research (FU Berlin)
Disaster Research Unit (FU Berlin)
Max Planck Institute for Human Development

Funded by



Project WEXICOM III

Population

German-speaking resident population in Germany aged 18 to 74

Methodology

Online survey (CAWI)

Sample size

N = 1.086

Quota based

For sex, age, education and region

Data collection

12 - 24 March 2021

Study Design

Notes

The report begins with a summary of the main findings according to the four research questions. The results are presented in more detail in four chapters. Chapter 1 (Weather Forecasts) describes the attitudes towards and the use of weather forecasts by Germans. This chapter introduces a weather-related attitude typology. Furthermore, it describes people’s climate change beliefs. Chapter 2 (Weather Warnings) discusses Germans' perception of weather warnings and their response to such warnings. Also, it presents a weather warning behavioural typology. Chapter 3 summarises the findings regarding the weather warning preferences of Germans. Finally, chapter 4 recapitulates the insights on uncertainty information.

Each page addresses a topic relevant to the study. The results are presented graphically and described verbally. Where applicable, a third section highlights the main variables influencing the aspect studied based on multiple linear regressions. The regression analysis included the following predictors:

- Gender (1=women; 0=men)
- Age
- Level of education (1=high education; 0=middle, low education)
- Size of residence (1=big city; 0=small city, village)
- The perceived vulnerability of the flat to weather events (1=not protected; 7=protected)
- Predominant means of transportation
 - o Car (1=car; 0=no car)
 - o Bicycle (1=bicycle, =no bicycle)
 - o Public transportation (1= public transportation; 0=no public transportation)
 - o On foot (1=on foot; 0=not on foot)
- Predominant stay outdoors or indoors
 - o Outdoors (1=outdoors; 0=equally indoors and outdoors)
 - o Indoors (1=indoors; 0=equally indoors and outdoors)

Gender			
	Absolute frequency	Percentage	Valid Percentage
Female	517	47.6	47.8
Male	563	51.8	52.0
Diverse	2	0.2	0.2
Total	1082	99.6	100.0
Missing	4	0.4	
Total	1086	100.0	

Age			
	Absolute frequency	Percentage	Valid Percentage
18 to 29 years	160	14.7	14.7
30 to 39 years	155	14.3	14.3
40 to 49 years	217	20.0	20.0
50 to 59 years	267	24.6	24.6
60 years or older	287	26.4	26.4
Total	1086	100.0	100.0

Education level			
	Absolute frequency	Percentage	Valid Percentage
Low	253	23.3	23.4
Middle	435	40.1	40.2
High	395	36.4	36.5
Total	1083	99.7	100.0
Missing	3	0.3	
Total	1086	100.0	

A microscopic view of numerous small, white, irregularly shaped particles, possibly crystals or granules, scattered across a grey, textured background. The particles vary in size and shape, some appearing more rounded while others are more angular. A green triangular shape is visible in the top right corner, and a green horizontal bar is at the bottom.

Summary

What are Germans' attitudes towards weather forecasts?

Confidence in forecasts and DWD: About three-third of Germans express trust in the Deutsche Wetterdienst (DWD) (77%) and confidence in the reliability of weather forecasts (72%).

Consumption of weather forecasts: Most Germans use weather forecasts regularly and consciously.

- Three-quarters (74%) of Germans obtain weather information daily.
- The vast majority (84%) use weather forecasts now and then, e.g., when they have something planned. Seven out of ten (69%) Germans deliberately obtain weather forecasts.
- One in ten would not pay attention to weather forecasts even if there is a weather warning.

Weather forecasts attitudes:

- Almost two-thirds (66%) of Germans are interested in weather forecasts or use them to plan everyday life activities.
- For one in ten (11%) Germans, weather forecasts are not relevant.
- About one-third (36%) report that severe weather affects them.

How do Germans perceive weather warnings and how do they respond to them?

Satisfaction with weather warnings: Most Germans are satisfied with weather warnings (81%) received so far and feel well warned (76%).

Response to weather warnings

- The majority of Germans would take precautionary measurements (e.g., close windows (93%) or secure property (74%)) when warned about hurricane force gusts.
- Nearly two-thirds (65%) would change private plans, but only less than one-fourth (23%) would alter business plans. Four out of ten (39%) would go home early from work or other appointments.
- Three out of ten (31%) people state they cannot respond to the warning due to work or other commitments.
- More than three-fourth (78%) would follow the weather forecast and seek further information. Many people (63%) would also inform others.
- Risk-taking behaviour is rare, but some people would show risky behaviour despite the weather.
- About one in ten Germans would not feel affected (12%) or not know what to do (10%).

What preferences do Germans have regarding weather warnings?

Warning time: Considering the relationship between warning time and warning certainty, most Germans prefer to receive a weather warning one (50%) or two (51%) days in advance (multiple answers were possible).

Warning channels:

- Germans prefer to receive severe weather warnings through traditional media such as television (67%), radio (63%), and weather apps (62%). Also, warn apps (39%) are important.
- Most Germans want to receive weather warnings through more than one channel.
- People often prefer the channels for weather warnings, which they also use in everyday life to obtain weather forecasts ($r = .16^{**} - .47^{**}$).
- Two out of 100 Germans state that they do not want to be warned of severe weather events at all.

Attitudes towards weather warnings: Most (85%) Germans would rather receive a false alarm than experience a missed event. Nearly half (46%) of the Germans want weather warnings issued even though the occurrence is still uncertain. Four out of ten (40%) Germans think weather warnings should only be issued when there is a great danger to the population.

Preferred warning communication components: Nearly six out of ten (59%) Germans selected all warning components available. About one quarter (24%) chose four to six different elements.

- The most relevant information for Germans is the region (93%) and period (93%) of the event, which was mainly desired in the first and second positions, respectively.
- Besides that, information about recommended behaviour (94%) is relevant for most Germans and mainly wanted on the first three positions,

followed by information about the impact (86%; mostly third and fourth position).

- Fewer Germans, but still more than two-third (between 67% and 76%), want alternative warning components such as comparisons with previous storms or likelihood of occurrence.

Impact of different warning communication components:

- Germans feel most threatened when they read behavioural recommendations, followed by descriptions of the impact (uprooted trees). Also, the climatological classification “similar event occurs every 10 years”, information about the wind speed, the note “severe danger” and a narrative describing a person ignoring the risk lead to high perceptions of the threat.
- Participants judged the behavioural recommendations as most useful in assessing or responding to the situation, followed by the impact in the sense of uprooted trees and the wind speed or force, respectively.
- Participants reported the highest intention to take preparatory measures when reading behavioural recommendations, followed by the warning of uprooted trees and a narrative on an unaware person. High intentions to act were also reported for information about the wind speed / force and narrative 3 “Indifferent”.

Uncertainty information: About three-quarters of Germans report being generally interested in information about the uncertainty of the forecast when a severe weather warning is issued.

- The assessment of uncertainty information varies depending on the level of uncertainty. A 60% likelihood of a violent storm is perceived approximately as threatening, useful, and motivating protective behaviour as many other warning communication components.

- A low probability (20%) results in significantly lower threat perception. The information is also perceived as less useful and leads to fewer intentions to act.
- People seem to perceive uncertainties as a coin flip: Most Germans would not alter their plans if the chance of severe weather occurring is below 50%. Only 6% would do so. Nearly two-thirds (65%) would alter their plans if the likelihood of severe weather would be 70% or higher. 3% would not change their plans at all.

Climate change: More than three-quarters (77%) of Germans believe that climate change is risky. One in ten does not think so. Seven of ten (71%) also believe that climate change is anthropogenic. 14% are of the opposite opinion.

Can specific user groups be identified?

Attitude types: Three weather-related attitude types were identified among Germans.

- Weather conscious (36%) people inform themselves consciously and are interested in weather forecasts. Bad weather doesn't make it hard for them to get around.
- Weather affected (30%) people are strongly affected by the weather as bad weather makes it difficult for them to get around. They are interested in weather forecasts and inform themselves consciously. They also report to a high degree that they only pay attention when severe weather is predicted. Many would not pay attention to forecasts even if severe weather is warned about.
- Weather disinterested (35%) people are not interested in or affected by weather and weather forecasts. They do not inform themselves consciously but casually and mainly pay attention only when high-impact weather events are forecasted. Some would not pay attention to a weather warning.

Weather attitudes and response to weather warnings: Patterns of attitudes and habits regarding weather and weather forecasts are related to the expected response to weather warnings.

- Weather disinterested people are less likely to respond to weather warnings, e.g., seek information, inform other people, change private or business plans, return home earlier or secure their belongings when receiving a warning as weather conscious or weather affected people.
- Weather conscious people are more likely to show preparatory measures such as closing windows, securing belongings, and searching for more information than weather affected or weather disinterested people. At the same time, they are less likely not to know what to do, not to feel affected, to wait and decide later, and not be able to.
- People affected by the weather in day-to-day life are more likely to stay home than weather conscious or weather disinterested people. At the same time, they are more likely to seek information and secure their property than weather disinterested but less likely to do these things than weather conscious people. They also believe they can assess the situation themselves better than weather conscious people.

Judgment of warning text components vary between different people

- Weather disinterested people assess all warning text components less threatening and less useful, and report less often intending to respond to the warning components than weather affected or weather conscious people.
- Weather conscious and weather affected people rate the traditional warning components similarly. But most alternative warning components (e.g., severe hazard, 11 m waves, narrative 1, probability information) were evaluated more positive by weather affected people than weather conscious people.



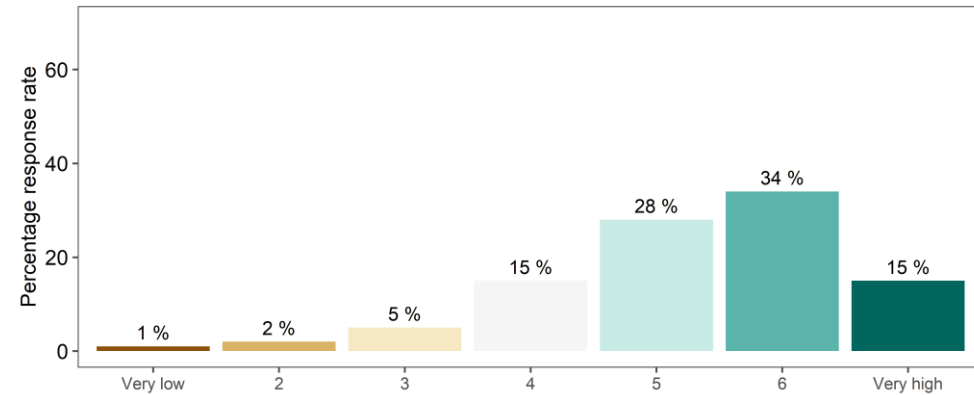
Weather forecasts

People trust in weather forecasts and the Deutsche Wetterdienst

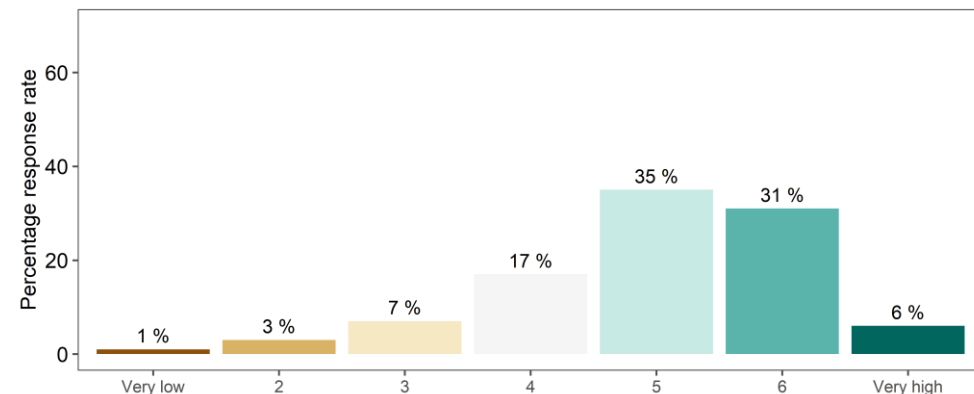
- Trust in the Deutsche Wetterdienst (DWD) and confidence in the reliability of weather forecasts both are high.
- Only a few Germans report a very high level of trust (15% and 6% respectively). There is still a potential for improvement.
- Confidence in the DWD and the reliability of the forecast are strongly correlated ($r = .826^{***}$).

- The older Germans are, the more likely they are to trust the DWD and weather forecasts.
- Germans who believe their apartment or house is protected against high-impact weather events report higher trust in the DWD and weather forecasts.
- Similarly, people who have already suffered material damage due to weather events confirm higher trust.
- Trust in the DWD is higher among individuals who primarily use a bicycle or public transportation to get around in their daily lives.
- Trust in the DWD is lower among individuals with low education level compared to people with a high education level.

In general, how much trust do you have in the Deutsche Wetterdienst (DWD)? (n=1059)



In general, how much confidence do you have in the reliability of weather forecasts? (n=1076)

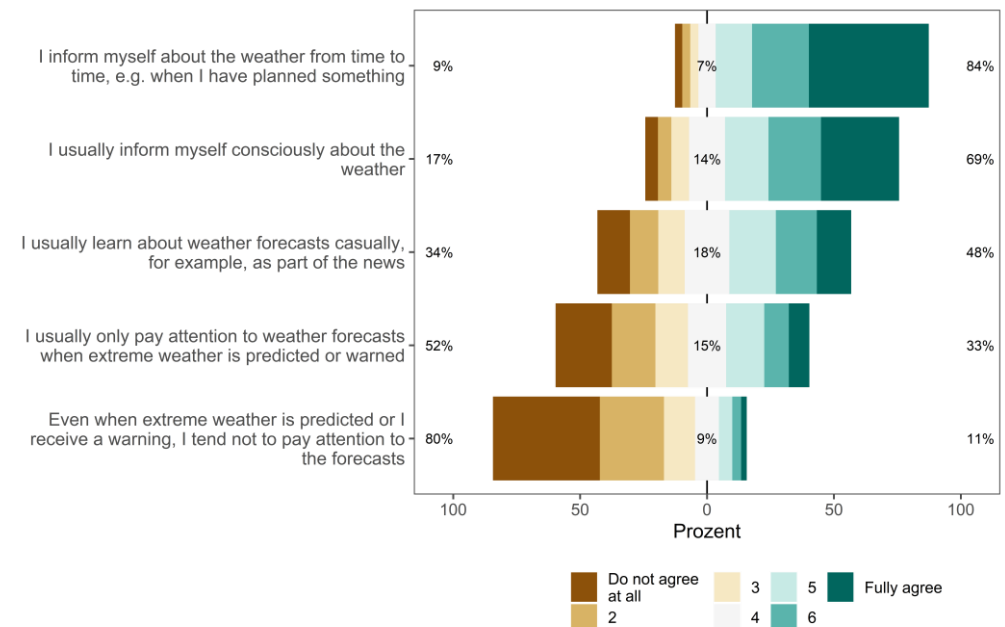
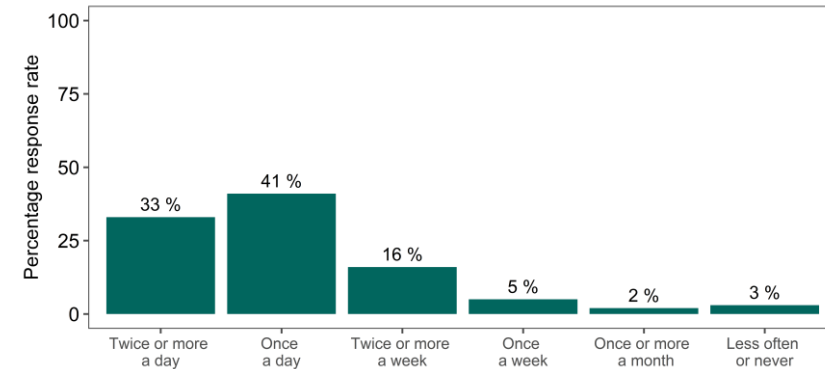


Most use weather forecasts regularly and consciously, but some would not follow weather forecasts even in the event of a weather warning

- Three quarters of Germans obtain weather information daily, one fifth weekly.
- Seven out of ten Germans deliberately obtain weather forecasts. However, according to their own assessment, the vast majority only use weather forecasts now and then, e.g., when they have something planned.
- One third of Germans only pay attention to weather forecasts when high impact weather events are expected.
- One in ten would not pay attention to weather forecasts even if there is a weather warning.

- Germans that experienced material damage due to weather events and the elderly are more likely to inform themselves consciously about the weather. The opposite is true for people being most of the time indoors.
- Women and people with a higher education level state more often to inform themselves about the weather only from time to time.
- Germans that are mostly indoors or get around usually with a bicycle are more likely to receive weather forecasts casually.
- People that spend most of their time indoors are more likely to pay attention to weather forecasts only when severe weather events are predicted.
- Younger people and men, in particular, tend not to pay attention to weather forecasts, even when a high-impact weather event is forecasted.

How often do you usually consume weather information - even on the side - e. g. through the radio, television, internet or a mobile phone app?



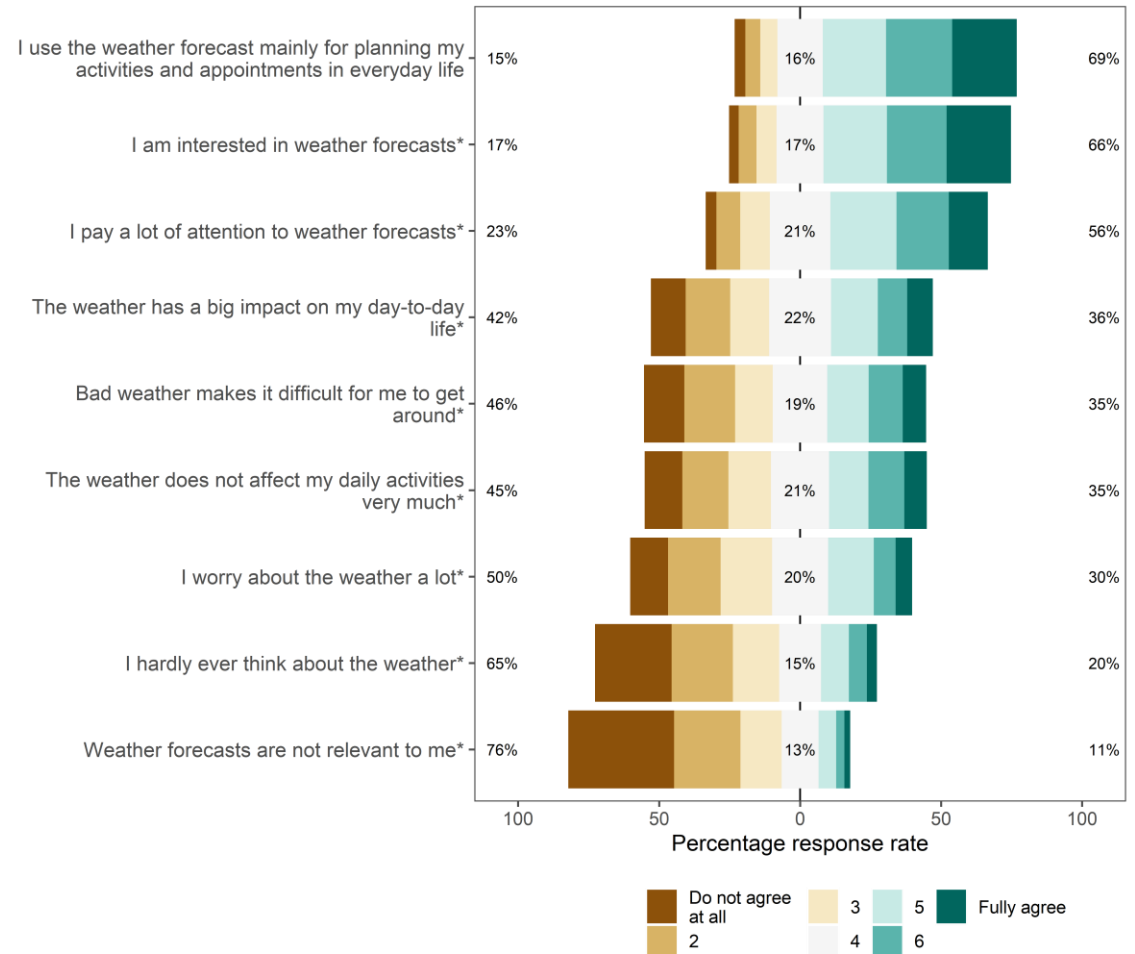
Interest in weather forecasts is high amongst Germans

- Almost two-thirds of Germans are interested in weather forecasts (66%) or use them to plan everyday life activities (69%).
- About one-third (36%) report that severe weather affects them.
- For one in ten (11%) Germans, weather forecasts are not relevant.

- The attitudes towards weather depend a. o. on the age of the people, i. e. the elderly pay more attention to and are more interested in weather forecasts. They also state more often to be affected by the weather and think more about the weather.
- Similarly, people that experienced material damage due to weather events are more interested in weather forecasts and pay more attention to them. They think and worry more about the weather.
- Also, the daily means of transport affect the attitudes towards weather, e. g., people mainly using a car are more interested in weather forecasts and worry more about the weather. At the same time, they are less affected by the weather when moving around.
- People that are mainly indoors are less affected by and think less about the weather.
- Bad weather makes it more difficult for women to get around than for men. Women also use weather forecasts more often to plan their leisure activities.

Attitudes towards weather and use of weather forecasts

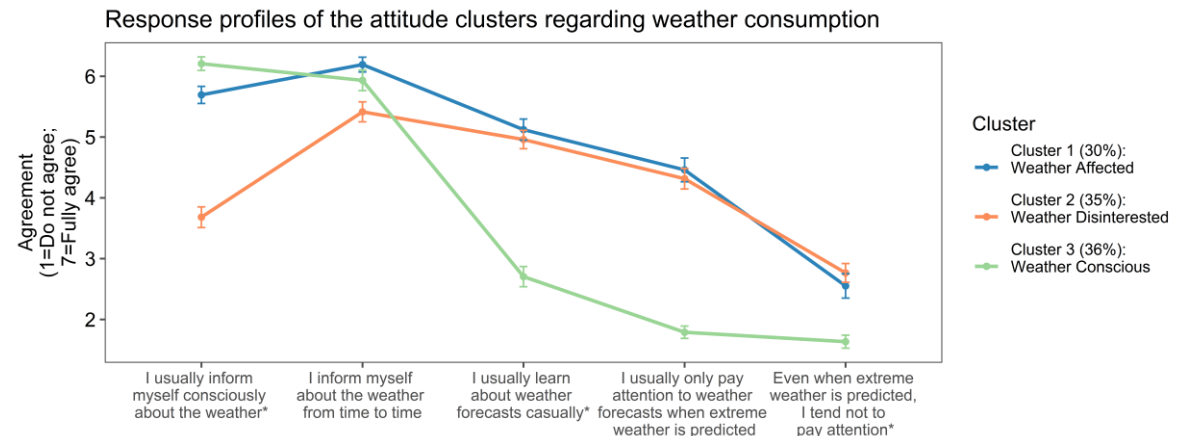
Notes: *Taylor et al. 2019



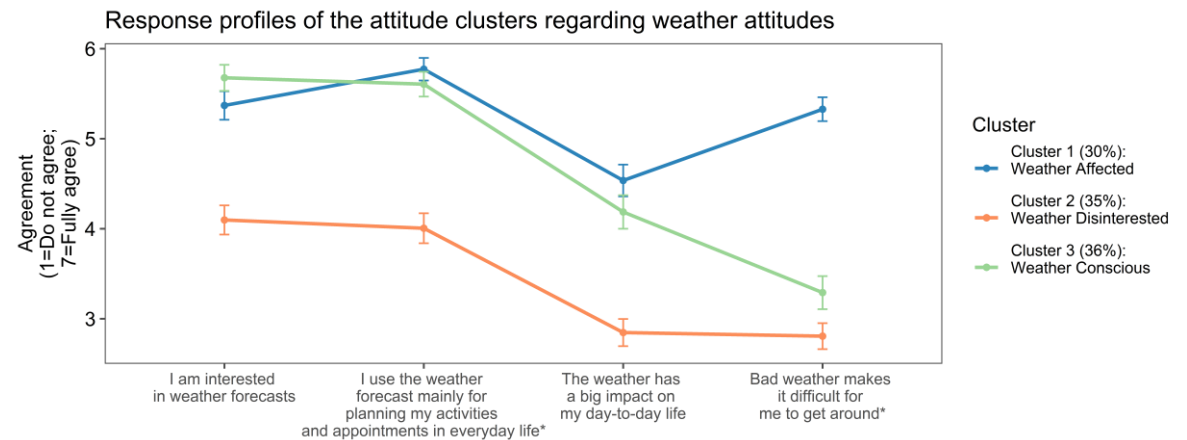
Three weather-related attitude types could be identified among Germans

- Cluster 3 (36%; Weather Conscious) consists of people informing themselves about the weather consciously and when they have something planned. They are interested in weather forecasts and use them for planning their activities. The weather affects their daily lives, but bad weather doesn't make it hard for them to get around.
- In contrast, cluster 1 (30%; Weather Affected) is composed of people being strongly affected by the weather. Bad weather makes it difficult for them to get around. As people from cluster 3, people belonging to cluster 1 are interested in weather forecasts, use them to plan their activities, and inform themselves consciously and when they have something planned. But they also report to a high degree that they learn about the weather casually and only pay attention when severe weather is predicted. Many would not pay attention to forecasts even if severe weather is warned about.
- People belonging to cluster 2 (35%; Weather Disinterested) are not interested in or affected by weather and weather forecasts. They do not inform themselves consciously about the weather but casually and mainly pay attention only when high-impact weather events are forecasted. Like cluster 1, to a certain degree, cluster 2 would not pay attention to a weather warning.

Method: To identify attitude patterns, we performed k-means cluster analysis with different sets of variables. The aim was to identify replicable clusters in terms of weather attitudes and habits with as few variables as possible. As a result, a k-means cluster analysis of five variables was performed. Based on the silhouette coefficient, we set the clustering number k as 3.



Notes. *Variables included in k-means cluster analysis

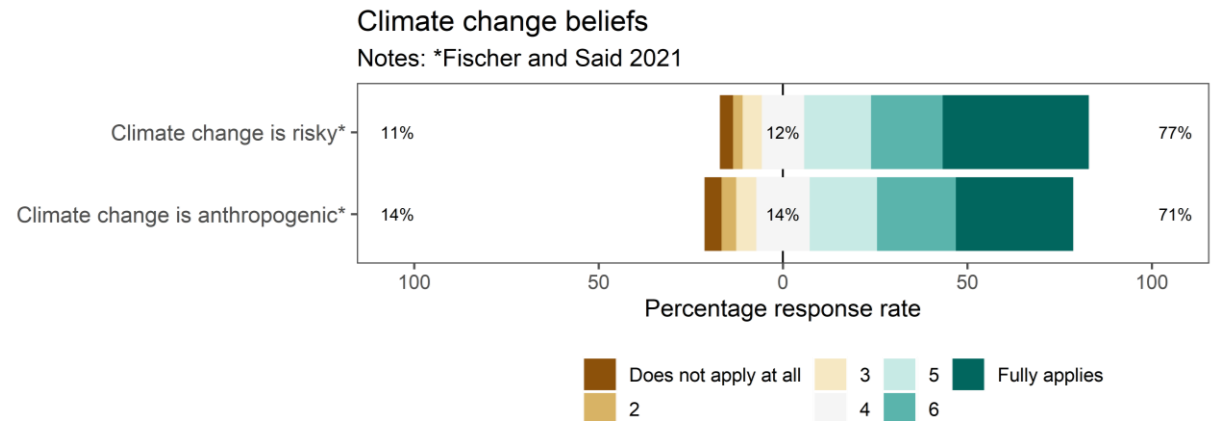


Notes. *Variables included in k-means cluster analysis

Most Germans belief climate change is risky and anthropogenic

- More than three-quarters (77%) of Germans believe that climate change is risky. One in ten does not think so.
- Seven out of ten (71%) also do believe that climate change is anthropogenic. 14% are of the opposite opinion.

- The climate change beliefs are only influenced to a marginal extent by sociodemographic variables.
- People with high education levels are more likely to believe climate change is risky and anthropogenic than people with middle or low education levels.
- Women and people that have experienced material damage due to high-impact weather events are more likely to perceive climate change as risky than men or people without damage experience.
- More crucial seems to be the individual evaluation of weather forecasts and weather warnings.
- The higher the confidence in the reliance on weather forecasts and the higher the satisfaction with weather warnings, the more people believe climate change to be risky and anthropogenic.



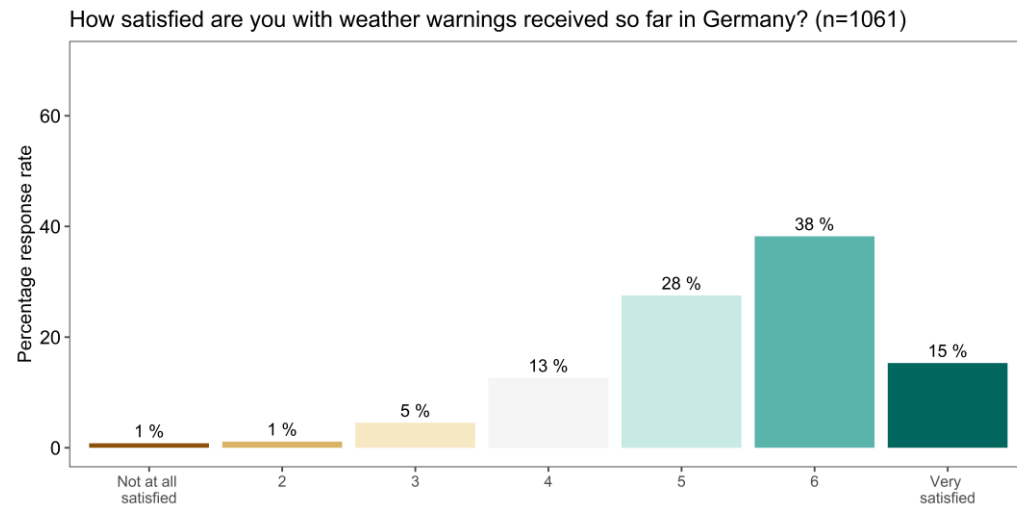
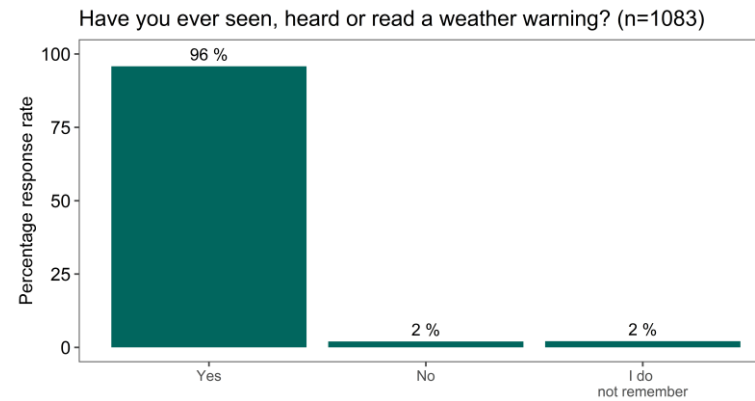


Weather warnings

Satisfaction with weather warnings is high

- The vast majority (96%) of Germans have already received a weather warning in the past.
- Most (81%) Germans are satisfied with received weather warnings so far.

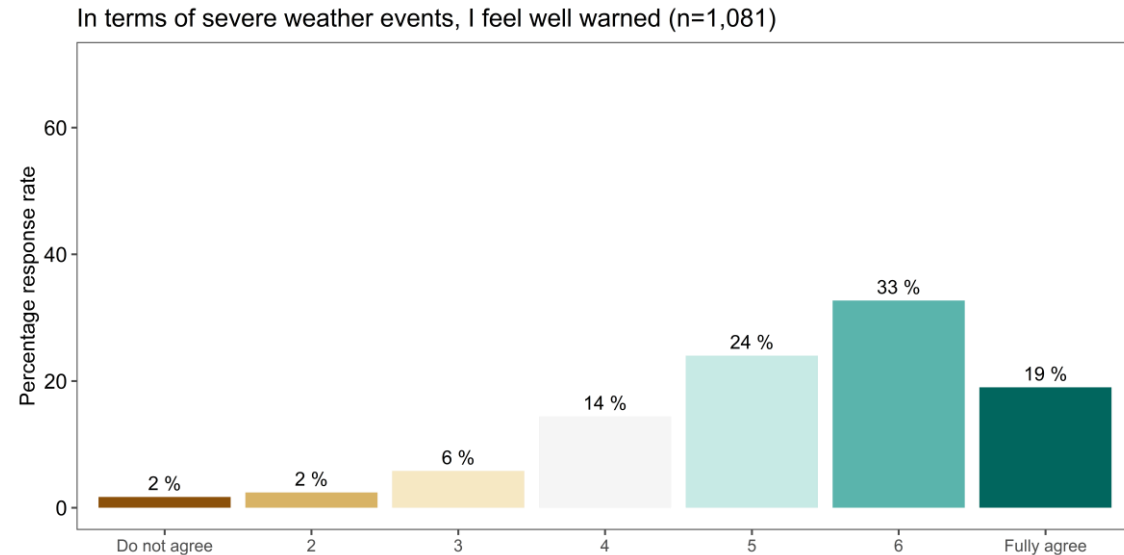
- Germans, who predominantly get around by bicycle or on foot, report higher satisfaction with weather warnings.
- Germans living in a house or apartment that is protected against weather events state higher satisfaction with warnings against high-impact weather events.
- Age, gender, and education have no impact on the warning satisfaction.
- Also, experiencing material or physical damage does not affect the amount of satisfaction that people report.



Germans feel well warned

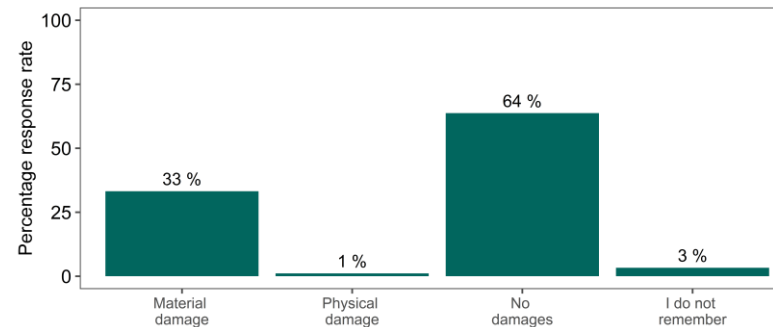
- Three-quarters of Germans feel well warned against severe weather events.
- This aspect relates to the satisfaction with weather warnings ($r = .576^{***}$).
- One-third (33%) of Germans report material damage due to weather effects.
- 1% experienced physical damage.

- Germans, who predominantly get around by bicycle, feel better warned.
- Germans living in a house or apartment that is protected against weather events state that they feel better warned.
- People living in a big city feel better warned than people living in a village.
- Germans between 18 and 39 years of age do not feel as well warned as people between 40 and 64 years of age.
- People with a low education level feel not as well warned as people with a high education level.



Have you ever been affected by high-impact weather, i. e. have you suffered material or physical damage as a result?

Notes: Multiple answers possible

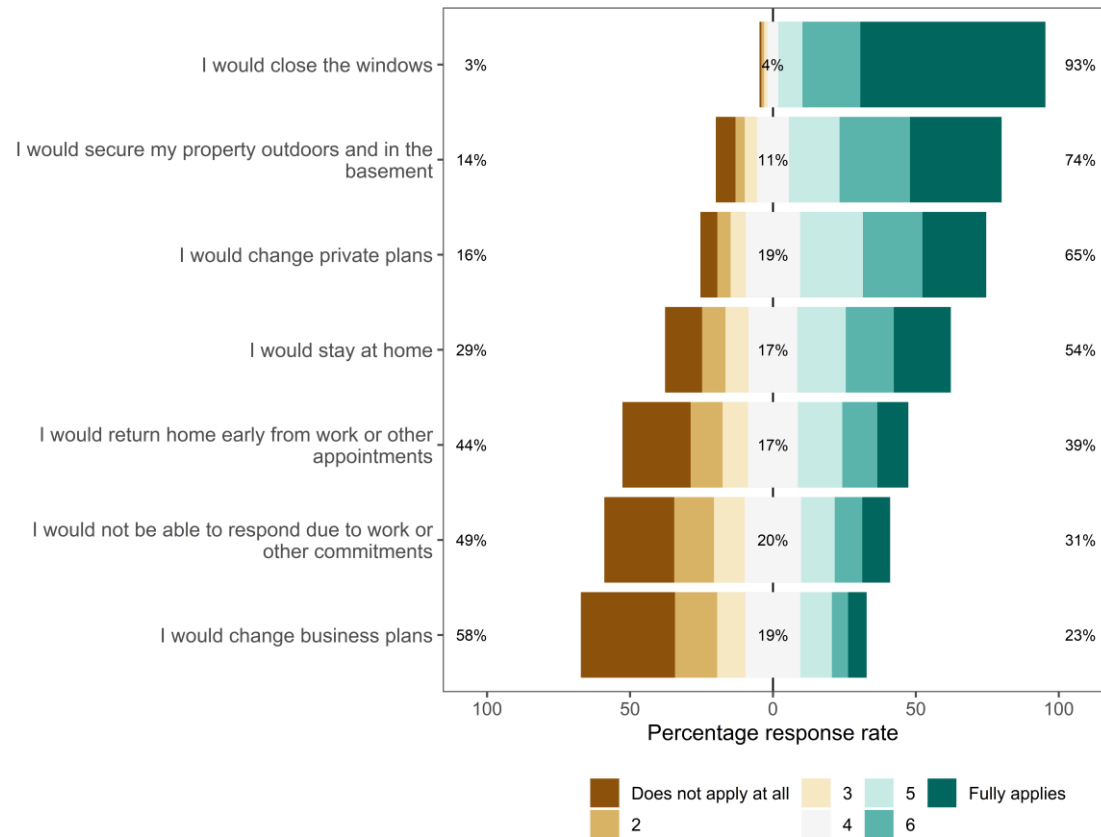


Most people would prepare themselves and change private plans following a weather warning; altering business plans is less likely

- The majority of Germans would take precautionary measurements (e.g., close windows (93%) or secure property (74%)) when warned about hurricane force gusts (orkanartige Böen).
- Nearly two-thirds (65%) would change private plans, but only less than one-fourth (23%) would alter business plans. Four out of ten (39%) would go home early from work or other appointments.
- Three out of ten (31%) people state they cannot respond to the warning due to work or other commitments.

- Women and people that experienced material damage in the past are more likely to change private plans and to take precautionary measures (e.g., closing windows and securing their property). Additionally, people living in a big city are less likely to secure their property. The opposite is true for people getting around by car.
- People with higher education levels are more likely to change business plans and leave work earlier than people with middle or lower education. The same is true for people that have experienced material damage due to severe weather.

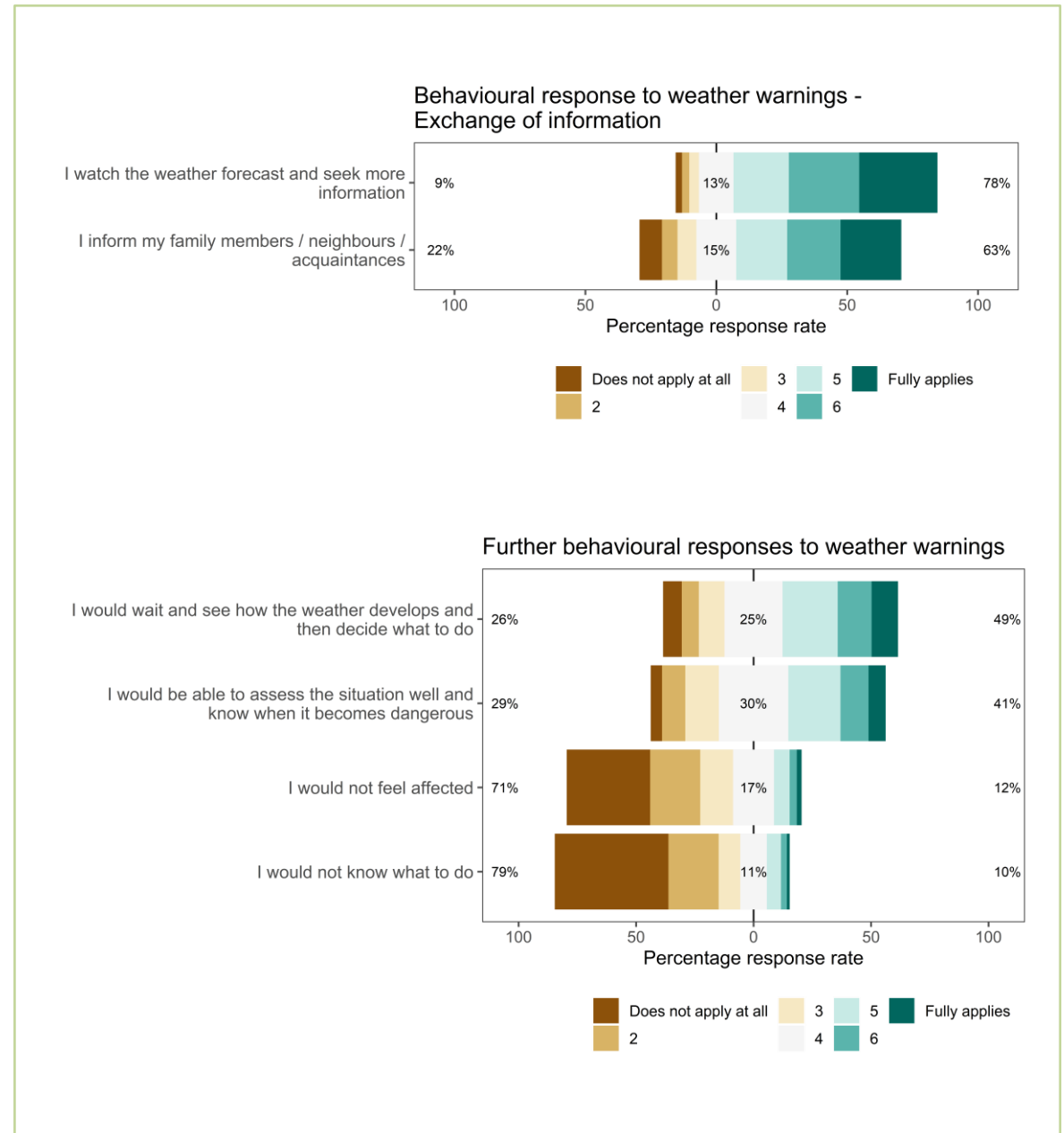
Behavioural response to weather warnings - Protective action



The majority would seek or share information about the warning; one out of ten would not know what to do

- More than three-fourth (78%) would follow the weather forecast and seek further information. Many people (63%) would also inform others.
- Nearly half (49%) state they would wait for how the weather develops and decide based on that assessment what they would do.
- Four out of ten (41%) report they can assess the situation well themselves and know when it becomes dangerous.
- About one in ten Germans would not feel affected (12%) or not know what to do (10%).

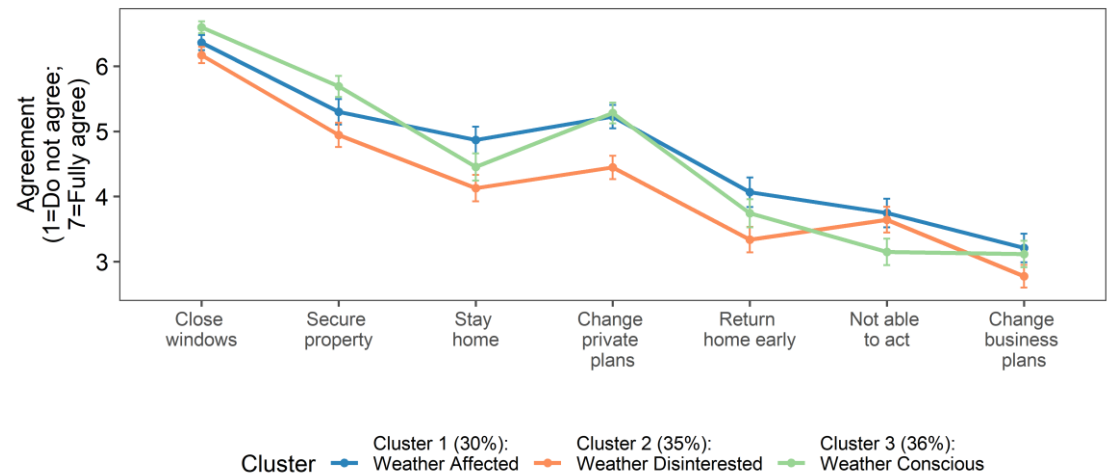
- The older people are, the more likely they are to seek further information. Also, people that experienced material damage in the past are more likely to search for information than people without such experiences.
- The younger the people are, the more often they state not to know what to do, not to be affected, to wait and react to the situation, and to self-assess the situation.
- People that experienced material damage due to high-impact weather events report less often not to feel affected. Also, they are less likely to assess the situation themselves than people without such experiences.
- People living in flats or houses in exposed locations state less often not to know what to do.
- People being most of the time outdoors are less likely to wait and see how the situation develops.



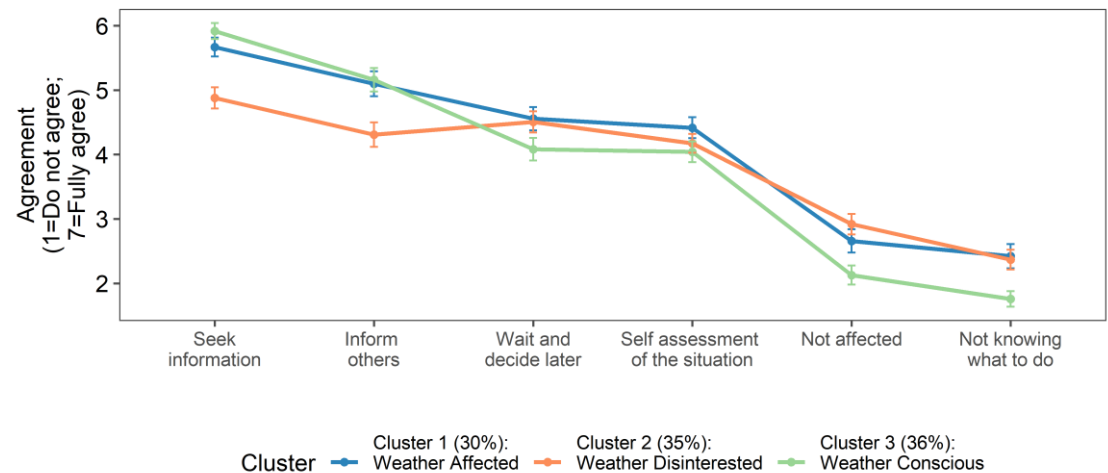
Different behavioural patterns do exist depending on weather attitudes and habits

- Patterns of attitudes and habits regarding weather and weather forecasts are related to the expected response to weather warnings.
- People not interested in or affected by weather and weather forecasts and do not inform themselves consciously about the weather (“Weather Disinterested”; cluster 2) are less likely to act, e.g., seek information, inform other people, change private or business plans, return home earlier or secure their belongings when receiving a warning as weather conscious (cluster 3) and weather affected (cluster 1) people.
- Weather conscious people, with a strong interest in weather forecasts (cluster 3), are less likely not to know what to do, not to feel affected, to wait and decide later, and not be able to act than the “Weather Affected” and “Weather Disinterested”. At the same time, they are more likely to show preparatory measures such as closing windows, securing belongings, and searching for more information.
- People affected by the weather in day-to-day life and being interested in weather forecasts, even though they often learn about the weather casually (cluster 1), are more likely to stay home than “Weather Conscious” and “Weather Disinterested”. At the same time, they are more likely to seek information and secure their property than “Weather Disinterested” but less likely to do these things than weather conscious people. They also believe they can assess the situation themselves better than weather conscious people (cluster 3).

Preparatory measures depending on attitudinal clusters



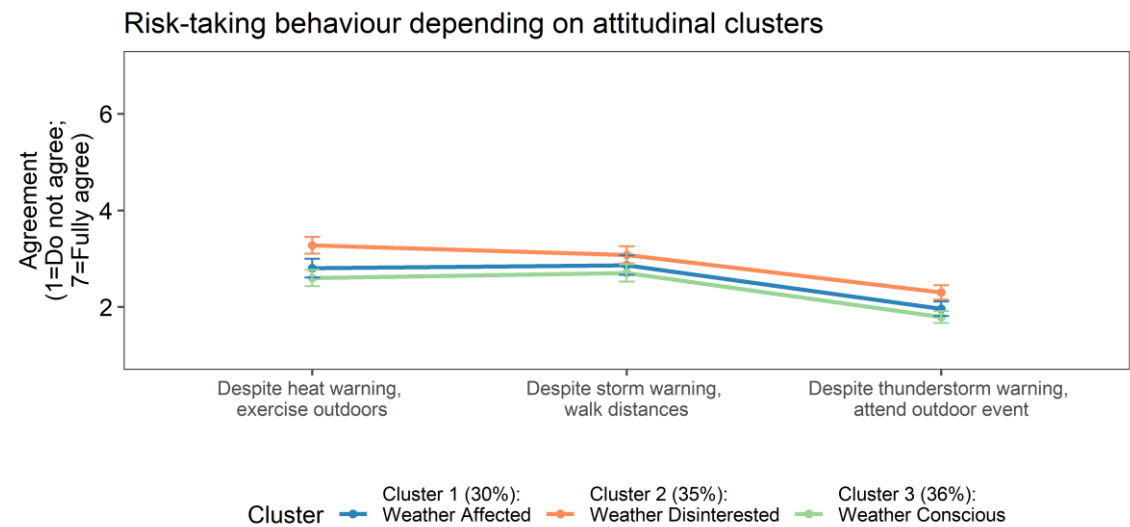
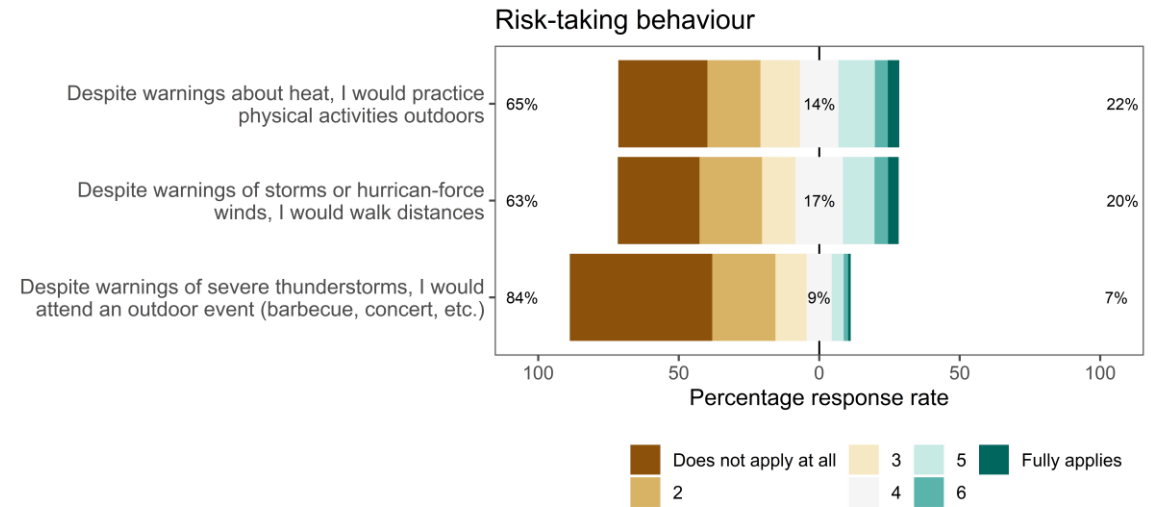
Behaviour depending on attitudinal clusters



Risk-taking behaviour is rare, but some people would show risky behaviour despite weather warnings

- Although more than six out of ten Germans would not exercise outdoors when receiving a warning about the heat (65%) or would not walk distances after an alert of hurricane-force gales (63%), about one-fifth would show such risky behaviour (22% and 20% respectively).
- 7% would attend an outdoor event like a barbecue or concert, even though there have been warnings of severe thunderstorms, 84% would not.

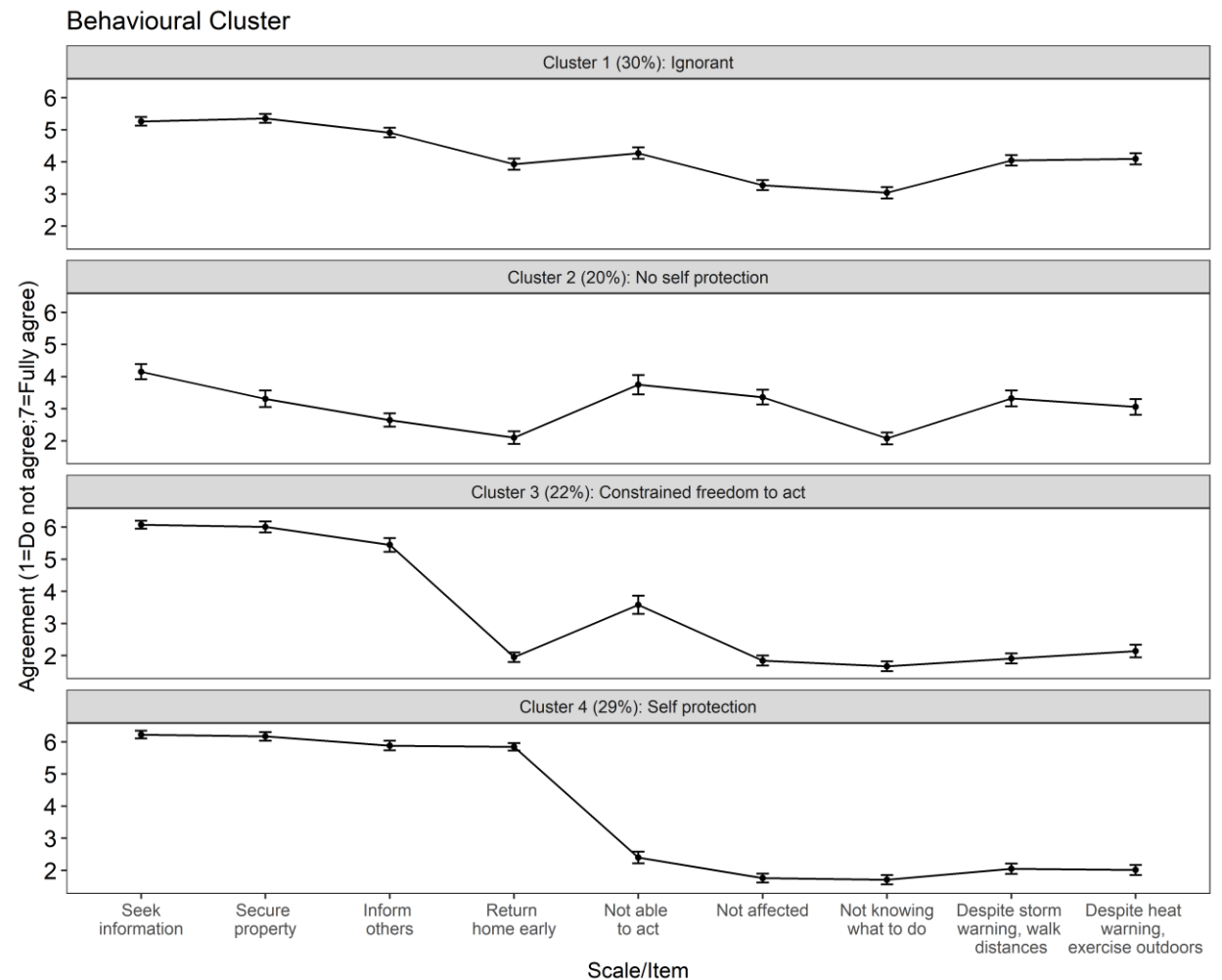
- The strongest predictor for risk-taking behaviour is age. The younger the people, the more likely they are to show risky behaviours.
- Furthermore, men, and people with high education level are more willing to engage in risky behaviour than women and people with middle or low education level. People spending most of the daytime indoors are less likely to behave in a risky manner.
- Also, the higher people's confidence in the reliability of weather forecasts, the less they show risk-taking behaviour.
- People not interested in or affected by weather and weather forecasts, and not paying attention to weather warnings (cluster 2), are more likely to show risk-taking behaviour than weather conscious (cluster 3) and weather affected people (cluster 1).



Four different behavioural types were identified

- Cluster 4 (29%; Self-protection) consists of people responding to a weather warning with protective action. They would seek information, secure property, inform others, and return home early. They would not show risky behaviour.
- People belonging to cluster 3 (2%; Constrained freedom to act) would also seek information, secure property, and inform others. But they would not return home early, state that they cannot respond due to commitments. Nevertheless, they would not show risky behaviour.
- Opposite to these two clusters, cluster 2 (20%; No self-protection) would to a higher degree show risk-taking behaviour. They also are less likely to show protective action, i.e. seek information, secure property, and inform others. They state that they could not respond due to responsibilities and would not feel affected.
- Cluster 1 (30%; Ignorant) states to a higher degree than all the other clusters that they would not know what to do after receiving a weather warning. Nevertheless, they would seek further information, inform others, and secure their property. But at the same time, they would engage in risk-taking behaviour. They also state, they could not respond due to commitments and would not feel affected.

Method: To identify attitude patterns, we performed k-means cluster analysis with different sets of variables. The aim was to identify replicable clusters in terms of response to weather warnings with as few variables as possible. As a result, a k-means cluster analysis of nine variables was performed. We set the clustering number k as 4.



A 3D-rendered weather vane with a red and white striped pattern is mounted on a vertical metal pole. The vane is positioned horizontally, pointing towards the left. The background is a dramatic sky with dark, heavy clouds and patches of blue sky with white clouds. A green banner is overlaid at the bottom of the image.

Weather warning preferences

Most Germans want to receive a weather warning one or two days in advance

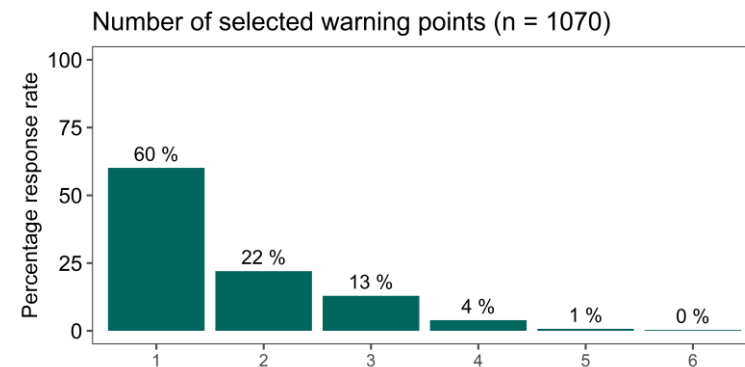
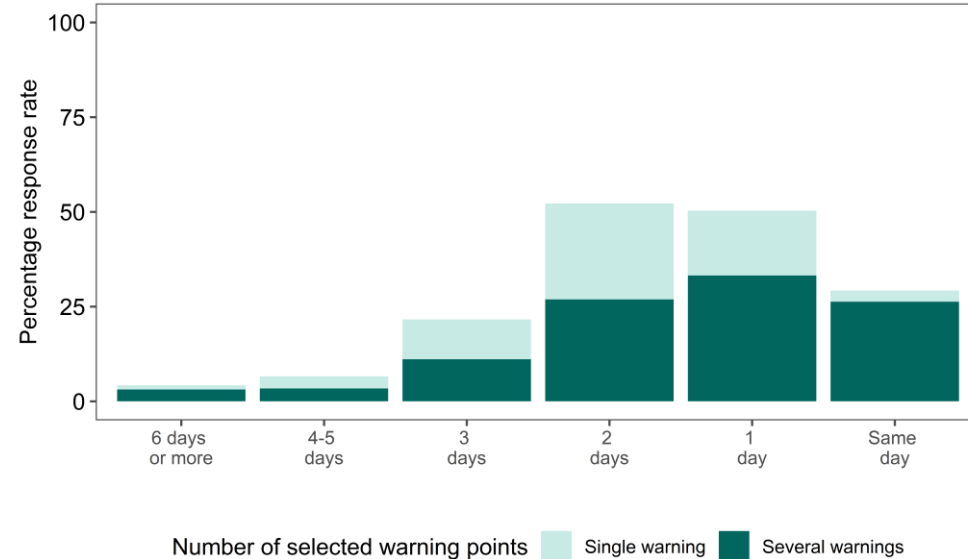
- Considering the relationship between warning time and warning certainty, most Germans prefer to receive a weather warning one (50%) or two (51%) days in advance.
- Although respondents could choose to receive warnings more than once, the majority (60%) selected only a single warning point.
- People that report preferring to be warned very early (i.e. six days in advance) or late (i.e. on the same day) usually want to be warned more than once.

- People that are young, women, have a high education level, experienced material damage in the past due to weather events, and are getting around mainly on foot chose more often to be warned more than once.
- Among respondents who selected only a single warning point, people spending most of their time outdoors, people living in a village, and younger people chose more often to be warned six days or more in advance.
- A short-term (1 day before) and single warning were more often selected by the elderly and men.

Preferred warning time depending on number of selected warning points

Question: A weather warning can be issued several days in advance. But the further in advance the forecast is made, the less accurate it is and also the lower the probability that the severe weather will actually occur. At what time would you like to be warned about a storm?

Notes: Multiple answers possible



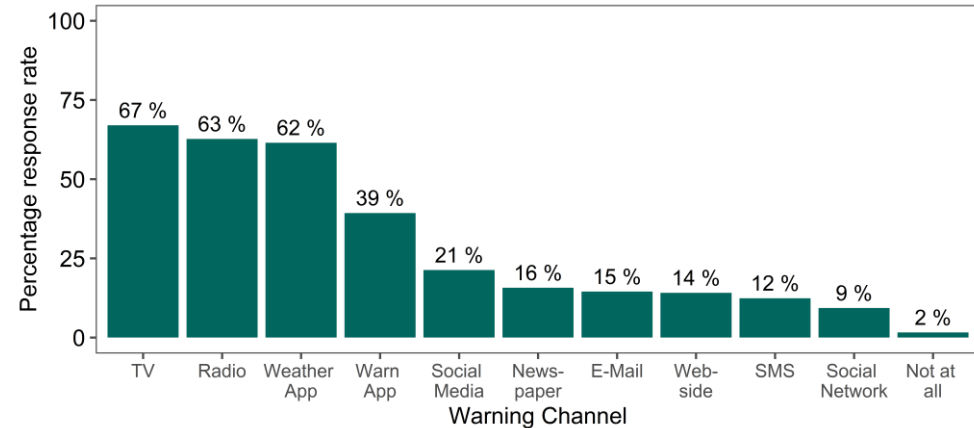
Traditional media and weather apps are the favoured weather warning channels

- Germans prefer to receive severe weather warnings through traditional media such as television (67%) and radio (63%) and weather apps (62%). Also, warn apps (39%) are important.
- Two out of 100 Germans state that they do not want to be warned of severe weather events at all.
- Most Germans want to receive weather warnings through more than one channel, i.e. two (20%), three (24%), or four (19%) different channels.
- People often prefer the channels for weather warnings, which they also use in everyday life to obtain weather forecasts ($r = .16^{**} - .47^{**}$).

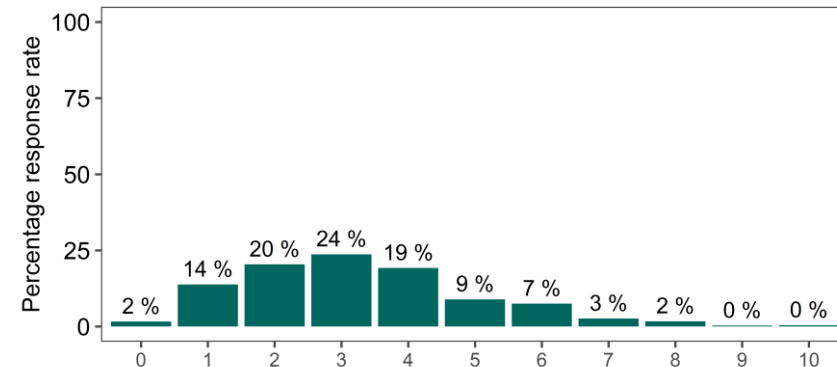
- The older the people are, the fewer warning channels they select. People using mainly public transportation and bicycles chose more warning channels than people using other means of transport.
- The elderly want to receive weather warnings more often through television and E-Mails, but less often through weather or warn apps, websites, social media, and social networks than younger people.
- Women prefer television and social media as sources for weather warnings compared to men.
- People that have experienced material damage due to severe weather chose more weather and warn apps compared to people without such experiences.

Which channel do you prefer to receive warnings of severe weather in the future?

Notes: Multiple answers possible



Number of selected warning channel(s)

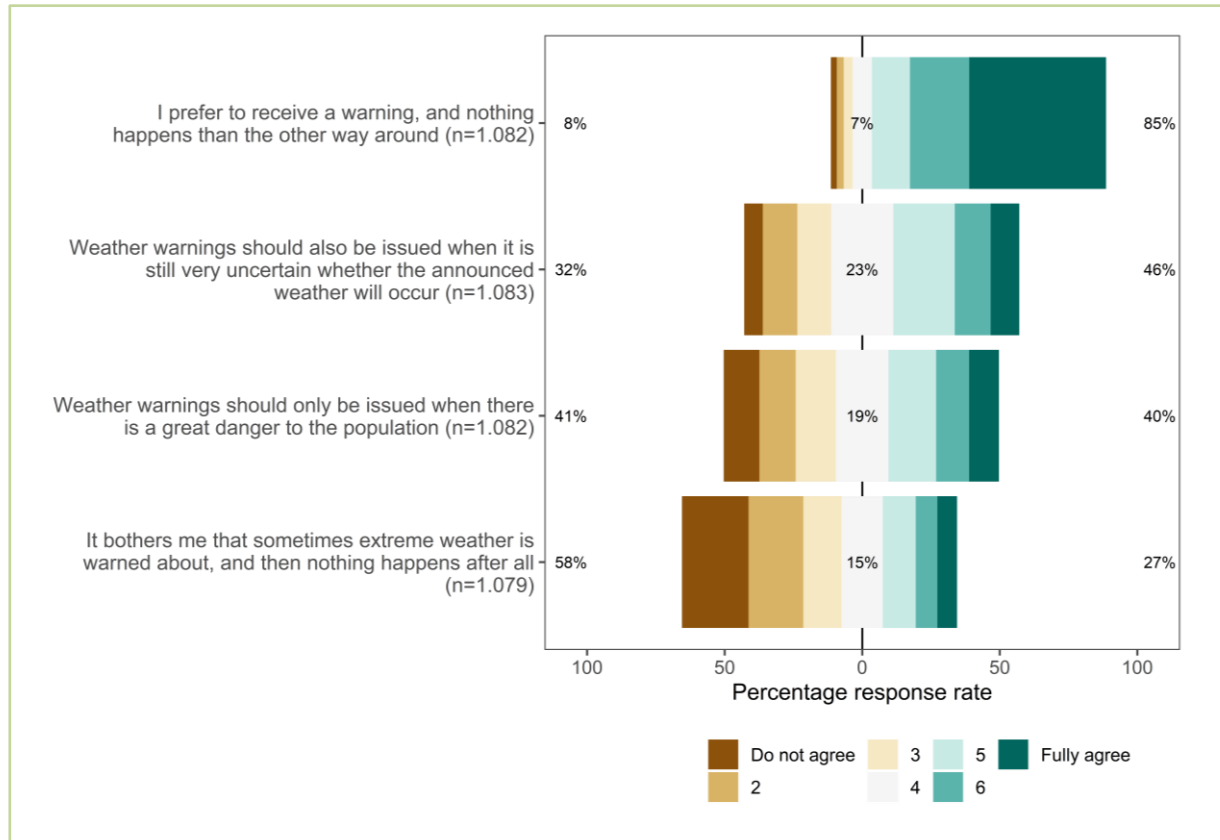


Most Germans prefer to receive a false alarm than experiencing a missed event

- Most (85%) Germans would rather receive a false alarm than experiencing a missed event.
- About a quarter (27%) of Germans are bothered by false alarms. More than half (58%) are not.
- Nearly half (46%) of the Germans want weather warnings issued even though the occurrence of the event is still uncertain.
- On the other hand, four out of ten (40%) Germans think, weather warnings should only be issued when there is a great danger to the population.

- The attitudes towards weather warnings depend a. o. on age, gender, own experience and preferred means of transport of the people.
- The older people are, the more they believe warnings should be issued, even if the occurrence is still uncertain, and the less they feel bothered by false alarms.

- Women more often prefer to receive a warning and nothing happens than men. They also disagree to a higher extent with the statement, that warnings should only be issued when there is a great danger.
- Similarly, people who have suffered material damage due to weather events in the past report more often to prefer a false alarm than experiencing a missed event, and less often, warnings should only be issued when there is a great danger to the population.
- People using a car do less prefer false alarms compared to missed event and are more likely to be bothered by false alarms compared to people using other means of transport. People using public transportation state more often a weather warning should be issued even though the occurrence of the event is still uncertain, and less often that weather warnings should only be issued when there is a great danger.



Most Germans prefer to have all information available

- Participants could tailor their individual weather warning and select from a list of warning communication components those relevant to them regarding hurricane force gusts ("Orkanartige Böen"). They should rank them in order of priority, too.
- Nearly six out of ten (59%) Germans selected all warning components available. About one quarter (24%) chose four to six different elements.
- Some (4%) respondents did not answer this question and were excluded from the following analysis.

- The older the people, the more warning components they want.
- People being mainly outdoors select more warning components than people being equally indoors and outdoors.
- People with high education levels want fewer warning elements than people with lower education levels.

What should an optimal warning of hurricane force gusts look like for you? If you could compile a warning yourself, what information should this warning contain? In what order?

Text components used by DWD

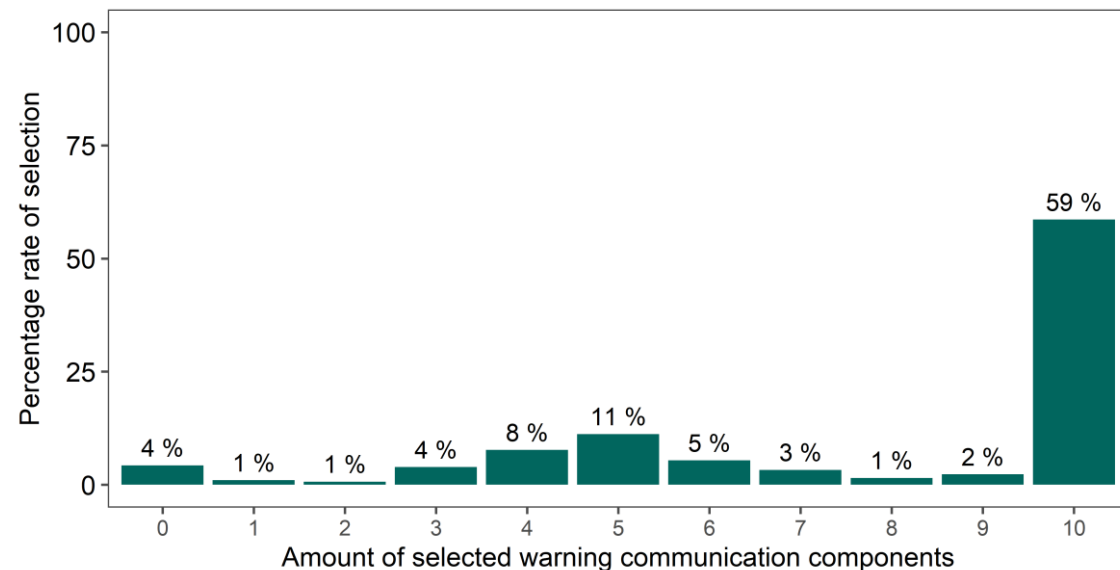
- Region for which the warning is valid
- Period for which the warning is valid
- Close all windows and doors! Secure objects outside! Keep your distance from buildings, trees, scaffolding and power lines. Avoid being outside if possible!
- Trees may be uprooted
- Hurricane force gusts (Bft 11, 105 to 115 km/h)
- Hurricane force gusts (level 3 of 4)

Alternative text components

- Great danger
- Hurricane force gusts of the kind that occur on average only once every 10* / 3* years
- Warning of hurricane force gusts comparable to the storm "Sabine" in February 2020
- Hurricane force gusts with a probability of occurrence of 20% (unlikely)* / 60% (probable)*

Notes. *This variable was presented randomly to approximately 50% of participants.

Number of selected warning communication components



Evaluation of warning communication formats

Hurricane force gusts can be warned about in different ways.

1. When you look at the following warnings, how threatening do you feel the respective situation is for you personally?
2. How useful or helpful do you find the information below in assessing or responding to the situation?
3. How likely would you be to take preparatory actions (e.g., staying home as a precaution or securing items) in the respective situations?

Text components used by DWD

- Warning of hurricane force gusts (Baseline)
- Warning of hurricane force gusts: Close all windows and doors! Secure objects outside! Keep your distance from buildings, trees, scaffolding and power lines. Avoid being outside if possible!
- Warning of hurricane force gusts: Trees may be uprooted
- Warning of hurricane force gusts (Bft 11, 105 to 115 km/h)
- Level 3 of 4 warning

Alternative text components

- Warning of great danger
- Warning of hurricane force gusts as they occur on average only once every 10* / 3* years
- Warning of hurricane force gusts comparable to the storm "Sabine" in February 2020
- Warning of hurricane force gusts with a probability of occurrence of 20% (unlikely)* / 60% (probable)*
- Warning of hurricane force gusts capable of producing waves more than eleven meters high
- Narrative 1 „Unaware“*
- Narrative 3 „Indifferent“*

Notes. *This variable was presented randomly to approximately 50% of participants.

- Participants were asked to judge different warning components regarding hurricane force gusts (“Orkanartige Böen”). They could rate in how far these text components would threaten them, would be useful to them, and would lead to protective action.
- The warnings consisted of traditional text components already used by the DWD and of alternative text components.

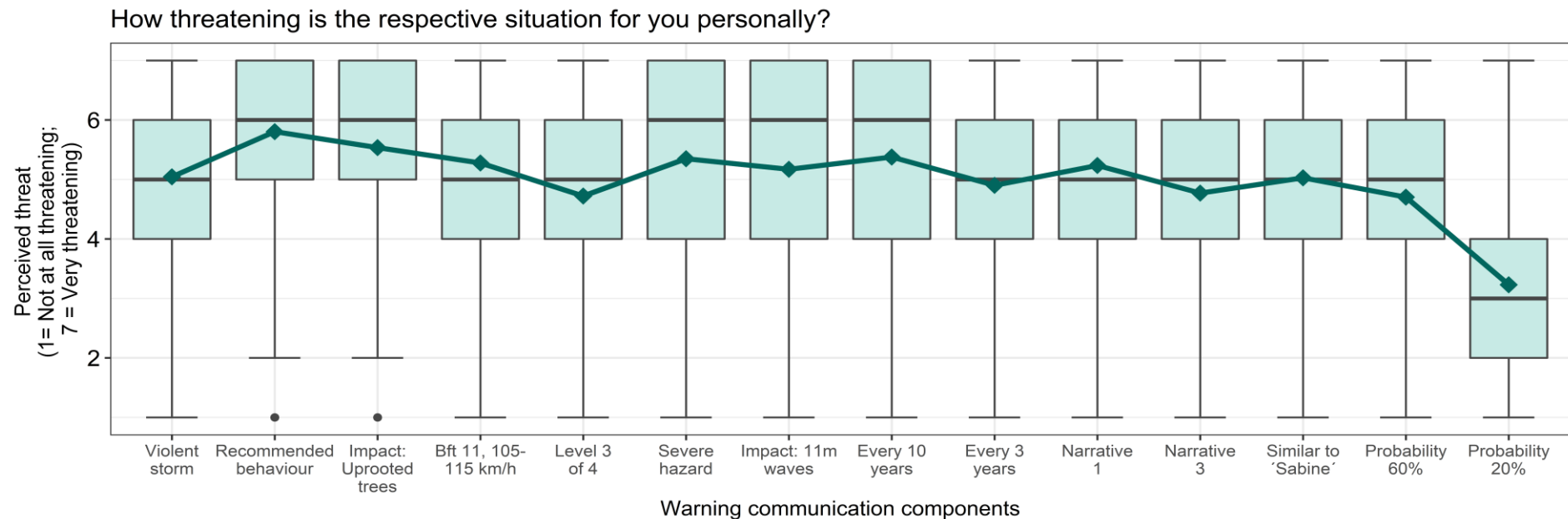
Narrative 1 „Unaware“

"I don't go out in bad weather unless I have to. I also heard on the news that there was supposed to be a storm, but it doesn't really happen here, and when I looked out the window in the morning, it wasn't windy and I also had to go shopping. So I went out... But then when I came out of the store and was on my way home, all of a sudden it started, all kinds of things flew around, roof tiles, branches, paper, I don't know, trees cracked and then there was the pain; something must have hit me. I was in the hospital for four weeks..."

Narrative 3 „Indifferent“

"I got the warning, too, but I didn't react to it. I never do. I don't care about the weather. I don't change my daily schedule because of the weather. I adjust to the weather - whether there is a warning or not has no influence on my plans, because I don't know whether it will really happen. I see when it starts to storm and then I move when the storm is there as quickly as possible home and not already when I hear about it. That's how I've always done it and also on that day ... And then the storm actually came and then I made sure that I got home, but then it was already too late, a branch or something broke off directly above me and hit me. I was in the hospital for four weeks..."

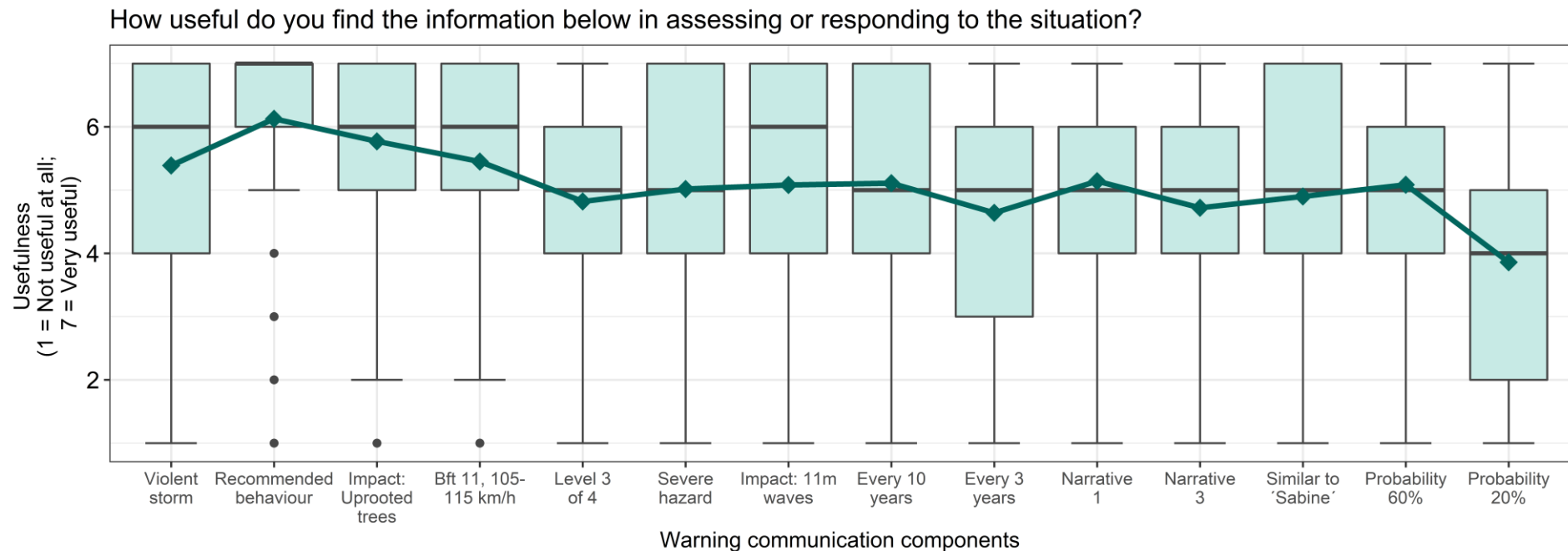
Threat perception is highest with recommended behaviour



Notes. Figure shows boxplots while the median is represented by the vertical black bar, the first quartile by the lower side of the box, the third quartile by the higher side of the box, the minimum by the tip of the bottom whiskers, and the maximum by the tip of the top whiskers. The green quadrangles and lines represent the mean values.

- The warning components have an impact on threat perception:
- Germans feel most threatened when they read behavioural recommendations, followed by descriptions of the storm's impact (uprooted trees).
- Also, the climatological classification "similar event occurs every 10 years", information about the wind speed, the note "severe danger" and a narrative 1 describing a person ignoring the risk lead to high perceptions of the threat.
- Information of the level (3 of 4), a narrative describing a person being indifferent to the risk and uncertainty information (60% or 20% probability of occurrence) result in the lowest threat perception.
- The threat perception for these warning components is even lower than for the basic information "violent storm" (Orkanartige Böen).

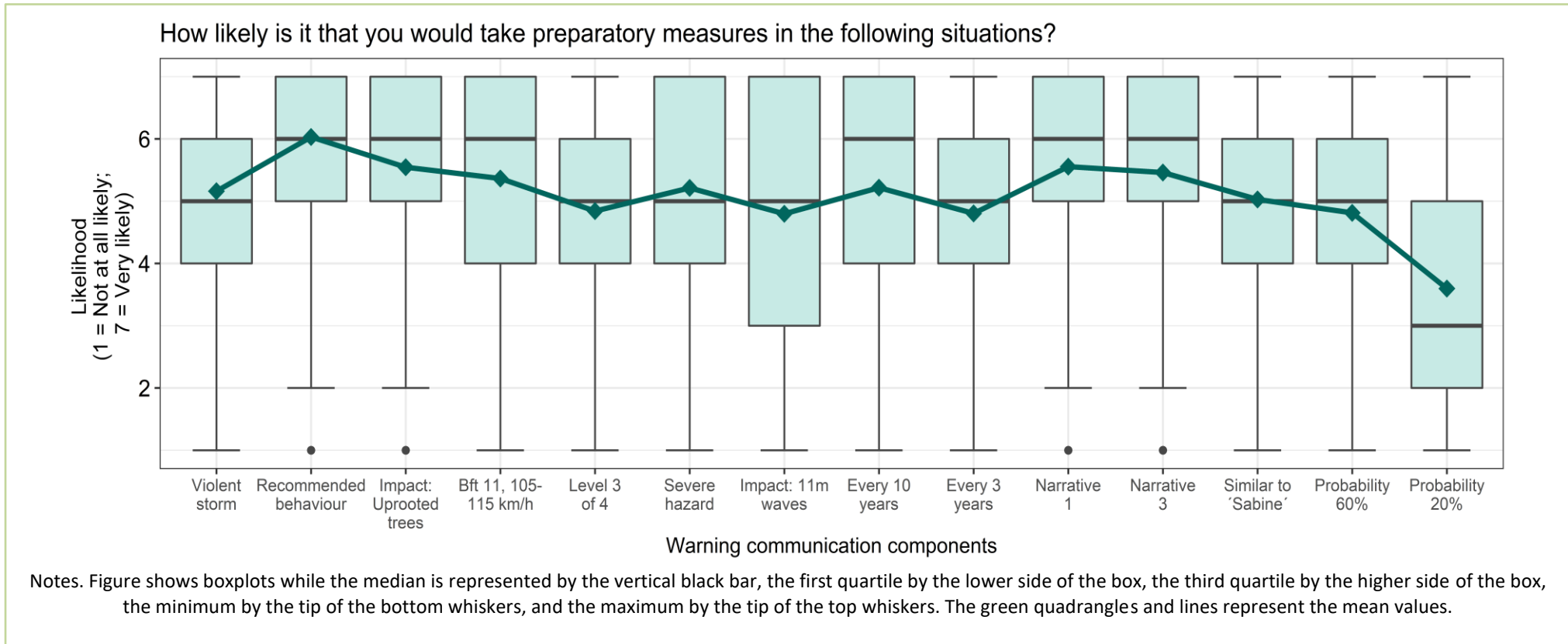
Recommended behaviour and impact are the most useful information in assessing or responding to the situation



Notes. Figure shows boxplots while the median is represented by the vertical black bar, the first quartile by the lower side of the box, the third quartile by the higher side of the box, the minimum by the tip of the bottom whiskers, and the maximum by the tip of the top whiskers. The green quadrangles and lines represent the mean values.

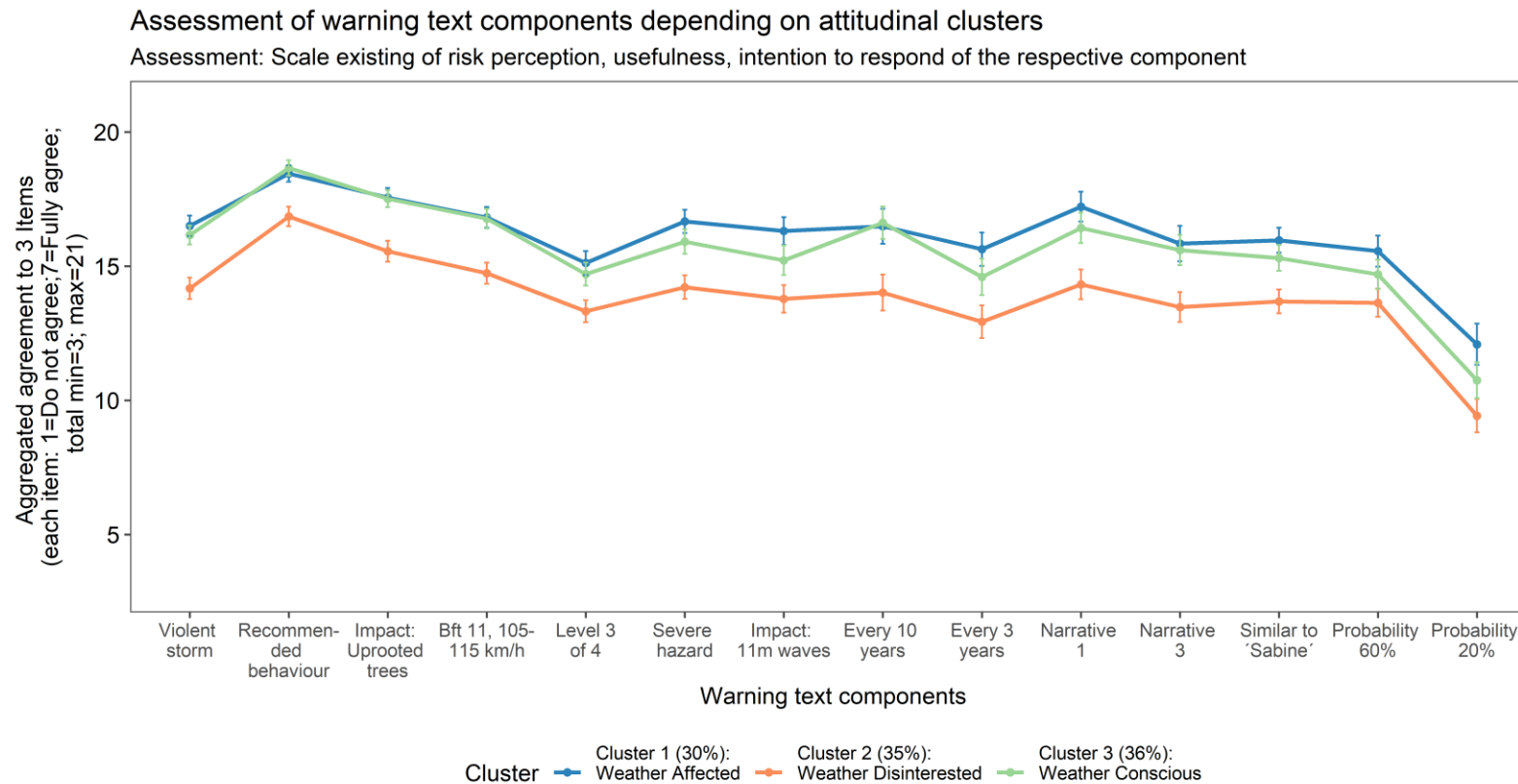
- Participants judged the behavioural recommendations as most useful in assessing or responding to the situation, followed by the impact in the sense of uprooted trees and the wind speed or force, respectively.
- Recommended behaviour and warning of uprooted trees were assessed more helpful than the basic information “Warning of hurricane force gusts”.
- The other presented warning components were judged equal or less useful than the basic information “Warning of hurricane force gusts”.

Information about recommended behaviour results in highest intention to act




- Participants reported the highest intention to take preparatory measures when reading behavioural recommendations, followed by the warning of uprooted trees and narrative 1 “Unaware”. These text components resulted in higher intention to act than the basic information “Warning of hurricane force gusts”.
- High intentions to act were also reported for information about the wind speed / force and narrative 3 “Indifferent”.
- Information about probability of occurrence (20% ad 60%), about occurrence on average once every 3 years, about the impact of the event in form of 10 m waves and about the level 3 of 4 resulted in the lowest reported intention to act.

Judgment of warning text components vary between different people





- People not interested in and affected by weather or weather forecasts in day-to-day live (cluster 2) assess all warning text components less threatening and less useful. They also report less often intending to respond to the warning components.
- Weather conscious people (cluster 3) and people less conscious but strongly affected by the weather (cluster 1) rate the traditional warning components (e.g., recommended behaviour, wind speed, level) similarly.
- But most alternative warning components (e.g., severe hazard, 11 m waves, narrative 1, probability information) were evaluated more positive by weather affected people.



 -Wahrscheinlichkeit: 70%

70% = 70 von 100

Ja, aber 100 was denn überhaupt?

 JA
 NEIN 



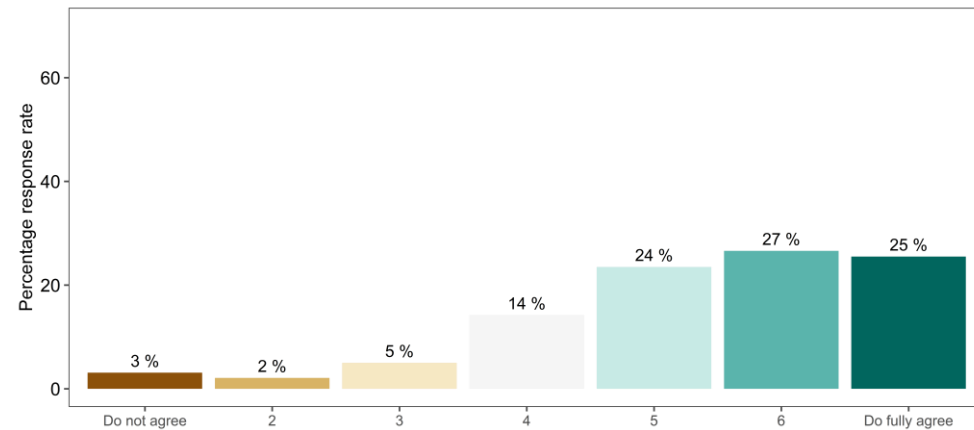
Uncertainty information

Although people generally would like to have information about uncertainty, they tend to find it mainly useful when the probability is high; low probability is perceived as less useful, less risky and leads to fewer intention to act

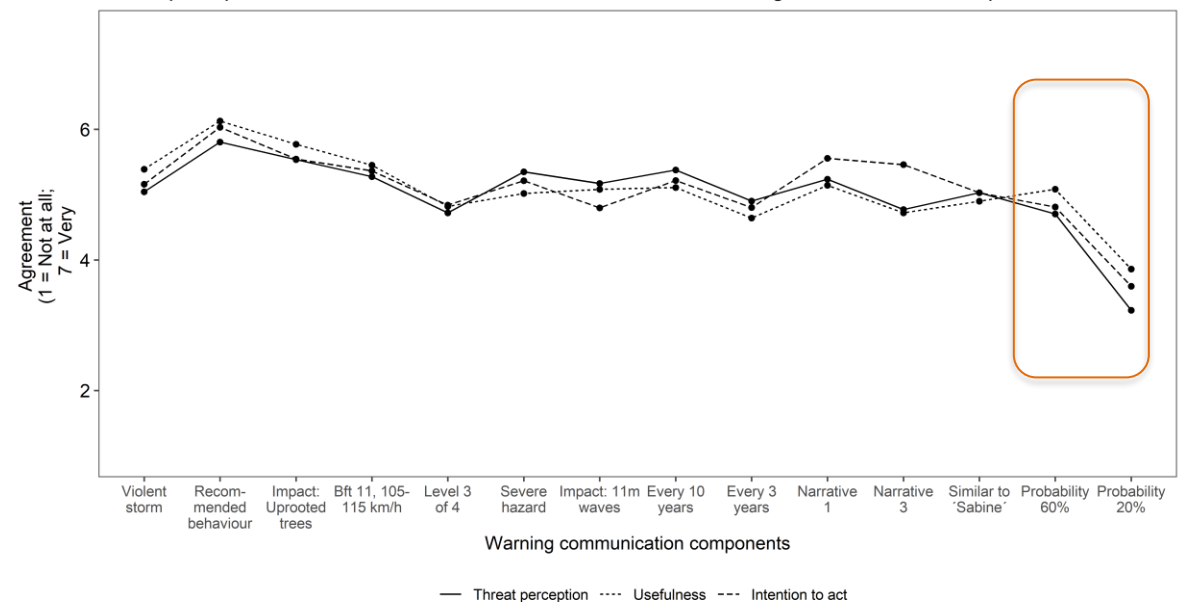
- About three-quarters of Germans report being generally interested in information about the uncertainty of the forecast when a severe weather warning is issued.
- The assessment of uncertainty information varies depending on the level of uncertainty. A 60% likelihood of occurrence of a violent storm is perceived approximately as threatening, useful, and motivating protective behaviour as many other warning communication components.
- A low probability (20%) results in significant lower threat perception. The information is also perceived as less useful and leads to fewer intention to act.

- The interest in uncertainty information is not dependent on people's sociodemographic.
- Only people that have experienced material damage due to high-impact weather events report being slightly more interested in uncertainty information than people without such experiences.
- But people interested in weather forecasts in daily life also report a higher interest in information about the uncertainty of weather forecasts.
- At the same time, the more people indicate not paying attention to weather forecasts even though a severe weather event is forecasted, the less interested they are in uncertainty information.

I am also interested in information about the uncertainty of the forecast when a severe weather warning is issued, such as the probability of occurrence (n=1.084)



Threat perception, usefulness, and intention to act of different warning communication components

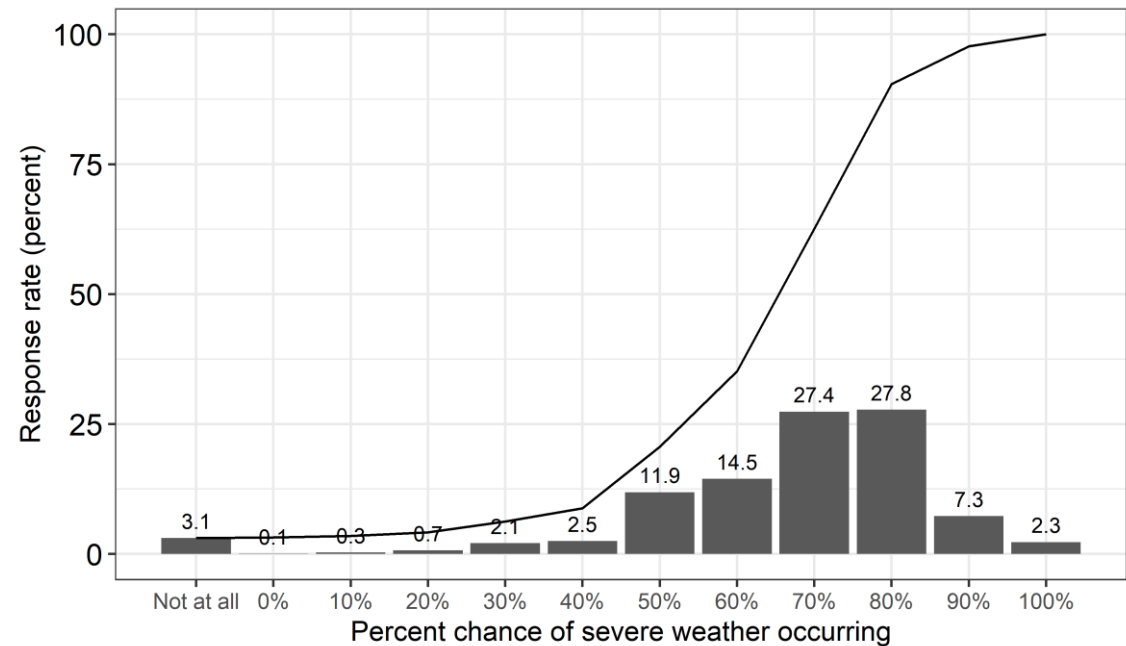


People seem to perceive uncertainties as a coin flip

- Most Germans would not alter their plans if the chance of a severe weather occurring is below 50%. Only 6% would do so.
- Nearly two-third (65%) would alter their plans if the chance of a severe weather occurring would be 70% or higher.
- 3% would not change their plans at all.

- The older the people, the earlier (i.e. at a lower chance of severe weather occurring) they would change their plans.
- The threshold at which people would alter their plans is lower for people living in an exposed location. That means people that live in houses or flats that they perceive as vulnerable to weather events would change their plans at a lower chance of severe weather occurring than other people.
- People using public transport often report higher thresholds.
- Furthermore, the more people have confidence in the weather forecasts in general, the lower the threshold.
- The opposite is true for people that report weather not influencing their day-to-day activities.

Threshold at which public would alter plans



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