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Performance of the flood warning system in Germany in July 2021 – insights from affected residents

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Supplement

Questionnaire

This short survey is aimed at **residents of the places affected by the heavy rain and flood event around July 14, 2021**. Processing the survey should not take more than 10 minutes. Participation in the survey is of course anonymous. The results should help to clarify the warning situation in July 2021 and to improve the warning situation for future events. We therefore ask you to support us with your participation despite the current difficult situation.
Thank you very much!

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Surveys can help to process what has been experienced, but can also lead to the event becoming a burden again. Please seek help in this case. If you need acute psychological help, please contact the BDP (Professional Association of German Psychologists) Flood Hotline: ☎ 0800 7772244.
Here you will find an overview of regional offers:
https://www.psychiatrie.de/flutkatastrophe-in-deutschland-seelische-unterstuetzung-fuer-betroffene-angehoerige-und-helfende.html

1. First of all, we would like to record the situation in your area: To what cause do you attribute the floods to in your immediate area in July? (Multiple choices possible)	
○	The sewage system could no longer drain the water on the road
○	Overland water flow from streets or slopes
○	Water overflow directly from the sewer system via drains, toilets and showers into the rooms below street level (e.g., into the cellar).
○	Flooding caused by overflowing water bodies (i.e., nearby river or smaller body of water has overflown)
○	Flooding as a result of a dike breach or dam breach
○	Rising groundwater
○	Other, namely:
○	I do not know.
○	My immediate surroundings were not flooded. *(Go to question 3.)*

2. At the maximum water level: How high was the water approximately on the outside of the house?
(This means the water level above the surface of the ground)

- ○ There was no water in or around the house.
- ○ There was only water in the cellar.
- ○ Up to 0.5 meters
- ○ >0.5 to 1 meters
- ○ >1 to 2 meters
- ○ >2 to 4 meters
- ○ More than 4 meters

3. Please think back to the hours before the event. How did you find out that the risk of flooding was becoming acute for you? (Multiple choices possible)

- ○ Severe weather or flood warnings by authorities or on-site disaster response (e.g., fire brigade, municipality, police)
- ○ Warning by evacuation call
- ○ Radio
- ○ Television (e.g., weather report or teletext)
- ○ Daily newspaper
- ○ Weather app
- ○ Severe weather app (e.g., Katwarn, NINA, Warnwetter App)
- ○ Siren or loudspeaker truck
- ○ Self-research on the Internet
- ○ Social networks on the Internet (e.g., Facebook, Twitter)
- ○ Through others, e.g., neighbors, acquaintances, colleagues, friends etc. (e.g., personal conversation, phone call, e-mail, WhatsApp)
- ○ Through my employer
- ○ Through care or educational institutions (e.g., school, daycare)
- ○ Other, namely:

- ○ I do not know.
- ○ I was not made aware of the danger at all / I was not warned.

4. Which of the following information did the warnings contain? (Multiple choices possible)	
○	Time for the onset of heavy rain
○	Time for the occurrence of the high water or the flooding
○	Dangerous areas (place, district, etc.)
○	Expected amount of precipitation
○	Expected water level (e.g., height of the maximum water level)
○	Instructions and recommendations for self-protection (e.g., switch off the electricity, lock windows and doors, do not go into the cellar)
○	Information about evacuations
○	Information about dike or dam breaches
○	Assessment of the life-threatening nature of the situation
○	Information about diversions, road closures and / or train cancellations
○	Information on possible effects, e.g., damage
○	Comparison of the expected event with past events / floods
○	Other information, namely:
○	I do not know.
○	None of this information.

5. Approximately when did you receive the first warning? Please include the day and approximate time period that you were warned.			
	Day of the Warning		**Time**
○	Saturday, 10 July	○	Before 9:00 a.m. in the morning
○	Sunday, 11 July	○	9:00 a.m. to 12:00 p.m.
○	Monday, 12 July	○	12:00 p.m. to 3:00 p.m.
○	Tuesday, 13 July	○	3:00 p.m. to 6:00 p.m.
○	Wednesday,14 July	○	6 p.m.to 9:00 p.m.
○	Thursday, 15 July	○	After 9:00 p.m.
○	Friday, 16 July		
○	I do not know.	○	I do not know.

6. How credible did you think the warnings were?							
Completely credible	①	②	③	④	⑤	⑥	Not at all credible

7. Based on the warnings, how did you assess the severity (magnitude) of the anticipated event?							
It will rain, but that is not a problem.	①	②	③	④	⑤	⑥	There is a storm with extensive flooding, damage and life-threatening situations.

8. Did you know how you can protect yourself and your household from flooding before the risk of flooding became acute for you?							
It was completely unclear to me.	①	②	③	④	⑤	⑥	It was perfectly clear to me.

9. When you became aware of the risk of flooding, what did you do? (Multiple choices possible)

- ○ I went about my daily activities without paying attention to the event.
- ○ I informed others (e.g., friends, acquaintances, family) or helped them.
- ○ I researched information about heavy rain and / or floods.
- ○ I took measures to reduce the damage (e.g., secure documents and valuables, put furniture up, erected water barriers).
- ○ I turned off electricity / gas in my house.
- ○ I went to a safe place.
- ○ I got help.
- ○ I prepared for an evacuation and packed up important documents and things.
- ○ Other, namely:

- ○ I do not know.

10. How badly was **your place of residence** affected by the heavy rain or flood event?

Not affected at all	①	②	③	④	⑤	⑥	Very badly affected

11. How badly was **your household** affected by the heavy rain or flood event?

Not affected at all	①	②	③	④	⑤	⑥	Very badly affected

12. In your opinion, how much could your response before/during the event and/or private precautionary measures reduce the damage? *

Not at all	①	②	③	④	⑤	⑥	Almost completely
						○	I do not know.

** Private precautionary measures include, for example, the use of flood-adapted building and construction materials, the installation of flood-proof heating, the purchase of pumps or water barriers, etc.*

13. How surprising did you find the magnitude of the event in your immediate vicinity?

The magnitude of the event didn't surprise me at all.	①	②	③	④	⑤	⑥	The magnitude of the event totally surprised me.

14. How often have you personally – before July 2021 – been damaged by floods?	
○ Never before	○ Three times
○ Once	○ Four times
○ Twice	○ More than four times
○ Not specified	

15. When was the last time you were affected by a flood (before July 2021)?	
Year:	Month:

16. To conclude, we would like to come back to the warning situation. Many options for adapting the warnings are currently being discussed.						
How helpful do you think the following measures are?	Not helpful at all					Very helpful
Cell broadcast, i.e., automatic sending of a warning to all cell phones in a certain region without prior registration	①	②	③	④	⑤	⑥
Warning messages via SMS or APP with prior registration	①	②	③	④	⑤	⑥
Comprehensive installation of sirens	①	②	③	④	⑤	⑥
Increased reporting on severe weather and / or flood warnings and correct conduct in the media (radio, television)	①	②	③	④	⑤	⑥

17. How important is it to you that the following information is included in severe weather warnings?							
	Not important					Very important	I do not know
Time for the onset of heavy rain	①	②	③	④	⑤	⑥	○
Time for the occurrence of the high water or the flooding	①	②	③	④	⑤	⑥	○
Dangerous areas (place, district, etc.)	①	②	③	④	⑤	⑥	○
Expected amount of precipitation	①	②	③	④	⑤	⑥	○
Expected water level (e.g., height of the maximum water level)	①	②	③	④	⑤	⑥	○
Instructions and recommendations for self-protection (e.g., switch off the electricity, lock windows and doors, do not go into the basement)	①	②	③	④	⑤	⑥	○
Information about evacuations	①	②	③	④	⑤	⑥	○
Information about dike or dam breaches	①	②	③	④	⑤	⑥	○
Assessment of the life-threatening nature of the situation	①	②	③	④	⑤	⑥	○
Information about diversions, road closures and / or train cancellations	①	②	③	④	⑤	⑥	○
Information on possible effects, e.g., damage	①	②	③	④	⑤	⑥	○
Comparison of the expected event with past events / floods	①	②	③	④	⑤	⑥	○
Other information, namely:							

18. In order to be able to make statements about what the warning situation looked like for people in the different affected regions of Germany, it is important that we know where most of them live. Therefore, please enter your postcode and place of residence.
Postcode: Location:

19. How old are you?
_____ Years old

20. Are you...?			
O female	O male	O other	O not specified

21. How many people live in your household at all times, including yourself and all the children?
_____ People

22. Do you have any further comments?

Thank you for your participation!

Thank you very much for taking your time for this survey. We wish you personally and the whole region a lot of strength for the reconstruction. If you have any questions, please contact: extrass@uni-potsdam.de

Table S1: Variable definitions, coding and summary statistics of the data set containing all cases from North Rhine-Westphalia and Rhineland-Palatinate (n = 1315).

Variable	Definition	n	Summary statistics Mean (Standard deviation) OR percentages
Dependent variables			
Receipt of an official warning	Dummy variable indicating whether respondents received an official warning from authorities or local disaster response.	1250	Yes = 42.7% No = 57.3%
Situational knowledge on protective behaviour ("Knowing what to do")	Answer to the question: "Did you know how you can protect yourself and your household from flooding before the risk of flooding became acute for you?" 1= it was completely unclear to me to 6 = it was perfectly clear to me. Please note that the scale was reversed for Fig. 2.	1302	2.62 (1.60)
Perceived effectiveness of risk reducing behaviour/measures	Answer to the question: "In your opinion, how much could your response before/during the event and/or private precautionary measures reduce the damage?" 1= not at all to 6 = almost completely.	1303	2.37 (1.58)
Independent variables			
Age	Age of the respondents in years	1299	48.0 (13.2)
Gender	Gender of the respondent: 1 = female; 2 = male	1224	Female = 54.0% Male = 45.8% Non-binary = 0.2%
Federal state	Indication of the federal state of the respondent: 5 = North Rhine-Westphalia (NW); 7 = Rhineland-Palatinate (RP)	1315	NW = 67.8% RP = 32.2%
Flood pathway	Description of the flood pathway (multiple answers possible): no flood in immediate surroundings; overload of sewage water system; wildly flowing surface runoff; water ingress from toilets, floor drains etc.; fluvial flood, i.e., overflowing waterbody (e.g., river); dike/dam breach; groundwater ingress	1315	No flood = 6.6% Sewage system = 46.8% Surface runoff = 43.0% Floor drains = 18.6% Fluvial flood = 76.3% Dike/dam breach = 9.2% Groundwater = 28.8%
Warning source indicator	Nominal index that indicates the source of the warning with 0 = no warning; 1 = own search; 2 = friends or neighbours; 3 = national news; 4 = warning issued by authorities. In case of several warning, the most credible source (0<1<2<3<4) was assigned.	1250	No warning = 34.8% Own search = 2.4% Friends = 14.7% National news = 5.4% Authority = 42.7%
Warning information indicator	Index that indicates the quality of the warning content with 0 = no warning/no relevant information; 1 = information on detours, road blockages and/or train cancellation, evacuation; 2 = information on timing and intensity of rainfall, on (maximum) water levels, potential	1246	0 = 40.9% 1 = 1.8% 2 = 43.7% 4 = 13.6%

Variable	Definition	n	Summary statistics Mean (Standard deviation) OR percentages
	damage, and/or information on dike breaches; 4 = information on how to behave and protect oneself and/or information on the life-threatening situation.		
Number of floods experienced prior to 2021	Answer to the question: How often have you personally–before July 2021–been damaged by floods? 1 = never; 2 = once; 3 = twice; 4 = three times; 5 = four times or more	1308	1.35 (0.87)
Perceived surprise	Answer to the question: How surprising did you find the magnitude of the event in your immediate vicinity? 1 = The intensity of the event didn't surprise me at all to 6 = The intensity of the event totally surprised me.	1313	5.56 (0.97)
Perceived flood impact on own household	Answer to the question: How badly was your household affected by the heavy rain or flood event? 1 = not affected at all to 6 = very badly affected	1313	3.50 (1.78)
Water depth	Answer to the question: “At the maximum water level, how high was the water approximately outside at the house?” 1 = There was no water in or at the building; 2 = There was only water in the cellar; 3 = up to 0.5 meter; 4 = more than 0.5 and up to 1 meter; 5 = more than 1 and up to 2 meter; 6 = more than 2 and up to 4 meter; 7 = more than 4 meter.	1248	3.57 (1.82)

Table S2: Results of the ordered logistic regression model predicting respondents' situational knowledge on protective behaviour (n = 1097; SE: Standard Error).

Explanatory Variable	Coef.	SE	p	95% Conf. Interval	
Age	0.003	0.004	0.530	-0.006	0.011
Gender	0.493	0.115	0.000	0.268	0.717
Federal state					
North Rhine-Westphalia	0.000	(base)			
Rhineland-Palatinate	0.392	0.122	0.001	0.153	0.630
Warning source indicator					
Not warned	0.000	(base)			
Own search	0.124	0.429	0.773	-0.718	0.965
Friends or neighbours	0.154	0.221	0.485	-0.279	0.587
National News	0.527	0.294	0.074	-0.050	1.104
Official warning	0.571	0.209	0.006	0.162	0.981
Warning information indicator	0.147	0.067	0.028	0.016	0.279
Number of floods experienced prior to 2021					
Never before	0.000	(base)			
Once	0.680	0.173	0.000	0.342	1.018
Twice	0.901	0.271	0.001	0.370	1.432
Three times	2.010	0.448	0.000	1.132	2.888
Four times or more	2.001	0.442	0.000	1.135	2.867
Perceived surprise	-0.648	0.068	0.000	-0.780	-0.516
Perceived flood impact on household	-0.078	0.033	0.019	-0.143	-0.013

Table S3: Results of the ordered logistic regression model predicting respondents' perceived damage reduction by risk-reducing behaviour (n = 1003, SE: Standard Error)

Explanatory variables	Coef.	SE	p	95% Conf. Interval	
Situational knowledge ("knowing what to do")	0.296	0.046	0.000	0.207	0.385
Warning source indicator	0.029	0.052	0.574	-0.073	0.132
Warning information indicator	0.07	0.067	0.293	-0.060	0.200
Age	-0.012	0.005	0.008	-0.022	-0.003
Gender	0.216	0.123	0.081	-0.026	0.458
Federal state	-0.224	0.068	0.001	-0.357	-0.092
Number of floods experienced prior to 2021	0.212	0.081	0.008	0.054	0.370
Perceived surprise	-0.248	0.073	0.001	-0.392	-0.104
Water depth	-0.28	0.036	0.000	-0.351	-0.209