To act or not to act

Warning communication and decision-making in response to weather-related hazards

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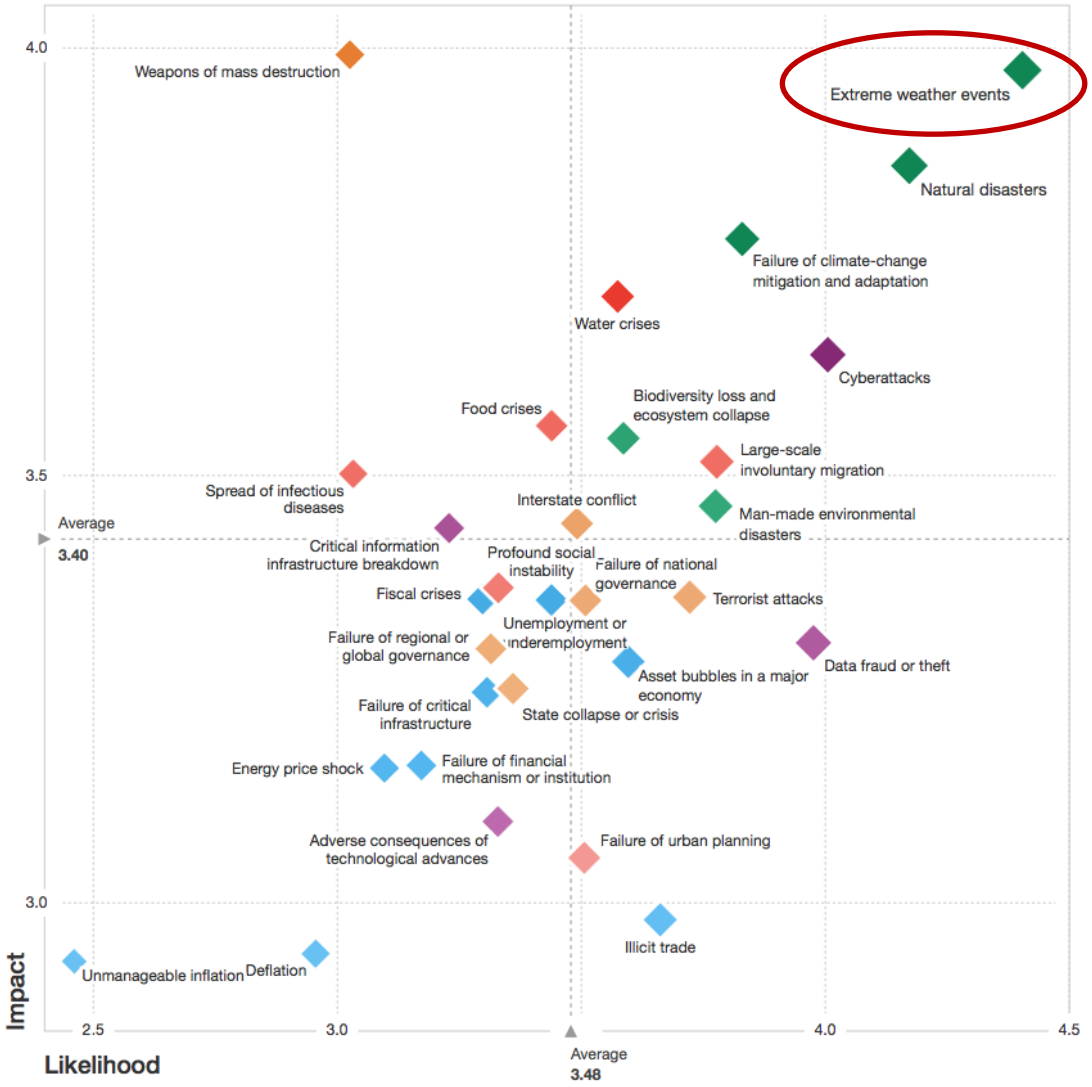
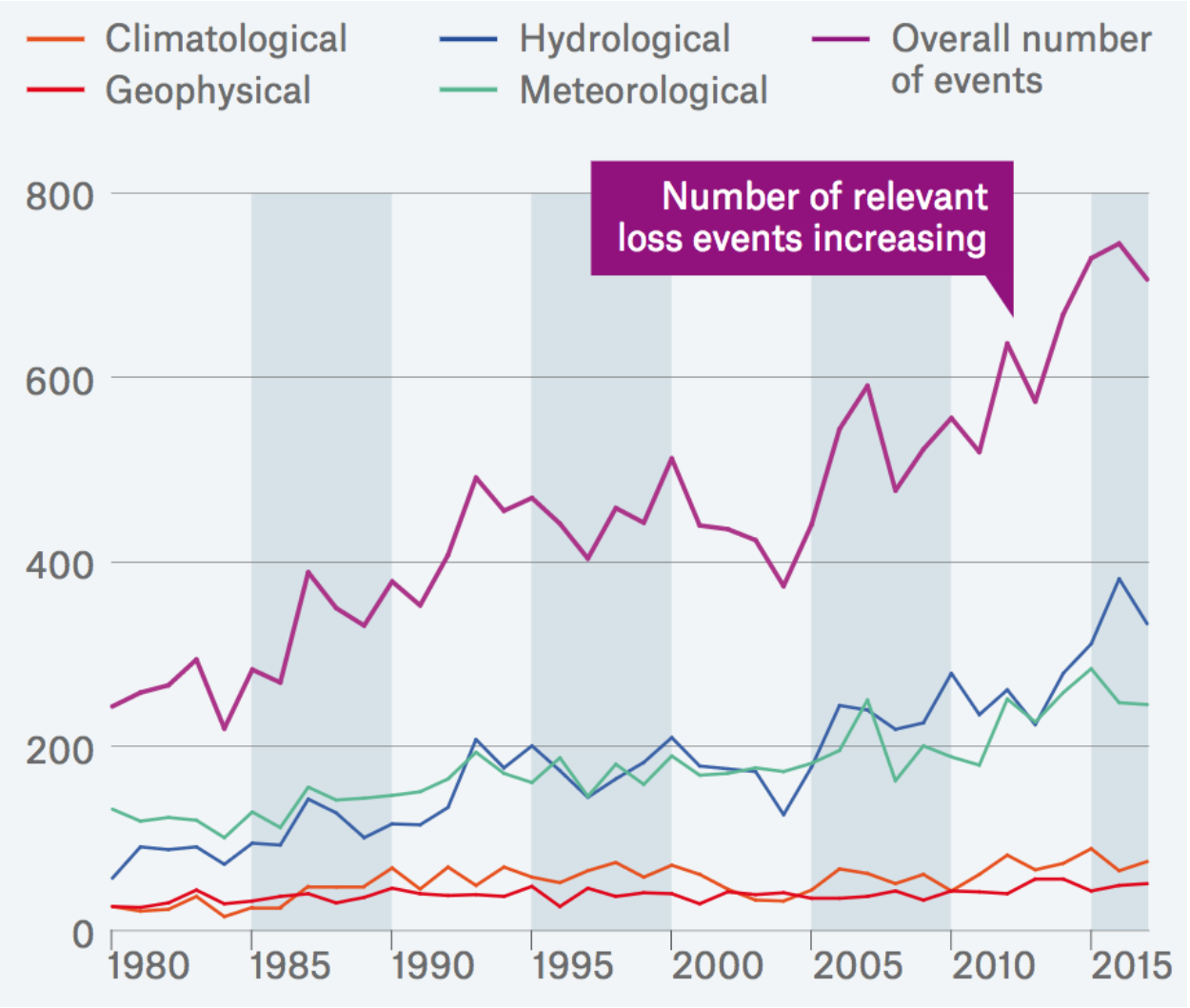
Global Risk Landscape



World Economic Forum Global Risks Perception Survey 2018

Number of loss events for natural catastrophes

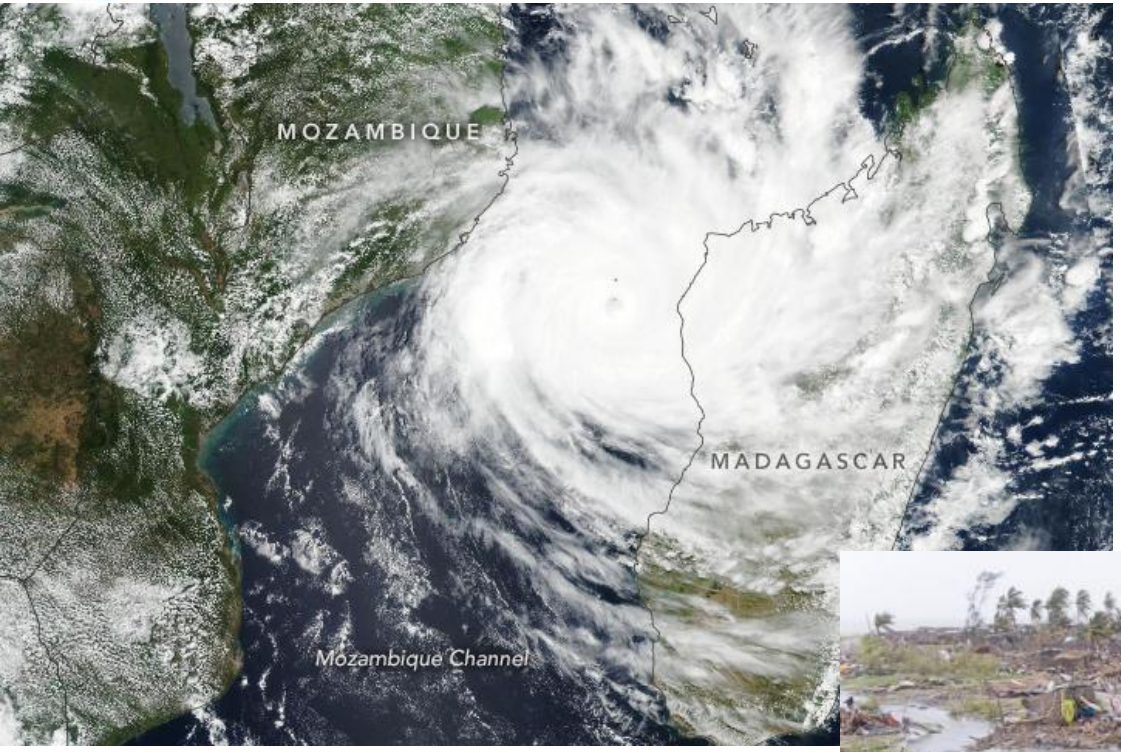


Munich RE

Good forecast, bad outcome!

Tornado Outbreak	April 3-4, 1974	April 27-28, 2011
Number and Strength	comparable	
Tornado track Length	similar	
Tornado time	similar	
Outbreak forecast and warning	No Only “Indications”	Yes 4-6 days prior ~24 minutes
Fatalities	316	314

Uccellini at EMS 2018



Accurate, but inadequate warnings

NASA Earth Observatory
WMO

Research design and questions

How do we achieve good outcomes from good warning and risk communication?

Study 1: *Are impact-based warnings more effective than standard warnings?*
Study 2: *Does the presence of fear influence the effectiveness of impact-based warnings in real-world crises?*
Study 3: *Does inconsistency in warnings influence evaluation of warning quality and behavioural response?*
Study 4: *Do different protection motivation variables affect people's behaviour to undertake risk reduction measures differently, depending on the* type and number of measures already undertaken*?*

Study 1: Effectiveness of impact-based warnings (IBW)

Standard Warning = Describes the weather
Impact-based warning = Describes the impacts that result from the weather

Some evidence

- Qualitative (Losego et al. 2013; Harrison et al. 2014; Weyrich et al. 2018)
  - "helpful", "increase understanding", "correct interpretation"
- Quantitative (Perreault et al. 2014; Ripberger et al. 2014; Casteel 2016; Potter et al. 2018; Morss et al. 2018)
  - The effect of IBW on *behavioural response*: ambiguity!
  - The effect of BR on *behavioural response*: ?
  - The additive effect of IBW and BR on *response*: ambiguity!

Research question

- Do both IBW and BR have effects, and what are their relative magnitudes?

Weyrich, P., Scolobig, A., Bresch, D. N., & Patt, A. (2018). Effects of Impact-Based Warnings and Behavioral Recommendations for Extreme Weather Events. *Weather, Climate, and Society*, *10*(4), 781–796. https://doi.org/10.1175/WCAS-D-18-0038.1

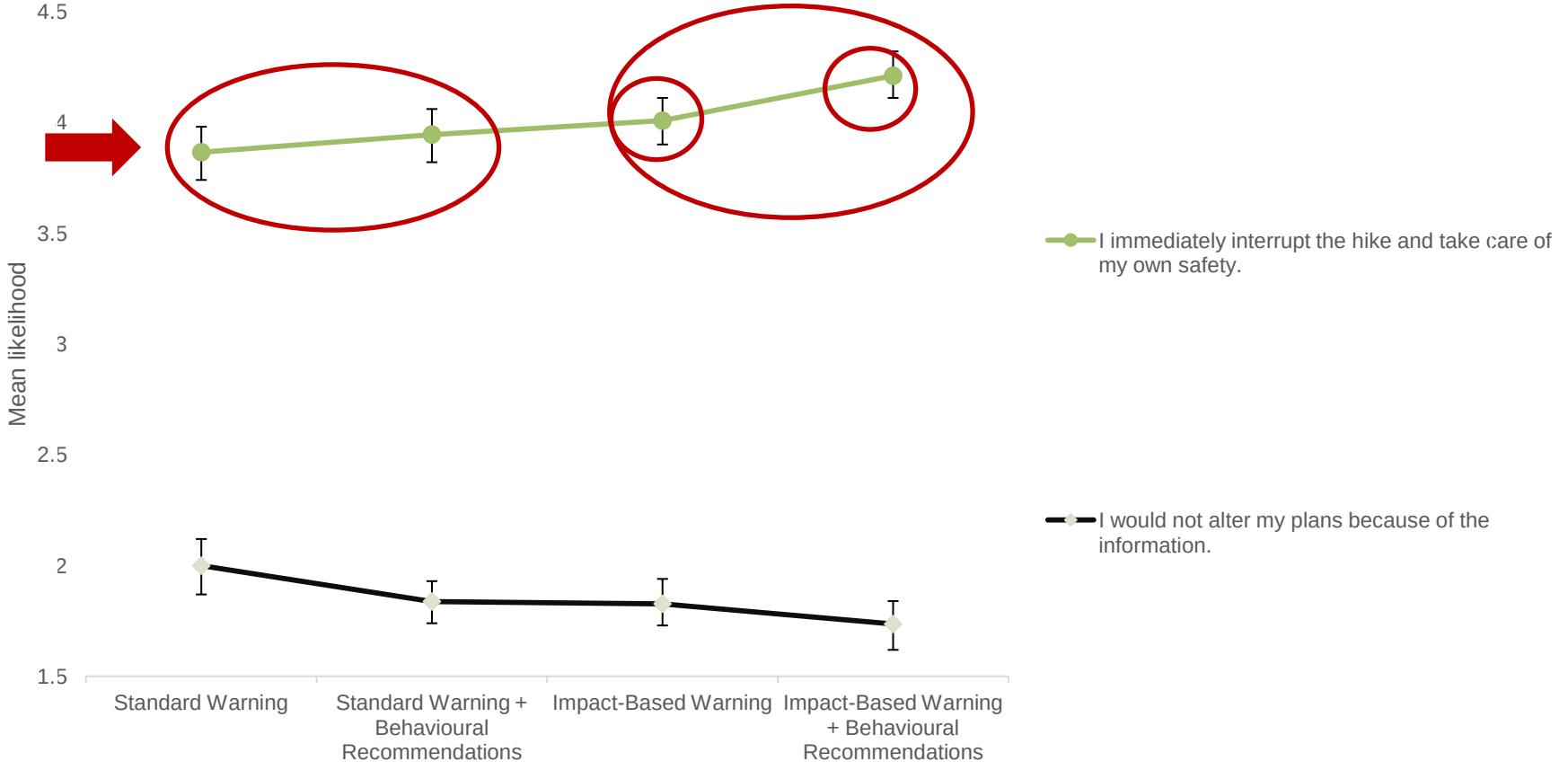
Study 1: Effectiveness of impact-based warnings (IBW)

Methodology	Research 1
Method	Experimental survey
Sampling procedure	Imagined decision scenario
Survey form	Online survey
Recruitment	Access panel provider
Number of warning types	4 (SW; SW + BR; IBW; IBW + BR)
Number of participants	1219
Country	Switzerland

Standard warning = SW
Impact-based warnings = IBW
Behavioural recommendations = BR

Study 1: Effectiveness of impact-based warnings (IBW)

Do IBW's and BR's have an effect on behavioural response?



Study 1: Effectiveness of impact-based warnings (IBW)

Key findings

- IBW and BR **improve** *behavioural response.*
- IBW and BR together have the **greatest effect**.
- IBW alone have a **greater effect** than BR on *behaviour*

Implications

- Use IBW with BR in high-impact weather warnings!
- IBW and BR are clear and understandable, regardless of the target audiences' characteristics

Limitation

- Self-reported responses to a hypothetical situation, rather than a field observation of actual behaviour in response to actual danger

  → feelings?

- Test the effectiveness of IBW and BR during a real event!

Study 2: Effectiveness of impact-based warnings (IBW) in crisis situation

Two different decision-making models (Loewenstein et al. 2001; Slovic et al. 2004; Kahneman 2011)

- Rational model, that is slow, based on risk assessment and probabilities
- Affective model, that is fast and intuitive, based on experience, emotion and affect

Very limited evidence

- Feelings, and not deliberate evaluation, drive evacuation behaviours to tsunami warnings (McCaughey et al. in review)
- Emotions and some (but not all) cognitive factors influence adaptive behaviours to fire warnings (Gutteling et al. 2018)

Research question

- Does the presence of fear influence the effectiveness of impact-based warnings in real-world crises?
- Are effects of warning lead time and hazard severity level consistent with an rational or affective model of decision-making?

Study 2: Effectiveness of impact-based warnings in crisis situation

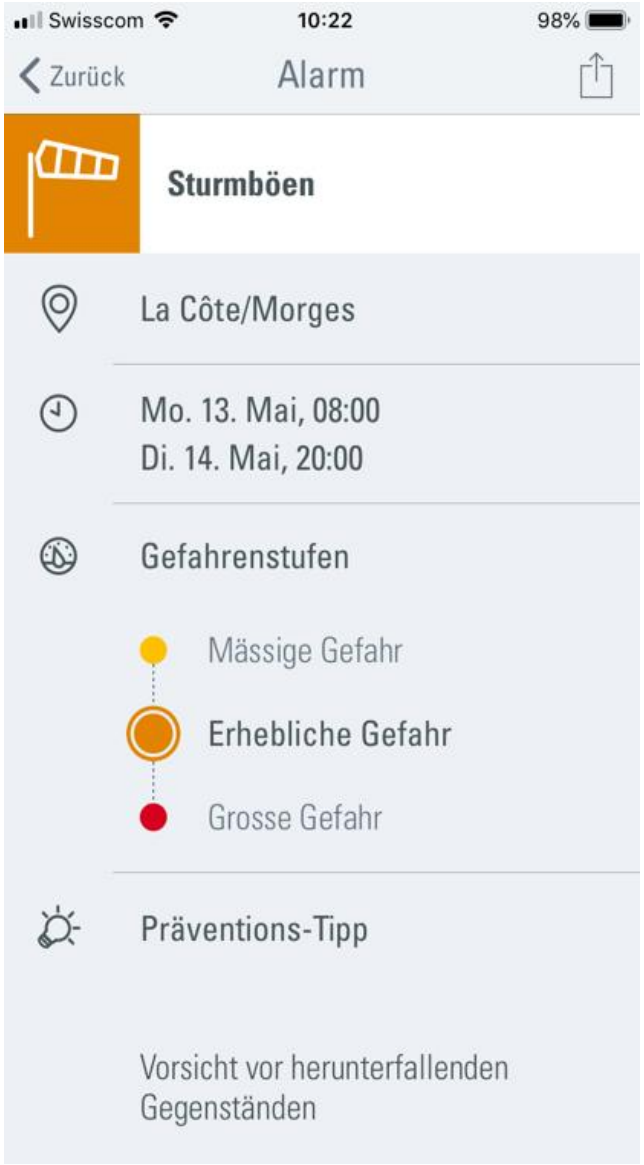
Methodology	Research 1	Research 2
Method	Experimental survey	Field experiment
Sampling procedure	Imagined decision scenario	Real warning situation
Survey form	Online survey	Online survey on mobile phones
Recruitment	Access panel provider	Smartphone application "Wetter-Alarm"
Number of warning types	4 (SW; SW + BR; IBW; IBW + BR)	2 (SW + BR; IBW + BR)
Number of participants	1219	2615
Country	Switzerland	Switzerland

Standard warning = SW
Impact-based warnings = IBW
Behavioural recommendations = BR

Study 2: Effectiveness of impact-based warnings in crisis situation

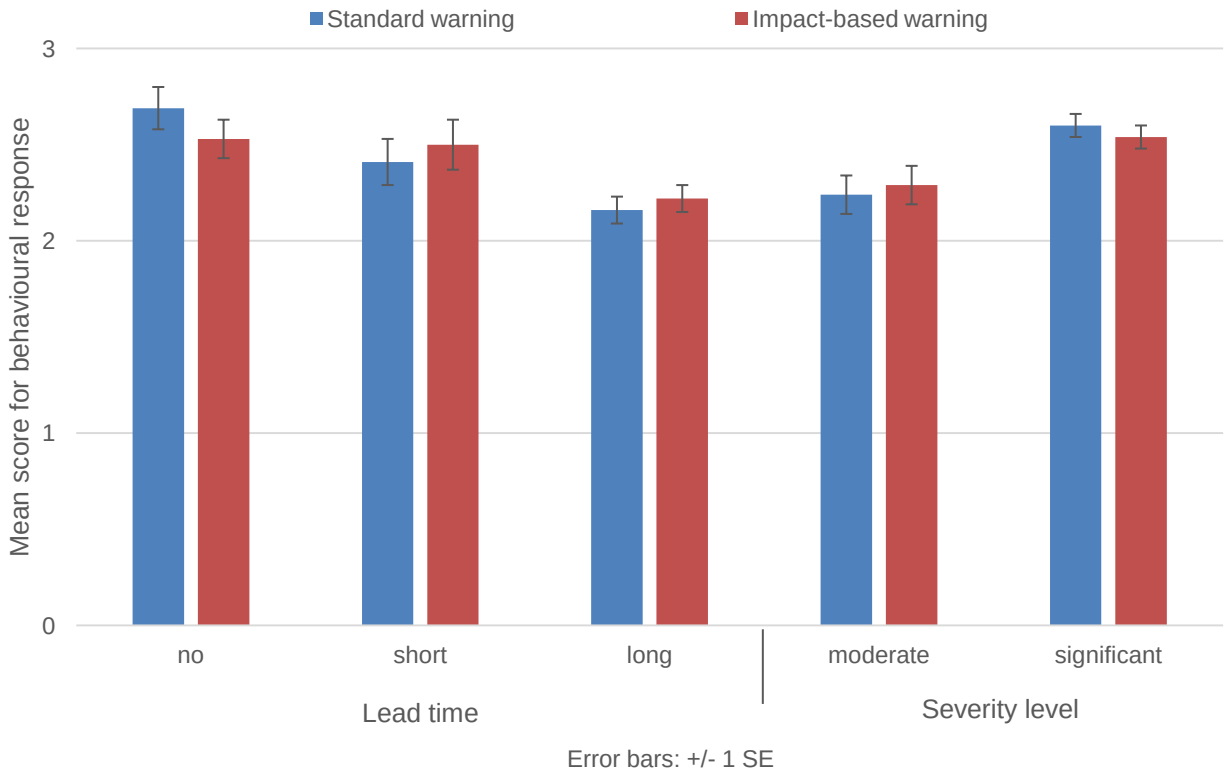
Message content: SW vs. IBW
Severity level: low vs . medium
Lead time: No vs. 0-6 hrs vs. >6 hrs

Wind warning level 1	Wind warning level 2	Wi arni leve
Traffic delay	Traffic disruption or restriction	Traffic on or stands
Overturning of objects	Damage to individual buildings	Damag buildi
Falling of smaller branches	Falling of branches	Falli ee



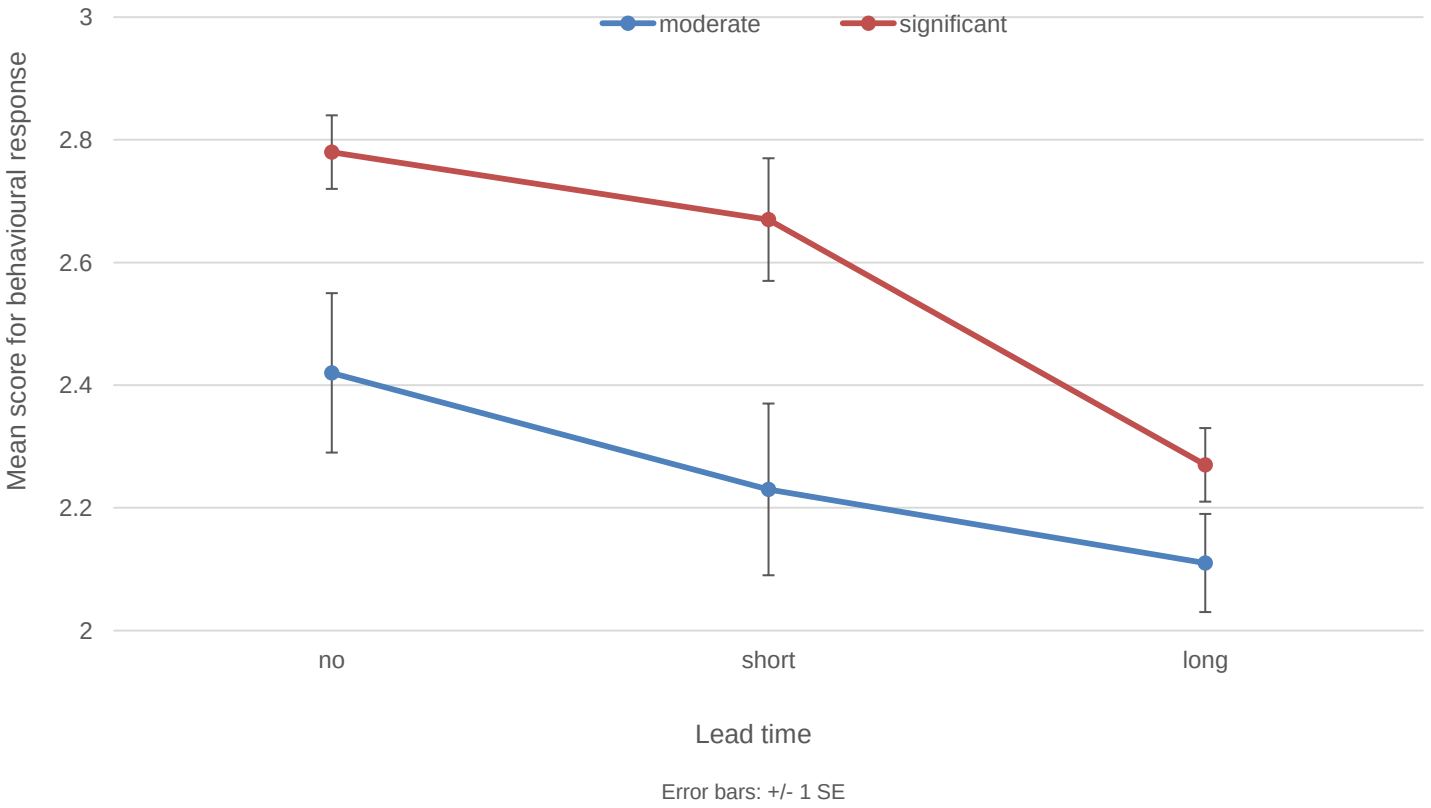
Study 2: Effectiveness of impact-based warnings in crisis situation

Mean likelihood to change behaviour for the two warning types and the three lead times, respectively the two severity levels.



Study 2: Effectiveness of impact-based warnings in crisis situation

Mean likelihood to change behaviour for all three lead times and two severity levels.



Study 2: Effectiveness of impact-based warnings in crisis situation

Key findings

- IBW result in no greater behavioural change than SW
- Decreasing lead times result in greater response
- Increasing severity level result in greater response

→ Consistent with an affective model of decision-making

→ Under an imminent threat, fear and other feelings are more influential than deliberate evaluation.

Implications

- For our model of self-protective behaviour and the design of warning systems.
- For using smartphone applications to collect data in real time and for relatively low cost

Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

Risk communication research (Mileti and Sorensen 1990; Mileti and Fitzpatrick 1992) and best practices (NOAA 2016)

- Be consistent within itself and across different messages
- Inconsistency of sequential same-source forecasts (i.e., from one weather provider) VS **inconsistency of different-source forecasts** (i.e., from different weather providers).

Inconsistent public weather warnings from different providers

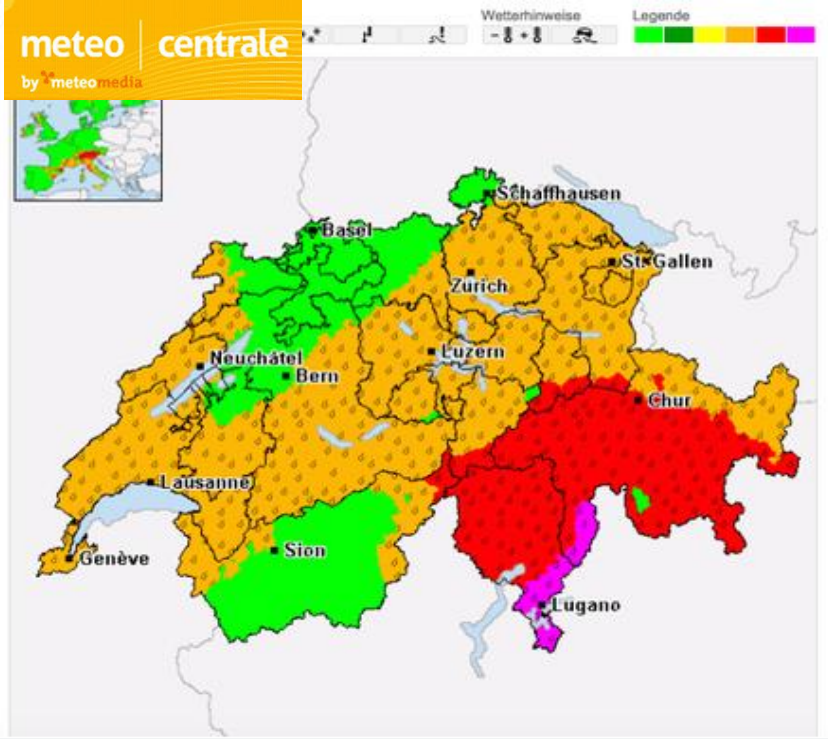
MeteoSwiss

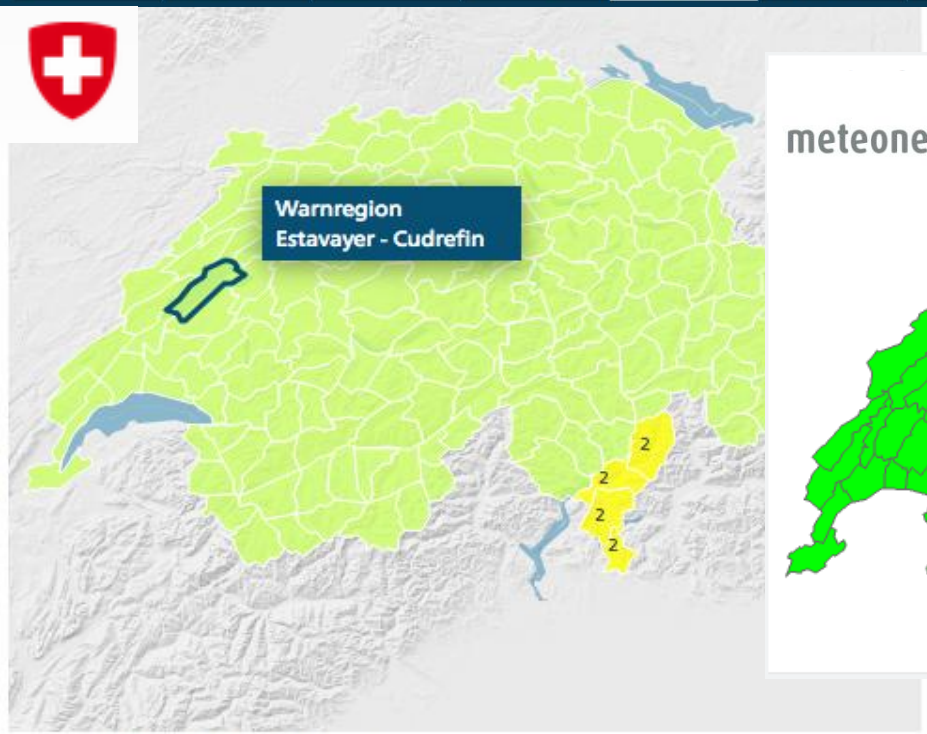
MeteoNews

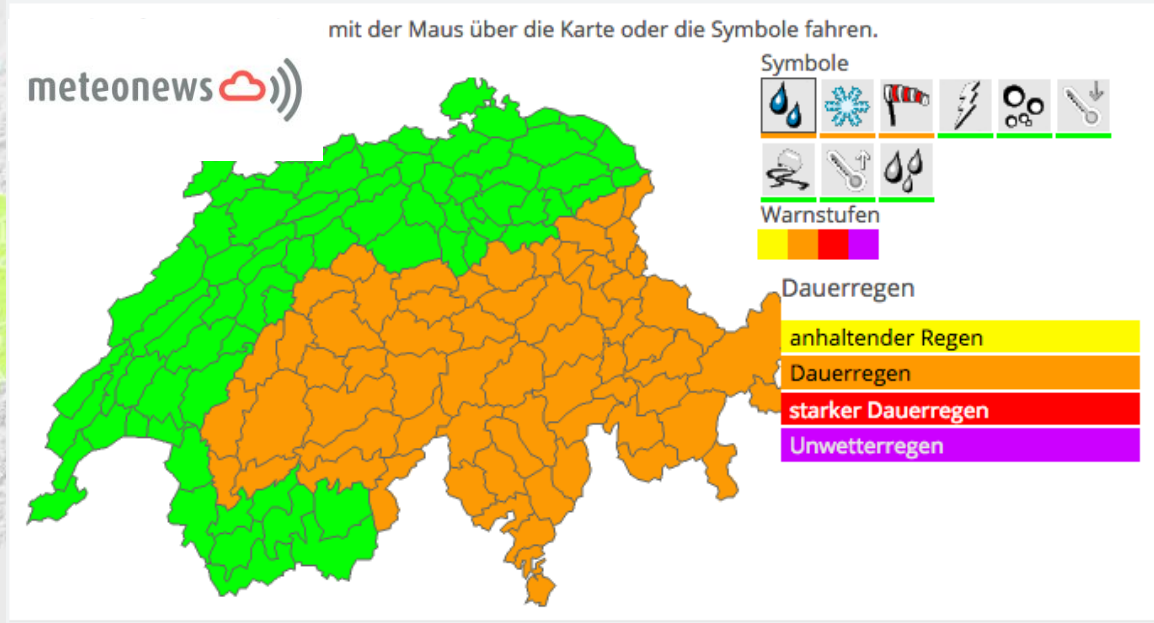
SRF Meteo

Meteocentrale

→ Differences in visualization (based on number and colour of warning levels) and text (based on data, weather models and interpretation)







FE, uno strumento finanziario dell'Unione Europea
Life

Prognose zuletzt aktualisiert: 05.11.2017, 12:36

Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

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Inconsistent public weather warnings from different providers

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Meteocentrale

Research question

- How are people affected by differing, sometimes conflicting, information coming from various weather providers at a given point in time?

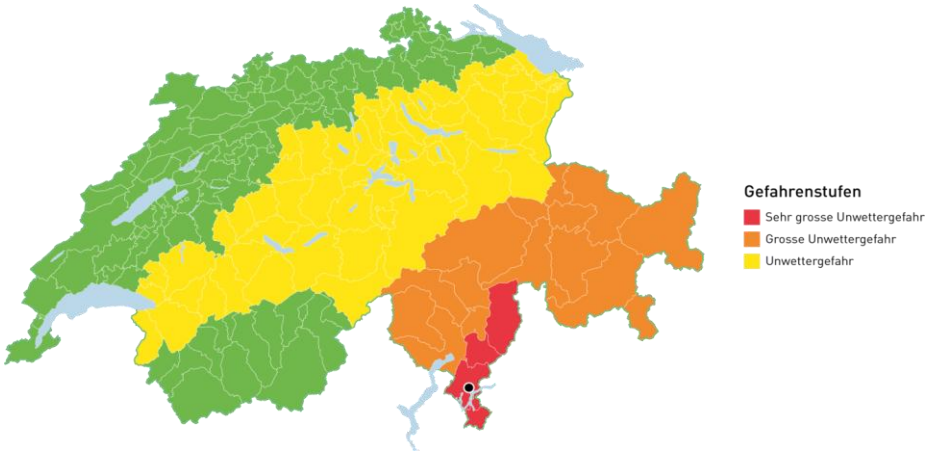
Weyrich, P., Scolobig, A., and Patt, A. (2019): Dealing with inconsistent weather warnings: Effects on warning quality and intended actions. *Meteorological Applications*. DOI:10.1002/met.1785.

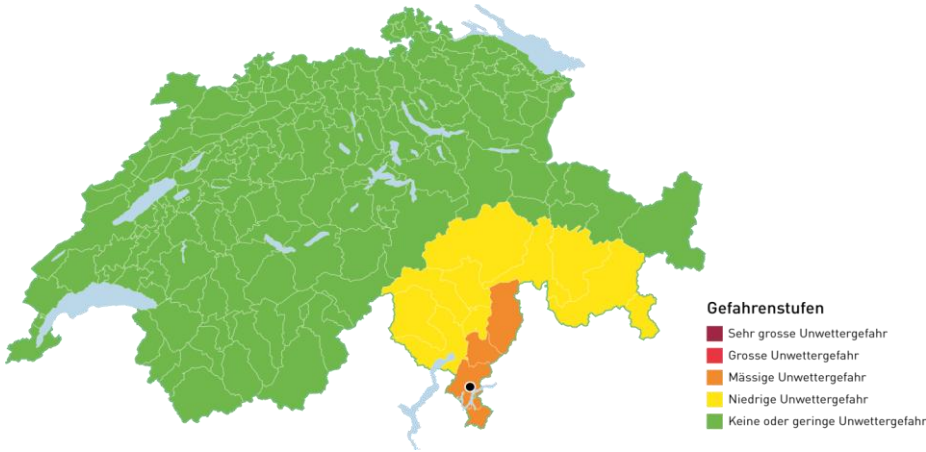
Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

Methodology	Research 3
Method	Experimental survey
Sampling procedure	Imagined decision scenario
Survey form	Online survey
Recruitment	Access panel provider
Number of warning pairs	4 (consistent; inconsistent visual; inconsistent textual; inconsistent visual and textual)
Number of participants	1335
Country	Switzerland

Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

Inconsistent visual warning pair





At the weekend, there will be intense rainfall in Ticino. Precipitation of up to 100 l/m^2 in 24 hours must be expected in the entire region, whereas levels of rainfall of up to 120 l/m^2 can occur in the southern part (Sottoceneri). In the night to Sunday, the rain decreases significantly.

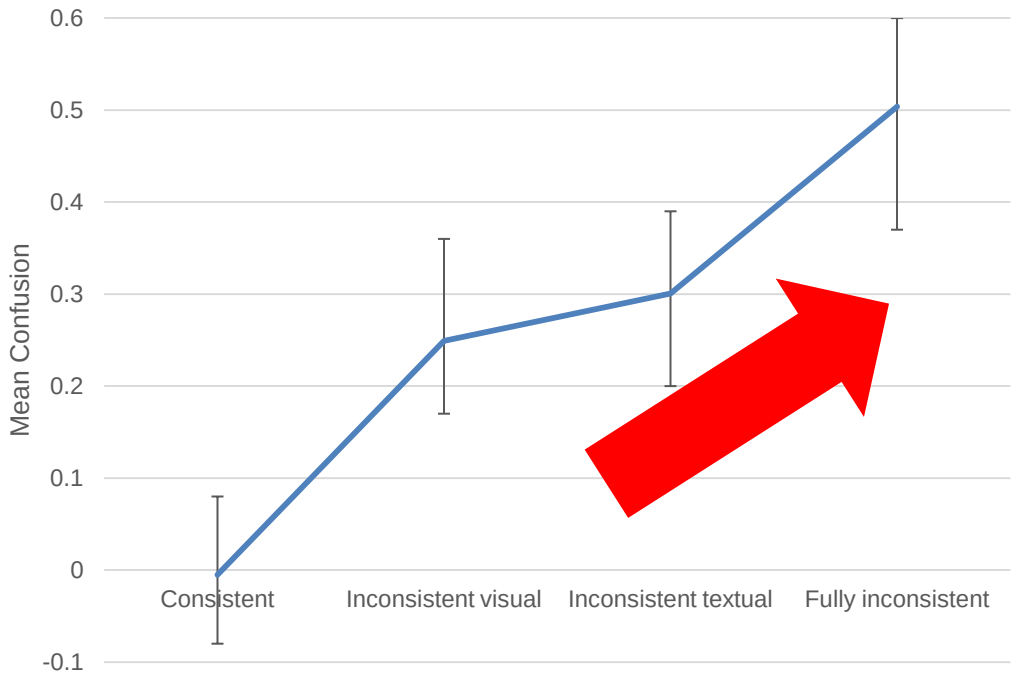
Intense rainfall is expected in Ticino on Saturday and Sunday. Rainfall in Ticino will vary between 90 and 120 l/m^2 in 24 hours, whereas the highest precipitation rates are expected in the southern part of the canton (Sottoceneri). At Sunday night, the rain decreases significantly.

Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

Weather information behaviour:

- Consult regularly
- Use smartphone applications
- Received inconsistent info

Confusion in the four warning conditions



Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

Intended actions and evaluation of warning quality

Study 3: Dealing with inconsistent weather warnings: effects on warning quality and intended actions

Key findings

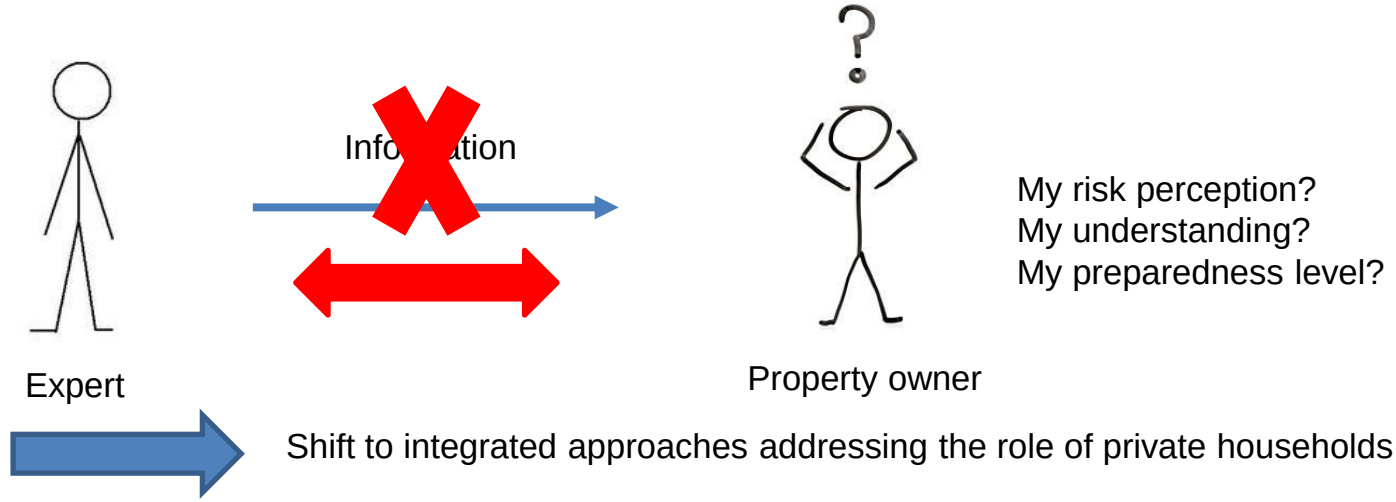
- Negative effect of inconsistency on warning quality and intended actions
- No differences between visual and textual inconsistencies

Implications

- Enhance cooperation between public and private weather providers (e.g. find an agreement to be consistent either in the text or in the visualization

Study 4: A dynamic protection motivation framework to explain risk reduction behaviours

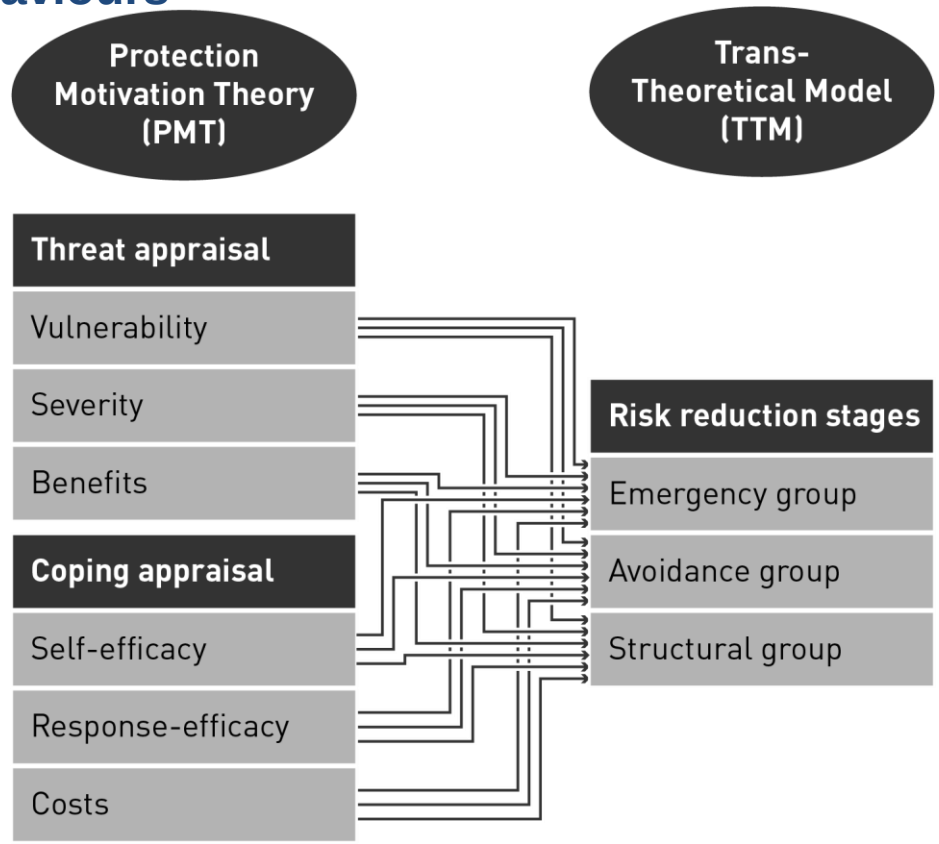
Risk communication strategies



Shift to integrated approaches addressing the role of private households

Type of behaviour	
Structural	Anti-backflow valves
	Water-resistant construction materials
	Special installation (e.g. higher up) of heating and electric system
Avoidance	Keeping personal valuables above expected flood levels
	Keeping expensive appliances above expected flood levels
	Adapted use of basement and ground floor
Emergency	Mobile barriers available
	Emergency plan for household

Study 4: A dynamic protection motivation framework to explain risk reduction behaviours



Research question

- Do different protection motivation variables affect people's behaviour to undertake risk reduction measures differently, depending on the type of measures already undertaken?

Study 4: A dynamic protection motivation framework to explain risk reduction behaviours

Methodology	Research 1
Method	Household survey
Sampling procedure	Snowball, municipality of Negrar
Survey form	Face-to-face interviews
Number of risk reduction stages	3 (structural, avoidance, emergency)
Number of participants	124
Country	Italy

Study 4: A dynamic protection motivation framework to explain risk reduction behaviours

Risk reduction behaviours regressed on vulnerability, severity, self-efficacy, response-efficacy, benefits and costs.

	Risk Reduction Stage Readiness			
	Emergency	Avoidance	Structural	Overall
Vulnerability	-.477	.609*	.664*	.195
Severity	.702*	-.362	-.672*	-.023
Self-efficacy	-.223	.922**	.181	.325*
Response-efficacy	-.241	.253	.456*	.280*
Benefits	.021	-.187	-.008	-.147
Costs	-1.067*	-.154	-.741**	-.541**
F-ratio	4.331*	6.701**	5.194**	6.228**
R^2	0.79	0.73	0.66	0.42

Study 4: A dynamic protection motivation framework to explain risk reduction behaviours

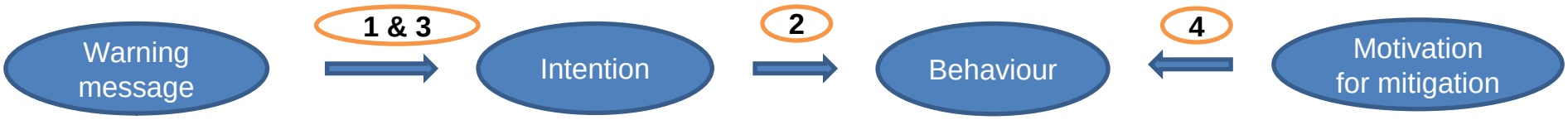
Key findings

- Overall, low adoption of risk reduction behaviours
- People are motivated by different factors in prompting risk reduction behaviour based on their stage readiness.

Implications for communication strategies

- Property owners are not a homogenous community
- Link particular patterns of perception or capacity to effective patterns of communication
- Surveys to assess the current preparedness levels of these people at risk should be implemented in flood risk management practices

Conclusion



- Use impact information
- Give guidance
- Be consistent

- Feelings are more influential than rational deliberation
- Use research designs that capture real-world conditions

- Target individual communication strategies emphasizing different motivations

**“Forecasts possess no intrinsic value. They acquire value through their ability to influence the decisions made by users of the forecasts.”
(Murphy 1993)**

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Pictures

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- WMO (2019): https://public.wmo.int/en/media/news/tropical-cyclone-idai-hits-Mozambique

GRAZIE

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Interested?
Then, let's talk.

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