Emotional responses and perceptions of false alarms in flood warnings and their impact on evacuation action in the Kyushu Region, Japan

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1. Summary

- People define a warning "hit" similarly to the JMA and feel "pleased" rather than frustrated when an alarm is false (RQ1, 2).
- Living in an area with frequent false alarms does not necessarily make people feel that warnings are unreliable, regardless of how a "hit" is defined (RQ3).
- While feeling that there are too many false alarms reduces evacuation, this negative impact is softened by the positive emotional responses towards false alarms (RQ4).

2. Background

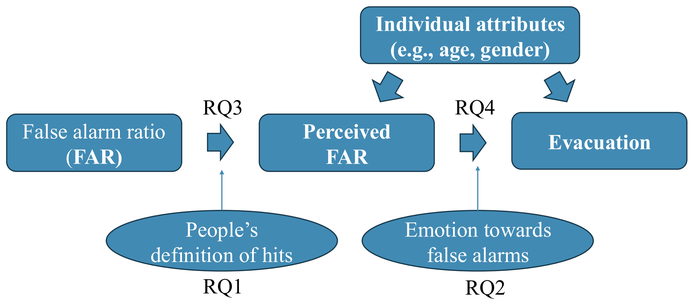
- False alarms may reduce people's trust in warnings and discourage them from evacuating.(e.g., Nakamura, 2008)
- No previous study has empirically analyzed the impact of flood warning FAR on evacuation behavior through people's perceived FAR.

False Alarm Ratio (**FAR**) → **Perceived FAR** → **Evacuation**

- Furthermore, it remains unclear whether these impacts vary depending on the definition of a "hit" or the emotions felt toward false alarms.

3. RQs

RQ1 What events do people define as a warning hit?
RQ2 What emotions do people experience when false alarms occur?
RQ3 How does the actual FAR affect pFAR? (RQ3-1)
Does this effect vary according to the definition of a hit?(RQ3-2)
RQ4 How does pFAR affect people's evacuation action?(RQ4-1)
Does this effect vary according to the emotions that people feel toward false alarms?(RQ4-2)



→Provide academic insights for future warning strategies and social activities related to warning operations

4. Data

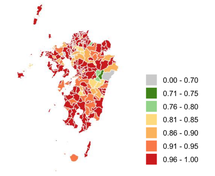
i) Warning data by JMA
Record the number of warnings issued each month by municipality.
ii) Flood data by MLIT (MLIT: Ministry of Land, Infrastructure, Transport and Tourism)
Record cases of river flooding (e.g., breaches, overflowing embankments, overflowing)
iii) Questionnaire surveys targeting the Kyushu region



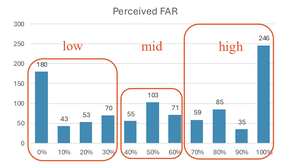
Target area	7 prefectures in the Kyushu region
Screening conditions	・People who recognize the risk of flooding in their homes ・People who live in detached houses or on the first or second floors of apartment buildings
Sample	997 people allocated by prefecture, age, and gender
Questionnaire method	Web survey (December 18-19, 2024)
Survey topics	Definition of. "Hit" in flood warnings, Emotional responses toward false alarms, perceived FAR, actions taken when flood warnings were issued in the past, personal attributes

➢ FAR of flood warnings
Using i) and ii), calculate the FAR for flood warnings for each municipality (n=231) over a five-year period (1 January 2018 to 31 December 2022) using the following formula.

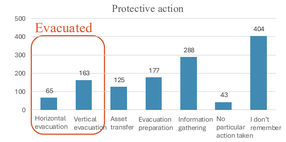
$$FAR = 1 - \frac{\text{ii) } Number\ of\ floods}{\text{i) } Number\ of\ warnings}$$



➢ Perceived FAR
What percentage did you think false alarms for flood warnings occurred in your area?
Created with reference to Lim et al. (2019), Ripberger et al. (2015), and Trainor et al. (2015)



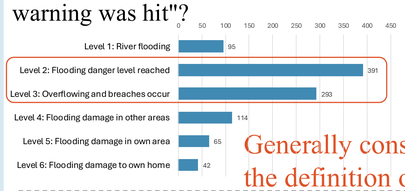
➢ Actions taken when flood warnings were issued
Since 2023 (over the past two years), have you taken any of the following actions when flood warnings were issued ? Created with reference to Trainor et al. (2015)



5. Results

RQ1: People's definition of hits

When a flood warning is issued in your city, what situation do you think would constitute "the flood warning was hit"?



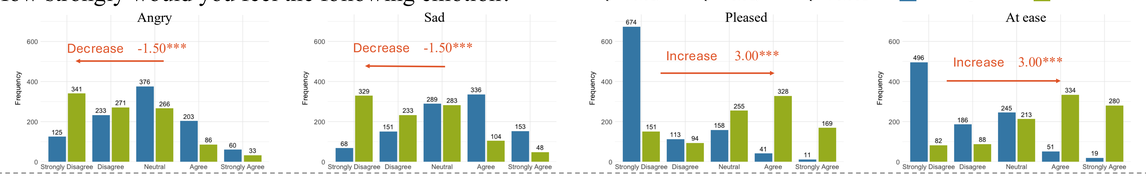
Generally consistent with the definition of the JMA

RQ2: Emotional responses toward false alarms

People tend to emotionally accept false alarms.

- Imagine that a flood warning has been issued in your city. How strongly would you feel the following emotions?
- Imagine that a flood warning has been issued in your city. However, in reality, no flooding occurred. How strongly would you feel the following emotion?

$*\ p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$



RQ3-1: The impact of the FAR on perceived FAR

- Causal inference using multiple regression analysis
  → Estimate: -1.712 (t = -1.221, p = 0.222)

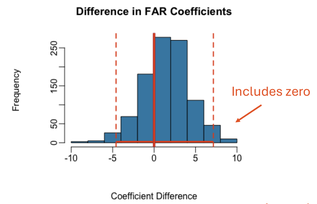
Covariates：
Number of flood warnings issued, Trust in the JMA, Presence of elderly people, Daily disaster awareness

The FAR cannot be said to affect perceived FAR.

RQ3-2: Heterogeneity in RQ3-1 effects by "Hit" definition

Output the 95% confidence interval (CI) for the difference between the estimated values of the two groups using the bootstrap method.

Whether the definition of a "hit" is consistent with the criteria used by the JMA.



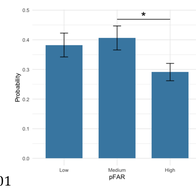
Not significant heterogeneity in the FAR affecting perceived FAR.

RQ4-1: The impact of the perceived FAR on evacuation

- Causal inference using generalized propensity score analysis

Covariates：
FAR, Number of warnings issued, Gender, Age, Experience of flooding, Presence of children, Presence of elderly people, Trust in the JMA, Daily disaster mitigation awareness, Income, Educational background, Risk awareness

People with high perceived FAR are less likely to take evacuation.

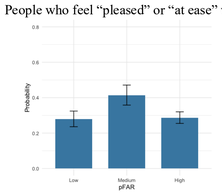


$*\ p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$

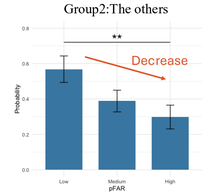
RQ4-2: Heterogeneity in RQ4-1 effects across emotional responses

Output the 95% CI for the difference between the estimated values of the two groups using the bootstrap method.

Group1: People who feel "pleased" or "at ease" when FA



Group2:The others



	95% CI
high - low	[0.063, 0.505]
mid - low	[0.127,0.560]
high - mid	[-0.252,0.144]

Excludes 0

$*\ p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$

People who feel emotions such as "pleased" and "at ease" are less affected by the negative impact perceived FAR on evacuation than those who do not feel such emotions.