

Community Response to Early Warning System: An Empirical Study on Action Delay and Risk Perception

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Abstract

Effective early warning systems (EWS) are critical for minimizing disaster-related losses; however, their success largely depends on community response behavior. This study investigates how individuals respond to early warning messages and identifies factors influencing delayed or ignored action. A structured survey was conducted among 2357 respondents from rural and urban areas to assess response time, trust levels, and decision-making patterns following warnings related to cyclones, floods, or storms. Descriptive analysis reveals that 42% of respondents reported taking immediate action upon receiving a warning, while 35% delayed action and 23% reported ignoring warnings in certain situations. The findings indicate that a significant proportion of the population does not respond promptly, highlighting potential gaps in risk perception, trust, and communication effectiveness. Delayed responses were commonly associated with perceived low severity of the threat, previous false alarms, transportation barriers, and social influence. The results suggest that improving clarity of warning messages, strengthening public trust, and ensuring logistical support could significantly enhance evacuation compliance. This study contributes to disaster risk reduction research by providing empirical evidence on behavioral response patterns and offers policy recommendations for strengthening community-centered early warning systems.

1. Introduction

Chronic natural disasters, like cyclones, floods, and storms, still threaten vulnerable communities in major ways. Early Warning Systems (EWS) are proactively established to provide timely warnings that allow individuals to take protective action and avoid harm. But the effectiveness of those systems will depend not only on accurate prediction and distribution but also on how we perceive the risk and react to its warning message. Relying on advances in communication technology, however, a substantial segment of the population postpones or disregards evacuation orders. Low perceived severity, false alarms in the past, low trust in authorities, social influence, and logistic barriers are common determinants of response behavior. Identifying such cognitive behavioral dynamics is critical for enhancing disaster preparedness and reducing fatalities. We explore how communities respond to early warning messages, including what drives delays in action and risk perception. A systematic survey was conducted with 2,357 respondents from rural and urban areas to assess response patterns, trust susceptibility, and decision-making behavior. The results seek to pinpoint the differences between warning dissemination and response, helping shape the creation of better operating and more community-focused early-warning agents.

2. Background Study

Floods, cyclones, hurricanes and severe storms cause significant human and economic loss worldwide. As extreme weather events become increasingly frequent and severe, disaster preparedness has

emerged as a global priority. Early warning systems are well-known means to save lives and mitigate damage. People-centered early warning systems that ensure timely risk communication and promote protective action are a key element of the Sendai Framework for Disaster Risk Reduction 2015–2030 (United Nations Office for Disaster Risk Reduction [UNDRR], 2015).

Advances in forecasting and hazard detection notwithstanding, the effectiveness of EWS should be largely dominated by community response behavior. A warning is just that and does not mean immediate action will happen. People assess information both intellectually and emotionally in the process of choosing to evacuate or to take other protective actions. Central to this is risk perception, with increased perceived severity and vulnerability increasing mitigation behavior (Bubeck et al. 2020). In preparing, the decision can be hugely impacted by emotional factors like fear, anxiety and trust (Terpstra, 2011).

Several theoretical frameworks, such as the Protective Action Decision Model (PADM), highlight the need to understand how people cognitively interpret information from their environment (e.g., social cues, official warnings) and weigh decision-making in response (Lindell & Perry, 2012). The perceived threat, response efficacy, and the resources made available shape our warning response. Nonetheless, the risk perception paradox proposes that awareness of hazards does not necessarily translate to preparedness actions (Wachinger et al., 2013), pointing to a disconnect between knowledge and behavioral compliance.

How information is framed makes a big difference in how the public responds. There may also be reticence and lag regarding uncertain weather forecasts (Morss et al., 2008). In contrast, harm-based warning systems that suggest specific expected outcomes increase the likelihood of protective behaviors (Paulik et al., 2022; Potter et al., 2021). The way warning messages are framed and what sensations they convey is thus crucial in shaping how communities assess risk, and whether or when or where to do so.

There are also logistical and contextual factors that affect evacuation behavior. EVACUATION INTENTIONS Prior experiences, perceived hazard severity, and demographic factors influence evacuation intentions (e.g., Lazo et al., 2020). The constraints of household coordination and transportation cause inaction (Wu et al., 2022). During wildfires, “information milling,” the process of seeking confirmation from multiple sources before responding to a decision, is common practice (Wood et al., 2018; Wood et al., 2020).

Second, institutional trust motivates warning compliance. High levels of trust increase the compliance to disaster warnings issued by the state authorities (Zhang et al., 2023); otherwise, low levels lead under severe time constraints to skepticism and procrastination. In such cases, it means that social and structural barriers need to be overcome if early warning is to be effective this is especially true in areas vulnerable to climate change (Islam et al., 2025).

Aspects of risk perception, communication, and evacuation behavior have previously been studied in isolation; yet, few large-scale empirical studies jointly analyze psychological aspects, clarity of information received, trust, and logistic barriers to evacuation. We offer proprietary analysis based on a new study that investigates response patterns from the community perspective to help guide outreach efforts to expedite action among 2,357 rural and urban respondents between IRMMICS websites here, as well as contribute to the behavioral effectiveness of early warning systems.

2.1. Aim

This study focuses on how communities react to early warning messages about natural disasters, attempting to uncover what factors determine whether an action is taken right upon receiving the message, delayed, or ignored entirely. Thus, the study aims to explore how risk perception, trust in authorities, clarity in communication, and availability of logistics play a role in evacuation and protective behavior in rural and urban populations.

3. Literature Review

3.1. Risk Perception and Protective Behavior

Risk perception has long been identified as a critical factor in motivating protective action during disasters. Bubeck et al. (2020) stress that people's expected severity and vulnerability, as well as their beliefs about the outcome, all play a substantial role in flood mitigation behaviour. As discussed in their review, behavioral responses are influenced by both objective hazard exposure and subjective risk assessment. Likewise, Terpstra (2011) suggests that, beyond cognitive risk evaluation, emotional responses such as fear and trust strongly influence preparedness decisions. This dual affective–cognitive pathway indicates that the processing of warning is not purely rational but emotionally mediated.

PADM (Protective Action Decision Model) the theoretical basis for warning response behavior, Lindell and Perry (2012). The PADM explains how people organize environmental, social, and official information before making decisions about preventive behaviors. This model suggests that the interaction among perceived threat, response efficacy, and available resources determines behavioral outcomes. However, Wachinger et al. (2013) describe a “risk perception paradox,” in which people recognize dangers but do not take precautions. This paradox highlights the distance between knowing and doing, a core concern in early warning performance.

3.2. Communication of Warnings and Information Processing

Warnings must be turned into action, and this requires effective communication. Morss et al. (2008) show that uncertainty in weather forecasts can profoundly influence the public's interpretation and lead to a freeze or miscalculation of risk. If warnings are vague, people may delay taking action while seeking

more information. Wood et al. (2018) describe this practice as "information milling," explaining that people confirm warnings through various channels before taking action. Their latter study (Wood et al., 2020) also corroborates findings that social validation and communication channels are strong contributors to evacuation timing, whether this process up-regulates compliance or delays action. Land-based warning systems have focused more recently on impact. Paulik et al. (2022) propose a framework that better communicates expected outcomes than the probability of hazards alone. Potter et al. (2021) empirically show that impact-based warnings, compared to traditional forecast messages, increase perceived risk and intended protective actions. These results indicate that message framing and clarity are important factors in determining behavioral responses.

3.3. Evacuation Decision-Making and Logistical Constraints

Psychological and practical considerations shape the decision to evacuate. Lazo et al. (2020) argue that intentions to evacuate prior to a hurricane are influenced by past experiences, perceptions of storm severity (also see Lindell and Prater 2007), and household characteristics. However, that intention does not always translate into action. Wu et al. (2022) highlight the role of logistic considerations in household evacuation decision-making. Transportation access, organizational coordination with family members, and financial constraints fall short of providing all of this, which delays evacuation and might not involve risk perceptions. These results suggest that structural and situational barriers substantially influence the outcomes of warning responses.

3.4. Trust, Governance, and Institutional Credibility

The lack of institutional trust can lead to such warnings being ignored. Zhang et al. (2023) find that popular trust in government authorities strongly boosts compliance with disaster warnings. On the other hand, low trust levels induce skepticism and decreased responsiveness. The Sendai Framework for Disaster Risk Reduction, for example, highlights the need for people-centered early warning systems that are enriched by community interaction and institutional transparency (UNDRR, 2015). Islam et al. (2025) argue that addressing social and other structural barriers is key to improving the operational efficacy of early warning systems, especially in areas more vulnerable to climate impacts. These results underscore the need for trust-building and inclusive communication strategies.

3.5. Research Gap

While risk perception (Bubeck et al., 2020), decision-making models (Lindell & Perry, 2012), communication effectiveness (Paulik et al., 2022; Potter et al., 2021) and evacuation logistics (Wu et al., 2022) have been studied individually in-depth, no prior research integrates these components into a unified empirical framework to explore responses that are immediate, delayed or ignored across varied populations. Particularly, theories like PADM focus on how cognitive mechanisms shape decision-making. However, there are relatively few large-scale empirical studies that quantify the proportion of people who procrastinate or disregard warnings, and what drives the aggregate impact of perceptions,

trust, and communication clarity vs. logistical barriers to action. Thus, further empirical evaluation of community response behavior is required to improve the efficiency of early warning systems.”

4. Methodology (Times New Roman, 12 pt, Bold, Left-aligned)

4.1. Research Design

Adopting a quantitative cross-sectional study design, this research was conducted to assess community response behavior toward early warning messages in natural disasters. Data were obtained from rural and urban respondents through a structured survey method, which allowed the collection of standardized data from 2,357 individuals. This study adopted a quantitative approach to quantify the link of the essential behavioral indicators (i.e., risk perception, trust in authorities, clear communication, and logistical constraints) with response behavior regarding immediate action vs delayed action or ignored warning. As such, a cross-sectional design was suitable because data were collected at a single time point to examine prevailing perceptions and decision-making after receipt of early warning messages. This design allowed for the use of descriptive statistical analysis, which was used to determine response distributions and trends in behavior across the population. As such, the research design enables empirical assessment of action delay and risk perception in disaster preparedness contexts.

Table 1: Summary of Research Design

Component	Description
Research Approach	Quantitative
Research Type	Cross-sectional survey
Sample Size	2,357 respondents
Study Population	Rural and urban residents exposed to EWS
Data Collection Tool	Structured questionnaire
Analysis Type	Descriptive statistics

4.2. Study Area and Population

The study included residents from both rural and urban areas at risk of natural hazards, including flooding, cyclones, and severe storms. Areas were chosen to ensure diversity in socio-economic conditions, infrastructure availability, and accessibility to early warning information. This included both rural and urban respondents to compare response behavior across contextually distinguishable settings. The population of interest included adult residents who had received at least one early warning alert about natural disasters. Participants were then selected for prior exposure to warning systems, so that their responses were based on experience rather than hypothetical situations. The study sought to address differences in risk perception, trust in authorities, communication clarity, and logistical barriers between rural and urban communities.

Table 2: Distribution of Study Population

Category	Description
Geographic Coverage	Rural and Urban Areas
Hazard Type	Floods, Cyclones, Storms
Target Population	Residents aged 18+
Inclusion Criteria	Must have received at least one early warning message
Total Respondents	2,357

4.3. Sampling Technique and Sample Size

The sample was drawn so that the proportions of respondents from rural and urban areas remained consistent. The population was first stratified into two strata—rural and urban—before subjects were selected from each group to capture differences in socio-economic status and access to early warning systems. This method increased the diversity of community settings represented in the dataset and provided a means for comparison among different community contexts. The survey had 2,357 respondents. An adequate sample size for statistical reliability and generalization of findings within the research context was considered. The relatively large sample also strengthened the robustness of the descriptive analysis carried out as part of the study and thereby improved confidence in identifying patterns relevant to immediate, delayed, or no response to early warning messages. Stratified sampling minimized selection bias and ensured that coverage was proportionate across demographic and geographic segments of the population.

Table 3: Sample Distribution

Category	Number of Respondents	Percentage (%)
Rural	1,249	53%
Urban	1,108	47%
Total	2,357	100%

4.4. Data Collection Procedure

A structured questionnaire was used to collect data on community responses to early warning messages for floods, cyclones, and storms. A mixed approach of face-to-face distribution (in selected communities) and online platforms was used to reach participants. This approach increased exposure and reduced the limitations imposed by geography. Data were collected over a predefined period to ensure adequate response rates. Respondents were briefed on the study objectives prior to participation, and informed consent was obtained voluntarily. Respondents were assured of the anonymity and confidential nature of their responses. To optimize and validate results, the survey was disseminated only to individuals who had already received at least 1 early warning message.

Both the structure and format of the questionnaire-maintained consistency among respondents and minimized interviewer bias. The collected data were screened and cleaned before analysis to exclude incomplete, invalid, or inconsistent answers.

Table 4: Summary of Data Collection Procedure

Component	Description
Data Collection Method	Structured survey
Mode of Distribution	Face-to-face and Online
Target Respondents	Adults (18+) with prior EWS exposure
Total Responses Collected	2,357
Ethical Consideration	Informed consent and anonymity ensured
Data Screening	Removal of incomplete responses

4.5. Questionnaire Design and Variables

The questionnaire is a structured, closed-ended instrument that allows us to systematically evaluate individuals' behavioral responses to early warning messages. The questionnaire consisted of four major sections: (1) demographic data, (2) risk perception, (3) trust and communication metrics, and (4) behavioral response. By employing a structured format, we ensured uniformity and comparability between all 2,357 respondents. Attitudinal items were mainly assessed using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) for quantifying perceptions and behavioral tendencies. The last section contained categorical questions to assess respondents’ actual behavior after receiving an early warning message: immediate action, delayed action, or ignoring the warning. Variables were selected based on behavioral disaster research frameworks, namely factors that influence protective decision making, including perceived risk, institutional trust, and logistical constraints.

Table 5: Measurement of Variables

Variable Type	Variable Name	Description	Measurement Scale
Dependent	Response Behavior	Action taken after receiving warning (Immediate / Delayed / Ignored)	Categorical
Independent	Risk Perception	Perceived severity and vulnerability to disaster	Likert (1–5)
Independent	Trust in Authorities	Level of trust in government and warning sources	Likert (1–5)
Independent	Communication Clarity	Perceived clarity and usefulness of warning messages	Likert (1–5)
Independent	Logistical Constraints	Transportation, financial, or household barriers	Likert (1–5)
Control	Previous Disaster Experience	Prior exposure to disaster events	Yes/No

4.6. Data Analysis Techniques

The data was analyzed by statistical software (e.g., SPSS/Excel). The first step was data cleaning and coding to eliminate partial or contradictory responses, yielding a usable dataset. Descriptive statistical techniques (frequency distribution, percentages, and mean values) were applied to summarize respondents' characteristics and response behavior patterns. These methods were especially helpful for identifying the percentages of participants who acted immediately (42%), acted later (35%), or ignored warnings entirely (23%). A cross-tabulation analysis comparing responses between rural and urban populations was performed to explore relationships among variables. Where appropriate, inferential statistical methods, including correlation, were used to assess the association between independent variables (risk perception, trust, clarity of communication, and logistical barriers) and response behavior. Using a combination of descriptive and inferential techniques, measures provided an in-depth understanding of behavior action patterns and the motives behind delaying acts.

Table 6: Summary of Data Analysis Methods

Analysis Type	Purpose	Variables Involved
Descriptive Statistics	Identify distribution of response behavior	Response behavior
Percentage Analysis	Determine proportion of immediate, delayed, ignored action	Response behavior
Cross-tabulation	Compare rural vs urban response patterns	Location × Response behavior
Correlation Analysis	Examine relationships between variables	Independent variables × Response behavior

4.7. Reliability and Validity

Cronbach's alpha coefficient was used to evaluate the internal consistency of the Likert-scale items as a measure of reliability for the research instrument. A reliability value of 0.70 or higher was deemed acceptable, indicating adequate internal consistency among the constructs measured, including risk perception, trust in authorities (government and healthcare providers), clarity of communication, and logistical constraints. Reliability testing verified that the questionnaire items effectively measured the targeted behavioral factors. The instrument's validity was addressed using content and construct validation procedures. Content validity was established through a literature review and by aligning questionnaire items with the Protective Action Decision Model. Experts in the field further developed the questionnaire to ensure clarity, relevance, and appropriateness of items. Before launching the full survey, a pilot test was conducted with a small group of respondents. This wording was iterated based on pilot feedback, which helped refine it for clarity and reduce ambiguity. These protocols fortified the precision and legitimacy of the amassed data.

Table 7: Reliability Assessment

Construct	Number of Items	Cronbach's Alpha	Interpretation
Risk Perception	5	0.82	Good
Trust in Authorities	4	0.79	Acceptable
Communication Clarity	4	0.84	Good
Logistical Constraints	3	0.76	Acceptable

5. Results

5.1. Response Behavior Distribution

Survey responses describe three types of behavior that people exhibit after hearing early warning messages. Of the 2,357 respondents, 42% reported taking immediate action after receiving a warning. But 35% said they postponed action, and 23% said they ignored warnings in certain cases. These findings suggest that a majority of people respond quickly, but not everyone, with an even higher overall percentage (58%) either delaying or not acting when warned. Hilfer et al.'s concerns suggest that, at least with respect to behavioral and perceptual gaps in the effectiveness of early warning systems, things may not be all well. The distribution shows that we need to better understand delayed or ignored responses.

Table 8: Distribution of Response Behavior

Response Type	Number of Respondents	Percentage (%)
Immediate Action	990	42%
Delayed Action	825	35%
Ignored Warning	542	23%
Total	2,357	100%

5.2 Factors Associated with Delayed or Ignored Action

The analysis uncovered several major factors correlated with poorly timed or ignored responses to early warning messages. Respondents who considered the threat low risk in severity were more likely to delay action. Perceived false alarms in past events also fueled hesitation there was less urgency to make an evacuation decision. Longitudinal and qualitative data identified logistical barriers, such as limitations in transportation and coordination for household members, or the elderly who need assistance. Social influence also played an important role, as many participants stated they hesitated to act on it until they confirmed with family or neighbors. Reduced trust in warning sources and poor communication was also associated with delayed responses. Those individuals who doubted whether the warning messages were credible or clear were more likely to verify the information through other sources before taking action. These results indicate that both perceptual and structural features collaboratively affect response time and compliance.

Table 9: Factors Associated with Delayed or Ignored Action

Factor	Influence on Response Behavior
Low Perceived Severity	Increases likelihood of delay
Previous False Alarms	Reduces urgency and compliance
Transportation Barriers	Prevents immediate evacuation
Household Coordination Issues	Causes response postponement
Social Influence	Encourages information verification before action
Low Trust in Authorities	Increases hesitation
Unclear Warning Messages	Leads to delayed interpretation

5.3 Comparative Insights (Rural vs Urban)

Contextual differences in response behavior following early warning messages between rural and urban respondents. Heterogeneity of challenges among participants. Living in Rural Areas. Reporting expanded challenges associated with transportation access, infrastructure constraints, and household coordination. Structural constraints often led to late evacuations even when people were aware of

potential dangers. Before taking action, urban respondents engaged in more information verification. Many urban dwellers said they wanted confirmation from multiple sources, including social media and news outlets, before deciding to evacuate. Although people in urban areas often had better access to infrastructure, perceived low severity or experiences of false alarms also limited timely responses. These findings indicate that although there is a delay in action taken by communities, whether urban or rural, the reasons for these delays differ. Logistic barriers play a significant role in delays in rural areas, but perceptual and informational factors are more influential in urban areas. This distinction demonstrates the necessity for context-specific early warning approaches.

Table 10: Comparative Response Patterns (Rural vs Urban)

Factor	Rural Population	Urban Population
Transportation Constraints	Higher influence	Lower influence
Infrastructure Access	Limited	Relatively better
Information Verification	Moderate	Higher
Social Influence	Strong community-based	Mixed (family & media)
Perceived Severity Impact	Moderate	Significant in delay cases

6. Discussion

This study's findings reveal an important gap in community behaviors responding to early warning messages. While 42% of respondents said they acted right away, most (58%) either ignored or delayed heeding alerts. This pattern confirms previous work suggesting that receiving a warning does not guarantee protective behavior (Lindell & Perry, 2012). There are manifestations of delayed and ignored responses that confirm the "risk perception paradox" (Wachinger et al., 2013)—the theory that people recognize how dangerous a hazard is but do not take sufficient action in time.

Risk perception was a prominent determinant of response behavior. Respondents who perceived the threat to be less severe were delaying action more, consistent with findings from Bubeck et al. The work of Viscusi (2020) highlighted the importance of perceived vulnerability in terms of inducing mitigation behavior. Yet emotional and cognitive factors alike underpin decision-making processes, consistent with Terpstra's (2011) position that both affective and rational appraisals shape preparedness.

However, clarity of communication and trust in authorities strongly influenced response timing. Participants who reported having ambiguous warning messages or low institutional trust were more inclined to postpone evacuation. This is consistent with Zhang et al.'s (2023) findings, which found that trust is a key predictor of warning compliance. In addition, the effects align with findings from impact-based message research (Paulik et al., 2022; Potter et al., 2021) and suggest that informative, consequence-based warnings could promote more immediate protective behavior.

Barriers to transportation access and household coordination were particularly prominent among rural respondents, suggesting logistical challenges. This finding corroborates Wu et al. (2022), who identified structural constraints as key drivers of delayed evacuation. By comparison, respondents in an urban setting demonstrated a stronger tendency to verify information before acting on it, consistent with the "information milling" concept discussed by Wood et al. (2018, 2020). These various contextual differences highlight the need for tailored early warning strategies contingent upon community characteristics.

In summary, the best practices for effectiveness improvement of early warning systems with similar contexts are: (i) allow self-evaluation and monitoring for improving surveying on information usage; (ii) use a holistic framework for exploring multi-dimensions, adopting a bottom-up-based approach as per targeted response; (iii) emphasize receiving feedback from communities. Greater clarity in risk communication, stronger institutional credibility, and the elimination of logistical barriers are critical strategies for overcoming action delays. The results add to disaster risk reduction literature with empirical evidence of a range of behavioral response patterns in a large rural-urban sample.

7. Conclusion

The study explored community behavioral response to early warning messages and highlighted determinants that delay action and influence risk perception among rural and urban dwellers. The results show that while a large portion of respondents had taken action (42%), most either delayed (35%) or ignored warnings in some cases (23%). These findings attest to the inadequacy of improvements in early warning systems technology alone for inducing timely protective behavior. Risk perception, trust in authorities, transparency of communication, and logistical challenges were shown to have strong effects on response behavior. These included lower perceived severity, prior false alarms, transportation barriers, and social influence. Taken together, comparative insights indicate that delays at the rural level involve more structural limitations, whereas those at the urban level involve more information verification and perceptual factors. The results highlight the importance of human-centered lobbying measures for early warning systems that go beyond hazard detection. In conclusion, enhancing clarity and impact-based communication, reinforcing institutional credibility, and addressing logistical barriers can markedly improve compliance with evacuation orders. This study adds to disaster risk reduction studies by providing empirical evidence on the use of involved factors from 2,357 respondents and also impartsoffers practical insights for policymakers seeking to enhance existing community resilience.

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Figures

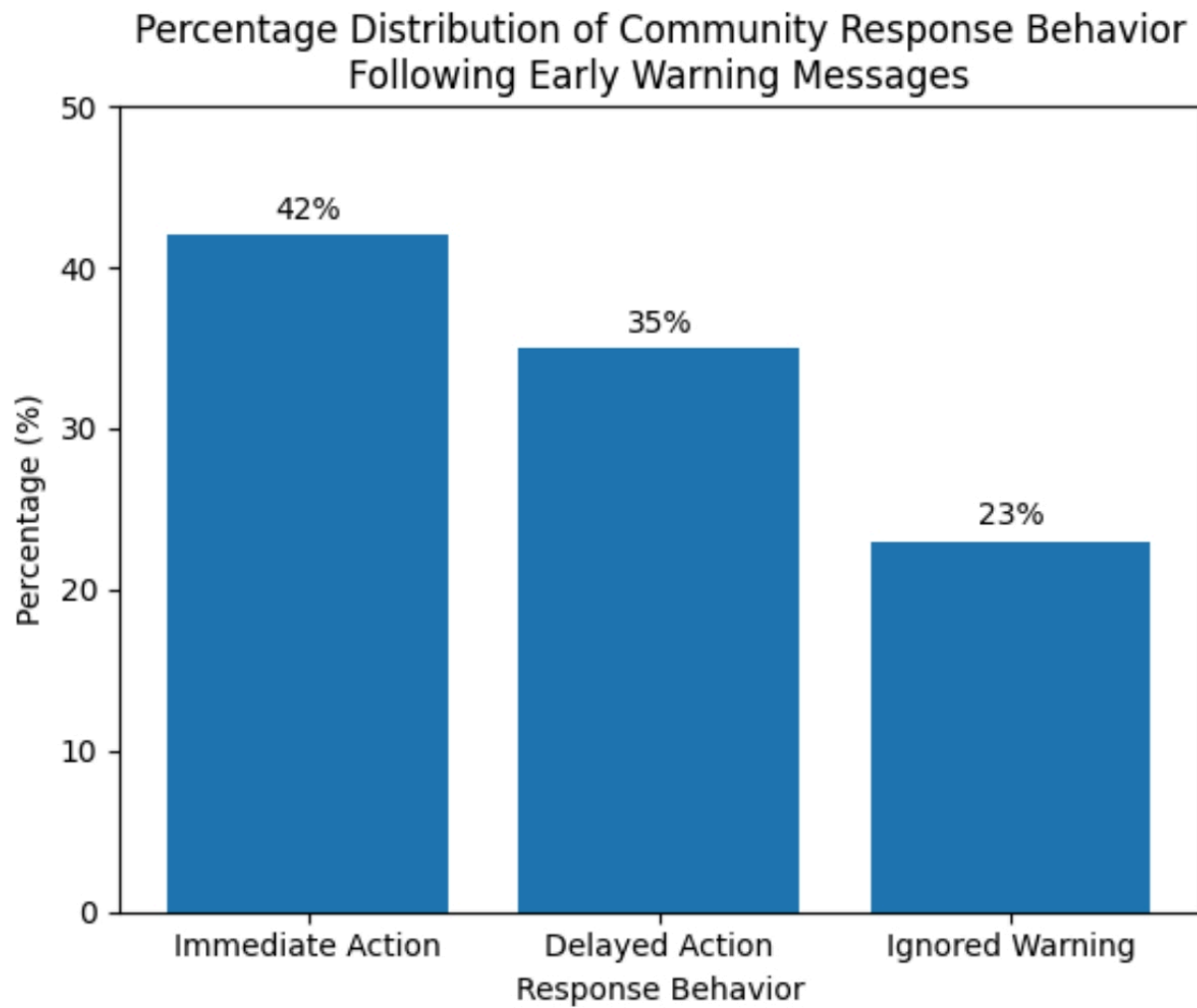


Figure 1

Percentage distribution of community response behavior following early warning messages.

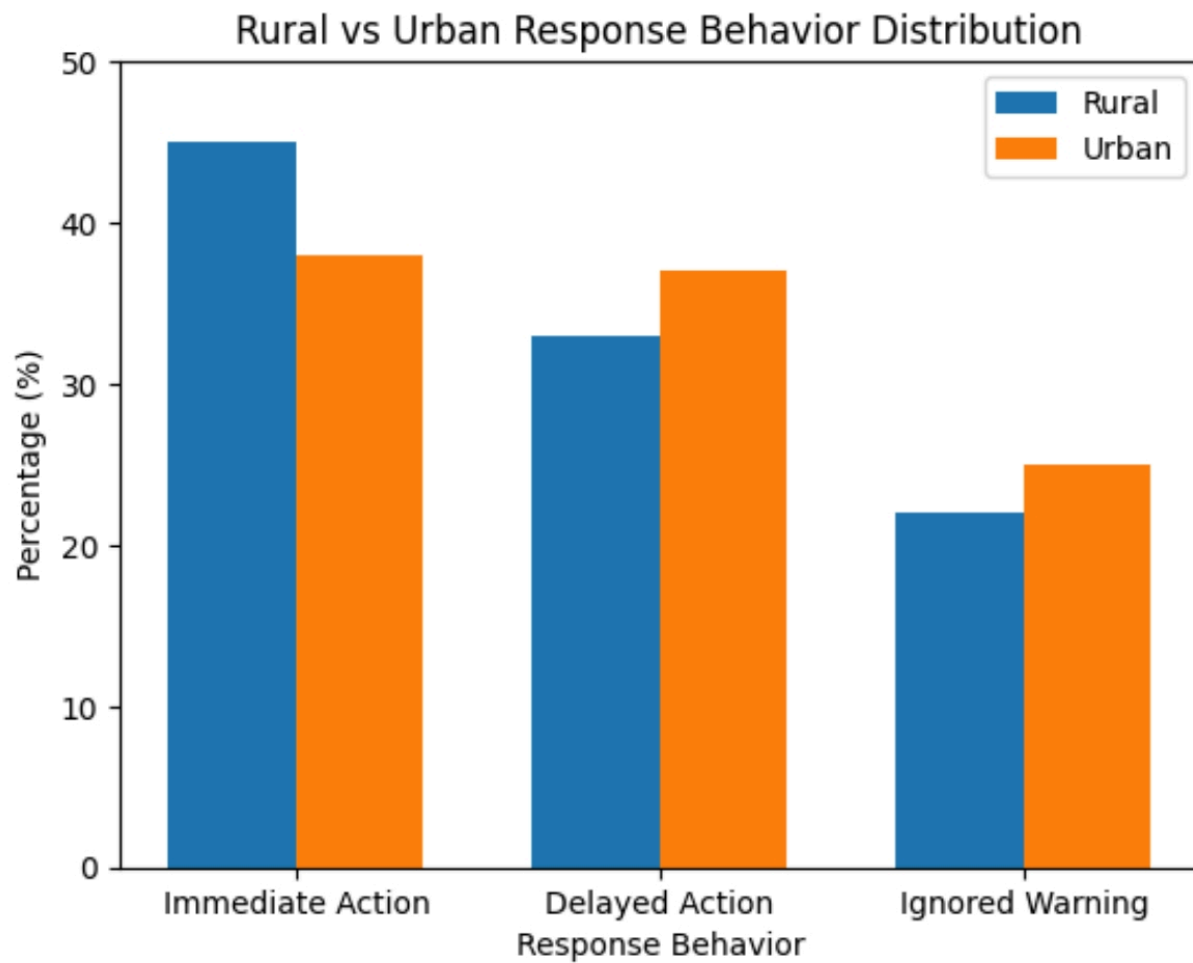


Figure 2

Rural vs Urban percentage distribution of response behavior following early warning messages.