The early warning system's significance in the information society and the revision of information literacy during natural disaster operations

Developing resilience is crucial to prevent and manage natural disasters, each of which has unique characteristics that demand adaptable solutions. Nevertheless, preventive guidelines mostly apply technical or scientific approaches only, which significantly complicates the development of appropriate informational behavior and actions. The aim of the study presented here was to clarify the consequences of the deficit in resilience that affects communities, a significant cause of which is distrust stemming from the lack of proper information. In developing information literacy for crisis and warning communication, knowledge of disaster risks—as well as the ability to detect, monitor, analyze, and forecast hazards—is essential for effective early warning systems. The practical use of those features not only contributes to long-term prevention and risk analysis but can also be useful before a disaster occurs, given the opportunity for avoidance from the time of detection to the time of warning.

Keywords: *global information society, information literacy, integral security, resilience, early warning system, crisis communication*

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1. Introduction

The effects of climate change are clearly being witnessed with rising frequency across all aspects of the environment. Ongoing alterations in the environment, including soil erosion, earthquakes, and diminishing water supplies, contribute significantly to unanticipated natural disasters. In turn, devastating natural disasters undermine critical infrastructure, education systems, and other social services and thus create numerous challenges. Essential factors in addressing the problem are the theory and practice based on resilience-based experiences with early warning systems (EWSs), which constitute a significant feature of the process of sharing information in regional societies (Baudoin et al. 2016).

Developing resilience contributes significantly to the success of the pre- and post-disaster reconstruction, an important aspect of which is the level of trust within the community. After all, trust is central in human relationships and in mechanisms for coping with complexity. In that sense, both trust and resilience are ways to cope with complexity as well as uncertainty (Besenyő 2019).

In translating theory into practice in crisis communication, informing communities properly is a part of complex EWSs that is essential during both the prevention and rebuilding processes.

2. Methods

The study presented here was conducted by adopting the chief principles of international intergovernmental organizations and nongovernmental organizations as secondary sources of data. Given the complexity of the study's topic, comparative document analysis was applied while critically acknowledging the credibility, relevance, and timeliness of the data used. Data and results in domestic and international literature relevant to the topic were collected and examined by using secondary research. The study's objectives were also pursued by collecting and inspecting relevant domestic and foreign literature, including polls, articles, essays on the topic, and doctoral theses, both by civilian researchers by institutes of public security meanwhile, relevant literature was reviewed using both analytical and synthetic approaches.

3. Significance of developing community resilience in the information society

Understanding the informal role of EWSs in developing resilience requires clarifying the concept of resilience. *Resilience* is generally defined as the process of appropriate adaptation following events that cause trauma, tragedy, and other dangers or sources of significant stress using tools that are fundamentally biological, psychological, social, and cultural in nature and that help individuals to apply ppropriate processes of responding to stress (American Psychological Association 2014).

The development and characteristics of resilience vary by region and community, and it is important to distinguish between the traumas experienced by communities and individuals, for responses to stress from those traumas differ as well. For instance, the process of promoting a sense of hope and unity following trauma by adapting resilience differs in a war-torn or developing country compared with a developed, resource-rich region (Walker and Salt 2006).

The resilience matrix clearly and comprehensively summarizes the process of establishing of an appropriate level of resilience in affected communities, with the development of adaptive behavior based on raising awareness, considering social being, and practically applying scientific theories. On that basis, the resilience matrix can be divided into eight parts, in which predominantly negative values continuously affect positive ones and, by extension, significantly reduce their characteristics and impacts. In the process of developing resilience, the goal is to enable the affected individual or community to reverse the process in the resilience matrix by allowing the positive areas and values to dominate while continuously correcting the negative ones (Karvalics 2022b).

3.1. Trust in effectively using community-based information and enabling resilience

A particular community's level of resilience is significantly determined by the level of trust within it, the degree of inequality within it, and their interrelationship.

The established level of trust can be interpreted using a two-level scale. On this two-tier scale, one value reflects the degree of knowledge supported by adequate information, while the other indicates the extent of uncertainty or missing knowledge. Together, these two values define the appropriate level of trust.

(Sumpf 2019). The familiarity principle can be applied to balance the scale based on the idea that trust fundamentally represents favorable future expectations and belief in situations in which the outcome is unpredictable (Möllering 2006). Building the level of trust is essential not only for resilience but also for the success of each community's functioning, because individual social interactions are also based on mutual trust when a favorable outcome is expected (Luhmann 2017).

An affected community can easily manage misinformation within it if it retains a sufficient level of trust toward the institutions, organizations, and individuals providing that information. Overall, theoretical reasoning suggests that communication about limits of knowledge can foster conscious trust in the system by recognizing the potential for failure and adjusting expectations to maintain stable trust (White and Eiser 2006).

Building on these expectations surrounding trust in risk and warning communication, it is essential to clarify how crises themselves are conceptualized within the broader field of crisis communication. Crisis communication is a multidisciplinary area of study encompassing a variety of practices that organizations use to communicate before, during, and after crises to restore normal operations. According to Ulmer et al. (2015), crises are unique moments that move beyond common,

unpleasant calamities and, following Herman (1972) have three distinguishing markers: surprise that exceeds expectations, a threat or risk that exceeds standard operations, and the need for organizations to respond quickly and effectively. Although many definitions of organizational crisis exist, a multidisciplinary approach to understanding an organizational crisis includes acknowledging that a crisis is a highly consequential event or series of events of little to no predictability that either perceptually or actually threaten an organization's performance or public perception and consequently cause the organization to engage in sensemaking in order to reduce uncertainty and restore stability (Coombs 2014; Ulmer et al. 2015; Weick and Sutcliffe 2007). To be clear, that definition comprises five components:

1. Organizational crises have significant consequences for organizational operation and reputation;
2. Organizational crises an be a simple or complex event or a series of events that converge;
3. Organizational crises surprises that have little to no predictability;
4. Organizational crises early or perceptually threaten performance or public perception; and
5. Organizational crises enquire organizations to engage in a sensemaking process to reduce uncertainty and restore a semblance of stability that allows organizational life to be sustained.

4. Crisis communication and EWSs as tools to improve information literacy

As a result of climate change, numerous disasters occur worldwide each year that cause trillions of dollars in damage and alter, if not threaten, the daily lives of countless human lives. In the coming decades, that trend will become increasingly significant as natural disasters become more frequent (Intergovernmental Panel on Climate Change 2013).

In response, disaster-based risk management has recently been articulated in the fields of hydrology, and meteorology and in numerous theoretical and practical guidelines (Plate 2002). The application of those theories and guidelines can be interpreted as the development of EWSs. In general, EWSs operate based on forecasting, disaster assessment, communication, and timely response, all with the aim of delivering the appropriate information to individuals, communities, and governments in affected areas in time. Such action and information are essential for timely responses to reduce the risks posed by natural disasters.

Each EWS is a distinct kinds of technology, including sensor devices and ICT for sensor data exchange (Mokhov et al. 2011). To achieve the most efficient results, the system also uses specialized software that filters, deletes, and stores information and data, complemented by software that analyzes usable tools, documents, and models. Most of the models examined in research and/or used are mostly hydrological and evacuation models, whose combined application of tools supports the ultimate purpose of any EWS: to aid the decision-making process (Krzhizhanovskaya et al. 2011).

Because EWSs are influenced by numerous geographical and administrative features, systems such as the Delft-FEWS (i.e., Flood EWS) and MIKE Flood Watch have been developed that apply general analysis and tools. Both of those systems aim to flexibly ensure timely information exchange, facilitate the integration of sensors and other data, and provide the most effective response process during emergencies with the help of appropriate models and visualization tools (Werner et al. 2013).

4.1. Categories of EWSs

Socially based EWS developments for risk management and forecasting are typically adapted to accommodate the social characteristics and changes of the community affected and increase the community's disaster resilience capacity Such developments significantly reduce damages that cause loss of life, severe health issues, and material destruction.

One of the most-used hazard warning systems is the multi-hazard EWS, which was developed for managing various, distinct disasters in which hazardous events can occur independently, in parallel, or in a chain reaction but necessarily impact each other. The multi-hazard EWS, through coordinated integrated mechanisms and abilities involving multiple scientific disciplines, is capable of simultaneously warning about multiple hazards and significantly increasing the effectiveness of forecasts (United Nations Office for Disaster Risk Reduction 2017).

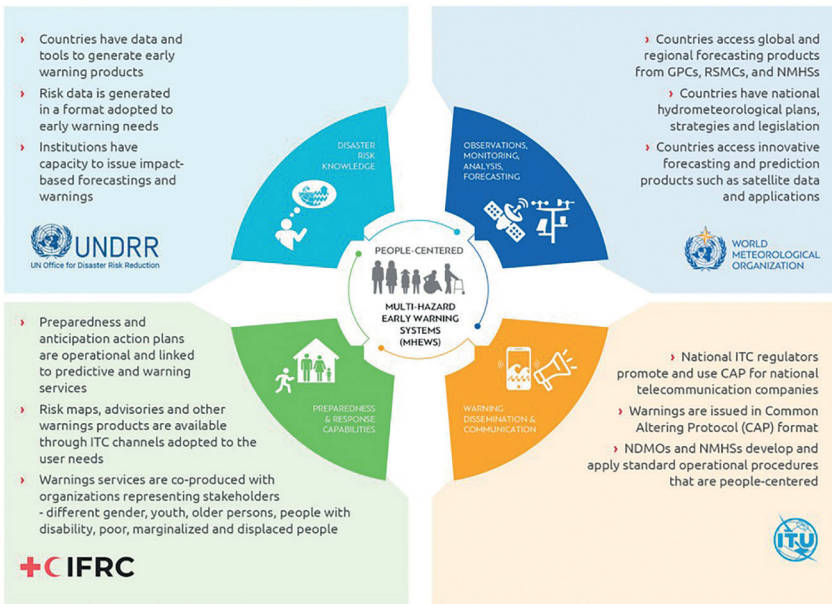

Figure 1. The multi-hazard early warning system (United Nations Office for Disaster Risk Reduction 2017)

By comparison, a people-centered early warning system (PEWS) is part of community-based developments in EWSs that are fundamentally characterized by people-centered, bottom-up organized systems. In the PEWS approach, different fragmented areas are provided with unified information regarding disaster situations (Zia and Wagner 2015). The primary goal of a PEWS is to "empower individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment" (United Nations International Strategy for Disaster Reduction 2006). It contributes to the affected individuals by recognizing their important role in the process of reducing vulnerability and damage, and, as a result, it strengthens the community's capacity for resilience so that they can cope with regional risks on their own (Marchezini 2020). Each PEWS has four fundamental elements: risk awareness, risk surveillance and alert services, risk communication and distribution, and reaction capacity.

Figure 2. Elements of a people-centered early warning system (United Nations International Strategy for Disaster Reduction 2006)

4.2. Crisis communication

Crisis communication is the primary tool for establishing the level of trust necessary for appropriate resilience and community information. In interpreting crisis communication, it is essential to examine the development and principles of informational behavior, which has determined human and other forms of life throughout evolution by in terms of timely preparation for survival and changes in environmental impacts.

Theory on informational behavior was first developed by Lajos Kardos (1899–1985), who created the informational cycle model named the "adiaphora determination schema." According to the schema, the essence of informational behavior is that an environmental effect that is barely perceptible at first reaches the individual, but that reaction is already capable of bringing about impending danger. During the time between the effects of the two processes, the individual has the opportunity to provide the most appropriate response to the dangerous situation—that is, to process, interpret, and finally make a decision and implement effective action in response (Kardos 1976).

Other significant research and theory concerning informational behavior has been developed by John Richard Boyd, a former colonel of the U.S. Air Force who created the observe–orient–decide–act (OODA) loop model (Frost et al. 2012). The OODA model's central concern is the evolution of the characteristics of the continuously changing environment of threats and opportunities in relation to the application of effective action and feedback loops. In the OODA model, four processes can be distinguished: observing the environment (i.e., observe), processing observations (i.e., orient), decision-making (i.e., decide), and action (i.e., act). Accordingly, behavior is determined by the result of decisions arising from comparing information formed by a combination of the perception of the external and internal world and the meanings associated with them (Karvalics 2022a).

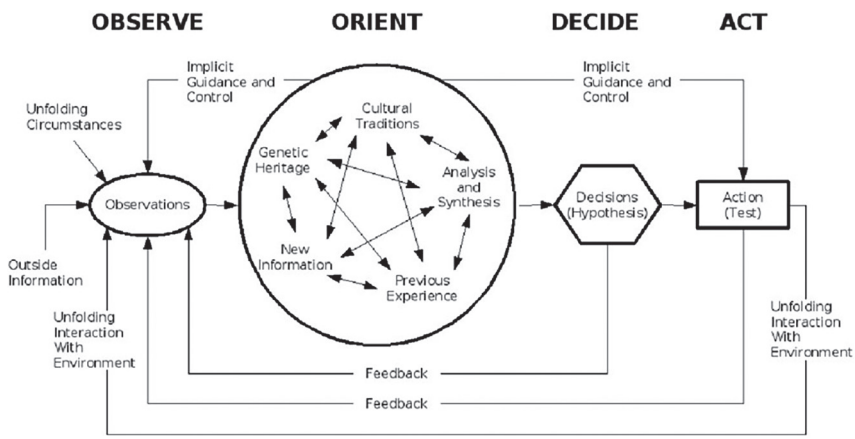

Figure 3. Boyd's observe–orient–decide–act loop model (Frost et al. 2012)

In Kay and King's (2020) work on the theory of radical uncertainty regarding informational behavior, it is suggested that experiential, practical information does not contribute to successful forecasting when only partial information and understanding are available. As a result, preventive responses to an emergency are necessarily limited. That theory also highlights the relationship between confusion arising from the lack of access to appropriate information and limited action.

Overall, crisis communication is a theoretical and practical tool that applies specific communication before, during, and after any crisis to eliminate the threat. According to the general definition, a *crisis* is a unique situation in which an unexpected threat and risk arise that affects the normal daily functioning of individuals and communities and whose resolution requires responsible organizations to respond as effectively as possible within a short period (Ulmer et al. 2015). By extension, a *crisis* is also an unpredictable event or series of events that have extremely significant consequences for the individuals and communities affected, for the unexpected situation threatens stability and security and significantly impacts public opinion (Weick et. al 2007). Turner (1976) has additionally separated each crisis into stages such as regular operations, beginning of the crisis, triggering event, early stages of the crisis, rescue and recovery, and the reorientation of the belief structure (Fischbacher and Smith 2001).

Those models and theories emphasize the significance of the pre-crisis phase, when organizations can prepare for possible future threats by developing and implementing preventive solutions and training and by using models that are appropriate for critical situations, which contribute to establishing proper relationships between individuals and relevant institutions (Karvalics 2019). Furthermore, during precise and timely crisis communication, certain cultural aspects have to be considered, for neglecting those factors can reduce the effectiveness of the response to the crisis both in the preventive phase and in the period following the crisis (Aldoory 2010).

5. Conclusion

Climate change, as one of the greatest global challenges of our time, presents numerous challenges to affected communities and their governments. Due to differences arising from the social, cultural, and economic characteristics of communities and individuals, the tasks involved in preventing and managing unexpectedly occurring natural disasters require an extremely complex solution. Among those solutions, the most effective methods include establishing and applying resilience-based strategies, guided by specific knowledge about the complexities, to ensure the exchange of accurate information and establish information literacy in order to develop the foundations of trust in affected communities. The benefit of those processes is significant, for the tasks involved in preventing and managing natural disasters rely on timely, accurate information within communities. By extension, the exchange of such information depends on the level of trust between communities, governments, and competent authorities and, if adequate, can ultimately establish the essential characteristic of resilience.

Being essential to information literacy, EWSs play a significant role in reducing and managing the risk of disasters, for their effectiveness contributes to extending lead times and minimizing losses by applying proper models of crisis communication.

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