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FLOOD RISK REDUCTION AS A CRITERION FOR VALIDATING TECHNOLOGICAL INNOVATION STRATEGIES WITH RESPECT TO HUMAN SECURITY

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Abstract: Heavy rainfall that has caused floods worldwide in the last few decades has resulted in a great death toll, a significant number of displaced persons and severe destruction of material goods. The importance of planning in the process of disaster impacts mitigation has been recognized in numerous disaster risk reduction strategies developed by international organizations. In this paper, the authors point out the concepts of preparedness and prevention as the key criteria for validating certain innovation strategies, in particular those with an important technological component regarding flood risk reduction. A holistic approach is implemented in assessing the relevance of innovation opportunities with respect to flood prevention and risk management. In accordance with the conceptual framework for flood risk management, the authors use normative, physical, informational, environmental, social and political indicators. Also, a number of agents of change that may affect future flood risks are investigated: climate change, community development and changes in land use, changes in population, the condition of flood mitigation systems (success of system maintenance, changes in system configuration, etc.), changes in the watershed etc. Special attention will be paid to human security aspects of flood risk reduction as a criterion for validating technological innovation strategies. Floods generate human insecurity due to numerous human casualties, diseases, environmental pollution, critical infrastructure destruction and the potential disruption of other institutional activities. Human security and vulnerability as a framework for disaster risk reduction research has great potential in measuring changes related to the public perception of flood risk and new technologies usage as well as measuring a community's confidence in state and non-state security providers.

Keywords: floods, risk reduction, technological innovations, human security.

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1. INTRODUCTION

Disaster management systems include people, infrastructure, and the environment. Each element is vulnerable to natural hazards or human error. Using a systems view, Simonovic (2011: 49) states that disaster losses are the result of interaction among three systems and their many subsystems: the Earth's physical systems (the atmosphere, biosphere, hydrosphere, etc.); human systems (e.g. population, culture, technology, social class, economics, and politics); and constructed systems (e.g. buildings, roads, bridges, public infrastructure, and housing). All of the above systems and subsystems are dynamic and involve constant interactions between and among subsystems and systems. Changes in the size and characteristics of a population and changes in the constructed environment interact with changing physical systems to generate future exposure and define future disaster losses (Simonovic, 2011: 49). By the end of the twentieth century, the concept of flood risk management had been widely accepted in Europe and was beginning to take hold in the United States. The current approach to flood risk analysis does not address certain components that are critical to a modern flood risk analysis. These include uncertainties in risk perception, the consequences that result from human behavior during actual flooding, and the probabilities of success of actions such as, for example, the evacuation of the elderly and disabled. Capturing these factors in the methodological approach to flood risk analysis is the source of the modern risk-based analysis.

When it comes to the theoretical framework, vulnerability theory and preparedness theory can be used for a better understanding of flood risk reduction in the context of human security issues (Richey, 2009).

2. HUMAN VULNERABILITY AND RISK PERCEPTION AS A FRAMEWORK FOR DISASTER RISK REDUCTION

Disaster risk reduction from the human security perspective is almost universally confused by the imprecision of human judgment. According to Simonovic, this is perhaps the most important misconception that blocks the way to more effective societal disaster risk management. The ways in which a society manages disaster risks appear to be dominated by considerations of perceived and subjective risks, while it is the objective risks that kill people, damage the environment, and create property loss (Simonovic, 2011: 102). Furthermore, risk perception is assumed to be the trigger for human behavior during disasters – including emergency response practice – in such a way that many incidents have involved an inadequate reaction of people and their misconception of certain events. People respond to hazards according to their perceptions of the risks those hazards pose. What they perceive, why they perceive it in that way and how they will subsequently behave are matters of great importance to industries and governments trying to assess and implement new technologies (Peters & Slovic, 1996). Furthermore, people's perceptions of the risks posed by a specific hazard vary based on their personalities, experience, knowledge and many other criteria, and these perceptions vary among individuals and groups as well based on their awareness of a particular hazard (professionals vs. laypeople), personal and cultural differences, and hazard characteristics. Psychometric

paradigm studies have demonstrated that perceived risk is quantifiable and predictable (Slovic et al., 1981).

In addition to technological difficulties, management should be aware of and prepared to deal with human factor limitations. Risk perceptions by various groups should be communicated and discussed until a common vision is achieved on the existing hazards and required controls, based on all available information and professional analysis (Ivensky, 2016). In practice, many communities may not distinguish between high potential and low potential hazards in such a way that many strategies try to prevent and respond to all actual events, minor and major, while high potential hazards might go unrecognized. These strategies also risk losing population support if they are perceived as creating an unnecessary burden and controls for situations that are perceived (correctly or incorrectly) to pose only minor risks, or, conversely, as providing insufficient support or control of critical, high potential hazards.

3. CHALLENGES OF THE HUMAN SECURITY ASPECTS OF FLOOD RISK REDUCTION

Continued urbanization and industrialization, and consequently higher population densities result in more people who could be affected by evacuations, or depending on the supply with daily goods, in the shortening of the reaction times of practitioners.

Floods generate human insecurity by causing numerous human casualties, diseases, environmental pollution, critical infrastructure destruction and potential disruptions of other institutional activities. The vulnerability of the population to flood risk varies greatly depending on risk drivers such as geographical exposure (floodplains), the quality of urban planning and housing conditions, combined with climate change. The risk reduction approach to the human security aspects of flood disaster management goes beyond the focus on reducing physical damage to infrastructure to help draw a more dynamic picture of risks and enhance contingency planning and response operations by emergency authorities. Developing resilience indicators for human security harmed by an event can help better inform disaster response plans and accelerate recovery.

The list of key criteria established in the Sendai framework (such as the number of deaths, of missing or injured people, etc.) is not complete without other indicators of human security (MacFarlane et al., 2006) as they have been recognized in scholarly literature and related projects, but it helps to point out the main challenges for individual security in response to disaster as follows:[1]

3.1. CIVIL PROTECTION RESOURCES

Civil protection resources include material and personnel issues, but also organizational challenges, such as spontaneous volunteers or questions of standardization.

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[1] D1.1 – DAREnet Challenges and RDI Topics, H2020- SEC-21–GM-2016/2017, Deliverable submission date (16 April 2018) DAREnet. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 740750.

Material challenges comprise the technical equipment available to the respondents, where functionality and robustness are of key importance. In the field of flood management, this can be having barrier systems substituting classic sand bag barriers, having trucks equipped for mud and high-water levels or boats capable of operating in flooded urban areas. Ensuring the supply with the right equipment or goods at the right place and the right time is essential for a sustainable and efficient disaster response. Events like floods usually demand a high number of responders. Many civil protection units rely on volunteers; therefore if they are not immediately available, this requires mechanisms to make them available and mitigate possible economic damage for them or their employer.

A relatively new phenomenon is the engagement of citizens who spontaneously volunteer.[2] This can be very helpful, yet there are new challenges, for example liability issues or lack of training and understanding of disaster management structures (e.g. the chain of command). The efficient involvement of spontaneous volunteers requires training for the responders and the preparation of structures and processes in advance. During the Danube and Elbe floods in 2013 many spontaneous volunteers showed up and wanted to help. Their workforce was a good addition at sandbag filling stations, where they supported the logistics, filling bags or preparing them for transportation. However, new standardization approaches to the classical coordination of responders during emergency situations are required.[3] International Standard - *ISO 22319 Security and resilience - Community resilience - Guidelines for planning the involvement of spontaneous volunteers* provides the guidelines for planning the involvement of spontaneous volunteers (SVs) in incident response and recovery. Spontaneous volunteers can provide a significant resource of timely labor, skills and abilities to enhance the capacity of incident response organizations, provide valuable local knowledge and personalize the response and recovery in an area by members of its local community. However, in large numbers, SVs can overwhelm incident response organizations, interfere with operations and create additional risks. SVs who provide relief outside of official operations can put themselves in danger, as well as those they aim to help. It is important to understand and implement best practices for involving and mobilizing SVs, and the integration of SVs into response and recovery activities needs to be carefully managed.[4] This topic also resembles a communicational challenge. For cross-border incidents in particular, lacking standardization is a huge challenge, which ranges from used terminology to specific

[2] A spontaneous volunteer is an individual who is not affiliated with existing incident response organizations but who is motivated to contribute unpaid work during and following incidents. The range of tasks performed by SVs can require only basic planning (e.g. for people who are first on the scene), or a plan that is more complex (e.g. for people who travel to the affected area to volunteer)

[3] See: **ISO 22315** Societal security – Mass evacuation – Guidelines for planning; **ISO 22319** Security and resilience – Community resilience – Guidelines for planning the involvement of spontaneous volunteers.

[4] Duncan Shaw (UK), the project leader responsible for writing ISO 22319.

equipment norms. This intersects with challenges in the field of communications, where the lack of standardized protocols becomes even more evident. Demographic change in most European countries is another challenge. On the one hand, disaster management is faced with older volunteers, underlining the need for ergonomic technical solutions and aid. On the other, it means that the population is also becoming older and potentially less mobile or that it depends on assistance (e.g. medical supply or mobilization), which is challenging when dealing with e.g. evacuations. Emphasizing self-protection could be key in building resilience to disasters caused by natural hazards.

Security culture is important for the vulnerability of a society. Are people aware of certain dangers and willing to act accordingly? This becomes even more obvious when the dependence on technical standards is taken into account. For example, when communication technologies change to digital formats, there will be a high dependence on electricity to guarantee those services compared to classical landline services. The individual resilience of the affected is directly linked to the safety culture, e.g. do they have the necessary reserves (e.g. food and water) to be self-sufficient for a period of time, or do they know how to build a sand bag dam to protect their property? These determine their ability to self-protect.

Governmental preparedness takes into account questions related not to individuals, but to groups or society as a whole. In this area, the state of citizens' preparedness is a huge challenge. In this context, widespread warning systems resemble a challenge to enable timely warning and information. Efficient information management is another potential issue, especially in terms of a uniform language and access to data. Legal regulation has made flood risk maps and management plans obligatory in Europe. However, proper training of the people involved is necessary to enable a proper usage of those documents in case of an emergency.

Another area in the category of information is ensuring that the public is informed as a very important task in reducing vulnerability. Also important is the high quality and transparency of information from authentic and verified sources, to avoid the spreading of "fake news" and preserve the trustworthiness of information services. This also affects the previously mentioned spontaneous volunteers, since specific information can enhance the efficiency of their involvement, while uncoordinated communication could cause problems or frustration, e.g. due to controversial information on where to help.

Political aspects usually set the frame, mainly due to a legal framework that enables effective disaster management and the availability of communication resources. Another political challenge is creating the incentives for prevention and collaboration, as well as fostering the understanding of consequences. This is especially true for rivers, since all measures undertaken upstream, might directly or indirectly influence the outcome downstream.

3.2. CITIZENS AND VULNERABLE GROUPS CHALLENGES

A prepared society is less vulnerable and the ability of self-protection is demanded by many flood directives and strategies. Here, information on dangers as well as options to protect property are helpful. This could also mean, for example, trainings on how to

handle sand bags and build simple barriers. Supportive recommendations might lead to a better preparation for disasters (e.g. storage of food, water, batteries).

Continuous urbanization leads to higher population densities in urban areas, but also bears the danger of pushing living space into flood-prone areas. The general public needs to know about evacuation concepts, such as safe routes, timing and execution. Evacuation plans should be partly accessible to the public. Also, a well-established marking of safe routes would increase efficiency. In cases of evacuation or temporary supply, responders would need to know where special aid is needed, for example respiratory support systems requiring power supply or oxygen bottles for exchange. In cases of evacuations, certain information, e.g. about immobile persons, would be valuable to efficiently plan these types of operations.

In remote areas, or areas that have become isolated due to infrastructural failures (e.g. the collapse of bridges), temporary solutions for (emergency) medical services are particularly needed. In the case of flooding, regular medical service might be interrupted due to devastated hospitals or doctors' offices or a possible cut-off of some places. Temporary support from e.g. truck-based doctors' offices could maintain a basic service to residents in the affected area. The increasing number of elderly people requires a critical review of whether existing concepts are sufficient in terms of maintaining basic medical services during response or recovery in flooded/affected areas. In cases of massive disruptions in power, potable or waste water supply, temporary supply concepts are needed such as transportation into the affected area, but also concepts regarding the recovery of such systems. Flooding events usually require a huge logistical effort. Concepts established in advance as well as decentralized logistics hubs would therefore decrease reaction and supply times. Time is critical, especially during emergency situations. Decentralized material and logistic support centers help avoid long transportation paths and enable better availability to local/regional responders.

It is also important to emphasize the role of technological innovations in improving human security in the context of flood risk management. Integrated disaster management systems include integrating situational awareness or decision support based on modern but system-oriented technologies. From the civil protection point of view, building higher dikes might be a local solution, yet it poses a higher risk to the protected area in case of a dam failure.

4. CONCLUSION

Critical re-evaluations of the applied concepts in risk reduction strategies from the perspective of human security call for the identification of the affected parties in an emergency.

It can be anticipated that in the years ahead, advances in technology will permit more effective and efficient capabilities to identify and deal with risk. At the same time, increased communications capabilities will better prepare the population at large to understand and participate in the development and use of risk strategies.

Open communication channels between all levels of an organization and between organizations in multiemployer projects are critical for ensuring an effective exchange of

risk-related information. While it may be difficult to quantify risk, the management must have complete data and must "deal in a world of reality in understanding technological weaknesses and imperfections well enough to be actively trying to eliminate them" (Ivensky, 2016).

In addition to technological difficulties, the management should be aware of and prepared to deal with human factor limitations. Risk perceptions by various groups should be communicated and discussed until a common vision is achieved on the existing hazards and required controls, based on all available information and professional analysis.

While conducting a risk reduction and hazard analysis, disaster management teams need to be sure that all parties, including the management, the responders and citizens, share the perceptions of hazards, controls and residual risks that match those of experts.

The psychometric paradigm is typically applied in public risk perceptions management from higher to lower in order to avoid fear, panic and outrage. Important trends, such as climate change, urbanization growth or the ageing of populations, need to be recognized and a reverse application needs to be suggested where risk uncertainties and potential dreadful outcome scenarios are emphasized to move the perceived hazard from lower to higher. This would result in increased risk perceptions and increased support of risk reduction strategies by the population and affected groups and individuals. Focusing on high to medium-potential hazards versus all flood hazards may increase the resilience of citizens in case of hazard events like floods. Efficient communication strategies are needed in order to have resilient systems, capable of reaching the public.

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