



## **D4.8: THE POLICY AND PRACTICE INNOVATIONS REDUCING VULNERABILITY OF EUROPEAN POPULATION TO NATURAL AND MAN-MADE HAZARDS**

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## Executive Summary

The aim of this report is to synthesize results from the case studies in the BuildERS project, regarding viable policy and practice innovations to reduce vulnerability of European populations to natural and man-made hazards. The report is part of WP4, which involves seven national investigations seeking to establish how vulnerability, risk awareness and social capital, disaster resilience and recovery management vary across the four EU member states (Estonia, Germany, Italy and Finland), Indonesia and the US in the context of the natural, seismic, biological and man-made hazards. The case studies use a range of different methods, collecting data through interviews, surveys etc. but a main common focus in many of them is a co-creational approach, aiming to develop and test new perspectives, processes and products that can improve emergency preparedness and management.

WP4 provides conceptual innovation, as it involves the introduction of a new worldview, perspective or purpose for emergency management as a whole. This means to approach vulnerability from a more nuanced, intersectional perspective. Innovations developed in WP4 lay the foundation for the implementation of this perspective on vulnerability in European emergency management, through concrete innovations which have been tested by relevant stakeholders.

BuildERS WP4 case studies also include additional conceptual innovations, i.e. innovations which provide ground-breaking perspectives which challenge current policies. One of these is the new perspective on inclusive policing, provided in T4.1 (“Managing chemical spill emergency and mis-/disinformation through simulated responses”), aiming to build good relationships with all citizen groups and thus increase linking social capital. Another one is the suggestion in T4.5 (“Impacts of Elbe flooding disasters on socially underprivileged groups and lessons for resilience improvement”) to interpret disaster management and social policy as interdependent and mutually amplifying aspect of politics and in this regard promote strategies which consider these two together.

WP4 involves several process innovations. One of the most important process innovations of WP4 following from the crucial conceptual innovation mentioned above (intersectional/situational approach to vulnerability) is the tool for developing more multifaceted and precise indicators of vulnerability provided in D4.4 (Integration of public data bases for identifying highly vulnerable people in need of relief prioritisation by the Estonian Rescue Board). Ethical guidelines on data collection and integration is the second crucial process innovation from WP4. The next crucial process innovation provided by WP4 is the involvement of stakeholders in vulnerability assessments. A fourth crucial process innovation in WP4 is the T4.1 training scheme to allow for better communication in crises. The purpose of this was to build trust (and linking social capital) between first responders and people with different types of cognitive challenges and/or communication difficulties.

The technology and tool testing case studies, D4.3 (“Applying mobile positioning data for more precise rescue planning and emergency management under cyber-hazard in Estonia”), D4.4, D4.7 (“Indonesian Case “Using Mobile Operators’ Data to Locate, Protect and Evacuate Tourists and Other Vulnerable Groups in Disasters”), contribute to the development of guidelines to carry out vulnerability risk assessments and collect data for these assessments. These case studies have explored the issues like reliability and availability of data and its integration. These process and product innovations are closely related to scientific innovations on vulnerability assessments provided by WP4 tasks.



Some of the tasks in WP4 also involve social innovations, i.e. collaboration models and citizens' self-organisation into trust networks that implicitly have a tendency to build social capital and therefore resilience. This applies for instance to T4.5 ("Impacts of Elbe flooding disasters on socially underprivileged groups and lessons for resilience improvement"), which describes and recommends new ways of collaborating to increase resilience in disasters, and T4.1 which recommends first responders to establish collaborative partnerships with intermediaries of people with communication challenges. The innovations from WP4 will be developed further in WP5 and WP6, which seek to validate the innovations.



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## List of Acronyms

AB	Advisory Board
BuildERS	Building European Communities Resilience and Social Capital project
D	Deliverable
DoA	Description of Action
WP	Work Package



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# D4.8: THE POLICY AND PRACTICE INNOVATIONS REDUCING VULNERABILITY OF EUROPEAN POPULATION TO NATURAL AND MAN-MADE HAZARDS

## 1. Introduction

### 1.1 Background

The overarching objective of the BuildERS project is to increase the resilience of European communities against both natural- and man-induced disasters by enhancing the social capital and risk awareness of its citizens in the face of the increased use of new technologies and media. A key ambition of BuildERS is to translate the scientific knowledge generated within the project to practical recommendations for actors engaged in crisis management.

This deliverable presents the most viable policy and practice innovations reducing vulnerability of European population to natural and man-made hazards, from the seven case studies in BuildERS WP4. WP4 has the following objectives:

- i) Tools and guidelines development, since the practicalities related to technologies and other tools must be field-tested, piloted or simulated before considering their up-scaling and transferability to other contexts;
- ii) Demonstrations of how the tools, techniques and technologies can be applied and utilized;
- iii) Empirical testing of what works and what does not work in practice; the cases also serve policy, strategy and other recommendations to be given in the latter work packages;
- iv) The multiple case studies also offer additional materials for the comparative analyses and supplement the field surveys and questionnaires offering a wider base for synthesis and increase the reliability and validity of conclusions drawn from the research;
- v) innovation identification and proof-of-concepts.

Each case study has produced an independent report. The aim of the seven case studies is to produce innovations reducing social vulnerability of the population at-risk of natural and man-made hazards, and devise strategies and measures for transferability of innovative solutions to hazard prevention in other eco-locations and contexts. The seven cases studies are:

Case study WP4.1 “Managing chemical spill emergency and mis-/disinformation through simulated responses” (Jukarainen et al 2021) provides solutions for how to tackle the vulnerability of people who’s cognitive and/or mental conditions might restrict them from perceiving the hazard danger and adopting self-protection measures, and who thus are exposed to higher life or health-threatening risks when a disaster strikes.



Case study WP4.2 " Vulnerability in post-disaster temporary housing" (Savadori et al 2021) is related to the post-crisis phase within disaster management. The unique contribution of D4.2 is that it provides a new understanding of disaster survivors' needs, which suggests new policies and practices.

D4.3 provides a Practice and product innovation "Applying mobile positioning data for more precise rescue planning and emergency management under cyber-hazard in Estonia" (Võik et al 2021a). Mobile positioning data (MPD) enables to evaluate the mobility patterns of people – where, when, how and how much people move and stay. This information is important in emergency management before and during disasters.

Case study WP4.4. "Integration of public data bases for identifying highly vulnerable people in need of relief prioritisation by the Estonian Rescue Board" (Oru et al 2021a) aims at building a vulnerability assessment tool that brings together the varied factors of vulnerability and their representations in public datasets.

Case study WP4.5 is the German case study "Impacts of Elbe flooding disasters on socially underprivileged groups and lessons for resilience improvement" (Schobert, Windsheimer, Gabel et al 2021) studies lessons learned from Flooding Disasters during 2002, 2006 and 2013 with special focus on underprivileged groups in urban (Dresden) and non-urban environments (in the State of Saxony).

Case study WP4.6 "Assessing Strategies for Improving Hospital Capacity for Handling Patients during a Pandemic" (Shahverdi et al under review), examines how key hospital units associated with emergency care of both routine emergency and pandemic (COVID-19) patients can use capacity enhancing strategies to increase the capacity to help patients.

Case study WP4.7 Indonesian Case "Using Mobile Operators' Data to Locate, Protect and Evacuate Tourists and Other Vulnerable Groups in Disasters" (Võik et al 2021) has developed a dashboard using mobile positioning data (MPD), for better awareness about individuals that have fallen into vulnerable situations.

Policy inputs from the seven cases will be reviewed in WP5, while practical innovations will be tested in W6 Stakeholder Forum.

## 1.2 Aims

The aim of the present deliverable is to synthesize results from the case studies in WP4 to extract the most viable policy and practice innovations reducing vulnerability of European population to natural and man-made hazards. The innovations address two groups: 1) national and European policy makers and 2) practitioners.

## 1.3 Reader's guide

WP4 builds on the previous WPs in the BuildERS project, and we start by describing how in section 1.4. Chapter 2 presents the theoretical approach and key concepts that are used in the project; first the concepts of vulnerability, resilience, social capital and risk awareness. These concepts are used in the case studies. Chapter 2 also presents a discussion of the innovation concept and discerns between different types of innovations that are used in the case studies. Chapter 3 presents each of the seven case studies in WP4, focusing on their background, the innovations, the users of the innovations and their validation and implementation. Readers who are already familiar with the case studies may skip this chapter. In Chapter 4, the empirical descriptions of the case studies from



Chapter 3 are analyzed in light of the analytical concepts from Chapter 2. The reader who wants to get a quick overview of the innovations in the case studies can go straight to section 4.2 and section 4.7. Finally, in section 4.8, we describe how the policy and practice innovations in WP4 will be taken further in WP5, which focuses on policy recommendations at EU, national and local level and in WP6, which focuses on nominating professional rescue and emergency management agencies for practice innovations tests.

## 1.4 WP4 builds on challenges identified in previous WPs

### 1.4.1 Responses to challenges identified in WP2

*What are the main needs for policy and practitioner innovations, stemming from the empirical studies in WP2?* The tasks in WP4 provide responses to challenges in emergency management in European countries that are identified in BuildERS WP2. Deliverable D2.2 “Case Country Analyses and a cross-country comparative Analysis of the Functioning of Disaster Resilience Systems” (Orru et al 2020; Orru et al 2021b) explores the institutional aspects of resilience governance in Estonia, Finland, Sweden, Norway, Germany, Hungary, Italy, and Belgium. This report indicates that societal resilience tends to be mainly fostered through information campaigns that shed the responsibility for preparation on individual, with little scrutiny of the scope of necessary capacities for coping in crisis.

Orru et al (2020) argue that the “self-help” version of resilience dominating among the studied countries may exacerbate vulnerabilities by reinforcing social inequality. By contrast, state-sponsored resilience activities, whereby authorities focus on making society as a whole resilient, may prove more equitable and effective in the long run. Orru et al (2020) conclude that in the studied European countries, individual vulnerability is conceptualised primarily related to the individual capacities: personal readiness and social conditions (poverty). Efforts to respond to the needs of vulnerable individuals are concentrated on the municipal level. Yet they tend to have limited guidance on how to assess individual vulnerability and what could be the ways to address these vulnerabilities in preparing for, responding to and recovering from crises. There is no systematic approach to building social support networks as part of resilience building. Authorities tend to have poor knowledge of which informal support groups exist and how to work with them practically in crisis situations.

WP2 highlights the communicative vulnerabilities (Hansson et al 2020) that may amplify the vulnerabilities in disasters, if not appropriately addressed by the institutions responsible for disaster management. Next to the socio-structural conditions (e.g. the measures to tackle false information), individual and situational circumstances need to be considered as hindering proper access, understanding and reacting upon information, and thus aggravating vulnerabilities (Hansson et al 2021; Torpan et al 2021).

Thus, we may conclude that WP2 indicates a need for European emergency management systems to develop: 1) A better understanding of the factors (including communicative) influencing peoples’ vulnerability in disasters, 2) Better indicators and tools for assessing individual vulnerability in disasters, and 3) Better strategies for reducing vulnerability and increasing resilience in disasters. In the present document, we will see that this knowledge is provided in the tasks in WP4, and we will discuss this further in section 7.

### 1.4.2 Responses to challenges identified in WP3

*What are the main needs for practitioner innovations, stemming from the empirical studies in WP3?* The tasks in WP4 also provide responses to challenges that are identified in BuildERS WP3. WP3 involves analyses of quantitative survey data from 14 European countries, in addition to qualitative



interview data with social care organisations. The quantitative survey data measures all the key theoretical concepts studied in BuildERS, e.g. vulnerability, social capital, resilience and risk awareness (cf. Nævestad et al submitted, Orru et al in press).

WP3 results indicate that particularly linking capital is important for the risk awareness and protective behaviours of socially marginalized groups. This suggests future efforts to improve societal resilience in general and the resilience of socially marginalized groups in specific should aim at improving linking social capital and trust. Additionally, WP3 results also indicate that vulnerability in disasters is situational and dynamic, and that what counts as a vulnerability in physical disasters (e.g. extreme cold, heat, storm) might not count as vulnerability in a “psychological” disaster that the COVID-19 pandemic also is. This indicates the importance of maintaining an intersectional and situational approach to vulnerability. Additionally, WP3 indicates that individual resilience provides protection against negative psychological impact of COVID-19.

As we will see in the present document, these key issues are the main focus of the tasks in WP4. These tasks provide specific analysis of the situational, dynamic and intersectional character of vulnerability in several different types of disasters. Additionally, they take these insights further by developing tools that authorities and emergency management organisations can use to map vulnerabilities in specific disasters, integrating a lot of data from different sources that have not been employed in previous vulnerability analyses. Moreover, a key focus in the tasks is to develop ways to improve linking social capital and trust in authorities’ disaster related communication. The rationale for this is to improve risk awareness, both among the general population and among actors involved in emergency management.

## 2. Theoretical background and key concepts

### 2.1 Theoretical approach in the BuildERS project

BuildERS aims to improve resilience within (especially) European societies and communities against crisis and disasters. The project aims to uncover who are the most vulnerable in European societies and for which reasons. This is done based on the assumption that risk awareness, social capital and preparedness are core aspects influencing vulnerability. As such, the overarching themes in the BuildERS model (Morsut et al., 2020) are vulnerability, social capital, and risk awareness. The underlying assumption is that individual, community, and societal resilience can be enhanced by addressing these three themes.

The overall project aim of BuildERS is to improve the resilience within (especially) European societies and communities against crisis. BuildERS aims to find out more about who are the most vulnerable in European societies and for which reasons. This is done based on the assumption that a) risk awareness, b) social capital and c) preparedness are core aspects influencing to vulnerability Common Vision; Morsut et al., 2020).

In doing so, BuildERS does not eliminate vulnerability as such – this is neither possible nor feasible, given the opportunity costs linked to building resilience and vulnerability rooted in life itself. However, BuildERS does seek to mitigate vulnerability caused by discrimination and neglect of essential needs, intrinsic potential and special life contexts.

The expected impact of the BuildERS project is alternative strategies, technologies and tools to measure and reduce vulnerability and give recommendations on how to achieve them. These will engage different actors from all levels of European disaster management (EU/national/local), with a



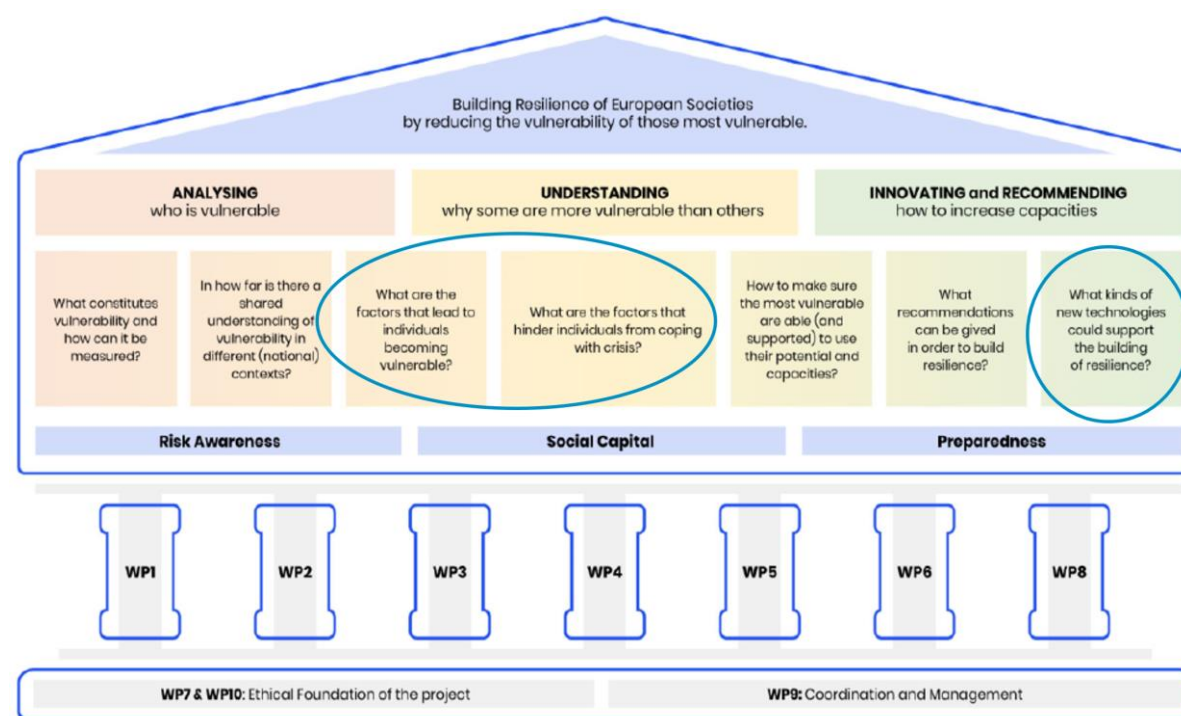


focus on policymaking officials, first responders, and civil society groups involved in crisis management activities. Furthermore, these recommendations will unfold an innovative potential for all phases of the crisis management cycle.<sup>1</sup> The vision of the BuildERS project is operationalized into the following questions (cf. Table 1):

Table 1. Operationalization of BuildERS vision (Source: BuildERS Common Vision)

ANALYSING who is vulnerable	What constitutes vulnerability and how can it be measured?
	In how far is there a shared understanding of vulnerability in different (national) contexts?
UNDERSTANDING why some are more vulnerable than others	What are the factors that lead to individuals becoming vulnerable?
	What are the factors that hinder individuals from coping with crisis?
RECOMMENDING AND INNOVATING how to increase capacities	How to make sure the most vulnerable are able (and supported) to use their potential and capacities as active agents in crisis?
	What recommendations can be given in order to build resilience?
	What kinds of new technologies could support the building of resilience?

The relationships between the BuildERS vision, objectives and WPs and the areas covered by WP4 is illustrated in Figure 1



<sup>1</sup> Consult Figure 4 in section 4.2 for an overview of the crisis phases addressed in the different case studies.

Figure 1 relationships between the BuildERS vision, objectives and WPs and the areas covered by WP4. Source: BuildERS Common Vision

## 2.2 Key concepts in BuildERS

WP4 builds on the theoretical BuildERS approach and the hypothesized relationships between key concepts in BuildERS, as outlined in WP1 (Morsut et al 2020; Morsut et al 2021). The relationships between these key BuildERS concepts are illustrated in BuildERS theoretical model (cf. Figure 2).

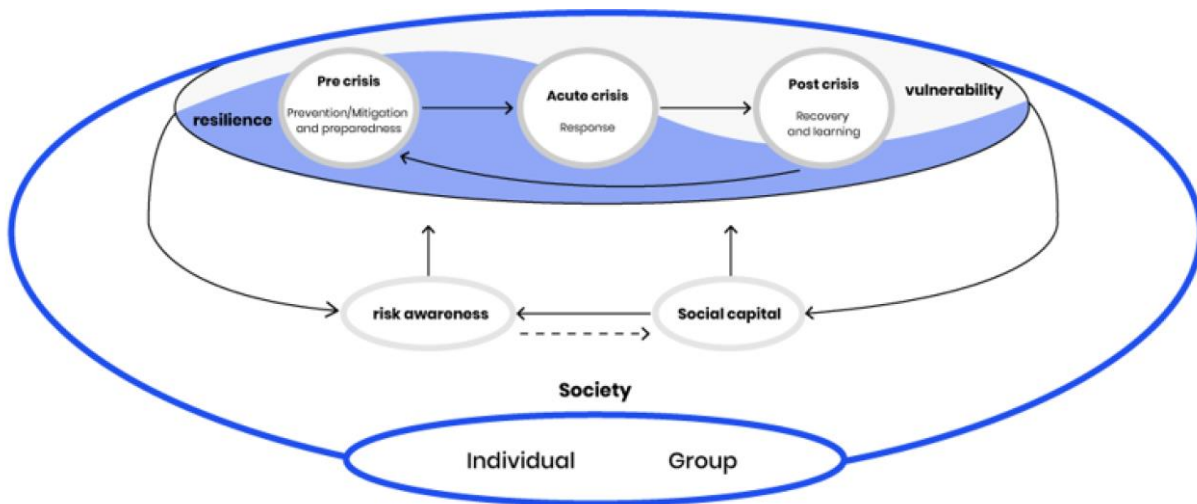


Figure 2 Final version of the BuildERS model. Source (Morsut et al 2020).

The oval at the bottom of the model includes individuals and groups explored by BuildERS in a given society in WP3 and WP4. Individuals tend to be aggregated in groups (see D1.3), which are/become vulnerable by cultural and social conditions. Vulnerability and resilience are intertwined and, as such, represented in a sort of yin and yang dyad. Resilience and vulnerability manifest in the pre/acute/post crisis phases according to a mutual interdependency. Risk awareness and social capital are placed in the outer circle. The relation of resilience and vulnerability with social capital and risk awareness is exemplified by the arrows, while there is a stronger relation between social capital and risk awareness, than vice versa, as the scholarship has pointed out (cf. Morsut et al 2020).

The disaster risk management cycle is defined through four phases: 1) Preparedness, 2) Response, 3) Recovery and 4) Mitigation. (In Figure 4 in Chapter 4.2, we show how the different case studies relate to the disaster risk management cycle).

### 2.2.1 Vulnerability

Vulnerability is generally interpreted as being prone or susceptible to damage or injury (Wisner et al., 2004: 11). The BuildERS framework defines vulnerability as the dynamic characteristic of entities (individuals, groups, society) of being susceptible to harm or loss, which manifests as situational inability (or weakness) to access adequate resources and means of protection to anticipate, cope with, recover and learn from the impact of natural or man-made risks. The BuildERS framework understands vulnerability as a characteristic of potentially any individual at a certain point in time, when they fall into a situation that renders them vulnerable. BuildERS aims to find out more about those situations that render individuals vulnerable. In its approach, BuildERS starts from the currently widely used definition of vulnerable groups (e.g. persons with mental and/or physical disabilities, the

poor, the elderly etc.), and takes a look at the diversity within them in order to find out which situations there are, that make individuals vulnerable.” (Morsut et al 2020, p.32).

Vulnerability refers to an understanding of disasters as not just being the result of an extreme event, but of an extreme event interacting with a vulnerable society (Wisner et al., 2004). The BuildERS framework differentiates between two main perspectives on vulnerability. On the one hand, vulnerability may be seen as an intrinsic and stable characteristic of an individual, a group or a community. In this ‘vulnerable groups’ narrative, vulnerability is cast as a characteristic attribute of certain societal groups due to their specific conditions (Sparf, 2016; Tierney, 2019). According to this view, groups such as people with disabilities, elderly or those living in poverty are considered vulnerable and tend to be seen as such not only in specific events but in general. There are also strong arguments against taking such an approach due to its tendency of vulnerability determinism (Gabel, 2019). This approach tends to overlook that those who are often not considered vulnerable might become vulnerable due to certain situations they are in.

On the other hand, vulnerability may be seen as situational and relative, and thus dynamic, phenomenon (Hilhorst & Bankoff, 2004; United Nations, 2015). This view argues that vulnerability is often in flux and cannot be reduced to a single metric to classify (Adger, 2006). This dynamic perspective of vulnerability reveals two important aspects of vulnerability: (a) vulnerability is dependent on the exposure to the crisis, the interplay of circumstances and individual conditions including abilities to respond without suffering, and (b) the interplay of different disadvantages which lead to a person being vulnerable, and how these factors of vulnerability change over time (Tierney, 2019). Vulnerability involves “a combination of factors that determine the degree to which someone’s life, livelihood, property and other assets are put at risk by a discrete and identifiable event (or series or ‘cascade’ of such events) in nature and in society” (Wisner et al., 2004: 11). As such, vulnerability can better be understood as a result of intersectional and interdependent factors that produce socially differentiated impacts. This is referred to as the situational character of vulnerability.

**An intersectional approach** to vulnerability assessment is needed as one’s exposure and the interplay of different disadvantages may lead to a person being differently vulnerable at different points in time and space (Morsut et al 2020; Kuran et al 2020). This approach helps to differentiate between the specific ways in which structural factors such as socio-economic inequality, inadequate preparedness policies as well as situational and temporal aspects may exacerbate vulnerabilities in, for instance, specific socio-demographic groups. To what extent a person with a certain impairment becomes vulnerable depends on the specific situation (hazard, strength, point in time, duration) but also on existing social structures and the extent to which those empower these persons (Gabel, 2019; Mechanic & Tanner, 2007; United Nations, 2015; Wisner et al., 2004).

### 2.2.2 Resilience

Resilience is derived from the Latin word *resilire*, which means to bounce back, jump back (Alexander, 2013). In psychology, it is used to describe the ability to adapt and deal with difficult events. However, the concept is not limited to the mental state of individuals, but is also used to describe the adaptability and resources in dealing with crises of organizations, societies, etc. BuildERS sees resilience as the processes of proactive and/or reactive patterned adjustment and adaptation and change enacted in everyday life, but, in particular, in the face of risks, crises and disasters. As for the resilience that state or organisations can enable, there are important considerations if individuals can expect that the state deals with crises on behalf of the individual and aims at getting ever better prepared or if individuals can expect that the state just enables and facilitates individuals’ ability to deal with their own risks. This discussion becomes crucial when the state or an organisation aims at helping vulnerable groups.”



(Morsut et al 2020 p.65). Similarly to vulnerability, resilience is considered a dynamic concept. In this regard, specific measures to increase resilience might not benefit everyone and might even raise new challenges for others.

## 2.2.3 Social capital

Social capital is defined as networks, norms, values and trust that entities (individuals, groups, society) have available and which may offer resources for mutual advantage and support and for facilitating coordination and cooperation in case of crisis and disasters (Morsut et al 2020). Social capital is usually traced through three modal dimensions - bonding, bridging and linking forms (Falk, 2018). Bonding social capital refers to relations between individuals who are similar to each other and emotionally close, such as friends or family. Strong bonding social capital proves useful in providing social support and assistance, especially during and after a disaster (Aldrich & Meyer, 2014). Bridging social capital allows for 'linkage to external assets', connecting individuals across various ethnic and racial groups, bringing together different groups in communities (Aldrich, 2011). Linking social capital connects regular citizens with those that hold positions of authority and power - those who often can distribute scarce resources (Aldrich, 2011). Strong social networks may also prove as a source of vulnerability during disasters (Morsut et al, 2021)

## 2.2.4 Risk awareness and risk preparedness

The BuildERS framework distinguishes risk awareness as a) a collective (groups' and communities') acknowledgment about a risk and potential risk preventing and mitigating actions, fostered by risk communication b) the Slovic's tradition of considering risk perception as individual and intuitive judgment and the risk awareness that is shaped at group level.

Misinformation and disinformation may increase risks and vulnerabilities and complicate the work of crisis managers and authorities. The first is intentional, the other not. On the other side, the way authorities communicate and the means they use to communicate about risks to people need to be adjusted to the fact that audience is not homogeneous. (Morsut et al 2020, p.56).

Risk awareness and risk preparedness are also factors influencing vulnerability and resilience: people have to get information about risks and crises and they have to understand them and be able to act on them. Especially the latter aspect is of importance here, as one can distinguish between (a) a conscious ignorance of risk and (b) the inability to act according to a known risk.

## 2.3 What is innovation?

### 2.3.1 Definitions and understandings of innovation

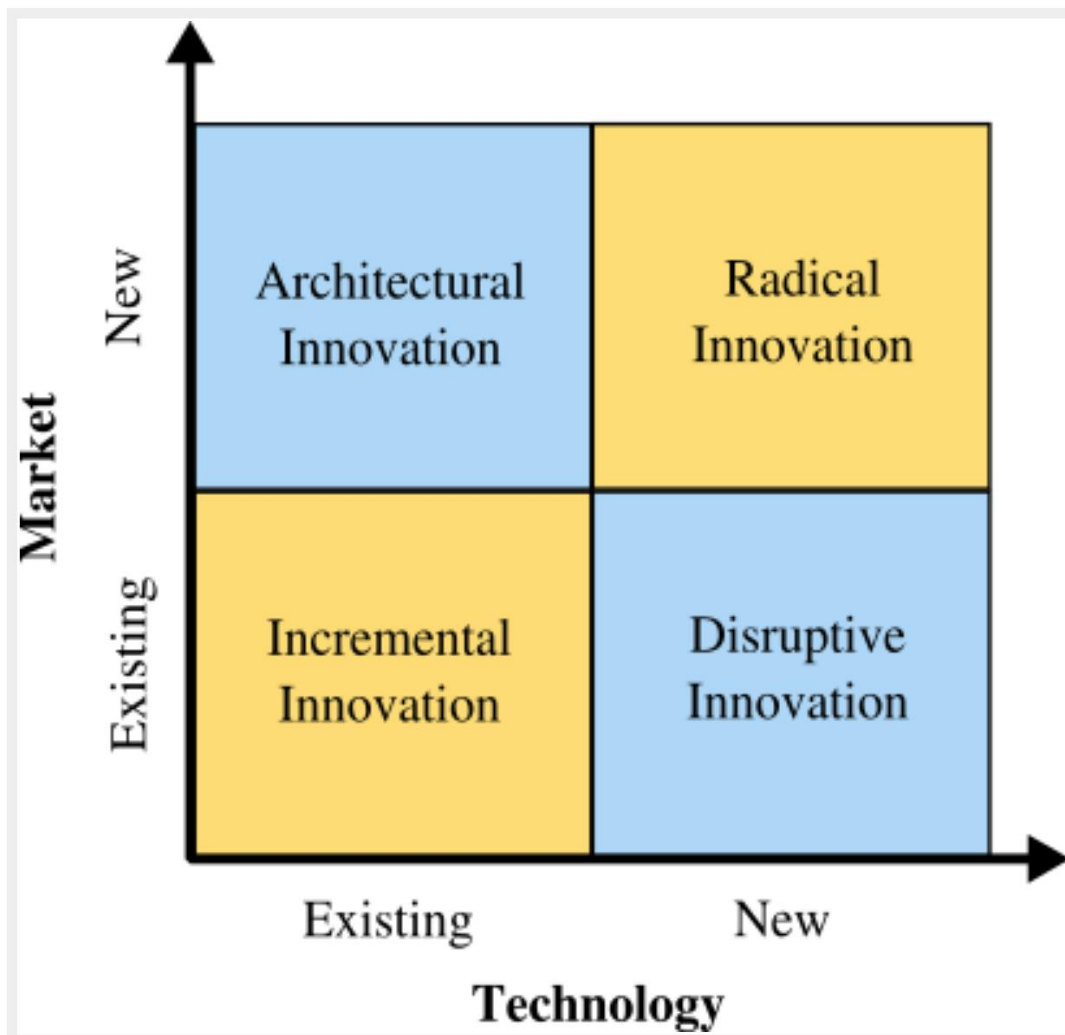
Innovation is defined in a range of different ways, and there is no agreement as to how it should be defined. Jordan and Huitema (2014) cite the Oxford Dictionary, which states that: innovation can be either a thing (a noun) or a process (a verb). This means that innovation can refer both the result of innovating ("a thing newly introduced"), or it can relate to the act of innovating ("the introduction of a new thing; the alteration of something established") (Jordan and Huitema 2014: 389). In the present deliverable, we focus on innovation as the "result of innovation", i.e. the introduction of a new thing, process or the change of something. One of the most basic definitions of innovation is that it is "an idea, practice or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). This indicates that the context is key to defining the innovation.

Another relevant issue is related to defining "how new" and different something should be to count as an innovation. Different levels of innovation can be described based on two dimensions: the use of technology and the market: 1) Incremental Innovation (Existing Technology, Existing Context), 2)





Disruptive Innovation. (New Technology, Existing Context), 3) Architectural Innovation. (Existing Technology, New Context), 4) Radical Innovation. (New Technology, New Context) (Henderson 1990).



Figur 2.1 Four types of innovations. Illustration by Techblog (2021) based on the research of Henderson (1990).

We can adapt this framework to our setting by using technology widely, to also include “concepts, perspective, method” etc. Likewise, market can be substituted with “context”.

Discussing the different definitions and types of innovations, Jordan and Huitema (2014) discerns between three aspects of, or perspectives on innovation:

- 1) Invention: Exploration, novelty, experimentation, tinkering, discovery, recombination, new to the world,
- 2) Diffusion: Learning, transfer, adoption, exploitation, new to a particular jurisdiction or agent,
- 3) Effects: Impacts, outcomes, substantial or radical change, disruption.

The purpose of these aspects is to sidestep the conceptual discussion of what innovation is and how it should be defined, and rather provide an overview of the key aspects of innovation, indicating that it means several things.

### 2.3.2 What is an innovation in BuildERS?

The BuildERS project discerns between four types of innovations: 1) Product and market innovations, 2) Process innovations, 3) Social innovations and 4) Scientific/concept innovations (cf. BuildERS DoA).

**1) Product and market innovations** are technologies and tools that may be used by administrations, companies or even NGOs and citizens for their resilience build-up. Product innovations are for instance: new products, methods, and algorithms to utilize mobile positioning and static database data; new visualization methods. Product innovations may enable market innovations when applications can be marketed and applied to new geographical or societal areas. This is a type of innovation that primarily can be used by practitioners.

**2) Process innovations** are processes and procedures for decision-making, particularly pointing out best or at least workable practices learned from others. Process innovations may, for example, be: new processes, decision-making mechanisms and procedures for the public sector as well as for unofficial first-responders. This is a type of innovation that primarily can be used by both practitioners and policy makers. Practitioners can use this type of innovation to e.g. train for crisis management and policy makers can use this type of innovation e.g. to inform and improve their policies by including more groups in the process. We may divide process innovations into several subtypes. One of these is management innovation, which is the introduction of new management practice, process, structure, or technique to improve the organization's ability to further organizational goals (Chen et al 2020). Another one is policy innovations, which are novel processes, tools, and practices used for policy design and development that result in better problem solving of complex issues (Brookfield Institute 2018).

**3) Social innovations** are e.g. collaboration models and citizens' self-organisation into trust networks that implicitly have a tendency to build social capital and therefore resilience. The social innovations include: new collaboration models through learning from others and exchanging ideas; they also entail extended trust networks. This is a type of innovation that primarily can be used by citizens. Practitioners can also use this type of innovation to e.g. train for crisis management and policy makers can also use this type of innovation e.g. to inform and improve their policies by including more groups in the process.

**4) Scientific innovations** come from the yet untried attempt to conceptually connect social capital, resilience, risk awareness and vulnerability. This can also be regarded as conceptual innovation: linking resilience with the concept of social capital, which is the cornerstone idea in BuildERS and which will extend the concept of resilience beyond technical factors, such as technology, organisational structures and managerial processes. This is a type of conceptual or abstract innovation which first and foremost is used by scientists, but it can also be used by policy makers as a background to, and as a way of informing and improving policies.

**5) Conceptual innovation** is the final type of innovation. This is the introduction of a new worldview, which involves reframing a phenomenon, seeing it in a new light and understanding it in a new way. Processes of reframing typically involve a change in the conceptual setting in which a phenomenon is experienced, and the placing of it in another frame that fits equally well or even better and thereby changes its meaning (Berg, 1985). Thus, reframing brings forth new frames of reference that may guide new interpretations and new actions. This is also related to the concept of paradigm shift. Reframing a phenomenon is important, as it motivates and legitimizes new strategies and actions.



### 2.3.4 Framework for defining innovation types in the tasks of WP4

Key questions when it comes to the definition of innovations in each of the tasks in WP4 are related to: a) Who is the actor(s) that is going to use the innovation? b) What is the activity or process that the innovation relates to? c) What are the products or the service delivered as an outcome of this process (that the innovation improves)?

To make a framework to answer these questions, we have made a model of actors involved in emergency management at different analytical levels:

Table 2 Model of emergency management actors, emergency management activities and types of innovation

Emergency management activity	Emergency management activity	Type of innovation
I) Policy makers	Make emergency management policies, which are described in formal documents, and which are the basis of training of emergency personnel.	Policy innovation, Social innovation, Conceptual innovation
II) Emergency management groups	Use these policies in practice in specific disasters, when they organize emergency management in specific situations.	Management innovation, Product innovation (e.g. technology), process innovation
III) Individual first responders (police, ambulance workers rescue workers)	(Are trained in accordance with the principles of the emergency management policies.) Their activity in emergency management is to have direct contact with the victims, provide information, rescue etc.	Product innovation (e.g. technology), process innovation (e.g. new methods)
IV) Social workers and NGOs	Are also involved in the disaster management process, e.g. before (in community building projects, preparation activities, during (provide aid). They also have a central role in supporting recovery.	Product innovation (e.g. technology), Process innovation (e.g. new methods) Social innovation (e.g. involvement of NGOs in policy development)
V) Private citizens, or "organized" citizens	Are more or less aware of the emergency management policies, and they are to different degrees informed and involved in the process of emergency management, before, during and after disasters. Are involved in all activities in emergency management, e.g. before (preparation), during (self-rescue) and after (rebuilding, rehabilitation).	Process innovation (e.g. new methods), Social innovations (new processes of involvement of citizens in policy development)

Innovations in emergency management may relate to all these different groups at the different analytical levels, and may address one or more of the processes and activities that the groups are involved in.

### 2.3.5 Who is the audience of the BuildERS innovations?

Communicating project results, BuildERS wants to address a broad audience including civil society organizations, citizen groups, official first responders, NGOs, policy and decision makers at the European, national and local level (BuildERS Common Vision).



The aim of the current deliverable is to extract the most viable policy and practice innovations reducing vulnerability of European population to natural and man-made hazards. The innovations will be addressed to two groups: 1) National and European policy makers and 2) practitioners. But who are the policy makers and practitioners?

***The target groups of the policy innovations.*** The resilience policy recommendations in BuildERS are targeted for decision makers and policymaking officials at all levels, who are responsible for the strategic planning and drafting of laws. We design our recommendations for all stages of the crisis management cycle (Preparedness, Response, Recovery and Mitigation ). (a) policymaking officials at all levels, (b) first responders, and (c) representatives of citizen groups/NGOs (BuildERS Common Vision).

***The target groups of the product and process innovations.*** The practical product and process innovations, such as process guidelines and products, are primarily targeted for the first responders (civil society organizations, civil protection authorities, fire and rescue services, law enforcement, health care, social services, and psychological support in crisis) and other agencies responsible for crisis management (to empower individuals). In addition, these innovations benefit their strategic partners, like the non-profit and civil society organizations active in inclusive and participatory resilience building.

***The target groups of the scientific innovations.*** BuildERS scientific contributions and innovations focus especially on the research community, scholars and students (European studies, IR, risk analysis, crisis management, DRR, resilience, human geography, psychology, ethnography, cultural and media studies, engineering and information technology).

## 3. Innovations in the case studies<sup>2</sup>

### 3.1 Training concept for first responders

#### 3.1.1 Background of the innovation

The full account of Case study WP4.1 “Managing chemical spill emergency and mis-/disinformation through simulated responses” is provided in Jukarainen et al (2021). We refer to it as T4.1 in the rest of the text.

In every crisis-situation, the interface between the front-line emergency responders and the people at risk is critical for protection and survival. Consequently, the quality of the interactions between the front-line rescuers, law enforcement and the people in danger is crucial for preservation of safety and security.

This is a larger conversation not only related to crises. The "Community-Oriented Policing (COP) in the European Union today" EUCPN Toolbox 14 from year 2019 states for example that "research shows that the social context has a major impact on the meaning, interpretation and implementation of policing practices. In regions where there is historical distrust, restoring trust may take decades. Therefore, COP should be seen as part of a larger shift from a police force to a police service with the police operating for and in the community." and that "it is important that sufficient time is taken for the community to get to know the police officers and for the police to understand how the community

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<sup>2</sup> For an overview of the different types of crises, different types of vulnerable groups, different key agents, different areas and different solutions in the seven case studies, please confer Table 5 in section 4.2.





operates. Encounters between police and public are crucial for the quality of the relationship." Effective, appropriate and timely communication is vital for a successful COP approach. COP should encompass a variety of innovative approaches to reach hard-to-reach target groups that may have little social capital." Of course, COP focuses more on crime prevention and preservation of security in communities. Trust is nonetheless an essential element in risk and crisis communication. It seems that currently, there is little education or training that focuses on the communicational needs or interaction related vulnerabilities in communities for law enforcement. The same can be said about rescue services.<sup>3</sup> Unfortunately, training on how to address the needs of individuals with disabilities during emergency situations is not included in the firefighters' initial training.

The focus of T4.1 is on risk and crisis communication with persons who have different types of difficulties in communication and/or social interaction. In the BuildERS project glossary, risk communication is defined as "the process of exchanging or sharing risk-related data, information and knowledge between and among different groups such as scientists, regulators, industry, consumers or the general public". Crisis communication is "collection and processing of information for crisis team decision making along with the creation and dissemination of crisis messages to people outside the team." (Morsut C. et al. 2020: 113). As demonstrated in D1.4. one of the key sources of vulnerability in disasters is poor accessibility and difficult to follow communication due to official information provision's poor consideration of the diverse audiences (Hansson et al 2020). The research of police encounters with individuals who experience the aforementioned difficulties indicate that there is a need to increase knowledge, skills and positive attitude toward individuals with communicational vulnerabilities in general. (Jukarainen et al 2021: 20-21). These skills are equally and especially useful in crises.

Reasons behind the communication and/or social interaction difficulties that this task focuses on are various: injuries, inherited disorders. For the case study the most common factors, where prevalence is increasing in Europe were selected: mental health conditions (like anxiety disorders, depression, post-traumatic stress disorders), brain disorders/neuropsychiatric disorders [like attention deficit hyperactivity disorder (ADHD), Autism Spectrum, Alzheimer's disease, Parkinson's disease], and intellectual disabilities. Common for the individuals that this task focuses on is that their challenges in terms of communication and/or interaction may remain unnoticed, as they are not always "visible".

This has both practical and ethical implications. First, if the interaction and communication fail, persons' needs in crisis may be "side-lined" and/or they may not be able to ask for help, tell that they have been injured or are in pain, or that they have understood the safety instructions correctly. Second, according to research, individuals with mental health conditions and/or brain disorders are more prone to believe misleading and/or false information (misinformation)<sup>4</sup> than control groups. This

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<sup>3</sup> The EU project Inclusive Emergency is producing material for rescue services on 4 different groups due to the same lack of education/training. On their website it states that: " According to the European health and social integration survey (EHSIS), in 2012 there were more than 70 million people with disabilities in the EU-27, equivalent to 17.6 % of the population. The EU's Charter of Fundamental Rights prohibits discrimination on the ground of disability. The rights of persons with disabilities in the EU are also protected by the UN Convention on the Rights of Persons with Disabilities (CRPD), accepted by the EU in 2010. Article 11 of the CRPD refers to the safety and protection of persons with disabilities in conflict and emergency situations. To enforce this, it is indispensable that firefighters are trained on how to address the special needs of individuals with disabilities during emergency situations.

<sup>4</sup> In the BuildERS glossary, misinformation is defined as "confusing, false or misleading information, without the intent to mislead". Morsut C. et al. (2020). D1.2 Final report of the unified theoretical framework on the



is because certain cognitive functions such as verbal fluency<sup>5</sup>, analytical thinking and numeracy skills<sup>6</sup> are related to the accuracy of judgement and decision-making, and our thinking styles: whether they are more intuitive than reflective<sup>7</sup> (Matei et al. 2020; De keersmecker and Roets 2017). It is also important to note that correspondingly, exposure to false information about the risk and/or crisis may worsen mental health and wellbeing: A recent study found that false information about COVID-19 pandemic was associated with psychological distress including anxiety, depression, and post-traumatic stress disorder symptoms (Lee et al. 2020).

Third, we should follow the principles of accessible and inclusive crisis management, advocated in the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR 2015). Consultations to develop crisis preparedness plans need to ensure that the discussions and associated materials are accessible to people with various disabilities. In addition, communication with first responders needs to be accessible to persons with disabilities, and persons with disabilities need to have the devices they require to communicate with first responders. (GFDRR 2018)

All the above-mentioned means that the first responders and other authorities responsible for risk and crisis communication need to give attention to the various communication- and interaction-related needs of these individuals. We should avoid simple categorizations of sub-groups with “special needs” like the “disabled” or “mentally ill” (Kailes and Alexandera 2007). Even if we encourage the first responders to consult the care takers and service providers for advice of the different – and often person-specific – needs, our aim is to improve the first responders’ competencies to communicate with the persons themselves. After all, first responders are, as already the term indicates, first to inform, and provide guidance for the citizens. They are also responsible for raising awareness of risks. The issue of training first responders in alternative communication styles is also addressed in WP5.1’s policy recommendation 5.3.1 “Target strategies to reach the most vulnerable” (Rhinar et al 2021: 49).

### 3.1.2 Innovation

Task 4.1 has innovated training for the first responders – especially for the police and the rescue services, to improve their risk and crisis communication competencies. The training is built on an idea of competence-based learning. This means that more important than formal certificates are the knowledge, skills, attitudes, and behaviour that have relevance in the first responders’ everyday work. Although many associate competence as just practical skills, (truly) competent individuals can reflect upon their knowledge, their skills, and their functioning (Westera 2001). These competencies are both generic (communication and interaction skills) and profession specific (collaboration skills, understanding accessibility requirements for crisis-related information)

The case study has engaged a variety of stakeholders in the process of developing a training scheme for first responders, on how to deal with people with different types of communication and interaction difficulties: first responders, NGOs, people with personal experience of communication-related

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concepts of risk awareness, social capital, vulnerability, resilience and their interdependencies, BuildERS project, p. 112

<sup>5</sup> Verbal fluency refers to word fluency: ability to produce and understand letters, words, and their categories.

<sup>6</sup> Numeracy skills help us to understand numbers, their magnitude and relationships and various kinds of mathematical operations.

<sup>7</sup> Intuitive thinking means understanding something instinctively: having “a gut feeling”, without cognitive reasoning and rational decision-making.



challenges, teachers, students, technology developers and CBRNE experts. This training scheme involves a range of key principles, in addition to specific learning outcomes and learning content.

**Key principles:** Among the key principles developed is that, in an acute crisis-situation, first responders need to be able to identify also such vulnerabilities that are not visible or clearly communicated. In this context, the first responders' must detect and realize that they:

- 1) Need to adopt specific bodily and verbal communications to deescalate the situational tension, and manage the problem through providing appropriate assistance tailored to overcome the recipients' mental and cognitive challenges, and
- 2) Face a situation involving diverse members of society which have different capacities and needs in terms of social interaction and communication
- 3) Defuse the crisis at hand, restore the law and order and, increase the citizen safety.

**Training concept:** This task has co-created a concept for training for the first responders to improve their knowledge of mental health conditions, neuropsychiatric disorders, and intellectual disabilities, and increase understanding of their impact on communication and social interaction. The development of the training has been based on the following key findings, identified in the co-creation process with the different stakeholders:

1) First responders need to address the digital divide in their risk and crisis communication. Publishing crisis-related information in social media and internet platforms serves nowadays a large majority of individuals and communities. However, social media messages and online releases may not reach those who have difficulties in understanding and/or acting upon information due to a variety of mental health conditions, neuropsychiatric disorders, and/or intellectual disabilities.

- First responders need to combine external communication with door-to-door interaction, text messages, and broadcasting in radio and TV
- To gain additional resources for better outreach, first responders should collaborate with other service providers (like the psycho-social support services) and intermediaries of persons with difficulties in terms of communication and/or interaction.

2) First responders need to increase accessibility of information. To address information overflow and to ensure that those with communicational vulnerabilities have access to and can understand crisis information messages have to be formulated in such a way that they are understandable to all.

- First responders need to increase their knowledge and capacity on alternative and additional communication means and methods such as plain language and easy-to-read language.

3) First responders need to increase inter-agency and multi-professional collaboration with intermediaries. People who have varying communicational needs often have service providers in their lives that understand their communicational (and other) needs. The first responders would be able to better accommodate the needs through better preparedness and cooperation.

- First responders should formulate collaborative partnerships with service providers and other relevant instances who commonly belong to the social networks of individuals with communicational requirements.



- Special attention should be paid to individual's and intermediaries experiences of situations where misunderstandings have previously happened and to situations where they have experienced where they have not been heard or given information in the right format.

Through co-creation, T4.1 has designed learning outcomes (and respective learning contents) for the first responders' training, based on the abovementioned areas of improvement. First, students will learn how to interact and have face-to-face encounters with persons, who have various kinds of difficulties in social interaction and/or communication. Second, students will gain knowledge of accessibility requirements for web contents and what are easy-to-read language and plain language. Third, they will learn to use the potential of an individuals' social network including their connections to the different service providers. In practice, this would mean that first responders (like police or rescue services) engage in multiagency and multi-professional work to reduce individuals' vulnerabilities.

The face-to-face interactions with police and rescue workers, fire brigades etc., will reduce the harm risks for the hearing-impaired people, individuals with mental impairments, poor language skills, and extremely overactive and suicidal persons, because they will:

- Receive help based on their needs to protect themselves (keep windows/doors closed, and/or take other precautions)
- Refrain from behaviors that might inflame the crisis severity (hysteria and/or panic-driven reactions), and
- Maintain trust in police and/or rescuers abilities to restore peace, order and citizens' mental and physical wellbeing.

More competent first line responders and recruitment of external resources, have the potential of reducing post-traumatic stress and making the workload in acute situations more manageable. The strengthening of social capital through receiving appropriate individualized guidance, assistance and recommendations will also reduce the vulnerability of disaster-stricken groups, and those dependent on help from aid agencies. These competent and situation aware behaviors increase the quality and the strength of vertical network links connecting the law enforcement functionaries, and the rescue and relief agencies with citizens in danger and their reference networks.

The training is comprised of two thematic modules, which teachers and trainers can integrate in their course content and to suit specific qualifications. This way the training concept will serve many different instances across Europe and be easily modified for the use of other first responder organizations.

The two training modules are:

Module 1. External communication and interagency collaboration

Module 2. Interaction and communication with people who have special needs in terms of communication

The learning objectives and the learning outcomes are based on the Bloom's taxonomy (Bloom et al 1956, 1994.) The learning outcomes focus on the student and contain measurable evaluation criteria so that the students know how and what is assessed.



### 3.1.3 Who are the potential users of the innovation?

The training is designed for practitioners at three levels:

- 1) For the communication specialists and duty commanding officers, responsible for communication. Those who would be activated in crisis communication within law enforcement agencies and possibly other first responder organizations; those responsible for all or most communication activities in a high pressure or crisis situation.
- 2) For the field operations officers, responding to emergencies and interacting with citizens. We may also refer to these as first responders, who are trained professionals who are among the first to aid in emergencies: firefighters, law enforcement officers, paramedics, emergency medical technicians EMTs.
- 3) For students of basic vocational training. Students in basic or bachelor level law enforcement educational setting who encounter the variety of the population in their face-to-face interaction while on duty.

The training comprises of two thematic modules, which teachers and trainers can integrate in their course contents. This adds flexibility in the implementation and lowers the threshold of including “externally designed” methods and materials in teaching. It will also support the idea of mainstreaming the principles of accessible and inclusive first responder services in other education. However, some of the training materials and methods are designed to be utilized specifically in the continuing education / in-service training and some as part of the basic vocational training.

The training aims at increasing students’ knowledge of different types of difficulties in communication and/or social interaction and providing practical skills to be applied in challenging situations. As it is a proof-of-concept, it serves as a “starter kit” type of repository for teachers and trainers, who may find inspiration to design even more developed forms of training.

### 3.1.4 Validation and implementation

The training concept development was co-created and comprised of several sequential and iterative stages of both innovation and validation/quality assurance/testing (cf. Jukarainen et al 2021 for details).

Although most training materials and methods have been designed within the task 4.1, the co-creation of the training concept will continue throughout the BuildERS project. After the initial planning has been completed, T4.1 will engage BuildERS first responder project partners (Estonian Rescue Board and the Civil Protection Department of the Autonomous Province of Trento) in the final validation of our pedagogical choices: expected learning outcomes and methods. In late autumn 2021, T4.1 will carry a test of the concept in the e-learning platform (LEEd) of the European Union Agency for Law Enforcement Training (CEPOL).

The teachers at the Finnish Police University College have expressed their interest to utilize the modules as part of their teaching. Validation within the Police University College (PUC) takes place in autumn 2021. It is an iterative process where the training material is presented to teachers from different fields responsible for bachelor level education and further training. These discussions have helped construct the material so that it is usable and useful in different educational contexts and in different subjects. The discussions have also been useful in fine-tuning the module structure. The iterative process makes the use of the training material more flexible also in different European contexts and will guide the construction of the training course available on the European Union





Agency for Law Enforcement Training (CEPOL) LEEd platform where it is available for European law enforcement officers in December 2021 where it will be further validated.

## 3.2 New understanding of disaster survivors' needs

### 3.2.1 Background of the innovation

The full account of Case study WP4.2 "Vulnerability in post-disaster temporary housing" is provided in Savadori et al (2021). We refer to it as T4.2 in the rest of the text.

The return to normality is an important part of the disaster resilience cycle because it strengthens resilience to future disasters. Unfortunately, however, it is a part of the disaster cycle that gets little attention because it occurs after the acute phase of the emergency has passed and the worst seems to be over. Instead, new vulnerabilities can arise in the post-crisis phase in disaster-affected communities that risk practitioners and policymakers need to be aware of so to plan innovative actions to reduce them.

The problem addressed in Task 4.2 "Vulnerability in individuals displaced in temporary housing after an earthquake" is related to the post-crisis phase within disaster management. Through a detailed analysis of physical, psychological, and economic well-being conditions of populations evacuated from their home due to a disaster, it was possible to identify the most significant aspects predictive of individual vulnerability in the management of post-crisis emergencies.

Professional rescue and emergency management agencies are the first to respond to disasters and quickly intervene in the devastated areas. When they leave, however, the land has been secured, but the community as a whole has not been fully restored. As a result, people whose homes were affected by the disaster and housed in temporary housing solutions might lack the sense of community they had before and become vulnerable individuals. This forced transition into temporary housing solutions is widely used in emergency management around the world, but its effects on the well-being of evacuated individuals have been studied using a narrow, non-integrated perspective.

Temporary housing, for example, is known to be a source of trauma, psychological distress, impaired recovery, and low well-being (e.g., Kukiara et al., 2014). Moreover, temporary housing is a frequent condition in many types of disasters (earthquakes, volcanic eruptions, hurricanes, landslides). Although temporary housing is a transitory (momentary) condition, it can also last for a long time, even years (Chang, 2010). Additionally, temporary housing is almost always a source of complaints from displaced people, often quite intense. According to some scholars, public expressions of discontent with the housing provided are an almost universal feature of significant disasters (Quarantelli, 1995). However, since virtually everyone who needs accommodation eventually gets it, then the degree of satisfaction with housing among the disaster survivors depends on specific aspects of the displacement. According to some researchers, temporary housing plans show recurrent problems, such as cultural or climatic inadequacy, bad location, social problems within the camps, delays related to the purchase of housing units, site finding, and lack of organizational skills, such as inconsistencies in the application of standards and requirements and sudden and unannounced changes in displacement policies (Johnson, 2007; Quarantelli, 1995).

Having experienced a displacement in a temporary solution is often accompanied by negative psychological consequences (Cofini et al., 2015; Kukiara et al., 2014). Whereas psychological distress is often more present in older and less educated disaster-affected populations, in other cases,



the factors contributing to a higher presence of post-disaster stress are of economic type (economic difficulties and unemployment) (Gigantesco et al., 2013).

The psychological consequences of temporary housing can be quite severe as it happened in the aftermath of Hurricane Katrina (August 29, 2005), when about one million inhabitants of the metropolitan area of New Orleans were displaced, and all residents of New Orleans (about 455,000 people) were forced to evacuate for 33 days from their homes. Some took refuge with their friends, some rented a house, but others used temporary caravans provided by the government. A strong positive correlation emerged between the symptoms of post-traumatic syndrome (PTSD) and the fact that the respondent was using the temporary trailer at the time of the survey instead of other housing solutions (DeSalvo et al., 2007).

However, these studies do not provide a broad view of the phenomenon since they investigate limited aspects on a case-by-case basis. This limitation prevents the discovery of the root causes of the psychological distress caused by this post-crisis intervention. Task 4.2 "Vulnerability in individuals displaced in temporary housing after an earthquake" overcomes this limitation by incorporating in the analysis not only psychological indicators of well-being but also quantitative indicators of the phenomenon from the physical, social and economic perspective. For example, it measures disaster preparedness, socio-economic status, and the size and strength of social networks before and during the displacement (see D4.2 for details). By doing this, Task 4.2 "Vulnerability in individuals displaced in temporary housing after an earthquake" adopts a broader frame than previous studies enabling to provide an integrated approach to system management.

### 3.2.2 Innovations

The unique contribution of D4.2 is that it provides **a new understanding of disaster survivors' needs**, which suggests new policies and practices. This new understanding is developed in an empirical study of three particularly disastrous events that occurred in Italy in the last 15 years where the temporary housing solutions were adopted, specifically in the 2009, 2012, and 2016 seismic disasters. In all three disastrous events considered in the case study, a relatively high number of evacuees were present. This feature makes the selected events particularly suited to study vulnerability in temporary housing after a disaster. Another feature that makes the selected cases particularly suited for our aim is that different post-disaster temporary housing solutions were adopted. Two hundred fifty-seven (257) individuals who experienced one of the last three major Italian earthquakes (2009 L'Aquila Earthquake, 2012 Emilia Earthquake, 2016 Central Italy Earthquake) participated in the study. The methods and results are outlined in detail in Lucia et al (2021).

In the earthquake aftermath, 75% of the surveyed participants stayed in a temporary housing solution. The type of prevalent temporary solution (i.e., where they spent most of their time) was very diverse. Most of the participants stayed in either a rented apartment or a Prefabricated Housing Module. On average, they stayed in the temporary solution for 48 months (4 years), but the range varied from 1 month (minimum) to 12 years (maximum). Many (41%) had to relocate to a different municipality than the one they lived in before the event.

The evidence collected showed that the survivors who have been displaced show a significant deterioration on all the vulnerability indicators measured. They show a significantly lower quality of life, more symptoms of post-traumatic stress disorder, higher health impairment, lower well-being, higher economic vulnerability, higher physical vulnerability, and, on the other hand, higher risk awareness than those individuals who suffered the disaster without being displaced. These negative



outcomes collectively form a coherent cluster of symptoms of vulnerability that go beyond those experienced by individuals who suffered the disaster but were not displaced.

**New understanding of disaster survivors' needs.** The results of D4.2 add something new to the literature. Previous studies, in fact, had not tried to identify the origins of the vulnerability of displaced people, but had limited their focus to individual factors such as age or education. The T4.2 study, unlike other similar studies, measured many individual, environmental and social variables at different points in time with the precise aim of identifying the causes of vulnerability induced by the experience of displacement, controlling for as many factors as possible.

Having controlled for the effect of different variables, the T4.2 study found that a variable particularly important in predicting vulnerability during displacement was the individuals' trait resilience capability. This is the individual's ability to adapt to change. Those who lack the ability to adapt to change are particularly vulnerable to the discomfort induced by being forced to leave their home for a period of time. The length of the displacement did not have a relevant impact. Individual resilience is a personality trait (Di Fabio & Saklofske, 2018; Oshio et al., 2018), but some studies suggest that perhaps it could be increased if social support increases (Gooding et al., 2012; Aldrich et al 2018). Thus, peoples' resilience can both be attributed to more stable personal characteristics and aspects that can be trained.

The second cause of vulnerability in displaced individuals was related to the satisfaction with the overall displacement experience and to the characteristics of the environment where the displacement was located (which was perceived depressive and not as good as desired). The cause of the evacuees' discomfort was not linked to specific aspects of the homes (the restricted space, lack of light, lack of privacy, distance to one's works and studies, etc.). Instead, it was linked to dissatisfaction with the overall displacement experience. This can be explained assuming that the experience of losing one's home and live a "suspended life" in a temporary home is itself a trauma on top of the disaster experience. However, some data also seems to indicate that it is likely that it is not just the experience of losing one's home, but the fact of losing the environment of life in which one's home was embedded that determines the strong distress in the evacuees. Previous literature indeed points to the fact that existing social networks are dismantled during relocation, thus eliminating a crucial source of social buffer, which might potentially mitigate evacuees' discomfort (Di Gregorio & Soares, 2017). Moreover, it has indeed been noted that relocating the elderly is especially a problem due to their need for social spaces and organized activities that enable them to meet others (Johnson, 2007). It has been emphasized that temporary housing should not only provide shelter but also offer everything to return to normal life, such as being in a place with easy access to services and the workplace or providing affordable transportation, proximity to the former home, and maintaining neighborhood ties and support networks (Johnson, 2007).

The third cause of vulnerability in displaced individuals is the lack of place attachment before the disaster. Place attachment is the degree to which an individual is attached to the place where he/she lives and the extent to which the place is part of his/her identity. Those who identified more with the place and the community they lived in before the disaster were more resilient because they were better capable of reducing the negative effect of the displacement. This is probably because they have incorporated the place into their self-schemas and have strengthened their psychological well-being (Scannell & Gifford, 2010). Place attachment, therefore, would be a sort of protective factor.





**A basis for new policies and practices.** A series of recommendations are proposed based on the mentioned results of the study. These recommendations address different actors, that we may be defined as potential users of the innovations.

**1) Improve structural resistance of buildings.** The first recommendation is to improve the structural resistance of buildings to disasters to avoid the displacement of individuals out of their homes for long periods of time since this was found to be a serious cause of vulnerability. The study indeed revealed that being displaced for more than one month from one's home is a highly disruptive and stressful psychological experience that goes far beyond simply experiencing the disaster. Compatibly with the severity of the emergency, avoid displacing people for long periods (more than one month) from their homes as much as possible. To reduce the likelihood that people will have to leave their homes following a disaster, it is essential to act on the preparatory phase. For example, it is necessary to carry out structural interventions to make buildings more resistant to natural disasters of all kinds (seismic events, but also floods, tornadoes, landslides and volcanic eruptions).

Indeed, all traditional policies (laws and incentives) that can be used to strengthen buildings to avoid the evacuation of people from their homes should be used, as well as more innovative policies, such as behavioural interventions (nudges). Among these, we believe that "default" rules or "opt-out" systems (e.g., automatic enrollment in programs offered by the government to retrofit the house to make it disaster-proof), could speed up the modernization of homes in at-risk areas. For example, an opt-out system in which people are automatically enrolled in the retrofitting program when they inherit their home, if they are located in an at-risk area, unless owners explicitly state otherwise, could be a new nudge policy that could be tested.

**2) Improve individual resilience capability.** The second recommendation is to improve individual resilience capability, as this was the most predictive factor of vulnerability. The study clearly revealed that the major protective factor against the stressful event of being displaced resides in the individual trait resilience capability, after all other possible factors that contribute to the negative impact of displacement were controlled for. Trait resilience capabilities are generally linked to personality traits (Di Fabio & Saklofske, 2018; Oshio et al., 2018) and higher age (Cohen et al., 2016). As such, it is difficult to improve them. However, the level of resilience among younger adults was related to their availability of social support (Gooding et al., 2012), leaving open the possibility that individual trait resilience could be improved through an increase in social support. It is also important to discern between individual traits which are inherent and individual capability which can be learned. There is also a substantial body of literature re the interplay between individual resilience and social resilience, e.g. studies showing the importance of belonging to local community groups (Gallagher et al 2019).

**3) Plan the location of the displacement more carefully.** The third recommendation is to plan more carefully the location and the environment where the displacement will take place, possibly by reestablishing a community environment. The study found that the satisfaction with the environment/location was more predictive than the satisfaction with the internal aspects of the house in reducing the negative impact of displacement. This indicates a need to pay close attention to the quality of the environment surrounding the temporary housing and the place where the temporary housing is located when planning displacement sites. To improve the quality of the environment/place/location surrounding the temporary housing, a better displacement plan should be implemented before the event occurs. In particular, displaced people seemed to suffer for having lost their "surroundings" that symbolized their community. Displacement sites should seek to replicate the lost community environment or be located in such a way that the original community environment is preserved and easily accessible to residents.



**4) Improve place attachment before the disaster.** Those participants who were more attached to the place and to the community they lived in before the disaster were better capable of reducing the negative effect of the displacement probably because they incorporated the place into self-schemas, and this strengthens ones' psychological well-being. To improve place attachment, city planners could design environments that increase place attachment by creating spaces that afford different opportunities for meaning-making by diverse user groups, and municipalities could motivate citizens to populate those places (Raymond et al., 2017). Place attachment indeed is created by the interconnection between the environment and the individual through social behaviour (Low & Altman, 1992)

### 3.2.3 Who are the potential users of the innovations?

The users of the innovations that emerged from T4.2 are policymakers, practitioners, voluntary groups, mayors of municipalities, civil protection workers, but also those who manage emergencies at the European level. All those who, for various reasons, must design an emergency plan are possible users of the innovations that emerged from the Task. Last but not least, citizens can increase their participation in community initiatives devoted to disaster preparedness and increase community attachment and social capital.

### 3.2.4 Validation/implementation

Results of Task 4.2 and related innovations that emerged from them were subjected to validations mainly in meetings/workshops/conferences with stakeholders.

These results and related innovations were shared during a meeting with a group of volunteers who are involved in intervening during emergencies. The group is called Psychologists for Peoples and is a national organization. Present at the meeting were: President of Psicologi per i Popoli – Federazione, Honorary President of Psicologi per i Popoli-Federazione e past President of Psicologi per i Popoli - Trentino ODV (Organism Of Volunteers of Trentino Region), Vicepresident of Psicologi per i Popoli - Trentino ODV (Organism Of Volunteers of Trentino Region), President of Psicologi per i Popoli – Umbria, and some operating partners of Psicologi per i Popoli - Trentino ODV (Organism Of Volunteers of Trentino Region).

The feedback collected from the participants seems to fully validate the conclusions and the risk management system innovations suggested for the post-crisis phase. In particular, the arguments raised during the meeting were:

- The loss of a house or, in any case, the situation of transience experienced by people evacuated and placed in temporary housing solutions is certainly a cause of discomfort. The loss of a home means losing all one's personal belongings and is like losing one's identity. The loss of a home is also accompanied by the loss of a community, which is perhaps the thing that causes the most pain. The ties that a person establishes within the country, city, or neighborhood in which he or she lives are important in maintaining the sense of attachment that is formed at birth but maintained throughout life.
- After an earthquake, in areas where temporary housing solutions arise, it would be important to find solutions to rebuild a sense of community and belonging. In order to rebuild a community, the role of the leader is important, so for example, establishing a tent or neighborhood leader is one way to maintain a sense of community belonging.



- Resilience capability is not a genetic trait but is built through life experiences, beginning with a child's early attachment experiences with the parental figure. The better the attachment, the better the individual's resilience.
- Citizens participating in simulations would be beneficial in increasing individual resilience capabilities and risk awareness.

The Task 4.2 work project was also shared in a meeting with civil protection experts involved in displacing people during an earthquake emergency. In particular, the developers of a software tool (DESIGNA) that is used to harmonize the management of displacement in temporary solutions participated in the meeting. The purpose of the meeting was to understand how to improve the tool in light of the results of T4.2. It was suggested that it would be possible to include feedback from the user in a new version of the tool to indicate the degree of satisfaction with the solution he has been assigned. This would result in more careful management of vulnerabilities during the management of temporary housing. The tool has a nationwide application (regions-municipalities-hotels), so it would result in a concrete impact of vulnerability management.

The results of T4.2 were also validated during a workshop created in HOWSPACE managed by WP6. The feedback obtained is still being processed. T4.2 results have been accepted and will be presented at two international conferences where feedback from academics and practitioners will be attained. The first is IDRIM2021 - The 11th International Conference of the International Society for the INTEGRATED DISASTER RISK MANAGEMENT, Online, September 22-24, 2021. The second is SRA2021- The Society for Risk Analysis Annual Meeting, Online, December 5-9, 2021.

### 3.3 Dashboard to examine vulnerability

#### 3.3.1 Background

The full account of Case study WP4.3 “Applying mobile positioning data for more precise rescue planning and emergency management under cyber-hazard in Estonia”, is provided in Võik et al (2021). We refer to it as T4.3 in the rest of the text.

Mobile positioning data (MPD) enables to evaluate the mobility behaviour of people – where, when, how and how much people move and stay – of wide ranges of population more dynamically and in greater detail than traditional census-based approaches (Panczak et al. 2020). Thus this tool offers a unique means to capture the dynamic and situational nature of disaster vulnerabilities in space. Traditional approaches tell how many people should be living in an area, but this does not include the fact that people are mobile, spend weekends at different places, commute before and after working day, some people live in a place only seasonally. This makes a big difference in population counts within a day, week, month and seasons – this is essential information to account for the people that may be under threat in particular hazard in specific geographic areas.

The MPD data are plotted into a dashboard, which is used to develop spatio-temporal human dynamic maps. Such maps inform the professional rescuers more precisely about population distribution at different locations and times and help to deliver better need-calibrated relief services. Positium, University of Tartu and the Estonian Rescue Board have tested and validated the dashboard in emergency simulations of crises like cyber-attack or extensive storms where connections are down, to assess if and how historical MPD could help in these situations – this is essential information to account for the people that may be under threat in particular hazard in specific geographic areas.



MPD is described as a quite a novel information source and scientists have yet started to discover its potential to develop decision-support tools in crisis situations. Bengtsson et al. (2011) examined the usability of MPD to assess the number of dislocated people after the earthquake in Haiti in 2010. Later a number of research projects followed assessing (i.e) the usability of MPD in disease outbreaks (Tatem et al. 2014, Cinnamon et al. 2016, Peak et al. 2018), floods (UN Global Pulse 2014) and earthquakes (Wilson et al. 2014). In this context, it should be remembered that Positium was founded already in 2003, and has been working on developing MPD methodologies since that. This indicates that the dashboard has been developed by a company with a long experience with this type of technology.

Mobility is shaped by demographic, social, economic and environmental factors, all of which influence population distributions and movement flows between locations spatially and temporally (Charles-Edwards et al. 2020). Although MPD is anonymous and, thus, does not enable to distinguish between socio-economic characteristics directly, some research has been done to describe socio-economic status of people through their mobility behaviour (Šćepanović et al. 2015). Long-term mobility of most people is highly regular, which allows researchers to predict approximate home or work locations, regular visiting places and geographical distribution of tourism trips of phone-users (Ahas et al. 2010, Saluveer et al. 2020).

Location-based services and data is proven to be potentially very beneficial. This is indicated by BuildERS' earlier estimations made by disaster management stakeholders about the need for new tools and technologies (BuildERS Deliverable 2.4, page 60), and previous research (Weidinger 2017). There have been essential gaps in transferring disaster management tools from development phases into real use (BuildERS Deliverable 2.4, page 59), which is why it is important to emphasize potential innovations BuildERS dashboard beholds to ensure its further development and use after the BuildERS project. Deliverable 5.1 "Resilience policy recommendations" also incorporates the use of MPD in BuildERS' policy recommendations. See Sections 3.3.1 (Rhinard et al 2021: 22), 3.4.2 (Rhinard et al: 31), and 5.3.1 (Rhinard et al 2021: 50).

### 3.3.2 Innovations

Positium has built a dashboard based on the input from the Estonian Rescue Board and University of Tartu. These participants have had multiple meetings and many discussions to go through what MPD is capable of, which indicators are possible to be calculated and which ones could be useful in crisis management.

This dashboard is mostly meant for the pre-crisis phase where previous disasters and events can be analyzed (how people usually behave versus how they have behaved during previous disasters) and based on this knowledge, planning of resources and processes for future crises can be adjusted. This dashboard can be used during disaster as well. The dashboard is knowingly built so that it works offline as well, meaning that if all other connections are down and other databases cannot be used, then this dashboard still works.

The dashboard's goal is to give rescuers enough information so that they could predict population behavior in crisis situations, plan their resources and processes better and by doing that, reduce the costs on aid and relief for emergency proliferation.

The dashboard that has been built by Positium shows historical MPD. It shows visually how many people are in different areas and what kind of people are there (people living in the area, people working in the area, people who regularly visit the area, domestic tourists, foreign tourists) and also,



in a table form, how many people in the area have a secondary home and how far away it is from the chosen spatial unit. Secondary homes information shows counts of people who have a secondary home that they could use as shelter in case of evacuation information helps to plan evacuation routes and accommodation more precisely. The dashboard also shows movements' directions and counts between different areas, which is essential to account for potential movements towards and away from the hazard area. The dashboard can give daily, weekly and seasonal volume changes and movement patterns that other databases cannot do. Estimations of the amount of different population groups are made in a more precise time step than before.

To create the dashboard, methodology for the whole process of converting MPD to population statistics has been developed (incl. pre-processing of data, definitions until generalisation to the whole population), which can be applied in other countries as well. This methodology is compliant with official statistics production standards. As passive MPD is relatively standard everywhere, the methodology developed for the dashboard is easy to transfer to other countries where MPD is made available to researchers or relief workers.

In tabletop exercise it was seen, that information on the location and movement of people with a precise time and space units, is needed in better coordination of the crisis planning and preparedness phase as well as in disaster response. Throughout the development of the dashboard and its validation, the project group gained insight into needed future development in using MPD in disaster management - here the communication with rescue workers has been very useful.

Some of potential problem areas, such as the impact of mobile coverage problems due to power breakdowns, were detected. Thanks to statistical validation there is now more information regarding where and when (geographical areas and time durations) historical MPD is more precise and where there are potentially more problems. It helps to understand the dashboard better and can make future methodology more accurate in these problem areas.

### 3.3.3 Who are the potential users of the innovation?

Research by Weidinger et al. (2017) has shown that universal using opportunities and simple readability of information-based tools are important factors for rescue workers. The dashboard consists of a map application that makes vast amounts of data easily comprehensible through its cartographic display. The map application can be used both on- and offline, ensuring that potential increase of situational awareness would not be restricted by power outage or lack of network connection in disaster.

The dashboard is foremost directed to official responders in pre-crisis situations. It increases societal resilience against disasters by increasing situational awareness of relief and medical workers, humanitarian and governmental organisations. It helps disaster managers make more informed decisions and disaster mitigation plans and also to allocate their resources more effectively. This, consequently, potentially reduces individual vulnerability of people and increases their social capital, as officials have greater likelihood of reaching more people in potential danger faster. MPD is a great data source that has a lot of scientific and technological potential that could be used for crisis management.

The end-users evaluated this dashboard as being a highly valuable asset to their pre-crisis phase where they learn from past crises and events. Based on this information it can be seen how people usually behave, if and how they move during crisis, respond to crisis notifications etc. It can also be very well used for doing risk evaluations on regions and buildings, for playing through crisis scenarios





in trainings and to plan evacuation accommodation and routes. Information from the dashboard could be included into local disaster plans.

Some new methodologies could be developed to distinguish (besides already existing population groups) people with multiple homes, people who commute between two or more places very often etc. With the information of these additional groups, rescue planning with this dashboard could get even more exact.

### 3.3.4 Validation/implementation

The dashboard was validated by multiple end users, such as Estonian Rescue Board, Police and Border Guard Board, Defence Forces and others. The validation was done in a tabletop exercise where the dashboard was demonstrated and case scenarios were played through. All participants could freely elaborate, if and how they could use this dashboard in the perspective of their organisation and area of expertise.

Results of the evaluation of the case study show that Positium's dashboard could be very beneficial in preparing for crises and learning from crises. The evaluation was done using questionnaire targeted for end-users i.e. those who participated in the workshop.

All respondents agree (63,6%) or strongly agree (36,4%) that the tool is effective in achieving its purpose. Respondents also mostly agree that regular use of the tool would be efficient in terms of resources. It also seems that the tool was found to be useful and respondents indicate that the tool should be in regular use in their country. Furthermore, the usability of the tool can be considered to be very good as most of the respondents agree or strongly agree that they would be willing to use it again and that it was easy to use, and there are clear instructions on how to use the tool. Most of the respondents said that the tool is suitable for civil protection and disaster risk reduction, but there was more dispersion when crisis management was considered.

It takes time and planning to start using the dashboard: on the one hand the scientific community has to think through working principles of the tool, potential conflicts with privacy and vulnerabilities; on the other hand, rescue workers have to devise ways where such a solution is most beneficial and make investments to their technological preparedness to use the tool.

To enable crisis responders to use the tool in disaster situations in different countries, long-term stability in laws and agreements regarding handling MPD is needed. This needs all-around agreements regarding privacy policy. In addition, the MPD has to be available for scientific research to develop methodologies of using MPD. In order to make it easier and clearer on if and how this dashboard could be used, MPD usage for crisis management should clearly regulated by EU and on a national level as well.

Besides the tabletop exercise with end-users in crisis management area, the dashboard has also been presented to ministries which are in charge of crisis management and protection of citizens. The meeting included over 40 participants, including the Ministry of Interior, Ministry of Social Affairs and Government Office of Estonia. Many contributors to these case study joined to listen in as well: Estonian Rescue Board, Defense Forces, Police and Border Guard Board and many others from the T4.3 tabletop exercise and interviewees and partners of the T4.4 case study. Ministries' feedback was very good and they did see potential in both case studies and their implementation. Politicians from the ministries said that the Emergency Act of Estonia is being updated and they will include the new information from this meeting to the discussions of the Emergency Act and this gives hope that both case studies will get an actual use in the near future.



By that time, only the department of Southern region of Estonian Rescue Board had seen the dashboard. During this meeting, the other departments of the Estonian Rescue Board saw it as well. They showed very clear interest in using this dashboard for doing risk assessments for flood areas. They are struggling with getting accurate information of population counts in different areas and are asking municipalities for this kind of information. This takes a lot of time and resources and unfortunately, the municipalities do not have accurate information from recent years as well. Estonian Rescue Board is currently in the process of the flood area training.

During the case study, Positium had a permission from the mobile network operator to use their data for research purposes, such as the BuildERS project. Now Positium has also gained permission from them for the Estonian Rescue Board to use this dashboard for their work. This means that they are one step closer to getting this dashboard to be used in everyday work. The Estonian Rescue Board is currently investigating their financial possibilities to be able to use this dashboard from 2022. If funding is found, it can enter into use very soon.

Besides the Estonian Rescue Board, potential users of this dashboard are other crisis management related organisations, such as Police and Border Guard Board, first aid, Defence Forces, municipality officials, Ministry of Interior.

### 3.4 Merger of databases for identifying vulnerable people

#### 3.4.1 Background

The full account of Case study WP4.4 “Integration of public data bases for identifying highly vulnerable people in need of relief prioritisation by the Estonian Rescue Board” is provided in Orru et al (2021a). We refer to it as T4.4 in the rest of the text.

BuildERS Task 4.4. “Reducing social vulnerability by innovative data fusion for more informed rescue prioritization” aims at building a vulnerability assessment tool that brings together the varied factors of vulnerability and their representations in public datasets. To meet this goal, Estonian crisis management system was used as a case study. The vulnerability assessment tool was co-created with practitioners in crisis management and social care. It follows the dynamic and intersectional perspective on vulnerability and guides relevant stakeholders to systematically think through the possible hazard scenarios, the related factors of vulnerability and the sources of information on these vulnerabilities. The testing of the tool in case of a large-scale disruption of electrical supply, COVID-19 pandemic, and a cyber incident demonstrated the value of the tool in showing how the factors of vulnerability intersect and their impact may be amplified or attenuated by the situational characteristics.

The need for a vulnerability assessment tool became clear in BuildERS deliverable 2.2 (Orru et al., 2020) and also in deliverable 2.5, which demonstrated the lack of systematic analysis of social vulnerability factors in crisis management and guidelines as one of the key impediments in preparing for and organising rescue and support in crisis in many European countries.

Social vulnerability assessments are used as input to develop mitigation strategies and promote disaster resilience. There are two key approaches to measuring vulnerability: 1) integrating various quantifiable data into compound indexes, and 2) a more qualitative approach that highlights the temporal and spatial dynamics in the multiple sources of vulnerability and the need for engaging various stakeholder views in assessing vulnerabilities (Wisner et al., 2004).



First, when it comes to more quantified approaches, The Hazard-of-Place-Model and the Social Vulnerability Index (SoVI) are examples of multi-dimensional compounds aimed at identifying the characteristics and experiences of communities and individuals that facilitate responding to and recovering from environmental hazards (Cutter et al., 2003). To quantify and explain social vulnerability, these models consider a variety of variables, such as age, individual economic status, presence of single-sector economy, density of the built-environment, forms and amounts of housing stock and tenancy, race and ethnicity, occupation and infrastructure dependency (Morsut et al., 2020). However, these models tend to collapse the versatility of factors into a single numerical. While reducing complexity, indexes do so at the expense of interpretability for choosing the factors of vulnerability for effective mitigation (Rufat et al 2019; Spielman et al., 2020).

Second, more qualitative approaches highlight the temporal and spatial dynamics in the multiple sources of vulnerability and the need for engaging various stakeholder views to ensure the sensitivity of the assessment to particular contextual factors (Wisner et al., 2004).

It is therefore important to open up the vulnerability assessment process to individuals with varied experiences (Krüger, 2019; see also Schobert et al 2021). The place- and hazard-specific vulnerability assessment methodologies foresee the need to consider the multiplicity of parameters: the various exposures, sensitivities, and adaptive capacities that may be changing over time, depending on the evolution of the hazards (Wisner et al., 2004). These more contextual measures of vulnerability are critical in helping communities and policy makers to better prepare for, respond to, and recover from extreme events.

The vulnerability assessment tool that is proposed in D4.4 highlights the value of both the quantified social indicator-based as well as context-specific approaches of vulnerability as basis of assessment. The tool is developed and implemented in an Estonian context, but based on the national disaster management shortcomings identified in Orru et al (2020) it is also relevant to other European countries. The Estonian Emergency Act (2020) indicates that risk analyses and emergency management plans do not foresee the need for assessment of social vulnerabilities or the factors leading to it. This indicates a failure to understand disasters as not just being the result of an extreme event, but of an extreme event interacting with a vulnerable society (Wisner et al., 2004).

In the interviews conducted in Task 4.4, the absence of strong stakeholder pressure, the lack of recognition of the need as well as clear institutional mandate, shortage of expertise and guidelines were brought out as the main reasons why vulnerability assessments have not been prioritised so far. The lack of clear responsibilities and guidelines for vulnerability assessment that could feed into the prioritisation of support needs was partly attributed to the lack of comprehensive overview of what could be the possible sources of vulnerability in various hazard situations.

Identification of vulnerable individuals is usually carried out on an ad hoc basis following the requests for help from individuals and social workers' habitual records. Furthermore, D4.4. discusses the strengths and weaknesses of other information sources currently applied: local support networks, social workers' and other officials' expert judgments and census data. The T4.4. study emphasizes that during emergencies, there is little time to explore what kind of support different groups may need and whose responsibility is to identify and reach out to them and ad hoc solutions may lead to suboptimal outcomes for the vulnerable.





Furthermore, recent crises caused by major electricity disruptions and the COVID-19 pandemic have underlined the need for more systematic tool for understanding of who might become vulnerable in a certain situation.

### 3.4.2 Innovations

The aim of developing a new vulnerability assessment tool is to systematically identify individuals who may need external support during crises and to use this information to improve the planning and provision of emergency, medical, and social care resources prior, during, and after crises. The tool combines crisis situation-specific understandings of the vulnerability factors, and the representations of these vulnerability factors (indicators) in different datasets and other sources of information.

***The use of new data sources.*** Via document analysis and interviews, Task 4.4 identified several databases that contain indicators of potential vulnerability factors. Task 4.4 therefore introduces the possibilities for combining data from various national registries and existing survey data (and other) to identify vulnerable people with the help of the elaborated vulnerability assessment tool. In addition to the Population Register with general census data about individuals, possible registries to use for detecting vulnerabilities and assess need for resources may include for example The Health Information System; the Health Insurance Fund Database; The Police and Boarder Guard registries; the Education Information System; client data of critical service providers.

The tool could be applied to different types of crises and the results can be utilized to enhance preparedness, demand-driven relief and rescue during critical events. The tool can be applied to increase the transparency of decision-making concerning vulnerabilities by laying out which parameters are included in the analysis and which information is involved in the assessment. By foregrounding the principles of engaging the representatives of diverse society including those most affected by vulnerability, the tool can be used to increase the fairness of crisis planning.

The tool takes a particular crisis situation as the starting point. The tool may be applied in:

- (a) A factual hazard situation with its real-life parameters determining the exposures, sensitivities, coping/adaptive capacities;
- (b) A hypothetical hazard situation that evolves into a crisis with the specific circumstances foreseen by the “worst case scenarios” often used in crisis planning.



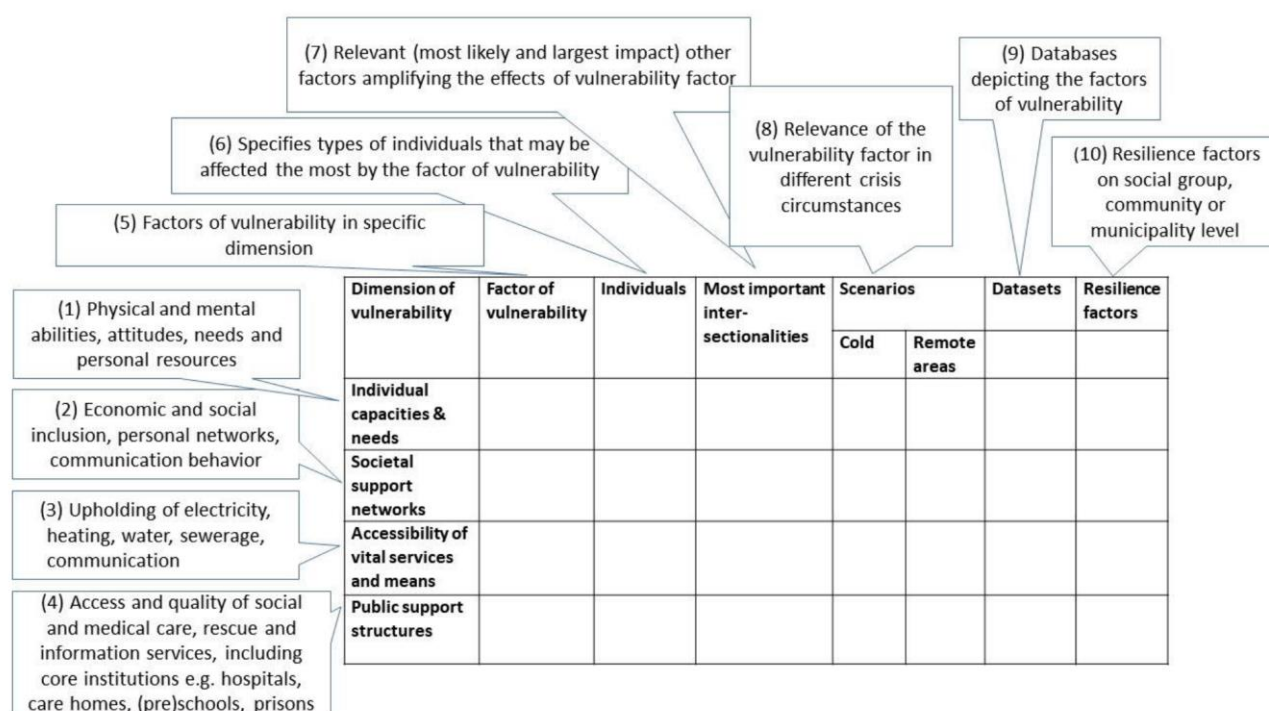


Figure 3: The components in the vulnerability assessment tool (Source: Orru et al 2021a).

Be it real-life circumstances or the scenario-based modelling, the particular circumstances shape the configurations of hazard exposure, coping and/or adaptive capacities in individuals. These situational characteristics determine which factors of vulnerability play which role in inhibiting individuals' resilience, and thus, which factors need to be taken into account in the vulnerability assessment tool. With the help of this tool, crisis managers in collaboration with relevant stakeholders are guided to systematically think through the possible hazard scenarios, the considered factors of vulnerability and the sources of information on these vulnerabilities. This preparedness work (b) is a precondition for updating the vulnerability assessments in situ (a).

To improve the representation of situational components, representatives of various stakeholders with their information on the geospatial, physical, as well as sociostructural conditions need to be involved in crisis management decision-making during the planning phase as well as in times of disaster. The tool can be incorporated into risk analysis for crisis management plans as well as into (table-top) exercises and simulations that involve vulnerability assessment.

For fair representation of possible impacts on varied groups, the perspectives of those most vulnerable should be included in the assessment process. Disaster management view is not able to cover the variety of lived experiences. The decision-making should be opened up to the members of a diverse society, particularly those who might be most affected by specific vulnerability factors.

The tool uses the categorisation of factors of vulnerability provided by Orru et al. (2021a). The tool guides users in distinguishing the following dimensions of vulnerability factors.

**(1) Individual capacities & needs** including physical and mental abilities, training/education, attitudes, needs, coping capacities and personal resources. This dimension refers to physical and mental abilities to take care of one-self on everyday basis as well as in a situation, when the person is cut away from usual supportive structures (e.g. electricity, communication, care provision) or when it is necessary to evacuate. This may also relate to abilities to follow risk information (literacy and

language skills), risk awareness and attitudes, including trust in authorities, crisis management skills, and the implemented preparedness measures.

**(2) Societal support networks** involving economic and social inclusion, personal networks, communication behaviour. This dimension addresses the social and economic capital held by a respondent (Bourdieu, 1997; Morsut et al 2020) the factors that concern the individual ties with family and friends, with community or even representatives of authority; the engagement in economic and social life in various ways reflecting the status of a person in society. This also concerns the routines of communicating: the ways and sources of receiving and sharing information and interpretations with close community or society at large.

**(3) Accessibility of vital services** including upholding of electricity, heating, water, sewerage, communication networks as well as private means (e.g. car, secondary home). This dimension concerns the technological capacities and infrastructures that support everyday life and the disruption of which may lead to a disaster or further complicate a multi-crisis event. Both public provision of this technological support as well as private material and technological means for self-sufficiency (e.g. alternatives to electricity-dependent heating) or being able to receive support (e.g. radio with batteries to stay informed) are relevant here.

**(4) Public support structures** that grant access and quality of social and medical care, rescue and information services, including core institutions e.g. hospitals, care homes, (pre)schools, prisons. This dimension concerns the official reaction of the institutions tasked with offering support during disasters (or also on everyday basis). This concerns the accessibility of the public services aimed at providing medical care and rescue services, social and psychological care, public information services, appropriate provisions to people that are under care, supervision or curfew. The dimension also refers to how the services are tailored taking into account the various needs of individuals.

The four dimensions of vulnerability factors intersect in unique ways in particular situations. For example, the vulnerability factors stemming from “Individual capacities & needs”, may be aggravated (or also compensated in case of strong resilience in this factor) by the vulnerability factors in e.g. “Public support structures” and vice versa. Depending on the crisis situation or the scenario, each of the dimensions and the underlying vulnerability factors need to be carefully considered. The tool guides in scrutinising the relevance of a multiplicity of factors and their interrelations in order to avoid blind-spots and to get a comprehensive overview of the possible sources of vulnerability.



Table 3. Example of the operationalisation of the factors of vulnerability under the dimension “Accessibility of vital services and means

Dimension of vulnerability	Factors of vulnerability	Individuals	Most important inter-sectionalities to be considered	Scenarios		Datasets and other information sources	Resilience factors
				Cold	Remote areas		
Accessibility of vital services and means - Upholding of electricity, heating, water, sewerage, communication networks	Electricity-dependent heating	Clients of central/communal heating	External help needed on everyday basis;	↑	↓	Client list of service providers	
		Users of private electricity-dependent heating systems	Families with small children; Availability of means to evacuate	↑	↑	Register of Construction Works	
	...						

The key analysis unit in the tool is the individuals affected by particular factors that influence vulnerability. Therefore, each row in the tool depicts one factor of vulnerability and the individuals that are burdened with this vulnerability factor. For example, in case of the disruption of electrical supply, in the “accessibility of vital services and means” dimension, one of the vulnerability factors is the electricity-dependent heating. The particular individuals that may be hampered due to this factor involve the clients of central heating and users of private electricity-dependent heating systems. Following the same row concerning particular individuals, next, most important inter-sectionalities are brought out to specify other key factors that may aggravate these individuals’ conditions (abilities to cope). Next, these individuals’ coping capacities in scenarios are assessed. In the final cell of the row, the possible information sources depicting the vulnerability factor are brought out. We will present these in-depth in the following:

**The factors of vulnerability (5)** column depicts the factors of vulnerability distinguished among multiplicity of factors in the broader vulnerability dimension in a particular (hypothetical) crisis situation. The users of the tool are guided to estimate the relevance of these factors by the likelihood and magnitude of the factor’s effect on individuals. The factors with the highest risk score should be involved as the vulnerability factor. The vulnerability factor’s effect may appear particularly in individuals in circumstances determined by other factors.

The tool guides its users **to consider which individuals (6)**, are burdened with specific factors stemming from the circumstances where the individual lies.

The tool takes into consideration the factors which are assessed to be **the most important intersecting factors that aggravate the conditions created by the vulnerability factor in case of the specified individuals (7)**. However, as with the vulnerability factors, not all the dimensions and intersecting factors are equally relevant for the specific types of individuals. Bringing out the most significant intersecting factors (7) that help to specify the impacts and narrow the circle of the most burdened people. The factors of vulnerability concern anyone, but the degree to which each individual is affected by the vulnerability factor may differ to a large extent.

The relevance of the vulnerability factors may change if the **base scenario changes and different crisis circumstances come into play (8)**. Therefore, the tool helps to assess the dynamics in vulnerability factors in case certain contextual parameters are changed.

The tool guides connecting the factors of vulnerability, **the affected individuals with specific databases, other information sources and their represented indicators depicting the factors of vulnerability (9)**. For each individual at risk of falling into vulnerable situation according to certain (intersected) parameters, **resilience factors can be connected on a social group, community-level or municipality level (10)**.

### 3.4.3 Who are potential users of the innovation?

The vulnerability assessment tool enables attaining at least three types of information that can be used in different stages of crisis management by the wide range of institutions that are responsible for preparing hazard risk analyses and crisis management plans, and preparing for or responding to the crisis situation including:

- Government ministries (e.g. Social Affairs, Internal Affairs, Economic Affairs and Communications, Environment), and their respective agencies (Rescue Board, Health Board, Environmental Board),
- Providers of critical services (private and state companies providing e.g. electricity, communications, water),
- Local governments,
- Third sector organisations supporting rescue, social care and other tasks.

The tool can be used for providing information with varied level of personalization of vulnerability information: First, the intersecting of vulnerability factors allows for specifying who needs what kind of support. This information gives qualitative guidance on the types of individuals to whom the resilience building activities and support in crisis response or recovery could be targeted. **Rescue, medical, and social care providers can use this information to plan their emergency response capacities, while policy makers can feed this into tailoring policy measures that would empower vulnerable individuals.** The prevention and preparedness-building authorities that were involved in co-creating the tool, see this as an opportunity to raise risk awareness and preparedness through communication. For instance, the application of the tool may indicate areas where people might not understand evacuation guidelines, and this information could be used to adjust the content and/or form of the guidelines to meet the needs of these people.

Second, if the qualitative understanding of vulnerability factors is further linked to specific datasets, it will become possible to estimate the number of people affected by some factors of vulnerability. By including geo-physical information on hazard and the population location data (e.g. mobile positioning data), situation-specific estimates can be attained. This analysis can also feed into **predicting the resource needs for rescue and care organisations prior to crisis** (e.g. means for evacuation, emergency social assistance, temporary accommodation and means to satisfy the primary needs). To organize help and support to the vulnerable individuals (possible victims), the tool enables to assess vulnerability factors and set priorities for (over)burdened individuals during the preparedness phase. This may also speed up decision-making during crisis response.

Third, in case the information in datasets is connected to identifiable individuals, this personalised data can be used for reaching out to certain individuals, and thereby help **rescue, medical, and social care providers**. This personalised information may be useful in crisis situations when scarce resources need to be targeted promptly.





The elaborated vulnerability assessment tool offers several opportunities for more targeted crisis management in its various phases.

**1. In planning and preparedness building**, the tool addresses the issue of lacking guidance for assessing vulnerability and the evidence-based planning for means (no overview of the vulnerable; no resources to offer support) to prepare for crisis on the individual as well as on the responsible institutions' level.

**2. During a crisis, especially vulnerable people need protection.** The assessment allows for better planning and targeted allocation of resources to rescue or evacuate individuals in need of support. Improved understanding of individuals in vulnerable situation facilitates coordination of efforts between *governmental first responders' agencies, NGOs and the individuals*.

**3. In the recovery phase**, people who have higher social vulnerabilities need more support. It is important to analyse which people suffered more and what were the reasons for this. That helps to find the main determinants that cause greater vulnerability (fragile physical environment, poor living conditions etc.)

#### 3.4.4 Validation/implementation

The designing of the tool was user-centred and participatory: the future users of the tool, professionals in crisis management and social care, altogether 64 experts were engaged in the development of the tool and evaluating its usability. These users involved in the co-creation shared an understanding that the possibility of using information from various databases and other information sources would enable a more nuanced understanding of those individuals that may fall into vulnerable situation in times of crisis. They noted that information about potential sources of vulnerability, such as health issues, disabilities, ability to work, and so on, is fragmented between different authorities and their databases. Integrating data to see the bigger picture of person's capacities, his/her private or official support networks could improve crisis planning. Combining several indicators from several datasets, would enable a cross-sectional and more detailed depiction of vulnerabilities: an essential overview of the potential vulnerability mixes in specific regions. This could serve as a basis for overall planning of resources. Furthermore, the cross-use of datasets could give a more nuanced overview of the individuals for the prioritisation of preparedness as well as response activities. This issue is particularly relevant in case of limited resources to offer support.

When the tool was presented in the D4.4 report, it was still going through the validation in BuildERS WP6. The D4.4 report outlines its premises while remaining open for further discussion concerning its analytical components.

The tool was presented to practitioners at a virtual workshop to 35 practitioners from different levels of crisis governance (Ministries, Agencies, Local governments) in Estonia on May 26<sup>th</sup>, 2021. As feedback, the participants recognized the need for such a tool in order to move away from the pre-determined groups based considerations of vulnerability. Considering the factors of vulnerability and their inter-sectionalities was considered helpful in planning for a well-targeted response. It was agreed that the tool should be integrated into the hazard risk analyses and the emergency management plans by responsible state authorities, critical service providers and local governments.

On 19<sup>th</sup> of August, the tool was presented to the representative of Estonian Government Office. The representative recognized the need for pointing out the tasks of analysing social vulnerabilities to different hazards in the renewed Law on Preparedness that is being compiled by Government Office.





This addition to the drafted law would foreground tailoring the application principles for the vulnerability assessment in the risk analyses by using e.g. the proposed tool.

On 3<sup>rd</sup> of September, the tool was presented to 6 Ministry of Interior department heads that work on the crisis preparedness and response in Estonia. The officials acknowledged the need for considering the informal and formal social support networks as factors of vulnerability. They commended the consideration of the synergistic and cascading effects of the intersecting vulnerability factors. The participants recognized the dilemmas between the need for being available (and non-discriminatory) with risk and crisis communication and support for anyone; and the need for being well-targeted (based on vulnerability assessment info) in order not to overstretch the resources.

The WP6 Indicators workshop with the academic experts on Howspace platform from July to September 2021 brought up important validation information:

- The tool was considered particularly useful in the strategic preparedness-planning phase, which allows more time for thorough analysis of the various vulnerability factors, circle of burdened individuals and information sources. Well thought-through vulnerabilities in the hazard planning phase can be further specified in a specific crisis situation.
- The point about the politicization of the vulnerability assessment was raised and the T4.4. basic principle of opening up the assessment process for the representatives of diverse society was commended.
- The time-sensitivity of the assessment process and the importance of updating the assessment even during crises (e.g. long-term pandemic) was brought up

Preliminary experiences reported in D4.4 (Ortu et al 2021a) indicate that the vulnerability assessment tool co-created with practitioners in crisis management and social care can be recommended for practical use. The tool can be applied in other countries, on national and local level, and in various hazard contexts, as its analytical components remain sensitive to the situational dynamics of vulnerability. However, 5 key challenges need to be addressed upon the application of the tool (See Ortu et al 2021a).

## 3.5 Seven recommendations for crisis management

### 3.5.1 Background

The full account of Case study WP4.5 “Impacts of Elbe flooding disasters on socially underprivileged groups and lessons for resilience improvement” is provided in Schobert et al (2021). We refer to it as T4.5 in the rest of the text.

Task 4.5 is the German case study “Lessons learned from Flooding Disasters during 2002, 2006 and 2013 with special focus on underprivileged groups in urban (Dresden) and non-urban environments (in the State of Saxony)”. In this case study, the German Red Cross together with University of Tübingen focus on insights that can feed social and technological innovations by exploring what should be considered to make disaster management and technologies appropriate to serve all members of societies. In this vein, the case study does not start with a focus on specific social groups but rather takes a closer look at a geographical area and all people who live in it. By using such an open approach, Task 4.5 aims to find out more about who became vulnerable for which reasons in



different disasters in the Dresden area. Due to insights that are to be expected from the current situation, the case study was extended to include the COVID-19 pandemic and crisis management.

In addition to these studies on the Elbe flooding of 2002, 2006 and 2013, and the ongoing COVID-19 pandemic, the German case study builds on empirical works carried out within the framework of WP2 of the BuildERS project. Orru et al (2020) documented that the risk assessment regarding vulnerable groups is still in its early stages in Germany and that adequate emergency plans that take vulnerable groups sufficiently into account are only beginning to be developed (see also: Orru et al., 2021b). Furthermore, not much emphasis is placed on the establishment of pre-crisis social networks for vulnerable groups, although they are a key component for a successful crisis response (Orru et al., 2020, 37, 42; Orru et al., 2021a). Furthermore, no comprehensive database on vulnerable persons exists in Germany due to data protection reasons.

### 3.5.2 Innovations

The innovation potential identified in this task involves seven recommendations that future disaster management policies should take into account in order to improve disaster responses. These recommendations are based on a research design which combines expert interviews (n=20) and a quantitative survey (n=118), focusing on four German disasters, three previous (floods) and one existing (pandemic). In these cases, the disaster management measures are scrutinized against their ability to support individuals or reduce their vulnerabilities in disasters. The first recommendation that is developed based on this approach is:

#### **1) Taking up responsibilities requires awareness, ability and the possibility to adjust**

A crucial feature of every functioning (disaster) management system is, that every actor knows his/her tasks and areas of responsibility and is able to live up to them. This encompasses three steps: First, individuals have to be aware of responsibilities they have to fulfil. Those who have to take certain responsibilities should not only know about them. Second, every “should” requires a “can” and therefore the ability to do so. Therefore, those who are responsible have to be able, trained and equipped to fulfil them. Third, individuals need to be able to raise concerns if they struggle to fulfil them due to conflicts with other responsibilities or a lack of capacities.

Against this backdrop, the study found that people (individuals as well as authorities) often do not have a clear idea on the tasks and capacities of disaster management structures. The lack of knowledge about official support options was not limited to citizens but also included disaster management or social service providers who only know their own services and not know about the other support offers.

With regard to improving this situation and in order to reduce vulnerability and improve the overall resilience, first a common understanding of the limits, tasks and abilities of disaster management must be developed. Second, individuals but also decision makers and other stakeholders have to be trained and empowered to be able to take up responsibilities that are ascribed to them as well as they have to be aware of the limitations of the disaster management structure (Begg et al., 2015; Begg, 2018). Third, in order to empower individuals, the existing social structures and social policy regulations have to be scrutinized regarding the exclusionary potential as a core condition that has to be adjusted. For all of this to be implementable, finally, responsibilities and responsabilisation have to be understood as contingent and the results of political decision making (Pohlmann, 2015; Krüger & Gabel, forthcoming), which can be adjusted and has to be societally negotiated. This refers to a



broader exchange and discussion between disaster management and the population, which the first is – especially in Germany – considered to be part of.

## **2) Improving crisis management requires both short-term adjustments and long-term changes of social structures**

Disasters are special and extraordinary situations which need experts to deal with the impacts that hazards have on the affected societies. Although crisis prevention, preparedness, response and recovery often take a technical, short- to midterm and rescue-related perspective, for an overall resilience it should not be overlooked, that many issues that come up during crisis are rooted in everyday structures (Cannon, 1994; Kelman & Stough, 2015).

Against this backdrop, the findings of D4.5 and other authors suggest a disconnect between crisis and social politics, which shows up a detachment of short-term disaster management activities and long-term strategies to reduce vulnerability (Krüger 2019; Gabel 2019; UN-DHA 1994; UN-ISDR 2015, para. 28f). For instance, disaster management often tends to associate more structural issues and especially the consideration of “vulnerable people” with social service providers rather than being understood as a topic for disaster management (Gabel, 2019; Krüger, 2019; Parthasarathy, 2018). In contrast, social service providers did not make such a clear distinction, emphasising that structures do not only have to be available in everyday life, but especially in crisis (SoSe3).

A specific topic that outlines this gap are communication related issues in crisis. Two key components of this are the abilities to access and understand given information (Demeritt et al. 2013, S. 147). In practice this prominently concerns the reduction of communicational barriers, in order to allow all affected individuals to access, understand and act upon given information.

## **3) Individual autonomy should be promoted by crisis management activities, while acknowledging its potential to put people in vulnerable situations**

Besides the above mentioned access and ability to understand information, the ability to act on them, in terms of interpreting given information on potential hazards as well as on how to behave and make conscious and well-informed decisions, is a core aspect of both individual vulnerability as well as resilience. This encompasses three things: the training of skills, access to information and the freedom to act upon what was identified as appropriate action. Especially the latter point is contested in crisis and disaster management, as on the one hand individuals are longed to be more self-sufficient and able to care for themselves. On the other hand, crisis management often builds on a command-and-control system, where the population is merely a receiver of instructions, or has a passive role.

Also, there might be «good» reasons for taking actions and making decisions, which are not in line with official disaster management recommendations, for example experiences of discrimination, negative experiences with authorities or disaster management.

Against this backdrop, in order to reduce the risk of becoming vulnerable, crisis management has to reflect on and scrutinize its own structures with regard to an individual who wants to protect her material existence, who fears to lose her status as an independent individual, who distrusts established structures because of previous experiences or avoid support due to a fear of being deported. With regard to the normative and ethical dimension of autonomy, these situations do also refer to a broader justice related issue presented in the capability approach (Nussbaum, 2014)

## **4) Crisis management activities should be considered as a potential factor of vulnerability**



In addition to the common finding that extreme events amplify existing inequalities (Cannon, 1994; Kelman & Stough, 2015), the results, especially on the pandemic, pointed towards the potential risk of an amplification of vulnerable situations, by measures that are taken in order to overcome disasters. While such issues can also be found with the Dresden flooding and the conscious destruction of dams and therefore flooding of villages for the greater good (Issing et al., 2013), this vulnerability factor has become even more prominent during the pandemic.

For instance, the results of T4.5 show that (also in other countries) a challenge emerged for communication of and with speech- and hearing-impaired persons due to the impossibility of for instance read lips when wearing an FFP2 mask (Eskyté et al., 2020). Even more prominent are the impacts of the lockdowns which aimed to “flatten the curve” by reducing the spread rate of the virus. This amplified vulnerable situation of people who depend on for example social services to cope with being homeless. As public life was reduced to a minimum, schools were closed and individual freedom was restricted, many of those who are commonly not considered specifically vulnerable were pushed into much more vulnerable situations. Furthermore, this emphasizes that it is not only extreme events, or inappropriate crisis management structures that can put persons in vulnerable situations, but that measures themselves redistribute risks and harms.

### **5) Recognition of psychosocial wellbeing as a factor for resilience and vulnerability**

The German case study shows the great significance of mental health and psychological/psychosocial support during crises. Consistent with other studies (see Hahad et al., 2020; Skoda et al., 2021), the collected material shows the increased stress level of the population in Germany during the COVID-19 pandemic. While the floods were handled relatively well by most people, the pandemic causes a lot of stress, tension, and anxiety. Many people feel lonely and have no one to talk to. Within the survey, the psychological difficulties posed by the COVID-19 pandemic, as well as the psychological impacts accompanying it, were also generally deemed to be the most severe effect of the pandemic.

Although it is clear that this cannot be the sole responsibility of crisis management, which is neither trained nor staffed in an appropriate way, a societal discussion is needed on what the role and responsibilities of crisis management structures can be and how they link to everyday life structures. This for instance encompasses to increase assets for short term psychosocial support within the disaster management structures, establish cooperation with support hotlines and networks and involve social workers and psychiatrics for long term recovery.

### **6) Social capital and social cohesion are powerful resources that should be recognized as situation-dependent**

Social cohesion describes a process and outcome of social solidarity, while social capital refers to resources derived from social relations. They are connected and influence each other.

The German case study reveals a strong sense of cohesion among the population during the floods. This observation is consistent with other research on the floods. The floods were perceived as collective experiences. The high visibility of the crisis, as well as the opportunity to take active action against it, led mostly to the experience of “collective efficacy” (Siegrist et al., 2009, p. 171), which in turn strengthened social capital. During the still ongoing COVID-19 pandemic, a different picture has emerged. Although there are no indicators for panicking, interviewees commonly refer to feelings of loneliness. This time, the threat itself tends to be invisible. Rather it is the virus countermeasures, the masks, precautionary activities and closed public life, that is visible and is credited with causing stress for some people.



This suggests at least two perspectives here: first, social cohesion in crises depends on the ability to work together and cooperate. Considering this point seems to be important, as the pandemic shows that this form of collaboration is not possible in every extreme event. Instead, thinking of alternative ways to bring people together in order to develop a positive narrative and thereby increase active involvement is required. This leads to the second thesis: the ability to actively take part in overcoming a crisis is an important part of psychological resilience.

## **7) Preparedness planning has to consider the embeddedness of disaster management personnel in social context**

Disaster management in Germany builds to a large degree on affiliated volunteers whose capacities and work force can be activated if necessary. In order to make the best from this resource, these persons do not only have to be trained and equipped appropriately to fulfil the tasks that they are meant for. Also, they have to have the possibility to go into action. This means to recognize that affiliated volunteers are embedded in sometimes fragile social contexts. They might have children or relatives to care for and an employment from which they have to be exempted. These potential conflicting roles of the private and the professional sphere have to be considered in preparedness planning. For instance by providing alternatives for childcare or for getting support, assistance for the relatives that people care for (Meinhardt, 2018). Especially in long-term crisis such as the pandemic, emergency personnel are often bound for long periods of time. If this is predictable, support structures should be implemented.

### **3.5.3 Who are the users of the innovation?**

In this section, we describe who the users of the innovations are, focusing on each of the recommendations presented above.

**First recommendation:** In particular, local disaster relief organizations could benefit from the first recommendation, by using it as a starting point for critically assessing their own preparations for disaster and by expanding their network with the local civil society. By deepening their exchange with the local civil society can assist it with improving their awareness, ability and the possibility to adjust in case of disasters.

**Second recommendation:** This potential for innovation is of particular significance for strategy planners of disaster relief organizations as well as policy makers. While improving the awareness of disaster relief organizations for situations than can render a person vulnerable is a good way to achieve a short-term improvement of crisis management strategies, a profound and substantial improvement can best be achieved by creating an awareness for how underlying social injustices and differences can make people less able to deal with challenges which can render them vulnerable. Based on this realization, long term changes of social structures can be addressed, ideally in close cooperation with social service providers. Such policies could also help to establish a personal network between disaster relief services and social service providers, which can be of great importance in case of a disaster.

**Third recommendation:** This potential innovation is of particular relevance for crisis management forces on the ground and, in extension, for their instructors. In order to develop a greater respect for individual autonomy and to better understand the potentially rational motives of a person disobeying commands issued by disaster relief organizations, the education of disaster responders should be adapted accordingly. Furthermore, providing the general public with better information about correct behavior during disasters could also enable them to make better and more well-informed decisions





during such an event, therefore using their personal autonomy as well as possible. Such an innovation would have to be implemented by the leadership level of disaster relief organizations.

**Fourth recommendation:** In order to reflect on the potential vulnerability factor of crisis management measures, it is necessary to include individuals with experience or knowledge on diverse living situations in disaster management structures. They could help to provide decision makers with the needed information to also take the potentially vulnerability increasing effects of crisis management measures into account while planning them. Consequently, they could take appropriate steps to mitigate, or at least reduce, such negative effects.

**Fifth recommendation:** Because of this innovation, potential psychologists and psychosocial care providers could become more involved in disaster planning activities to take the negative impacts of disasters better into account. Additionally, disaster relief services could also strengthen their network with psychological relief services and order to improve their sensibility for psychological impacts of disasters and to help them including qualified professionals in psychological disaster relief efforts. Finally, disaster planners and policy makers could also benefit from this innovation by adapting a more long-term view on disaster relief operations to also counter the long-term psychological impacts of such events.

**Sixth recommendation:** The insights gained from this innovation potential is of particular importance for disaster relief planners and people in commanding positions during the implementation of the relief measures, as well as policy makers. It could help to sensitize disaster relief organizations for the needs of people with less social capital during disasters both during the planning and mitigation phase of disasters, thereby increasing their visibility as well as countering at least some of the negative effects of the unequal distribution of social capital within society. Furthermore, a heightened awareness for the situational-dependent nature of peoples' ability to use social capital could also help policy makers to take into account the effect of disaster relief measures implemented by them on the ability of people to utilize the social capital available to them during disasters.

**Seventh recommendation:** The primary responsibility for achieving this aim falls to policy makers as well as government officials on a local level. While policy makers must make the resources for such prioritized support structures available, local government officials must make sure they are also created and maintained as well as ensuring that responders and their families can also access them when needed.

#### 3.5.4 Validation/implementation

All of the interview partners in T4.5 have expressed interest in receiving the findings. T4.5 will also present these findings to the people who are responsible for disaster management of the city of Dresden. They will also do a GRC publication in German that targets disaster management personnel and people who volunteer in organisations such as the GRC. Some of the findings have been presented at the NEEDS 2021 conference and received positive feedback. The findings will also be presented to stakeholders in a co-creation workshop in WP6.

The T4.5 case study did not focus to create a tool or a certain strategy but more on creating insights that are helpful in the development of strategies and tools for disaster management.

The findings can be transferred to other countries. However, as disaster relief systems can be quite different, not every finding will be useful for other countries. What parts of the findings that are applicable to other countries would need to be studied and validated.





### 3.6 Assessing Strategies for Improving Hospital Capacity for Handling Patients during a Pandemic

The full account of Case study WP4.6 “Assessing Strategies for Improving Hospital Capacity for Handling Patients during a Pandemic” is provided in Shahverdi et al (under review). We refer to it as T4.6 in the rest of the text. As the presentation of T4.6 is based on an article that is under review and not published yet and the content must not be shared or disseminated until the article is published.

#### 3.6.1 Background

The title of the US case study WP4.6, is: “Assessing Strategies for Improving Hospital Capacity for Handling Patients during a Pandemic”. The case study examines how key hospital units associated with emergency care of both routine emergency and pandemic (COVID-19) patients can use strategies to increase the capacity to help patients.

On January 30 2020, a Public Health Emergency of International Concern was declared by the World Health Organization (WHO) due to the Coronavirus disease (COVID-19) pandemic. Non-pharmaceutical interventions (NPIs), such as social distancing, masks, and limiting social and economic activities, have proven effective in reducing transmission, but have been applied variably and inconsistently. As a result, hospitals see demand fluctuations and must adapt by repurposing space, mobilizing resources, and modifying care when conditions warrant and then return to normal operations to serve routine patients, including emergency patients, when excess demand diminishes.

To support health care response to the COVID-19 pandemic, Currie et al. (2020) discussed how simulation modeling techniques, such as system dynamics, agent-based modeling, and discrete-event simulation (DES), can be applied to tackle challenges to hospitals caused by COVID-19, and Wood et al. (2020) proposed a stochastic DES framework for modeling Intensive Care Unit (ICU) operations. These studies tested various strategies, such as increasing the number of beds, decreasing length of stay (LOS), and flattening peak demand, for reducing deaths caused by insufficient ICU bed capacity. Results of their work indicate that mortality resulting from ICU capacity shortage could be reduced by up to 90% (from 3,780 to 382) through a combination of strategies. A current tool, COVID-19 Hospital Impact Model for Epidemics (CHIME 2021), uses an epidemiological model to aid hospitals in capacity planning. CHIME projects daily numbers of admitted pandemic patients based on the population in the surrounding area, the hospital's market share, assumptions about the spread and behavior of the virus, average length of stay of pandemic patients, and other parameters.

#### 3.6.2 Innovation

The main innovations provided by T4.6 are ***strategies that hospitals can use to increase patient capacity to handle demand surges***. T4.6 considers the timing for implementing and withdrawing these strategies as surge demand ebbs and flows. These outcomes have broader implications for other infectious disease outbreaks.

Five specific interventions and two critical shifts in care strategies were identified that can potentially significantly increase hospital capacity for routine emergency and COVID-19 patients during a pandemic. These include e.g.: 1) repurposing space, 2) modifying operations, 3) implementing crisis standards of care, and 4) requesting external support, thus, increasing the likelihood that arriving patients, both routine emergency and pandemic, can be served. The type of predictive modeling provided by the study can be critical to assist with planning for future epidemics.



The T4.6 study was conducted using whole-hospital, resource-constrained, patient-based, stochastic, discrete-event simulation models of a generic 200-bed urban U.S. tertiary hospital serving routine emergency and COVID-19 patients. Systematically designed numerical experiments were conducted to provide generalizable insights into how hospital functionality may be affected by the care of COVID-19 pandemic patients along specially designated care paths under changing pandemic situations from getting ready to turning all of its resources to pandemic care.

Four surge levels are considered that correspond with changing COVID-19 pandemic conditions of the hospital's service area: **Getting Ready, Initial Onset, Outbreak, and Hot Spot**. Getting Ready involves ordinary operations and standards of care without pandemic patients. Initial Onset and Outbreak levels involve the integration of added care paths specific to infectious (COVID-19) patients while a hospital continues to serve routine emergency patients. The level moves from Initial Onset to Outbreak when the design and preliminary Adapted Standards of Care (ASCs) cannot support the incoming patients and additional care path modifications are required. The Hot Spot level is necessary if pandemic patient arrivals continue to surge and prior changes and ASCs are insufficient. This Hot Spot level presumes that nearly all hospital resources are turned toward pandemic patient care and all reasonable modifications and care alternatives, including ASCs, are taken. Routine emergency patients will be turned away or even transferred out, creating a COVID-19 only care facility. External support will be required to create additional capacity.

Plans for implementing hospital capacity enhancements to cope with the increasing demand can be made by estimating the COVID-19 patient arrival rates at which each surge level is reached. These transitions are referred to as **switch points**. The T4.6 study identifies the switch points for the illustrative hospital for both increasing and decreasing cases. As surge demand recedes, modifications can be relaxed to again begin to serve routine emergency patients with usual levels of care.

In the following, we present the results of the simulations under different levels of patient surge. The different findings provide information about the impacts of different strategies that might increase hospital capacity.

### Initial Onset: Hospital Unit Performance with Integrated COVID-19 Patient Care Paths

**Finding 1.** The hospital can serve up to 75% of its usual routine emergency department (ED) demand with half the number of ED beds and three-quarters the number of internal general ward (IGW) beds retained for routine patients. Creating isolation rooms from ED and IGW rooms for infected patients can enhance a hospital's capacity to serve COVID-19 patients while preserving its ability to care for routine emergency patients.

**Finding 2** During the Initial Onset surge, a hospital may need to turn away emergency patients. To avoid turning away patients, hospitals may respond by placing patients in unconventional locations or even requiring two patients to share a single piece of equipment (e.g. ventilator) to cope with significant backups. To be better prepared for this phase, hospitals can, in advance, repurpose space, modify operations, implement ASCs, prepare to collaborate with other health care facilities, or request external support (tents, personnel, and so forth), increasing the likelihood that all patients will receive treatment.

**Finding 3.** With 25 COVID-19 and 200 routine emergency patient arrivals daily, each ICU bed serves up to five patients per month – that number decreases to about 3.5 as the number of COVID-19 patient arrivals increases. This is due to the longer length of stay of COVID-19 patients.



## Outbreak: Implementing ASCs or Other Interventions for Added Capacity

**Finding 4.** Cancelling elective surgery frees up in-patient (IGW) beds, increasing capacity for treating routine emergency patients while simultaneously coping with the COVID-19 patient surge. Results show that by redesigning the hospital to add a specialized care path for COVID-19 patients, the ED and larger hospital lose 30% and 32% weekly patient throughput capacity, respectively. To cope with periods of COVID-19 surge, hospitals have cancelled elective surgeries either by choice or mandate. Cancelling elective surgeries (75% of scheduled operations) enables the ED to serve 22% more patients and results in an 18% greater overall routine emergency patient throughput.

**Finding 5.** Treatments that reduce COVID-19 patient intensive care LOS by one day increase a hospital's ICU capacity by 24%. The most at-risk COVID-19 patients require ICU care. The simulation run results indicate that each one-day reduction in ICU LOS increases ICU patient throughput by between 9 and 24%.

**Finding 6.** A hospital's capacity for routine emergency and COVID-19 patients is highly dependent on the number of COVID-19 patients seeking care, as serving each COVID-19 patient requires, on average, more of the hospital's capacity (e.g. longer LOS in the ICU) than a single routine emergency patient. As the percentage of COVID-19 patients increases more resources are needed to serve the same number of emergency patients.

## Hot Spot: Unified COVID-19 Care Increases Capacity

**Finding 7.** COVID-19 designated hospitals can serve up to five times the number of COVID-19 patients compared with a similar facility accepting mixed patients. This increase is accomplished by: allowing ASCs and using all the available beds, nurses, and doctors ordinarily assigned to routine patients in the IGW, pre- and post-op units, and the ED for COVID-19 patient treatment. Increases of approximately 350% and 140% in throughput were noted for the ICU and isolation rooms, respectively. This can only be improved further with additional space (i.e. beds). It is estimated that a threefold increase in the number of COVID-19 patients can be served without compromising standards of care.

## Switch Points

**Finding 8.** There are two key switch points when hospitals must introduce strategies for increasing capacity or dedicate all resources to COVID-19 treatment to meet COVID-19 patient surge. Without such action, it may become necessary to ration care. A hospital can prepare for action by predicting the timing of these points.

Two key switch points can aid a hospital in coping with increasing COVID-19 patient demand. The first uses ASCs, specifically increased patient-to-staff ratios and repurposing of nonmedical space. Implementing ASCs allows the test hospital to serve, on average, 30 COVID-19 patient arrivals per day (~10 additional patients or 33% increase based on ICU throughput).

The second designates nearly all medical space and staff for COVID-19 treatment. Dedicating the hospital to COVID-19 patients along with ASCs allows the hospital to serve an average of 40 more COVID-19 patient arrivals per day in the isolation rooms (a 133% increase) and an average of 80 more in the ICU (a 400% increase). With additional negative pressure rooms for isolation and critical care nurses, the designated hospital could serve even higher numbers.



To sum up, these estimates can help a region forecast its total COVID-19 patient response capability. By taking actions at the switch points, or in advance of these points, hospitals will be prepared to meet increased COVID-19 patient arrivals at the onset of a surge and recognize tipping points where outside help or a hospital's complete dedication to COVID-19 would become essential. Anticipating switch points as surge demand diminishes can also aid in efficiently restarting routine services that were canceled during the surge.

### 3.6.3 Who are the users of the innovation?

Meeting the challenges of surge demand on hospitals is crucial for regional, national, and international COVID-19 response efforts. Hospital administrators and regional directors are faced with decisions whose implications depend on hospital functionality. Each hospital is a complex, dynamically changing, constrained system with interconnected work flows and users (patients) with unique needs and care paths. As hospitals in a region form an interacting, complex, dynamic priority system, it is difficult to predict the impact of any decision on hospital or regional health care performance. State-of-the-art computer simulation modeling as proposed in Case T4.6 can aid decision makers in meeting these challenges and avoiding circumstances where a patient in need of care is unable to find it. It also facilitates the study of individual strategies whose benefits would be difficult to isolate in reality due to confounding effects of simultaneous actions and changing circumstances.

### 3.6.4 Implementation/validation

Model details were built based on extensive interviews with the director of operations and an administrative director of ED/trauma, safety, security and employee health services, head nurse, and others, at the Johns Hopkins Hospital, Johns Hopkins Suburban Hospital, and Johns Hopkins Office of Critical Event Preparedness and Response (CEPAR). Parameters that could not be obtained from these interviews were developed from national averages and values from case studies in the literature.

To test the validity of the developed models, multiple numerical experiments were designed and implemented. Through experimental runs under routine conditions, model outputs were compared against averages from similar Trauma-level I and II hospitals. Unusual model behavior was investigated and refinements to model details were made and parameters were adjusted through further discussion with hospital experts. This process of model construction and verification is described in more detail by Tariverdi et al. (2019).

The T4.6 team is currently working with a significant hospital system to fully validate the COVID-19 model extensions against real-world data, a process that is expected to take another year or two, and is complicated by inconsistencies in data collection procedures over the course of the pandemic. The models are U.S.-centric. Modifications to hospital layouts, workflows and other details may be required to replicate operations in other countries. They were also created generically, with the aim of capturing the most important features of COVID-19 patient care. Additional details may be desired to model specific hospitals, proposals for restructuring and alternative settings to those used herein. The authors are extending the modeling capabilities developed herein to assess regional hospital capacity for coping with COVID-19 or other pandemics under varying collaboration strategies extending prior hospital coalition work. Other extensions might include study of: (1) the potential impacts of changing strategies on special patient populations by segmenting the routine patient stream into multiple classes; (2) the effects of limited PPE by restricting the PPE resource and requiring its use whenever a staff member is assigned to a patient (currently modeled, but with infinite PPE supplies); and (3) nurse, doctor or technician absenteeism, the probability of which might



increase with increasing number of patient contacts and/or limited PPE availability, or decrease when suggested interventions are taken.

## 3.7 Dashboard providing information about tourists in crisis areas

### 3.7.1 Background

The full account of Case study WP4.7 “Using Mobile Operators’ Data to Locate, Protect and Evacuate Tourists and Other Vulnerable Groups in Disasters” is provided in Vöik et al (2021). We refer to it as T4.7 in the rest of the text.

As a country located in the Pacific Ring of Fire, in which several major tectonic plates intersect and collide, Indonesia often experiences natural disasters on its many islands, such as earthquakes, tsunamis, and volcanic eruptions occurring due to tectonic activities, as well as debris flows, landslides, and slope failure due to its steep topography. According to the 2018 World Risk Index, Indonesia ranked as the 36th country with high disaster risk out of 172 countries assessed. Furthermore, The National Agency for Disaster Management (BNPB) stated that almost all districts in Indonesia are prone to hazard, where 80% of its districts are categorized as disaster high-risk areas.

The occurrence of natural disasters is often relatively unpredictable, hence it exacts a severe toll in terms of the economic impact, losses of human lives, and physical damage. According to risk assessment data published by the BNPB in 2016, Indonesia has to bear social losses of 86,247,258 lives, physical structure losses of IDR 406,689,834, and economic losses of IDR 182,185,171. To reduce these disaster risks, Indonesia needs to have an effective disaster and crisis management policy that promotes disaster risk reduction, increases regional resilience, and minimizes social vulnerability.

Tourists have been considered as groups of people that might become specifically vulnerable to natural disasters in the regions they are visiting because of their lack of preparedness and knowledge, inadequate place-based disaster- and vulnerability assessments (Becken et al., 2014), and their existing language barriers (Marlowe & Bogen, 2015). Moreover, the tourism industry often has limited integration with national disaster management systems, hence tourists are likely to lack the understanding and competency in knowing critical information and actions they need to take to protect themselves in the occurrence of disasters (Hystad & Keller, 2008; Uekusa, 2019).

The objectives of the BuildERS project explore how various population strata have been affected by life-threatening emergencies, whose exposure have been magnified by pre-event social, individual, and institutional fragility, and which might need highly targeted help and protection. To this end, innovative practices, measures, and technologies are proposed to reduce vulnerability and mitigate harms inflicted by past, present and future hazards by altering and/or adjusting the contextual features and processes to remove gaps and inadequacies in public safety, security, and social inclusion.

### 3.7.2 Innovation

Case study D4.7 Indonesian Case “Using Mobile Operators’ Data to Locate, Protect and Evacuate Tourists and Other Vulnerable Groups in Disasters” has therefore developed a dashboard using mobile positioning data (MPD). This dashboard presents how many tourists were in the crisis area, where they are from and if and where they are moving to. Unlike in the case study 4.3 where historical MPD is used, the Indonesian case study explores how near real-time MPD can be used for crisis management. This information can be used to:





- Estimate the number of tourists that were potentially affected by the crisis;
- Let embassies know how many people from their countries were in the area;
- Assess if crisis notifications reach vulnerable people understandably and on time;
- Assess, how many tourists are moving out of the area and how many are still there.

MPD in the context of this dashboard refers to passive mobile positioning, meaning the data that is automatically collected by the mobile network operator (MNO) based on customer billing, network maintenance and performance monitoring. Passive MPD has been becoming a more popular data for statistics. There are multiple reasons for that, such as the fact that data is collected passively and without any burden on people. There are many data points per person within a longer period, which gives the data consistency throughout the whole time period and does not only reflect one day, week or a season, but the changes throughout a longer period as well. MPD is also not as expensive as surveys that reflect less and the results can be used in many different domains, such as tourism statistics, transportation planning, mobility analysis and population statistics.

The dashboard shows the exact number of tourists in the area (no coefficients are used), but it is important to understand that Positium has MPD from one MNO who has the majority of the market share (around 60%), which means that tourists who only connect to other operators' cell towers are not included in the data. Also, tourists who have one SIM card in their phone and they have replaced it with a local SIM card, are not in the data as in the eyes of the algorithm, they are domestic subscribers and their data is stored in another database, which Positium has no access to.

MPD has many advantages. The data is passively collected by MNOs anyway so that they could bill their customers at the end of the month. No extra effort for gathering the data is needed. MNOs are obligated to gather this data and also to store it for a certain amount of time. In case of tourism statistics, gathering data with MPD is 4 times faster and sample size is up to 200 times higher, compared to travel questionnaires. It is also more cost efficient and less burden on tourists. MPD covers most of the population as SIM-cards are widely used by almost everyone.

The data might not be available due to its dependency on private companies who might change contracts and so forth. Unfortunately, recently and suddenly, the data access conditions in the main data provider in Indonesia have changed due to changes in internal data sharing policy. Positium is currently working with the data provider to sign a new data access agreement. It is unclear how long the new arrangements will take as the data is of highly sensitive nature. This brings us to the fact that real MPD was not used for this case study. Positium has access to an aggregate database of roaming subscribers from 2019, from which they are able to analyse tourism movement to some extent and it allows them to create simulated data that provide the input for building the tool described in D4.7. This means that MPD is not being used in the dashboard, but the tool demonstrates the capabilities that the tool could have with MPD. Against this description the data are “real” but “non-identifiable” due to the aggregation.

MNOs might collect the data with different structures or with different storing methods. For the Indonesian case study there is the strength, that Indonesia has been using MPD for tourism statistics for years. There is already a contract with one MNO in place, their data has been assessed for quality and structure and Positium has knowledge and experience on how to use their data in Positium Data Mediator. If a new country wants to use MPD for statistics, a longer pilot project will have to take place





first, but in the Indonesian case this is not necessary and the dashboard can be taken into use quickly (if data sharing policy within MNO becomes clear).

Positium has built a dashboard that helps rescue organizations plan their human and material resources more accurately during crises. Through more exact planning and knowledge of tourists' whereabouts during crisis, the processes of aid and relief during disaster can be faster and more effective. The dashboard currently has simulated event data in it, but it was built and validated as if the data was real. On the dashboard, there is inbound data of 1-2 days prior to the crisis and daily updates for a couple of days afterwards as well. In case the data was real and a crisis is happening real time, data would come from one MNO. Currently the dashboard is built on a municipality level but Positium is able to display the results on a smaller area level as well if that reflects the crisis area better. It strongly depends on where the crisis happens and what kind of crisis is being dealt with.

Table 4 Process flow of using MPD for crisis management in Indonesia

	AUTHORITIES IN INDONESIA	MOBILE NETWORK OPERATOR	POSITIUM	RESCUE SERVICES
DAY OF DISASTER	Let Positium know of crisis area and time; agree on area size (county/municipality/village)	Makes inbound data of last 1-2 days available for Positium in a secure server	Does the calculations in Indonesian servers (as required by law) and updates the dashboard	Can see how many tourists were in the area during disaster and where they are from; resource planning; evacuation management
DAY AFTER DISASTER	Can use country of residence information in communication with foreign consulates; resource planning; evacuation management	Makes inbound data of the last day available for Positium in a secure server	Does the calculations in Indonesian servers (as required by law) and updates the dashboard	Can see how many tourists are still in the area and where they are from; see if they are moving out of the area; resource planning; evacuation management

In case a crisis happens, this is the process flow (Table 4). Firstly, authorities will let Positium know which type of crisis, when and where it happened and also lets Positium know what area size is needed (county, municipality or village). At the same time, MNO makes sure that the inbound data of the last 1-2 days is available for Positium in a secure server. Then Positium does the calculations in the Indonesian servers, as required by law (data is not allowed to be transferred outside of Indonesia) and updates the dashboard within 24 hours. Rescue services can then see how many tourists were in the area during disaster, where they are from and they can base their resource planning and evacuation management on this information.

Authorities will also see the results on the dashboard and they are able to use the country of residence information in communication with foreign consulates to let them know how many tourists from which countries were potentially affected by the crisis. Authorities can also support rescue services with resource and evacuation planning. Similarly to the first day, on the next days MNO makes daily new inbound data available for Positium. Positium does the calculations and updates the dashboard. On the next days, rescue services and authorities can also see movements between different areas and how they have changed over days.

The tourist layer in the dashboard shows the number of foreign tourists in the chosen municipality, and can be used to determine the amount of tourists in an area for each day. The movements layer in the dashboard can be used to see how many movements of foreign tourists and to which directions

are happening between the municipalities and helps to determine which roads to block/unblock first or to estimate the amount of resources needed for different purposes. It can also be used to evaluate if tourists are moving out of the crisis area.

### 3.7.3 Who are the users of the innovation?

The main stakeholders of the dashboard are different embassies, BNPB and the ministry of foreign affairs. The dashboard that has been built helps rescuers create more accurate risk assessments for different crises. The dashboard is very case universal, meaning that it can be used not only for earthquakes and volcano eruptions, but also for floods, tsunamis, terrorism, bombings etc. Based on this dashboard, rescuers are able to more accurately plan risk assessments, evacuations and learn from past scenarios. Also, it can give accurate input for authorities for communication with foreign consulates (how many tourists from which countries were in the crisis area during the crisis and afterwards as well).

### 3.7.4 Implementation/validation

In April 2021, a focus group discussion was held with end-users to validate the usefulness of the dashboard. The purpose of the validation is to gain more insight on how the dashboard could fit better into the local disaster management system, by taking into account the expertise and experience of relevant institutions. Participants were from different agencies to cover more parts of the emergency processes. Around 30 people participated. There were the Indonesian Ministry of Foreign Affairs, Ministry of Tourism and Creative Economy, Ministry of Development Planning, National Disaster Management Agency (BNPB), National Statistical Office, Ministry of Social Affairs, and Provincial Government, and representatives from the Non-Government Organizations, and Civic-Tech organizations.

It was found that the dashboard reaches its highest usefulness when combined with already existing databases and dashboards. There are different data sources already existing, e.g. one that shows the count of people found on-site, one shows with GPS the tourists that have asked for help. Positium's dashboard could fill in the missing view that shows how many tourists in general were in the area potentially affected by the crisis. The wider the view and the more integrated dashboards with different aspects, the better overview of the crisis situation will rise. Stakeholder MOFA has already shown interest in future collaboration in regard to integrating this dashboard to their systems. Results from the stakeholder evaluation show that if this dashboard gets taken into use, updates should last up to 5 days and the main stakeholders are different embassies, BNPB and ministry of foreign affairs.

To further optimize the effectiveness of the dashboard, it is also possible to combine data from the dashboard with the data gathered through other sources, such as SafeMyLife application. The SafeMyLife application relies on GPS technology that could send an exact location when a person sends a distress signal by tapping an emergency button on the app. This application needs to be downloaded by the tourists beforehand and prefilled with information related to the end-user's health conditions. This information would be used by rescuers to prioritize disaster victims and accurately prepare the required aid and resources to help the victim. This SafeMyLife application could complement location data provided by Positium's dashboard, which has people's whereabouts calculated based on coverage areas of the cell towers. Combining data from SafeMyLife would increase data validity and also the effectiveness of search and rescue efforts, especially if the distress signal could confirm the movement and locations of the tourists made available by the dashboard.



The Ministry of Foreign Affairs (MOFA) is the agency that has the authority to issue medical evacuation for foreign citizens in Indonesia. The way the MOFA's dashboard works is that MOFA received a notification via WhatsApp, Short Message Services (SMS) or by phone from the Indonesian Disaster Management Agency (BNPB). Based on the discussion during the workshop, the dashboard developed by Positium could complement the existing dashboard managed by MOFA in the following ways:

**a)** The ability to locate tourists who have moved from one area to the others are also important. Most tourists came from major entry gates such as Jakarta or Bali. They will then go on to different areas including some of the remote areas. It would be difficult to locate the tourists only based on the information from the data gathered by the immigration authority at the entry gate.

**b)** The data gathered by BPNB is based on findings on the ground, which means BNPB's staff has to be able to directly locate and interview the tourists to identify the number of affected foreigners in the area. The issue here is that sometimes the BNPB would not be able to physically locate the tourists or the delay in which the BNPB would be able to locate the tourists. The dashboard could provide information about total tourists' count in the area that are potentially in danger.

MOFA has expressed that they are open for collaboration to improve the existing dashboard. They also welcome follow-up discussions in a small group meeting together with BNPB to explore the needs and solutions that could be developed from MPD and how it could complement already existing dashboards.

In conclusion, it was found that this tool alone does not help crisis management better, but if it was combined with already existing dashboards and other information sources, it could give a much better overview of the crisis situation. All data sources look at the crisis from different perspectives and all have their own limitations. Hence, the more different datasets there are, the better overview of the crisis situation will appear.

In the meeting, about 43% of the exercise participants who were not from the BuildERS project group answered a survey about the usefulness and relevance of the tool. 67% of the respondents represent the government, 11% were citizens/individual users, 11% from non-governmental organizations, and 11% from research organizations or universities. Participants indicated their agreement with different statements, e.g. "The tool or technology is suitable for crisis management" (89% agree), "The tool or technology is suitable for Disaster Risk Reduction (DRR)" (78% agree), "The technology or tool is easy to use" (78% agree) and "The tool or technology should be adopted to regular use in my country" (89% agree).

MOFA has expressed their interest in the dashboard during the validation meeting. They are interested to have further discussion to discuss how the MPD-based dashboard could be used to support the one that they're currently using.

## 4. Discussion

### 4.1 Summing up the case studies

In the following we sum up the case studies, focusing on the innovations they provide, the target groups for the innovations and the gaps that the innovations address.



#### 4.1.1 Innovations, target groups and gaps addressed in T4.1 Managing chemical spill emergency and mis-/disinformation through simulated responses

Task 4.1 provides the following innovations:

- A simulation training (Communication to better reach the chosen target groups).
- An interaction training handbook. (Face-to-face interaction with the chosen target groups)
- A concept for inter-agency training.
- Results that can be used to give recommendations to NGOs and first responders as to how to improve these people's resilience and actions during an emergency. How to mitigate negative and strengthen positive impact of social capital.
- Recommendations of how to interact with special groups during emergency.

The target audience for these innovations are European rescue services, law enforcement and their strategic partners in crisis communication. The training concept could be evaluated by European first responders, NGOs and other agencies. The training content will be presented to the European Police via the CEPOL platform (CEPOL = European Union Agency for Law Enforcement Training).

Gaps addressed by these innovations compared to current practices: The "Community-Oriented Policing (COP) in the European Union today" states that "research shows that the social context has a major impact on the meaning, interpretation and implementation of policing practices. In regions where there is historical distrust restoring trust may take decades. Therefore, COP should be seen as part of a larger shift from a police force to a police service. Encounters between police and public are crucial for the quality of the relationship, and effective, appropriate and timely communication is vital for a successful COP approach.

#### 4.1.2 Innovations, target groups and gaps addressed in T4.2 Vulnerability in post-disaster temporary housing, BuildERS project

Task 4.2 provides the following innovations:

- Emergency management procedures, by changing the guidelines or technological tools that are used in emergency management
- Knowledge that will then be used to improve the guidelines and tools used to displace survivors in temporary housing after a disaster so that they can take into account vulnerabilities.
- Knowledge necessary for the improvement of procedures for post-disaster emergency management, possibly by including fields in guidelines and administrative tools that account for the aspects of individuals' vulnerability that emerged as important from the study.

The target audience for these innovations are civil protection workers who are the ones who manage the relocation of people into temporary housing solutions. The ultimate and final beneficiaries of the innovations are vulnerable citizens.

Gaps addressed by these innovations compared to current practices: To date, the management of the post-emergency phase is handled in such a way as to prioritize the safeguarding of human life, leaving in the background psychological, social, and other aspects. Vulnerabilities are codified exclusively as physical vulnerabilities and treated as such. In contrast, the aspects of vulnerability are multiple, and the physical aspects intersect with the social, psychological, and environmental ones. By producing new knowledge about what aspects of vulnerability affect satisfaction with temporary solutions, we can improve post-disaster emergency management by including fields in guidelines and



administrative tools that account for the aspects of individuals' vulnerability that emerged as important from the study.

#### 4.1.3 Innovations, target groups and gaps addressed in T4.3 Applying mobile positioning data for more precise rescue planning and emergency management under cyber-hazard in Estonia

Task 4.3 provides the following innovations:

- A tool that helps rescuers to be more risk aware. The tool can be helpful for rescuers to prepare for disasters by doing more accurate risk evaluations in regions and buildings, etc., based on the application or by gaining general knowledge of population whereabouts and its dynamics.
- This helps rescuers to be more aware of the risks. Currently, additional tools in Estonia with the focus of localised notification systems are also under development, so in the future there is a possibility to integrate the tool with other systems.

The target audience for these innovations are Estonian Rescue Board, Police and Border Guard Board, Defence forces, Medical units and Municipal officials.

Gaps addressed by these innovations compared to current practices: The tool addresses a need for better understanding of the number of individuals in the area of hazard. Also, temporary populations groups such as tourists, who are often not considered with in official crisis plans because of lack of empirical data are included in the tool. With this knowledge the resources needed for offering people support and rescue can be better planned by institutions tasked with crisis management.

#### 4.1.4 Innovations, target groups and gaps addressed in T4.4 Integration of public data bases for identifying highly vulnerable people in need of relief prioritisation by the Estonian Rescue Board

Task 4.4 provides the following innovations:

- A vulnerability assessment tool linking crisis-specific vulnerability indicators and information from datasets and other sources of information.
- A map of types of datasets and information sources that could be used for vulnerability assessment; analysis of their strengths and weaknesses.
- Principles of a participatory process in the vulnerability assessments.
- Recommendations on clarifying institutional mandates and collaboration principles between different authorities and representatives of diverse society in vulnerability assessment.
- Recommendations on ethical principles and legal bases for the processing of personal data in vulnerability assessment

The target audience for these innovations are agencies responsible for crisis planning, e.g. municipalities, Health Board, Government Office, Rescue Board, Social Protection Board.

Gaps addressed by these innovations compared to current practices: A need for clarifying the tasks and guidance on responding to social vulnerabilities exceeding resilience capabilities during crisis on municipal and state government level. A lack of social vulnerability analysis in the state government risk assessments and as a basis of crisis management plans. A need for setting forth principles of analysis of vulnerability – a methodology that could be included in the elaboration of risk analyses and crisis management planning. A need for reviewing data protection measures' applicability during crisis. A need for frames of who among the diverse society should be engaged at which point in crisis planning, including vulnerability assessment.





#### 4.1.5 Innovations, target groups and gaps addressed in T4.5 Impacts of Elbe flooding disasters on socially underprivileged groups and lessons for resilience improvement

Task 4.5 provides the following innovations:

- Information on factors and structures that lead to vulnerability, high or low social capital and high or low risk awareness. This is very important information to develop inclusive policies and practices. For example, how policy makers and city administrations should work with social service providers to make sure that homeless people are taken care of.
- Findings about the shortcomings of current disaster management. These are likely to have indirect implications that can be traced back to certain existing tools. For instance, the availability of information and warning (use of warning apps) or guidelines for individual disaster preparedness (e.g. of the German Federal Office of Civil Protection and Disaster Assistance).

The target audience for these innovations are social services, disaster management authorities, target policy makers on a lower level, crisis management practitioners, school leaders and teachers, education departments, municipalities as the lower disaster control authorities, federal states as the responsible higher disaster control authorities, different parts of the population when faced with disasters could also aid crisis management practitioners and organizations during the planning phase of their work and civil society stake holders.

Gaps addressed by these innovations compared to current practices: By further developing the knowledge regarding the heterogeneity of vulnerable groups as well as the intersectionality and context dependency of vulnerability, and consequently resilience, this task hopes to provide a framework for future social, technology and policy innovations. In doing so, the results of the German Case Study can serve as an additional perspective in the creation of better disaster management measures and therefore can help to adjust ideas and wishes of disaster management actors.

#### 4.1.6 Innovations, target groups and gaps addressed in T4.6 Assessing Strategies for Improving Hospital Capacity for Handling Patients during a Pandemic

Task 4.6 provides the following innovations:

- Five specific interventions and two critical shifts in care strategies were identified that can potentially significantly increase hospital capacity for routine emergency and COVID-19 patients during a pandemic.
- These include e.g.: 1) repurposing space, 2) modifying operations, 3) implementing crisis standards of care, and 4) requesting external support, thus, increasing the likelihood that arriving patients, both routine emergency and pandemic, can be served.
- A predictive modeling technique which can be critical to assist with planning for future epidemics.

The target audience for these innovations are hospital administrators and regional directors faced with decisions whose implications depend on hospital functionality. Meeting the challenges of surge demand on hospitals is crucial for regional, national, and international COVID-19 response efforts.

Gaps addressed by these innovations compared to current practices: The simulations, analyses and recommendations in T4.6 provide the most recent knowledge building on and improving previous studies using different simulation techniques. As hospitals in a region form an interacting, complex, dynamic priority system, it is difficult to predict the impact of any decision on hospital or regional health care performance. State-of-the-art computer simulation modeling as proposed in Case T4.6 can aid





decision makers in meeting these challenges and avoiding circumstances where a patient in need of care is unable to find it. It also facilitates the study of individual strategies whose benefits would be difficult to isolate in reality due to confounding effects of simultaneous actions and changing circumstances.

#### 4.1.7 Innovations, target groups and gaps addressed in T4.7 Indonesian Case “Using Mobile Operators’ Data to Locate, Protect and Evacuate Tourists and Other Vulnerable Groups in Disasters

Task 4.7 provides the following innovations:

- Mobile Positioning Data and the Save my Life application.
- The tool can be used by institutions involved in crisis management to produce better rescue plans.
- Statistics can give better input for rescue organizations than the static databases available at the moment, that might not be as accurate the database provided by the tool.
- Decisions and planning made on best available statistics is a way that things should be done.
- Mobile positioning data is collected by mobile network operators anyway so that they could offer their services.

The target audience for these innovations are national Disaster Management Agency (BNPB), Indonesia Red Cross, Municipal officials.

Gaps addressed by these innovations compared to current practices: Mobile positioning data could be used for public good, if used in an ethically and legally sound way, e.g. for bettering rescue services to work more effectively and to minimise costs of planning, evacuation and relief. Building resilience through social support networks. Improving communication between first responders and people impacted by a disaster.

#### 4.1.8 Innovations ranging from general to specific

WP4 involves seven national investigations seeking to establish how vulnerability, risk awareness and social capital, disaster resilience and recovery management vary across the four EU member states (Estonia, Germany, Italy and Finland), and Indonesia and the US in the context of the natural, seismic, biological and man-made hazards. Hence, the case studies detect how the novel crisis response regimes, technology-enabled solutions, and organizational and policy innovations might reduce the scope of risk and adversities imposed on societal welfare and human life in seven socio-technological and governance settings and, what parallels could be drawn to similar and/or even divergent set ups. The Italian (4.2), Estonian (4.4) and German (4.5) cases represent larger research studies reporting important results leading to an innovation potential analysis. Thus, these case studies do not provide ready-made technological solutions that can be applied, but rather suggestions to conceptual innovations, policy innovations and process innovations that can be developed based on the knowledge produced. The Finnish (4.1), Estonian (4.3), U.S. (4.6) and Indonesian (4.7) case studies focus on simulating, testing and validation to improve operational work. These case studies provide specific process or product innovations that are relatively ready to be used.

We may discern between the innovations in the case studies on a general-specific axis, where we have “recommended new perspectives” in the “general end” and the “technology ready for use” in the “specific end”. When it comes to innovation potential, the “recommended new perspectives”, can give rise to specific technologies. Some of the tasks also include both end of the spectrum, e.g. Task 4.4, with its focus on a specific vulnerability approach and its specification in a vulnerability assessment tool.



## 4.2 Different types of crises and groups

The case studies focus on different types of crises, different types of vulnerable groups, different key agents, different areas and different solutions. This is indicated in Table 5.

*Table 5 Overview of type of studied crisis, type of innovation/output and studied groups in the seven case studies*

Task:	Type of crisis:	Type of innovation: (main output)	Studied group(s): (methods)
T4.1	Chemical explosion	Simulation technology and first responders' training	Communication related vulnerabilities
T4.2	Earthquakes in Italy	A new understanding of survivors' needs	Disaster survivors in temporary housing
T4.3	Can be used in all types of crises/situations	Dashboard to examine vulnerability	People in crises in general
T4.4	Disruption of electrical supply, COVID-19, cyber-incident	Vulnerability analysis tool for emergency management	Vulnerable people are identified, based on specific situations
T4.5	Three floods in Germany and Covid-19	Social innovation through co-creation. Seven recommendation for crisis management	Who became vulnerable for which reasons?
T4.6	Crises which raises challenges to hospital intensive care unit capacity, like e.g. Covid-19	Management strategies to enhance hospital capacity	Those who are vulnerable because of disease and (low) hospital capacity
T4.7	Disasters in tourist locations.	Dashboard providing information about tourists in crisis areas	Tourists struck by disasters

Table 5 indicates that the case studies focus on **different types of crises**, and that analyses of vulnerability factors have been made based on the specific crises. Based on these analyses, tools and frameworks have been developed and tested. The types of crises studied range from chemical explosion, earthquakes, disruption of electric supply, flooding, COVID-19 to hospital capacity challenges and disasters in tourist locations.

Consequently, the case studies also focus on **different key groups**, ranging from people with cognitive and/or mental conditions, disaster survivors in temporary housing, hospital patients and tourists. T4.1 focuses on persons with challenges in communication and/or social interaction due to factors, where prevalence is increasing in Europe: mental health conditions (like depression, post-traumatic stress disorders), neuropsychiatric disorders (like Autism spectrum, Alzheimer's dementia) and intellectual disabilities. T4.2 concentrates on persons living in temporary housing, specifically survivors of the 2009, 2012 and 2016 earthquakes in Italy. T4.3 focuses on all persons in a crisis area, as these are potentially vulnerable and might need support at some point in time depending on the hazard type and their preparedness. T4.4 takes an open approach to identify individuals burdened with specific factors of vulnerability appearing in specific crisis situations. T4.5 also uses an open approach focusing on citizens living in the area who experienced the Elbe floods and the ongoing pandemic. T4.6 focuses on intensive care units of hospitals that have to care for a large number of COVID-19 patients. T4.7 is aimed on persons in an area they are visiting, who lack knowledge of the

local circumstances, culture, and language, and with minimal competency on critical information and actions needed to take during disasters like volcano eruptions, earthquakes, tsunamis, floods.

Additionally, **the types of innovation also vary substantially** in the different case studies, from training schemes focusing on first responders, to vulnerability analysis tools for emergency managers and planners, to more general policy innovations aimed at higher level policy makers and politicians. Section 4.2 provided a detailed account of this.

This focus on different types of crises, different types of actors and different types of challenges is in line with the scenario based and situational approach to vulnerability analysis, which is one of the core outcomes of WP4. This approach is especially outlined in T4.4

The different case studies also focus on **innovations in different phases** in the disaster management process. This is illustrated in Figure 4, which sums up both how the case study innovations relate to different phases in the emergency management process and different target groups.

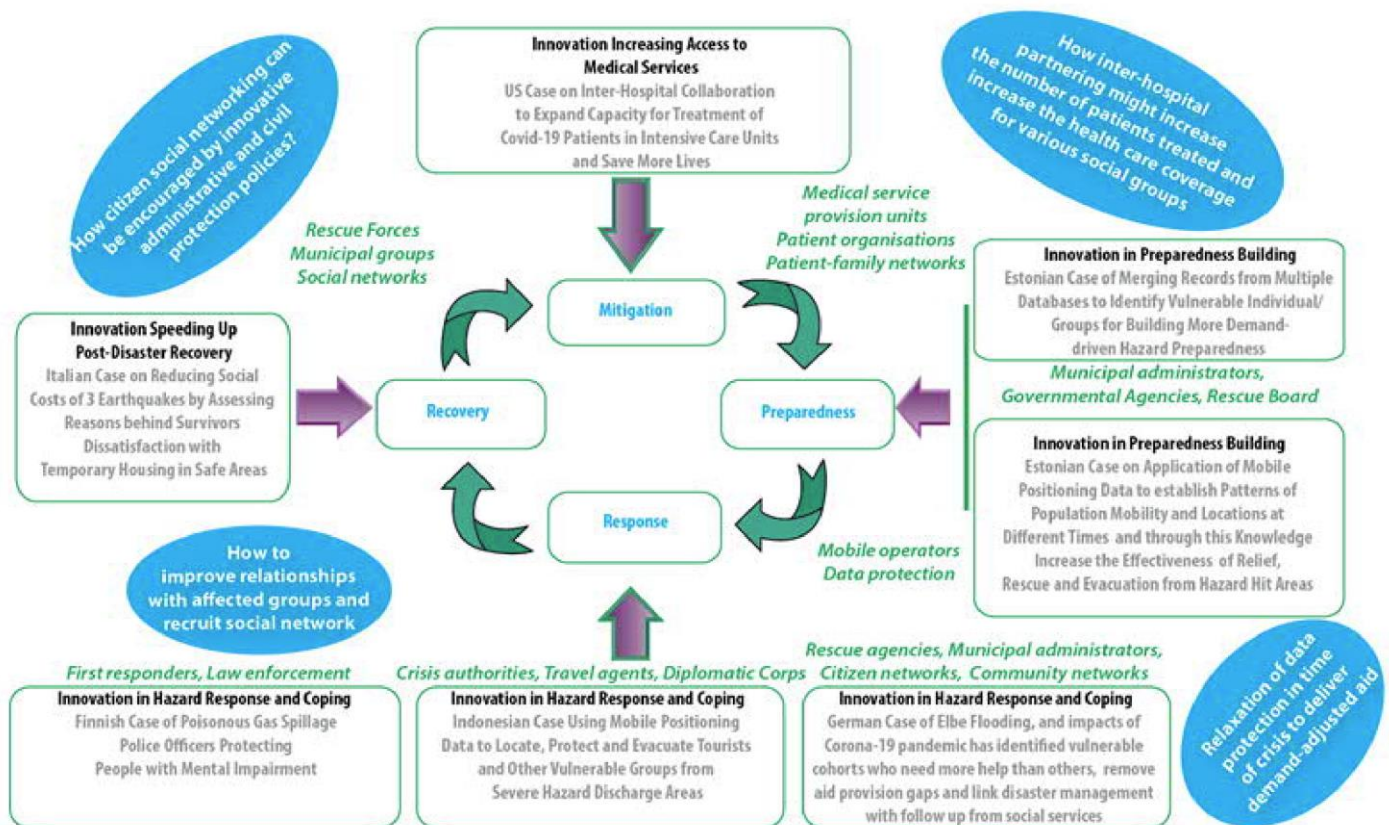


Figure 4. how the case study innovations relate to different phases in the emergency management process and different target groups, in EU Countries and Beyond Source: BuildERS Elaboration

The figure illustrates that the Estonian case studies (T4.3 and T4.4) apply to innovation in preparedness building, i.e. in the preparedness phase, aiming to assist municipal administrators, governmental agencies and the Estonian Rescue Board. The German case study (T4.5) relates to both the preparedness and response phase, providing innovations in hazard response and coping. The Indonesian case study (T4.7) relates to the response phase, providing an innovation in hazard response and coping. The Finnish case study (T4.1) provides an innovation in hazard response and coping, which applies to the response and recovery phase, but also preparedness, as the training

approach also can be used to build trust (and linking social capital) between first responders and people with mental impairment. A main purpose with this task is to improve relationships with affected groups and recruit social network. The Italian case study (T4.2) focuses on the recovery phase, aiming to provide policy innovations that can speed up the recovery process after disasters. The US case study (T4.6) focuses on the mitigation process, providing management innovations that will increase access to medical services and save more lives, e.g. during the COVID-19 pandemic.

Finally, when discussing the different phases in the disaster management cycle, it is important to note that the recovery phase has a long time-span; it may refer to the period immediately after the disaster but also e.g. 10 years after the disaster. In the BuildERS project, we find that experience with previous disasters influence how people cope in new disasters. Previous research also indicate that the recovery process may be long after disasters. In the Australian report about the consequences of the 2009 Australian bushfires, ten years after the bushfires, it is reported that 66.5% of respondents across all communities reported that they personally felt 'mostly' or 'fully recovered' (Gibbs et al 2021). Perceptions of community recovery were much lower, with 44.1% of participants reporting that they felt that their community was 'mostly' or 'fully recovered' (Gibbs et al 2021).

### 4.3 Can the innovations be transferred to other contexts?

It is important to discuss whether the innovative perspectives, strategies and tools provided in the case studies can be transferred to hazard prevention in other eco-locations and contexts. A general answer to this is that the perspectives, strategies and tools that are suggested are based on the situational and intersectional perspective on vulnerability in disasters. This means that all the perspectives, strategies and tools always must be adapted to a specific disaster context, focusing on the resources of the individuals involved and how these interact with the specific disaster and other contextual factors.

The general approach to training of police and other emergency personnel in T4.1 can be applied to other groups, although it is important to note that these groups may have different challenges influencing their communicative abilities. Nevertheless, the most important innovation in T4.1 is to adapt the communication to the situation and the communicative abilities of the receiver, and this principle is very relevant to transfer to other contexts, to ensure effective disaster communication. Additionally, this training will also be relevant in other types of disasters than chemical explosions, as the general principles behind the training apply across settings. The main focus is on the communicative preconditions of the receiver, and adapting the communication to those.

The insights from T4.2 can be applied to other types of disasters, which involve evacuation and or relocating of victims. The identified factors influencing the quality of this process and the factors that policy makers and emergency management personnel should take into account before, during and after disasters are likely to also apply to other kind of disasters than earthquakes. The main insights in the case study apply to peoples' attachment to a place, society and significant others, how these types of attachments are more or less influenced by relocation and the consequences of this for the wellbeing of relocated disaster victims.

The general approach in T4.3 and T4.7 can be applied in all types of situations, as the main focus on the technology produced, tested and validated in this case study is to provide information about the movements of different groups of people within specific geographical areas. As indicated this information can be used in several different settings related to disasters, for instance when planning notification of people in an area, evacuation, help during disasters, mitigating responses etc. As





noted, privacy rules and rules for data sharing are important preconditions for the use of these data, and these rules may differ in different countries.

The general approach in T4.4 can be applied to all types of disasters, as the main focus in the vulnerability analysis tool is on the situational and intersectional perspective on vulnerability in disasters. This means that the analyses takes a specific disaster as its point of departure, focusing on how the resources of the individuals involved and how these interact with the specific disaster and other contextual factors.

The general approach in T4.5 is applicable to different types of disasters, as these recommendations are developed through analyses across different types of crises. Additionally, the approach is also applicable to different groups, as it involves a situational and intersectional approach to vulnerability. On the other hand, the analysis is based on a specific socio-political context (i.e. the German society), and thus the applicability of some of the recommendations suggested will be influenced by this.

The general approach in T4.6 is relatively context specific in the sense that it relates to capacity enhancement strategies in a US hospital setting. The health sectors in other national contexts may, however, also learn from the general strategies which are related to different levels of COVID-19 infection and need for hospital services during a pandemic. Other sectors within emergency management may also learn from the principles behind the capacity enhancing strategies, in the sense that it defines different levels of demand, which requires different modes of operation with different types of strategies. T4.6 provides a systematic, planned and validated approach to this which, may be useful in emergency management in the health sector, as it sets specific limits for when to change operation mode and strategies.

## 4.4 Common analytical focus in the tasks

### 4.4.1 Designed to fulfil the three BuildERS objectives

As the tasks in WP4 focus on different types of crises, phases, actors, stakeholders and technologies, it is important to show the common analytical focus in the different case studies. In spite of the different focus etc. the case studies are designed to fulfil the three key BuildERS objectives, in line with BuildERS Common Vision. WP4 takes a threefold approach to find out more about who is most vulnerable, why, and innovates tools and strategies to address this.

**1) Analyze who is vulnerable.** T4.1 and T4.6 focus on specific groups who currently are assumed to be vulnerable, focusing on people with cognitive and/or mental disorders and hospital patients, respectively. T4.2, T4.3 and T4.7 explore the life conditions of those who currently are not described as vulnerable, focusing on earthquake survivors, people in a given geographical area and tourists. T4.4 and T4.5 take an open approach not focusing on specific vulnerable groups, providing rather an open approach to studying specific disasters and evaluate vulnerability in these specific situations.

**2) Understanding why some are more vulnerable than others.** Studies of T4.3, T4.4 and T4.7 focus on the operationalization of vulnerability factors. This is knowledge needed to develop a better understanding of vulnerability and to devise measures to reduce vulnerability. Studies of T4.1, T4.2, T4.4 and T4.5 focus on the relationship between vulnerability, risk awareness and social capital.

**3) Innovating and recommending how to increase capacities,** e.g. through developing new technologies for emergency management (T4.3, T4.7) and preparation (T4.4), new understandings of the needs of disaster survivors (T4.2), new process innovations to strengthen social capital (T4.4,



T4.5), new principles for hospital organization and new policies to reduce vulnerabilities and increase resilience (T4.6).

#### 4.4.2 Three key areas of recommendations and innovation outputs

The Areas of recommendations and innovation outputs are illustrated in the following figure (cf. BuildERS Common Vision):

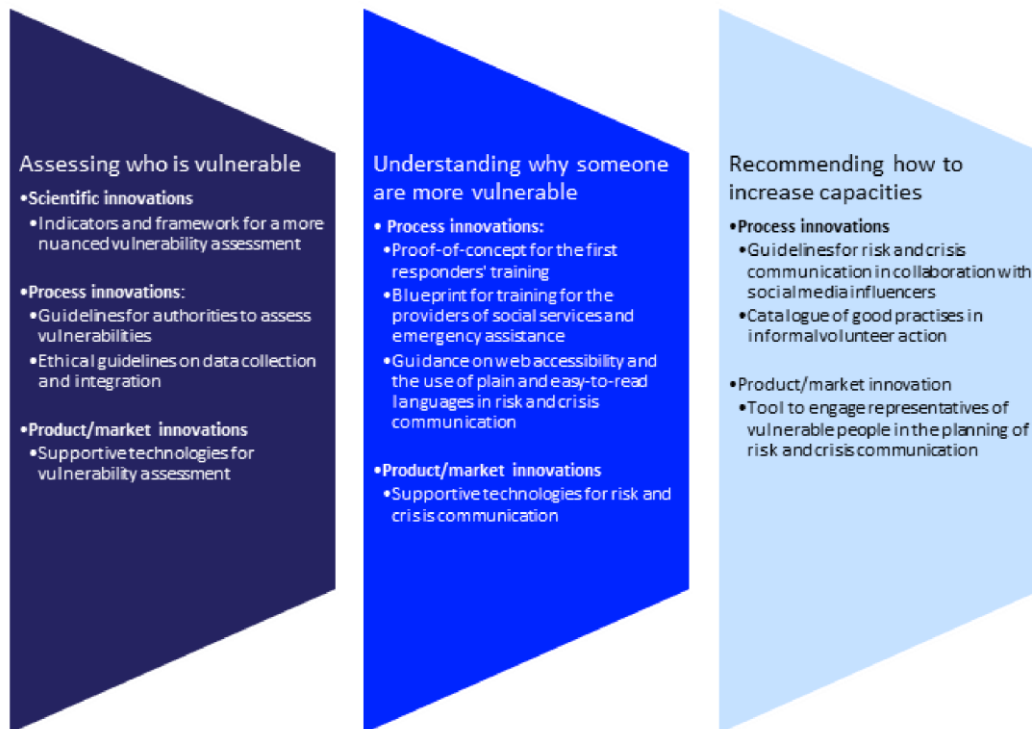


Figure 5. Recommendations and Innovation Outputs. (cf. BuildERS Common Vision).

Thus, although the case studies are diverse when it comes to the types of crises, actors, stakeholders and technologies, we see that they rest on a common, threefold analytical approach (i.e. the three key objectives of BuildERS). The combination of these three objectives is unique to the BuildERS project. It may thus be perceived as an analytical strength of WP4 that this approach is tested and validated across the different empirical contexts that the case studies comprise.

Summing up the results of all the tasks, it is important to remember that they do not only suggest, test and validate innovations, many of them also provide comprehensive empirical studies which provide important results. This especially applies to T4.2, T4.4 and T4.5. However, the remaining tasks also include empirical studies, which provide important results. To sum up, WP4 has led to:

**1) Improved understanding** of what vulnerability factors are and how they create vulnerable situations, e.g. individual behaviour of disaster management and citizens (T4.4, T4.5), disaster management measures (T4.5), communication strategies (T4.1), inaccessibility of social capital (T4.5), lack of geographical knowledge (T4.7).

**2) Creation of technological innovations**, e.g. tool for integration of diverse data for vulnerability assessment (T4.4), tool for the integration of location data (T4.3), tool for improved rescue for those without knowledge of an area (T4.7).



**3) Creation of social innovations**, e.g. points to consider for disaster preparedness planning (T4.4, T4.5), communicational training and strategies for interaction with mentally impaired persons (T4.1), strategies to improve intensive care patient capacity (T4.6).

**4) Creation of policy innovations**, e.g. seven recommendations for emergency policy management (T4.5), advice on how to include different vulnerable groups in the disaster policy development process (T4.4), new recommendations on how to reduce disaster survivors' vulnerability, e.g. after earthquake.

Finally, it is important to note that the outputs of WP4 are not only recommendations ("do this") to policy makers, or policy innovations ("methods or approaches for developing policies"), but also specific technologies that can be used to support the process.

## 4.5 Alignment with key concepts

The case studies focusing on diverse empirical contexts share another crucial commonality, which is unique to BuildERS, and that is their common basis in concepts that are key in understanding how people cope before, during and after disasters, comprising the theoretical BuildERS model. We will not reiterate the model here (cf. section 2.1), but simply sum up the relevance and use of the different theoretical BuildERS concepts in the different case studies. These are summed up in Table 6.

*Table 6 The relevance and use of the different theoretical BuildERS concepts in the seven case studies.*

Task:	Social capital	Resilience	Vulnerability	Risk awareness
T4.1	The aim of the training and communication approach is to increase linking social capital	Increase resilience by increasing linking social capital	Communication related vulnerabilities in general, dynamic and intersectional nature.	Help-recipients lower risk awareness is a key theme in training.
T4.2	The potential influence of social capital is studied	Individual resilience predicts vulnerability	Who is vulnerable in post-disaster temporary housing and why?	Risk awareness influences vulnerability
T4.3	The tool discerns between groups with different levels	Increasing resilience by improving situational awareness	Decreases societal vulnerability through informed decisions	Increase situational awareness of first responders
T4.4	Roles of private and institutional support networks	Social networking build stronger preparedness	Which vulnerability forms in different crisis-situations	Risk awareness was also tested empirically
T4.5	Studies social capital and provides policy implications	Provide lessons for resilience improvement	The contextuality and intersectionality of vulnerability	Studies risk awareness and how to improve
T4.6	Can be seen as an effort to increase linking capital	Examines strategies to increase health care resilience	Vulnerable because of disease and (low) hospital capacity	Improves the situational overview for health care
T4.7	Based on the insight that social capital is context dependent	Increasing resilience by improving situational awareness	Helping disaster managers make more informed decisions	Increase situational awareness of stakeholders

As noted, the analyses of the survey data in BuildERS WP3 indicates that linking social capital is crucial in disasters, as it seems to influence respondents' trust in information from authorities on how to behave during the pandemic, and thus their level of compliance with protective measures recommended by the authorities (e.g. their level of self-isolation during the pandemic) (Nævestad et al 2021b).



Based on this crucial insight from WP3, studying linking social capital and identifying ways to increase it is a recurring issue in the case studies. The aim of the training scheme for first responders in T4.1 is to increase linking capital. In T4.2, the potential influence of social capital is studied among earthquake survivors, and the study indicates especially the importance of linking social capital. The tool developed in T4.4 discerns between groups with different levels of social capital, including the roles of private and institutional support networks for peoples' abilities to cope in crises. T4.5 studies social capital and implications, both before, during and after disasters. This study has interesting discussions of how to increase social capital. T4.6 can be interpreted as an effort to increase linking capital, by increasing citizens' trust in the official hospital system to deal with large-scale health emergencies. Finally, T4.7 indicates that social capital is context dependent, as it indicates how people ("tourists") who are in a foreign geographical location may experience a higher level of vulnerability than they would have done in their home country, as their social capital is not necessarily "valid" in a foreign country. The reason is that their bonding and bridging relationships are not present in a foreign country and that the relationship to authorities (linking social capital) also may be different in a foreign country.

Most of the tasks in WP4 study factors influencing resilience, or study how to increase resilience. T4.1 study how to increase resilience by increasing linking capital. T4.2 concludes that individual resilience predicts vulnerability, while T4.3 focuses on increasing resilience by improving situational awareness. T4.4 indicates that social networking build stronger preparedness, and describe co-creation processes through which this can be attained. T4.5 also provides lessons for resilience improvement, both on the individual level and on the more general political level, by indicating how vulnerability and resilience also are influenced by social policies. T4.6 focuses on health care resilience and how to improve that through capacity enhancing strategies, while T4.7 focus on increasing resilience by situational awareness. Thus, we see that the tasks focus on resilience is at several different levels, e.g. among affected individuals (individual level), emergency teams (group level) and policy makers (society level). It is often assumed that increasing resilience at the more general level will also increase resilience at the individual level. This involves e.g. making social policies more resilient (T4.5) or increasing the situational awareness of emergency management teams (T4.3, T4.7).

As indicated above, vulnerability is also a main theme in the different tasks in WP4. On the one hand, vulnerability may be seen as an intrinsic and stable characteristic of an individual, a group or a community. In this 'vulnerable groups' narrative, vulnerability is cast as a characteristic attribute of certain societal groups due to their specific conditions (Sparf, 2016; Tierney, 2019).

On the other hand, vulnerability may be seen as situational and relative, and thus dynamic, phenomenon (Hilhorst & Bankoff, 2004; United Nations, 2015). This view argues that vulnerability is often in flux and cannot be reduced to a single metric to classify (Adger, 2006). This perspective is in line with the focus on vulnerability in the case studies of WP4. T4.4 and T4.5, which take an open approach not focusing on specific vulnerable groups. The approach to disasters followed in these tasks is situational, meaning that one should always focus on specific disasters and evaluate vulnerability in these specific situations. This involves a scenario-based approach, which defines vulnerability and vulnerable groups depending on the situation. The same applies to T4.2, which focuses on earthquake survivors, T4.3 which focuses on people living in a geographical area and T4.7, which focuses on tourists.

The situational and relative approach to vulnerability is in line with the BuildERS framework, which understands vulnerability as a characteristic of potentially any individual at certain point in time, when



they fall into a situation that renders them vulnerable. The methodologies provided in T4.4 and T4.5 are designed to evaluate this, i.e. to identify specific vulnerabilities in specific crises.

Finally, risk awareness is also a recurring theme in the different tasks. Risk awareness and risk preparedness are also factors influencing vulnerability and resilience: people have to get information about risks and crises and they have to understand them and be able to act on them. These relationships between risk awareness, risk preparedness, vulnerability and resilience are also central in the studied tasks in WP4. In T4.1, help-recipients' lower risk awareness is a key vulnerability that the training scheme for first responders is designed to reduce. T4.2 concludes that risk awareness influences vulnerability. The focus of T4.3 and T4.7 is to increase emergency managements' situational awareness. T4.4 also tests risk awareness empirically. T4.5 studies risk awareness and how to improve it, while the aim of T4.6 is to study the situational overview in hospital management and develop ways of improving this, by increasing the capacity to anticipate patient surges and devise strategies to deal with those.

To sum up, we can conclude based on the foregoing discussion that the main focus in the tasks has been to reduce vulnerability and increase resilience in emergencies, by increasing social capital and improving risk awareness.

## 4.6 Common methodological approach

Most of the tasks in WP4 also share important commonalities when it comes to the methods used in the development of the innovations, as they focus on co-creation with relevant stakeholders. This is in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR 2015), which advocates for accessible and inclusive crisis management. The Sendai Framework dedicates a section on the "Role of Stakeholders" highlighting the need for synergies between different actors in identifying the sources of vulnerability as well as its mitigation strategies.

T4.1 includes a wide range of different stakeholders in the development of the training scheme for first responders. Additionally, T4.2 involves several different stakeholders in the discussion of earthquake survivors' experiences and needs. T4.4 takes a user-centred and co-creational design approach in the development of the vulnerability assessment tool, which is based on the understanding of the users' needs, priorities and experiences in order to increase the application's usefulness and usability. In the co-creative design, the future users were invited to cooperate with designers, researchers, and developers during an innovation process (Trischler et al., 2018). T4.3 and T4.7 involves a wide range of actors in the testing of the Dashboard technology. Important feedback is also gathered on the current emergency management practices and technologies that the innovations will seek to complement or replace.

Thus, we see that the different tasks include stakeholders in the different phases of the development of the innovations. Stakeholders have participated through several stages, e.g. the initial exploration and problem definition, proposing ideas for solution, and evaluating, testing and validating suggested solutions. This user centered co-creational approach is an innovation in itself, which contributes to a high perceived relevance of the proposed innovations (cf. section 4.7). And these co-creation process further increasing the relevance of WP4 innovations will be continued in WP6 (cf. Section 4.8).



## 4.7 Analysis of the innovation types in the tasks

### 4.7.1 Conceptual innovations for policy makers and practitioners

As noted, one of the main shortcoming of European disaster management policies that was identified in WP2 was the failure to take the individual sources of vulnerability and its situational and intersectional nature properly into account. The results of the BuildERS project in general and WP4 in specific indicate that there is a need to approach vulnerability from a more nuanced, intersectional perspective. The innovations developed in WP4 therefore build on this perspective on vulnerability and seek to lay the foundation for the implementation of this perspective on vulnerability in European emergency management. This can be labelled a conceptual innovation, as it involves the introduction of a different worldview, mission or purpose for emergency management as a whole. The perspective of vulnerability as intersectional and situational involves the introduction of a “new worldview” in European emergency management, as it introduces a perspective that breaks with the previous perspectives, it involves a fundamental new view on the role on the role of vulnerability in crises, which require new methods of assessing vulnerability and new data.

This recognition that vulnerability is dynamic and intersectional is also crucial in the UN Sendai Framework. Given the contrast to the existing perspectives on emergency management in European countries identified in WP2, the intersectional and situational perspective on vulnerability can also be labelled a radical innovation, which involves a new perspective in a new context (Henderson 1990), or in other words, the recognition that everyone can become vulnerable, depending on the context, and the tools for analyzing it.

In the following, we will describe what this radical conceptual innovation involves. First, authorities must appreciate that vulnerability is determined by the interactions of a complex set of individual characteristics and their interlinkages with societal structures. By looking at the interactions of a complex set of individual characteristics, vulnerability assessments may become more precise, allowing for more nuanced measures to support vulnerable people. It supports the aim that resources are allocated to those that need them the most. Finally, it reduces the risk of victimizing and stigmatizing broad and heterogeneous groups (Morsut et al 2020). It may also help to move away from the current tendency for unjustified stereotyping (possible stigmatization) stemming from the vulnerable groups-based thinking (Orzu et al 2021a). These points are also addressed in the BuildERS’ policy recommendations in D5.1; specifically, in Section 3.3 “Key actions to enhance vulnerability assessments” (Rhinar et al 2021: 20- 26).

Second, vulnerability assessments must consider, and reflect on, the interplay of individual, socio-structural, and situational factors in vulnerability assessments. Identifying which individuals are subject to vulnerability, and in which situations they can help identify people who are exposed to a disaster or crisis (e.g., when an individual is located in an area suddenly struck by a disaster event) – thus making assessment more precise (cf. Morsut et al 2020).

Third, vulnerability must be understood as dynamic, i.e., changing over time, when conducting vulnerability assessments, rather than considering vulnerability as a stable condition of specific social groups. Anyone could be vulnerable at a given point in time, in a given context.

These three points make up the essence of the radical conceptual innovation of the BuildERS project in general and WP4 in specific.

BuildERS WP4 case studies also include additional conceptual innovations, i.e. innovations which provide ground-breaking perspectives which challenge current policies. One of these is the





suggestion in T4.5 to treat social policy as an emergency management strategy. Another one is the new perspective on inclusive policing, provided in T4.1, aiming to build good relationships with all citizen groups and thus increase linking social capital.

#### 4.7.2 Scientific innovations

WP4 contributes with crucial scientific innovations, not only as it uses a new perspective on emergency management, but also as it conducts several comprehensive empirical studies of what this perspective means in practice, when studying different types of disasters, e.g. electrical power outages, earthquakes, chemical spills, COVID-19, different floods, disasters hitting tourist areas etc.

The Italian (T4.2), Estonian (T4.4) and German (T4.5) case studies have provided detailed analyses of the multiple factors of vulnerabilities in different types of crises. These case studies have also contributed to theory-building when it comes to outlining the dynamic and intersectional approach to vulnerability in specific crises, and empirical testing of the framework developed.

In addition to the theory development, these three tasks have also influenced the development of additional important scientific innovations, e.g. vulnerability risk indicators and a vulnerability assessment framework. T4.2, T4.4 and T4.5 will contribute to the co-creation of tools for an improved vulnerability assessment. The aim is to create indicators and a framework for the practitioners, so that they will get a better understanding of vulnerabilities in crises and prepare accordingly. The indicators and framework will be co-created with the international academic communities, and then evaluated by practitioners.

Although these frameworks and indicators have been used to analyse specific disasters in a European context, the general methods and tools can be adapted to other countries, contexts and crises. This is an important area for future research that the BuildERS WP4 has laid the foundation for.

#### 4.7.3 Process innovations

WP4 involves, as noted above, several process innovations.

**Tools for assessing vulnerability in specific settings.** One of the most important process innovations of WP4 following from the crucial conceptual innovation mentioned above (intersectional/situational approach to vulnerability) is the tool for developing more multifaceted and precise indicators of vulnerability provided in D4.4.

To make vulnerability assessments more precise and create a better understanding of vulnerability factors and intersecting factors, it is recommended to use a situation-centred vulnerability assessment method. In line with this, T4.4 has developed a scenario-based tool, which is set to support crisis managers to assess who are more vulnerable than others and why (D4.4). This tool is based on a wider array of indicators than previous approaches to vulnerability assessments, better data, and process innovations to uncover vulnerabilities that are not typically recognised.

Contributing to the broader situation awareness in crisis management, T4.4 provides a systematic analysis of the various sources of information for assessing social vulnerabilities, also when employing the tool: - Individuals in need, - local support networks, community or other groups associations, - social workers' records, - state databases, - survey results.

**Ethical guidelines on data collection and integration.** A crucial aspect of the vulnerability assessment tool is its reliance on a broader set of data than what is used in previous assessments of vulnerability. This provides a better basis for such assessments. However, the collection of such



data from a wide range of sources, and the integration of these data into specific assessment requires ethical considerations. Thus, the ethical guidelines on data collection and integration is the second crucial process innovation from WP4.

In line with WP7, the D4.4 tool was discussed with regard to six ethical dimensions: (1) justice and participation, (2) responsibility and accountability, (3) freedom of choice and autonomy, (4) trustworthiness and transparency, (5) privacy and data protection, and (6) beneficence and non-maleficence. As a result, important aspects for the further development and crucial questions as well as potential mitigation strategies were identified. This discussion can be viewed as the starting point of more detailed discussion on ethical issues, which has to take place in the concrete application of the tool.

**Wider involvement of stakeholders in vulnerability assessment.** A third crucial process innovation provided by WP4 is the involvement of stakeholders in vulnerability assessments. This is also a novel approach in emergency management. The UN Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR 2015), advocates for accessible and inclusive crisis management. It dedicates a section on the “Role of Stakeholders” highlighting the need for synergies between different actors in identifying the sources of vulnerability as well as its mitigation strategies. It is therefore important to open up the vulnerability assessment process to individuals with varied experiences.

T4.4 and T4.5 therefore recommend that those responsible for vulnerability assessments engage a diverse actor group in the process of mapping and analysing vulnerabilities. Involving diverse actors makes it easier to identify the multitude of factors (individual, socio-structural, and situational) that determine vulnerability in a given situation, as well as how these might change over time (the dynamic dimension). These actors include people that are in contact with different societal groups in their everyday work, such as social care providers, and who therefore have a better understanding of the multiple living situations in existing societies. They also include decision- and policy makers in a broad range of areas, such as spatial planning and education. Hence, not only those who work directly with crisis management should be engaged in the task of assessing vulnerability (D2.2) (cf. D4.5).

In this way, it also aims to pull those currently overlooked or neglected into a discussion on the varied experiences of vulnerability and its mitigation possibilities. The process of engagement in the vulnerability assessment process introduces and strengthens social ties between those in vulnerable situations and authorities. Furthermore, it creates the necessary preconditions to raise the awareness of first responders about the needs of vulnerable target groups and to increase their capacity to provide appropriate assistance (cf. D4.4).

Prior identification of vulnerable individuals enables to plan and build capacities to empower them and tailor well-targeted risk communication messages. It helps people to recognise their possible sources of vulnerabilities and understand the rights for and sources of help in crisis.

**Training scheme to allow for better communication in crises.** A fourth crucial process innovation in WP4 is the T4.1 training scheme to allow for better communication in crises. The purpose of this was to build trust (and linking social capital) between first responders and people with mental impairments.

**Strategies for hospitals’ capacity enhancement.** Finally, the strategies for hospitals’ capacity enhancement in T4.6 can be labelled process innovations, as they describe processes and procedures for decision-making, particularly pointing out best or at least workable practices learned





from others. However, the concept of management innovation is even more relevant in this case. It refers to the introduction of new management practice, process, structure, or technique to improve the organization's ability to further organizational goals. The suggested strategies and their careful instructions for use (when, and with what impact) fit the definition of management innovation.

#### 4.7.4 Product innovation in the tasks

The technology and tool testing case studies, D4.3 (Estonia), D4.4 (Estonia), D4.7 (Indonesia), contribute to the development of guidelines to carry out vulnerability risk assessments and collect data for these assessments. These case studies have explored the issues like reliability and availability of data and its integration. These process and product innovations are closely related to the already mentioned scientific innovations on vulnerability assessments.

The dashboards enable getting information about different population groups, distinguished on their past mobility behaviour. They show presence of people living in the area, workers, regular visitors, domestic and foreign tourist in spatial units. They also give some additional information based on their previous mobility: how many people have a second place to go and in what kind of connection people have with distinct geographical areas, how many are regular visitors (like workers), how many live there or how many are tourists. The dashboard not only presents rescue workers' knowledge of society's ordinary mobility behaviour, but it can also be used to study effects of disaster situations which can help rescue workers to prepare for future crises (D4.3, p. 54).

#### 4.7.5 Social innovations

Some of the tasks in WP4 also involve social innovations, i.e. collaboration models and citizens' self-organisation into trust networks that implicitly have a tendency to build social capital and therefore resilience. This applies for instance to T4.5, which describes and recommend new ways of collaborating to increase resilience in disasters. In T4.5 it is argued that social cohesion in crises depends on the ability to work together and cooperate. The pandemic shows, however, that this form of collaboration is not possible in every extreme event. Instead, thinking of alternative ways to bring people together in order to develop a positive narrative and thereby increase active involvement is required, as the ability to actively taking part in overcoming a crisis is an important part of psychological resilience (D4.5)

### 4.8 Future contribution to other WPs

The innovation potential discovered in the WP4 case studies has been further developed within WP6. WP6 supports an iteration process, which validates the case studies' findings, and provides an internal and external quality-check of the project's overall results. Furthermore, in WP6 activities we have engaged various experts to ideate and create scientific and practical (process & product) innovations.

Both WP4 and WP6 have implemented a kind of Living Lab approach. A Living Lab is a complex real life setting where end users, practitioners and researchers come together to create and test innovations (Ballon & Schuurman, 2015). In other words, co-creation involves all relevant parties, occurs close to the actual context where the new product will be put in practice, and developing and testing can be organized as an agile iterative process. Although Living Lab approach was originally used in technology development, it can be adopted in policy making and strategy design too. (ENoLL, 2016.) In practice, we have held facilitated discussions and brainstorming events with the



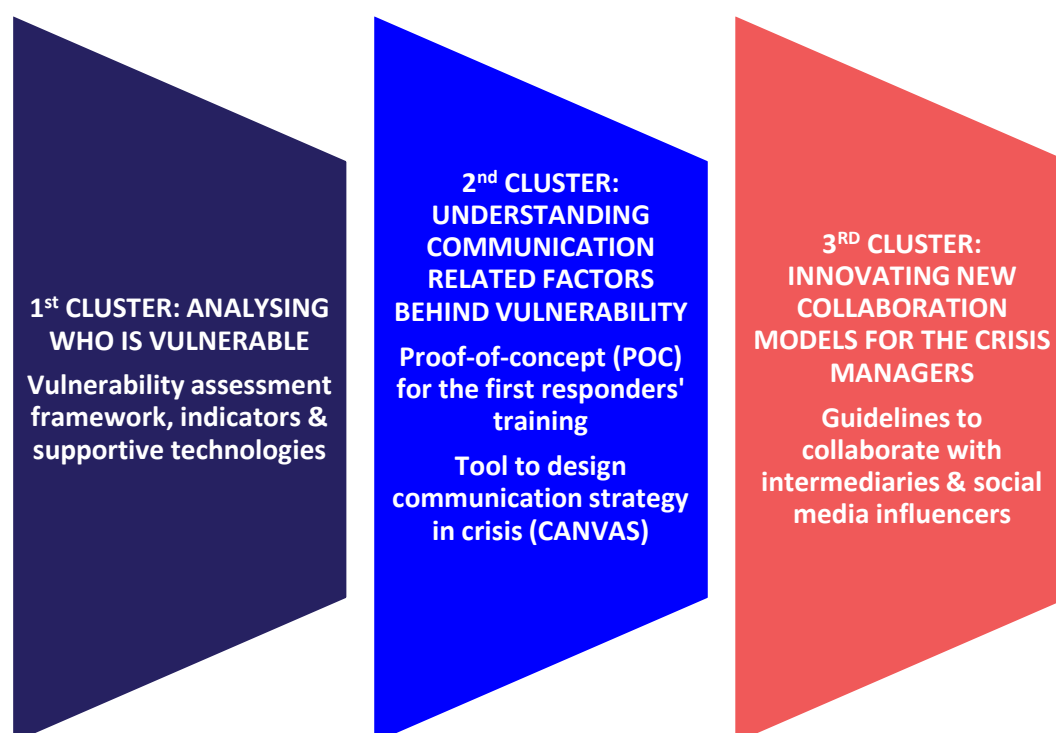
representatives of non-governmental organisations, authorities, technology providers and other businesses throughout the project lifecycle.

As the themes and issues examined in the BuildERS project are very broad, in our Common Vision we have decided to focus on three objectives:

- Improving our understanding of who are the ones we define as vulnerable in crisis or disaster situations
- Improving our understanding of communication related factors behind vulnerability
- Innovating new means and methods to collaborate, in order to reduce vulnerabilities and build people's abilities to cope with crises or disaster

WP5 in turn will synthesize the case study findings and translate them into policy recommendations that are aligned with the practical innovations. It will define the needed steps to improve people's awareness of risks, to increase their social capital (that is social relations and trust networks) and finally, build their resilience. WP5 will bridge the gap between scientific results and the information that the general audience receives.

The innovations in WP4, their relationship with the three key objectives in the BuildERS common vision is illustrated in Figure 6. Our innovations form three clusters, and include four different types of outcomes: scientific framework, training concept, practical tools and practitioners' guidelines.



*Figure 6 The innovations in WP4, their relationship with the three key objectives in the BuildERS common vision*

#### 4.8.1 Case study T4.1

The Finnish case study is contributing to the capacity building of first responders and 3rd sector service providers. It has produced learning outcomes and materials for the first responders' training;



the aim is to improve their competencies related to communication and social interaction with people who have special needs.

Together with the WP3, it will also serve the development of guidelines to collaborate with intermediaries of people, who are at risk of becoming very vulnerable in crisis. In practice, this means collaboration with NGOs and spontaneous volunteers, which may be able to reach people who “are not known” for the authorities and lack so-called linking social capital. Reasons behind vulnerability may for instance be that people are not recipients of public services (i.e. not found in public registries) or lack trust towards authorities. Here also the aim is to enhance capacities in raising awareness of risks and informing people about preparedness issues. We will also provide guidance on accessible risk and crisis communication: including how to make easy-to-read and plain language.

Future project deliverables related to this are e.g. **D6.6** Stakeholder validation of research findings and co-creation of innovations (Jan 2022), **D6.4** End-user assessment of tools & technologies (Dec 2021), **D5.2**: Innovation policy recommendations (Feb 2022), and **D5.5** Recommendations on ethically acceptable technologies & tools (Feb 2022).

Future dissemination within WP8 will be: infographic and other material of prototype of training on our website, and course contents for the practitioners. We will carry an online pilot course with the European law-enforcement officers, who are invited to join an online course on the LEEd platform by European Union Agency for Law Enforcement Training (CEPOL) (Dec 2021 – Jan 2022).

#### 4.8.2 Case study T4.6

We will also discuss possible policy implications following from Case study T4.6 with the WP5 team, and consider how to and whether we can involve innovations from T4.6 in the iteration process in WP6, validating the case studies’ findings and providing an internal and external quality-check of the project’s overall results. We will discuss the latter with the WP6 team.

As noted, the general approach in case study T4.6 is relatively context specific in the sense that it relates to capacity enhancement strategies in a US hospital setting. Thus, the process innovations following from this case study may be relatively contingent on the organisational hospital structure and the organization of the health sector in general in the US. It is, however, possible that the health sectors in other national contexts may, learn from the general strategies recommended in T4.6. The main strength of these strategies is that they are related to different levels of COVID-19 infection and need for hospital services during a pandemic.

Other sectors within emergency management could possibly also learn from the principles behind the capacity enhancing strategies, in the sense that they define different levels of demand, which require different modes of operation, with different types of strategies. The main strength of case study T4.6, is that it provides a systematic, planned and validated approach to this which, may be useful in emergency management in the health sector, as it sets specific limits for when to change operation mode and strategies. Moreover, other sectors and actors may possibly also learn from the simulation approach used in case study T4.6, which is used to test the implications of different management strategies to handle emergencies under different phases of crises.

#### 4.8.3 Case studies T4.2, T4.4 and T4.5

The Italian (T4.2), Estonian (T4.4) and German (T4.5) case studies have explored in more detail the multiple factors of vulnerabilities. These case studies have also contributed to theory-building when it comes to how the dynamic and intersectional approach to vulnerability in specific crises, and empirical testing of the framework developed.



These three tasks have thereby also influenced the development of important scientific innovations: Vulnerability risk indicators and a vulnerability assessment framework. We will elaborate in detail the multiple factors behind vulnerabilities, and also provide novel insights on vulnerability, like the resilience factors of first responders and other crisis managers. The three tasks will also contribute to the co-creation of concrete tools for an improved vulnerability assessment. In practice these tools include templates, indicator lists and practitioners' guidelines. The aim is to help crisis managers get a better understanding of vulnerabilities in crises and prepare accordingly. The indicators and framework will be co-created with the international academic communities, and then evaluated by practitioners.

The results of these three tasks will be followed up in future deliverables in other work packages, e.g. D6.9 Colloquium 3 (Jan 2022), D6.6 Stakeholder validation of research findings and co-creation of innovations (Jan 2022) and D5.3 Final report on resilience policy recommendations (Apr 2022).

The tasks will also be disseminated further within WP8 in the form of academic articles and conference presentations of vulnerability assessment framework and indicators (e.g. NEEDS 2021, SRA 2021).

#### 4.8.3 Case study D4.3, D4.4 and D4.7

The technology and tool testing case studies, D4.3 (Estonia), D4.4 (Estonia), D4.7 (Indonesia), contribute to the development of guidelines to carry out vulnerability risk assessments and collect data for these assessments. These case studies have explored the issues like reliability and availability of data and its integration. These process and product innovations are closely related to the already mentioned scientific innovations on vulnerability assessments.

The process innovations will inform guidelines for authorities to assess crises-related vulnerabilities and ethical guidelines on data collection and integration of crisis-related vulnerabilities. The product/market innovations will involve recommendations for the ICT -developers to create supportive technologies for vulnerability assessment.

These innovations will be followed up further in future work packages, e.g. **D6.4** End-user assessment of tools & technologies (Dec 2021), **D5.2** Innovation policy recommendations (Feb 2022), **D5.4** Recommendations on resource allocation for addressing risks (Feb 2022), **D5.5** Recommendations on ethically acceptable technologies & tools (Feb 2022).

Within WP8, which is related to dissemination, we will publish a Proof-of-concept (POC) of vulnerability assessment framework with indicators on a website, as well as a guidebook for practitioners of how to collect data in an ethical and sound manner, and how to collaborate with intermediaries and other agencies in order to improve the reliability of vulnerability assessment.

## 5. Conclusion

The case studies have had the following objectives:

The first objective was tools and guidelines development, since the practicalities related to technologies and other tools must be field-tested, piloted or simulated before considering their up-scaling and transferability to other contexts. In this report, we have seen that all of the case studies have contributed to several tools and guidelines, ranging from specific police training schemes (T4.1) to technological innovations (T4.3, T4.7) and more or less general guidelines targeted to policy makers and practitioners at different levels (T4.2, T.4.4, T4.5, T4.6).



The second objective was demonstrations of how the tools, techniques and technologies can be applied and utilized. This is especially provided in T4.1, T4.3, T.4.4, T4.6 and T.4.7. Additionally, this is also discussed in T4.2 and T4.5, based on experiences with previous disasters. This will be followed up in WP6.

The third objective was empirical testing of what works and what does not work in practice; the cases also serve policy, strategy and other recommendations to be given in the latter work packages. Such empirical testing has been done in This is especially provided in T4.1, T4.3, T.4.4, T4.6 and T.4.7, and it will continue in WP6.

The fourth objective was that the multiple case studies also offer additional materials for the comparative analyses and supplement the field surveys and questionnaires offering a wider base for synthesis and increase the reliability and validity of conclusions drawn from the research. This has especially been done in T4.2, T4.4 and T4.5

The fifth objective was innovation identification and proof-of-concepts. This has been provided in T4.1, T4.2, T4.3, T4.4, T4.5, T4.6 and T4.7.

The aim of the present deliverable was to synthesize results from WP4 case studies to extract the most viable policy and practice innovations reducing vulnerability of European population to natural and man-made hazards.

WP4 provides conceptual innovation, as it involves the introduction of a new worldview, perspective or purpose for emergency management as a whole. This means to approach vulnerability from a more nuanced, intersectional perspective. Innovations developed in WP4 lay the foundation for the implementation of this perspective on vulnerability in European emergency management, through concrete innovations which have been tested by relevant stakeholders. The BuildERS WP4 case studies also include additional conceptual innovations, i.e. innovations which provide ground breaking perspectives which challenge current policies, e.g. treat social policy as an emergency management strategy (T4.5), and a new perspective on inclusive policing and risk communication (T4.1)

WP4 involves several process innovations. One of the most important process innovations of WP4 following from the crucial conceptual innovation mentioned above (intersectional/situational approach to vulnerability) is the tool for developing more multifaceted and precise indicators of vulnerability provided in D4.4. The technology and tool testing case studies, D4.3 (Estonia), D4.4 (Estonia), D4.7 (Indonesia), contribute to the development of guidelines to carry out vulnerability risk assessments and collect data for these assessments.

Some of the tasks in WP4 also include social innovations, i.e. collaboration models and citizens' self-organisation into trust networks that implicitly have a tendency to build social capital and therefore resilience. This applies for instance to T4.5, which describes and recommends new ways of collaborating to increase resilience in disasters and T4.1 which recommends first responders to establish collaborative partnerships with intermediaries of people with communication challenges. The innovations from WP4 will be developed further in WP5 and WP6, which seek to validate the innovations.

Finally, we have also discussed the transferability of the innovative solutions provided in the case studies to hazard prevention in other eco-locations and contexts. A general conclusion is that the perspectives, strategies and tools that are suggested are based on the situational and intersectional





perspective on vulnerability in disasters. This means that all the perspectives, strategies and tools always must be adapted to a specific disaster context, focusing on the resources of the individuals involved and how these interact with the specific disaster and other contextual factors.

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