

LINKS

Strengthening links between technologies and society
for European disaster resilience

D2.1 DISASTER VULNERABILITY KNOWLEDGE BASE

*A CONSOLIDATED UNDERSTANDING OF DISASTER VULNERABILITY IN SOCIAL
MEDIA AND CROWDSOURCING*

Research Report

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EXECUTIVE SUMMARY

About the project

LINKS “Strengthening links between technologies and society for European disaster resilience” is a comprehensive study on disaster governance in Europe. In recent years, social media and crowdsourcing (SMCS) have been integrated into crisis management for improved information gathering and collaboration across European communities. The effectiveness of SMCS on European disaster resilience, however, remains unclear, the use of SMCS in disasters in different ways and under diverse conditions. In this context, the overall objective of LINKS is to strengthen links between technologies and society for improved European disaster resilience, by producing sustainable advanced learning on the use of SMCS in disasters. This is done across three complementary knowledge domains:

- Disaster Risk Perception and Vulnerability (DRPV)
- Disaster Management Processes (DMP)
- Disaster Community Technologies (DCT)

Bringing together 15 partners and 2 associated partners across Europe (Belgium, Denmark, Germany, Italy, Luxembourg, the Netherlands) and beyond (Bosnia & Herzegovina, Japan), the project will develop a framework to understand, measure and govern SMCS for disasters. The LINKS Framework consists of learning materials, such as scientific methods, practical tools, and guidelines, addressing different groups of stakeholders (e.g. researchers, practitioners, and policy makers). It will be developed and evaluated through five practitioner-driven European cases, representing different disaster scenarios (earthquakes, flooding, industrial hazards, terrorism, drought), cutting across disaster management phases and diverse socioeconomic and cultural settings in four countries (Denmark, Germany, Italy, the Netherlands). Furthermore, LINKS sets out to create the LINKS Community, which brings together a wide variety of stakeholders, including first-responders, public authorities, civil society organisations, business communities, citizens, and researchers across Europe, dedicated to improving European disaster resilience through the use of SMCS.

About this deliverable

In the face of the increasing role that digital technologies are assuming in dealing with disasters, and the potential consequences that their use could have in terms of social disparities, this deliverable aims to provide the state-of-the-art on how vulnerability is conceived and discussed in the existing scientific literature and how it can be affected by SMCS. For this purpose, an overview of vulnerability studies is provided which pays particular attention to its dynamic dimension and its potential links with risk perception and resilience. Accordingly, this deliverable (D2.1) provides the vulnerability dimension of the disaster risk perception and vulnerability (DRPV) knowledge base (KB) for the LINKS project and for the forthcoming DRPV methodology, as well as a discussion on the

main gaps emerging in the scientific literature and how the LINKS project can go beyond the state of the art in this domain.

The deliverable is the result of a structured literature review, based on secondary empirical sources that discuss SMCS in all the phases of Disaster Management Cycle (DMC). Disaster studies and climate change literature that address vulnerability as a social element were taken as the starting point. However, it is suggested that vulnerability is a dynamic concept, and its relationship with resilience is not linear. Thus, a conceptual, multi-dimensional approach for reading vulnerability in relation to SMCS and resilience has been produced on the basis of an in-depth analysis of the literature. The Vulnerability-Paradigm is based on four main variables: diversity, accessibility, connectivity and mobility. Diversity, in particular, is considered a central point to transverse other variables, that explains the dynamicity of vulnerability and resilience and the constant interaction and co-existence of the two conditions. The aim of this deliverable is to add to the knowledge base on DRPV along with Deliverable 2.2: Disaster Risk Perception Knowledge Base.

What emerges from this approach are the potential connections with the three other deliverables, D2.2, D3.1 and D4.1, the first one linked to the DRPV knowledge domain, and the second and third that cover the two other knowledge domains: disaster management processes (DMP) and disaster community technologies (DCT). What is relevant is how the other deliverables contribute to addressing diversity and how they (implicitly or explicitly) dialogue with vulnerability. In particular, they help to go beyond the idea that diversity and vulnerability are only 'human' properties, so that they may be addressed in a 'more than human' perspective by focusing on the diversity of systems and technologies and on the ways SMCS platforms can become 'more than tools' in the processes.

Thus, the key findings of the deliverable are:

- Vulnerability is an understudied topic in SMCS related disaster studies, especially in Europe, although the majority of the works highlight the potential consequences of the use of these platforms in increasing social and spatial (digital) marginalization;
- On the other hand, the use of SMCS may help some under-represented social groups to become 'visible', although visibility is not synonymous with (nor can it be directly translated into more) representativeness;
- The use of SMCS increases the need to consider vulnerability as a dynamic concept, in relation to resilience, as a consequence of the 'change of scenario' (into a virtual/digital one), which could challenge the traditional ways in which the concepts are interpreted. Accordingly, some social groups traditionally considered vulnerable may become less susceptible to disasters thanks to SMCS, but, in the same way, the opposite could also be true.

Vulnerability must also be addressed in relation to DMP and DCT, with the aim of understanding how vulnerability is shaped by technologies, and how SMCS can be governed to make them inclusive systems, especially in the face of the lack of attention to this topic in Europe. Thus, over the coming

years, the project will work towards developing and evaluating the LINKS Framework that encompasses the outputs derived from the studies across all three knowledge domains, DRPV, DMP and DCT.

To conclude, this deliverable provides three outputs feeding into the upcoming D2.3, on the DRPV Methodology:

- An overview of existing knowledge on how the uses of SMCS can improve/reduce vulnerability and research gaps that LINKS project can address in this regard;
- The first draft of the Vulnerability-Paradigm for DMPs in digital environment that will help to improve the role of SMCS in DM taking into consideration the role of vulnerability and its dynamic interaction with resilience;
- Registries of existing knowledge, summarized in Section 9 (Annexes), which will be translated from the KB into learning materials within the LINKS Framework, accessible to different stakeholders through the LCC.

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LIST OF ACRONYMS

Abbreviation / Acronym	Description
DCT	Disaster Community Technologies
DMP	Disaster Management Processes
DRP	Disaster Risk Perception
DRPV	Disaster Risk Perception and Vulnerability
DRR	Disaster Risk Reduction
DMC	Disaster Management Cycle
EU	European Union
GA	Grant Agreement
ICT	Information and Communication Technologies
IPCC	Intergovernmental Panel on Climate Change
LCC	LINKS Community Center
LGBTIQ	Lesbian, Gay, Bisexual, Transgender/transsexual, Intersex, and Queer
(P)GIS	(Participatory) Geographical Information Systems
SMCS	Social Media and Crowdsourcing
VGI	Volunteered Geographic Information
WP	Work Package

DEFINITIONS OF KEY TERMS¹

Term	Definition
Crowdsourcing	Describes a distributed problem-solving model where the task of solving a challenge or developing an idea is 'outsourced' to a crowd. It implies tapping into 'the wisdom of the crowd' (definition builds on Howe, 2006; see also LINKS Glossary).
Disaster Community Technology (DCT)	A DCT is a software(-function) for interaction with, within or among groups of people who have similar interests or have common attributes (communities) in case of a disaster as well as performing analysis of these interactions (LINKS Glossary and D4.1).
Disaster Management Processes (DMP)	A collective term encompassing a systematic series of actions or steps taken to reduce and manage disaster risk. Disaster management processes are often associated directly with the phases of the Disaster Management Cycle. In the context of LINKS, we specifically refer to DMP as the policy frameworks, tools and guidelines developed to govern disasters across all phases of the Disaster Management Cycle (LINKS Glossary).
Disaster Risk Management	Disaster risk management is the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses (UNDRR, 2016).
(Disaster) Risk Perception	Risk perception is the way individuals and groups appropriate, subjectivise and perceive risks that might or might not be calculated in an objective manner during risk assessments. The importance of studying risk perception more seriously is obvious: risk perception directly influences people's ability and level of preparedness. Risk perception covers what is also referred to as 'risk awareness' (LINKS Glossary and D2.2).
Diversity	Recognize diversity, the difference between people, including (but not limited to) gender, age, sexual orientation, economic status, religion, race, culture, ethnic background, political position and all the characteristics that make an individual unique. Beyond tolerance; demystifying, understanding and supporting. However, the LINKS project conceptualizes diversity in a broader manner, as the diverse processes, hazards and technologies that are involved in the disaster risk management cycle (LINKS Glossary and D2.1).
Institutions	Institutions are social structures that are composed of regulative, normative and cultural-cognitive elements that provide stability and meaning to social life. Institutions provide the 'rules of the game' and define the available ways

¹ All definitions are retrieved from the LINKS Glossary (forthcoming).

	to operate by discouraging, constraining or encouraging given behavioural patterns (Scott, 2001).
LINKS Framework	A set of learning materials, such as methods, tools and guidelines for enhancing the governance of diversity among the understanding of SMCS in disasters for relevant stakeholders. Methods in LINKS refer to approaches that will enable researchers and practitioners to assess the effects of SMCS for disaster resilience under diverse conditions. Tools are practical instruments supporting first-responders, public authorities and citizens with the implementation of SMCS in disaster and security contexts. Guidelines are recommendations for improving national and regional governance strategies on SMCS as well as introductions and explanations of how to apply the methods and tools under diverse conditions (LINKS Glossary).
LINKS Knowledge Bases	The outputs and knowledge obtained from the assessment of three knowledge domains. This knowledge is used to develop the LINKS Framework (LINKS Glossary).
LINKS Knowledge Domains	The three crucial domains of analysis for studying European disaster resilience and SMCS. These include: Disaster Risk Perception and Vulnerability (DRPV), for assessing changes in the citizens' perception of disaster risks induced by SMCS, as well as assessing the changes in the vulnerability of practitioners and citizens. Disaster Management Processes (DMP) for analysis of how SMCS changes the procedures and processes within the crisis and disaster management. Disaster Community Technologies (DCT), for assessing SMCS related technologies used by practitioners (and citizens) in disasters (LINKS Glossary).
Resilience	The ability of individuals, institutions, and systems to recover from disturbance and to develop and adopt alternative strategies in response to changing conditions (definition builds on Tyler & Moench, 2012; see also LINKS Glossary).
Social media	A group of Internet-based applications that build on the ideological and technological foundations of the Web 2.0 and that allow the creation and exchange of user-generated content. Forms of media that allow people to communicate and share information using the internet or mobile phones. Web 2.0 is the Internet we are familiar with today in which people are not just consumers of information but producers of knowledge through social networking sites and services like Facebook, Twitter and Instagram (definition builds on Kaplan & Haenlein, 2010).
Sustainable Advanced Learning	A maintainable and evolving collection of knowledge and best practices produced for and by relevant stakeholders. Sustainable advanced learning entails a cognitive dimension (the capability to gain in-depth knowledge of

	<p>crises and crisis response) and a social dimension (the ability to implement the knowledge into new practices) (LINKS Glossary).</p>
<p>Vulnerability</p>	<p>The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.</p> <p>The LINKS project focuses on social vulnerability, which is interpreted as a function of exposure, susceptibility and resilience. It is a pre-existing and dynamic condition, result of processes built over time (e.g. social power relations at national and international levels) and all the environmental and social circumstances that allow or limit community's capacity to deal with risks (LINKS Glossary).</p>

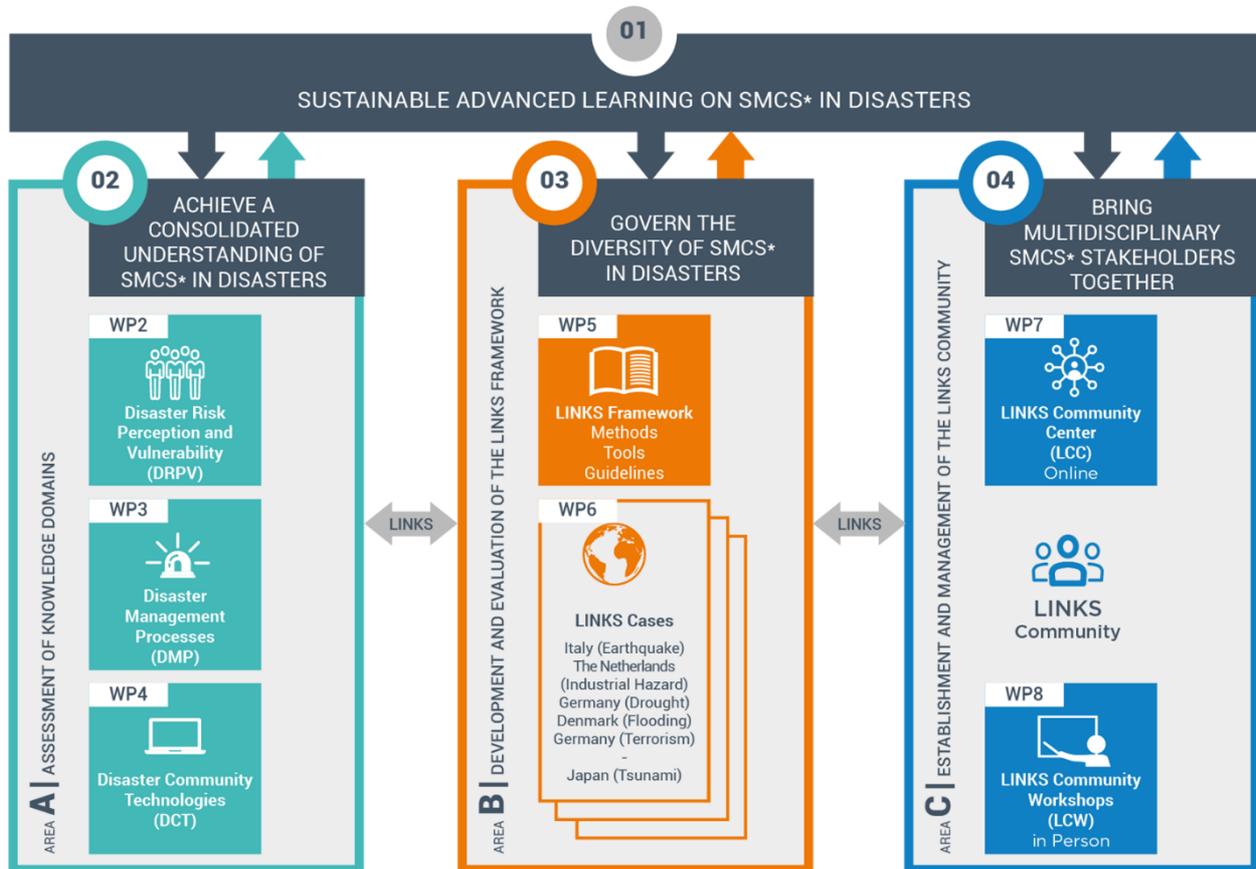
1. INTRODUCTION

This document is a research report which has the aim to provide the first part of the Disaster Risk Perception and Vulnerability (DRPV) knowledge base, focusing on vulnerability. The second part on disaster risk perception is provided by D2.2 (Pazzi et al., 2020). The dialogue between the two concepts is addressed in this deliverable at an introductory level, and will be discussed in depth in D2.3: First DRPV – Methodology for the LINKS Framework and case assessments, to be submitted in May 2021.

In the LINKS project the knowledge base (KB) is defined as the state of the art, theoretical foundations, key concepts, or data available at a given time (i.e. the D2.1, D2.2, D3.1, and D4.1 submission time) within the three knowledge domains of disaster risk perception and vulnerability (DRPV), disaster management processes (DMP), and disaster community technologies (DCT), and with regards for their role with social media and crowdsourcing (SMCS). To build the KBs, a structured review of secondary empirical sources (e.g., published scientific papers and European project reports) has been carried out (see Section 2 of this deliverable), as well as a scientific analysis of available data (e.g., DCTs in DMP). Building on this, within the LINKS project, it is important to make the collected knowledge applicable to various stakeholders.

Thus the results obtained with these four deliverables will form the foundational knowledge bases which feed into the LINKS Framework (see Figure 1). The KBs provide the first assumptions and gaps which will be validated in five cases-based assessments of the Framework in different phases of the project (see Fonio & Clark, 2021a: D5.1 and Fonio & Clark 2021b: D6.1). Accordingly, the LINKS Framework is defined as “**a set of learning materials**, such as methods, tools and guidelines for enhancing the governance of diversity among the understanding of SMCS in disasters for relevant stakeholders” that contributes to learning at different levels and in different phases of the project. At its core, the Framework enables sustainable advanced learning through the learning materials by providing a dynamic structured way of accessing and contributing to varied amounts of knowledge on SMCS in disasters. These processes are supported by the LINKS Community Center (LCC), which will be the online environment for stakeholders in the the LINKS Community (see Philpot & Reuge, 2020: D8.1) for accessing and contributing to the LINKS Framework and other project outputs (see Kiehl et al., 2021: D7.1).

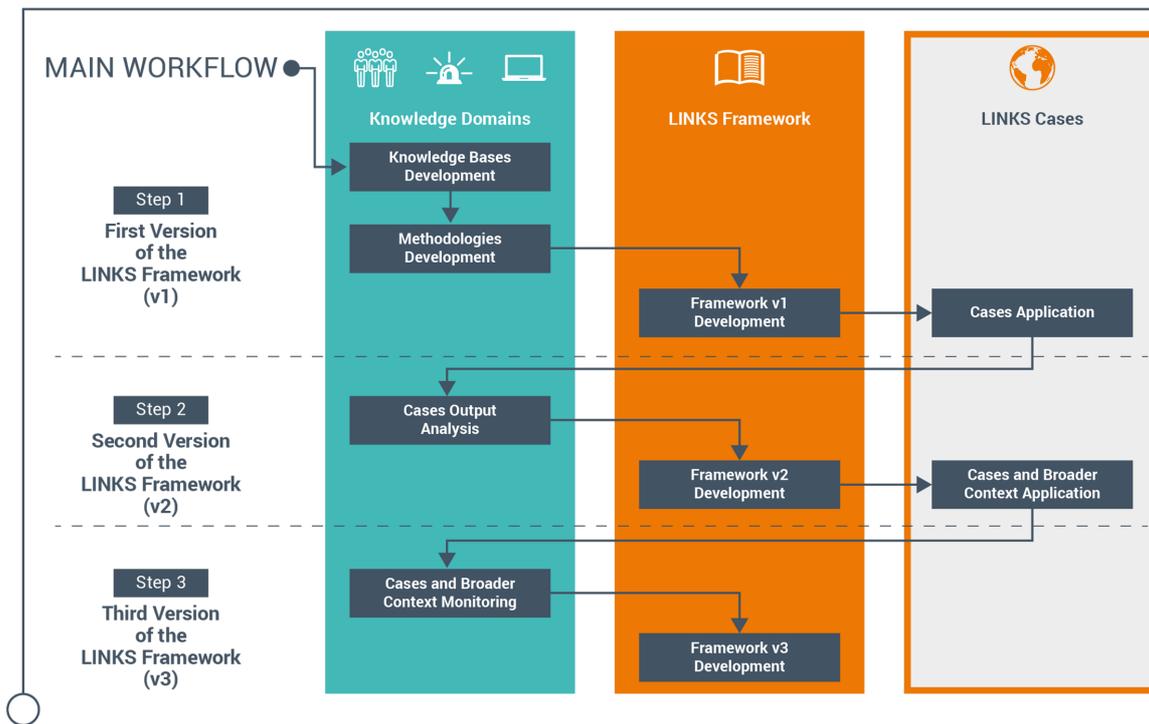
Figure 1: Concept of LINKS



Source: LINKS

This deliverable provides the first inputs from the DRPV KB for the development and evaluation of the LINKS Framework learning materials. In particular, the purpose of this deliverable is to provide the results of an in-depth review on the concept of vulnerability with the aim of offering a different perspective on the concept of vulnerability, moving by a static perspective to a dynamic one. The Vulnerability-Paradigm suggested in this KB will be improved and translated into a DRPV methodology in iterations in the project, and through the different phases of the development and evaluation of the Framework (see Figure 2).

Figure 2: Workflow of LINKS



Source: LINKS

Furthermore, this deliverable focuses on a primary objective of the LINKS project: to address diversity in order to strengthen resilience. In order to understand diversity, a vulnerability analysis is required. Although vulnerability is usually considered a non-operational concept compared to resilience, what this deliverable discusses is that the first step to reach resilience is taken by understanding and defining vulnerability (see also Nielsen & Raju, 2020: D3.1). Thus, the purpose of this deliverable is to challenge the idea that vulnerability is a non-operational concept and to show the potentialities of conceptualizing vulnerability as a dynamic property. Moreover, a deep understanding of vulnerability is useful to expand the concept of diversity, to be interpreted not exclusively as the sum of different characteristics, methods and contexts, but also as the capacity resulting from situations usually perceived as disadvantageous. Thus, the LINKS project does not adopt a position that contrasts vulnerability and resilience, but rather sees the two concepts as integrated and coexisting in different situations. Hence, this report addresses vulnerability as a dynamic concept, which constantly interacts with resilience, where diversity is one of the main variables working within this relationship. This is in line with the idea of diversity in a social perspective stressed in the LINKS project, as both a component of vulnerability which places some individuals at higher risk, and as a beneficial component that contributes to people's coping capacity (see more in Section 4.3).

At the same time, vulnerability is also a multi-dimensional concept, so much so that many different disciplinary perspectives have been adopted to study the concept, with the subsequent risk of

producing an excess of definitions, and the ensuing fragmentation of the concept. A main consequence of this is that the different disciplines have produced a large number of methods and approaches to understand and measure vulnerability, with limited attempts to integrate them through a holistic perspective. Thus, today it is possible to talk about physical vulnerability, social vulnerability, institutional vulnerability, and economic vulnerability as disjointed notions. Although a holistic approach is always desirable and is also sought in LINKS, the main focus of this document is on the social dimension of vulnerability with the aim of understanding how some individuals are more vulnerable in the face of risks and disasters owing to the socio-economic position they occupy in society. The social perspective is useful to consider the increasing role that social media, crowdsourcing platforms and new technologies are acquiring in disaster risk management (DRM), as discussed in greater detail in Section 4 (see also Deliverable 4.1 (D4.1) on Disaster Community Technologies (DCT), Habig et al., 2020). However, further clarification is needed: the social perspective considered here does not exclude the role of physical vulnerability in disasters, rather it is a way to claim a place for social analysis in DRM. Moreover, some considerations are also provided in relation to the multi-dimensional nature of vulnerability (for in-depth considerations on institutional vulnerability, see Deliverable 3.1 (D3.1) (Nielsen & Raju, 2020). Accordingly, this deliverable addresses vulnerability from a social perspective, to highlight the social dimension of risks and disasters according to the idea that disasters are always social processes (see e.g., Quarantelli, 1998; Wisner et al., 2004). This choice is justified both by the gap in vulnerability knowledge linked to social media and crowdsourcing (SMCS) and by the LINKS project's focus on diversity and intersectionality.

Thus, this deliverable is the result of the first task of Work Package 2 (WP2), which sets out to develop 'a consolidated understanding of social vulnerability for disaster risk'. The main purpose of WP2 is to assess disaster risk perception and vulnerability (DRPV) in order to understand:

- How SMCS can shape vulnerability and activate resilience-building processes, especially by challenging and discussing traditional concepts like community, connectivity and accessibility, and by activating new social relations;
- The potentiality and challenges of diversity in disasters and risk contexts and its multi-layered meanings in the interpretation of vulnerability;
- The impacts of SMCS on diversity in risk and disaster perception and in shaping vulnerability maps;
- The potential role of SMCS in terms of building participation and resilience in DRM, sharing local knowledge and creating connectivity.

Drawing from the results of D2.1 and D2.2, an integrated methodology for DRPV studies will be developed (D2.3 expected in Month 12) and integrated into the LINKS Framework, and then tested in the different case-based assessments (see Figure 2). Accordingly, this deliverable has been prepared to provide the state-of-the-art on disaster vulnerability in relation to SMCS, and to

illustrate how it could be used in the LINKS Framework. In detail, this deliverable proceeds in the following steps:

- It sets out the methods used for a literature review on the concept of vulnerability (Section 2);
- It discusses 'vulnerability' as a paradigm for understanding the role of SMCS in the different phases of the disaster management cycle (DMC) (Section 3);
- It systematizes the results of the literature on vulnerability and SMCS, also in terms of diversity (Section 4);
- It introduces the main methods employed in the social sciences to 'measure' vulnerability and SMCS and the main methodological gaps (Section 5);
- It illustrates the main conclusions, considerations and outputs for the following steps of the project, in particular for WP2 (Section 6).

This deliverable is first a product for the scientific community, to stimulate further studies on vulnerability and SMCS and understand possible future directions for discussions, for the LINKS partners involved in methodology developments, and for WP5 that has the responsibility to design the LINKS Framework. However, this does not mean that the results here produced are not able to dialogue also with other potential users, like practitioners and policymakers. On the contrary, the information provided here aims to be a resource for those stakeholders responsible for DMPs. Indeed, the assumptions and findings from the deliverable have already been discussed, contextualized and validated through meetings and workshops with LINKS practitioner partners which will be part of the case-based assessment of the Framework (see Section 2). These practical considerations are highlighted in boxes titled "Practitioners' Pointview" in relevant sections throughout this document.

One example of the applicability of the knowledge produced in this deliverable, in line with a scenario provided in all the KB deliverables, is considerations for a heatwave and long-lasting drought in Europe where many communities face water shortages and consequent restrictions on water consumption. This scenario is characterized by a top-down and authoritative approach with lack of citizens inclusion in DMP. In past emergencies this has resulted in the lack of trust in the authorities and high public criticism. Thus, in the current crisis authorities consider to use social media as a communication channel to better inform and reach citizens' needs. The Vulnerability-Paradigm established in this KB will help to identify who are the social groups that cannot access to this information and that require other ways to share their needs. It will further help to understand how to reduce the challenges linked to accessibility and connected conditions, like connectivity and mobility, and which are the groups that usually are at the margins of the system and that are most willing to use social media to reduce their invisibility.

To conclude, the relevance of this deliverable is linked with its ability to provide an interpretative lens for enabling the LINKS Framework to capture and read the dynamic interactions between

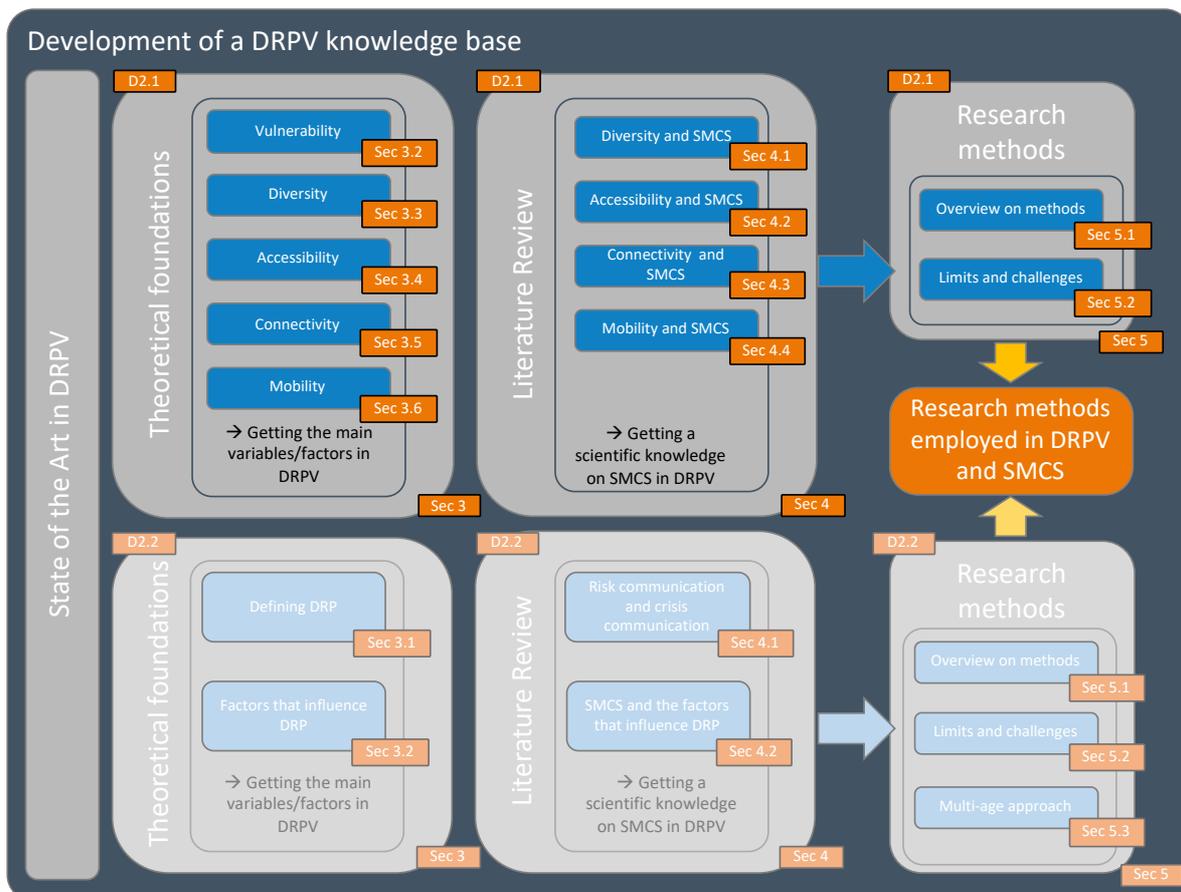
vulnerability and resilience contributing in a social perspective. Thus, the main variables and flows identified in this deliverable are the conceptual basis for the LINKS Framework on the vulnerability perspective, that will be used in defining the research questions and assumptions, and ultimately learning materials such as methods, tools and contents in the context of the overall DRPV KB.

2. RESEARCH DESIGN AND METHODS

This section contains information about the type of research conducted, the data sources and collection methods, and how the data were analysed and used in the research. Moreover, this section justifies the methodological choices.

The document provides a review of the literature on vulnerability and SMCS. It is an understudied topic and this work aims to search for emerging theories. Moreover, a conceptual framework is developed to identify the gaps in the existing research. In a conceptual framework, 'a concept', in this case represented by vulnerability, 'is chosen for examination, and the analysis involves, among other things, quantifying and tallying its presence' (Palmquist et al., 1997 in Jabareen, 2009, p. 52). The following step is to 'x-ray' the concept with the aim of understanding its components. Then, the components are reorganized into macro-categories that describe the main property/force they exercise as part of the 'body'. The main purpose of the conceptual analysis is to situate the study and support a research design decision, in this case for the development of the KBs and ultimately the LINKS Framework. The research design is visualised in Figure 2.

Figure 3: D2.1 Research Design



Source: Authors' adaptation from D4.1

Thus, the steps followed to produce the vulnerability knowledge base involve:

- Establishing the criteria to collect and select the data (Section 2.2);
- Collecting data through the selection of scientific papers and reports (see selected papers in the Appendix I);
- Analysing the selected papers (Section 2.3);
- Examining the occurrence of specific concepts (implicit or explicit) in the text and categorizing them in macro-concepts (Section 3);
- Providing a literature review (Section 4);
- Discussing the results of the literature review, and consulting local practitioners (Section 4);
- Identifying the main gaps and the following research steps (Sections 5 and 6).

2.1 Data Sources

This work presents the results of a literature review process that was carried out from June to October 2020. The analysis was built up by considering both theoretical and empirical works describing vulnerability in relation to the use of SMCS in the different phases of the DMC. A variety of sources were considered, in particular: books, papers and project reports. In this phase, the research was not limited to a specific kind of hazard but examined all three categories considered in the project: natural hazards, industrial/technological hazards and terror attacks. Additionally, papers focusing on hazards not specifically addressed by the project were also considered when relevant. No other qualitative sources, such as interviews or surveys, were considered in this phase. These research methods are expected to be used in the next steps of the project.

2.2 Data Selection and Collection

The papers were selected using the main online search systems for scientific documents, in particular the Web of Science and Google Scholar. Keywords were used to make a first selection of the papers. Specifically, combinations of the following words were used: disaster; risk; social media; crowdsourcing; big data; (new) technology(ies); natural hazard(s); industrial/chemical hazard(s); terrorism/terror attack(s); (social) vulnerability; and (socially) vulnerable groups. On the basis of the results obtained using these words, more detailed searches were done, focusing in particular on different socially vulnerable groups, that is, children, the elderly, women, immigrants, refugees, temporarily vulnerable people, people with disabilities, as well as on the main identified variables of vulnerability: diversity, accessibility, connectivity, and mobility. Other words used were: Facebook; Twitter; (mobile/smart) phone(s); gender; (social) vulnerability index; participatory research; participatory vulnerability assessment; survey(s); focus group(s) and questionnaire(s) (for details see Table 1).

Table 1. The Most Relevant Keyword Combinations Used for the Literature Review

Section no.	Main keyword combinations used	Time frame
Section 3	disaster, risk, natural hazard(s), industrial/chemical hazard(s), terrorism/terror attack(s), earthquake(s), flood(s), drought(s), (social) vulnerability, (socially) vulnerable groups, vulnerability framework, conceptual analysis, accessibility, diversity, connectivity, mobility	2000-2020
Section 4	disaster, risk, social media, crowdsourcing, (new) technology(ies), big data, natural hazard(s), industrial/chemical hazard(s), terrorism/terror attack(s), earthquake(s), flood(s), drought(s), (social) vulnerability, (socially) vulnerable groups, children, the elderly, immigrants/refugees, temporarily vulnerable people, people with disability(ies), Facebook, Twitter, gender, LGBTIQ, women, (mobile/smart) phones	2000-2020
Section 5	(social) vulnerability index, participatory research, participatory vulnerability assessment, surveys, focus groups, questionnaires, vulnerability, big data, sentiment analysis, research methods, natural hazard(s), industrial/chemical hazard(s), terrorism/terror attack(s), earthquake(s), flood(s), drought(s)	2000-2020

The papers were first selected on the basis of their abstract, or if that was not enough, on the basis of the introduction and conclusion sections. The papers that fit the scope set by the research question on how SMCS can produce/reduce vulnerabilities in hazard-related contexts, were downloaded and read all the way through.

Articles published before 2000 were excluded from the first phase of the literature screening (see Table 1). This was for three reasons:

- First, this work is based on an older literature review of vulnerability (Bonati, 2014) that covered papers until 2014, and a further literature review on vulnerability in climate change studies considering papers until 2019 (Bagliani et al., 2019), that provided already a basis on which to start the research;
- Second, there are a large number of literature review papers on social vulnerability covering the previous period (e.g. Cutter, 1996; Singh et al., 2014; Tapsell et al., 2010);
- Third, a lack of scientific production and attention to vulnerability and SMCS in disaster studies was seen in the previous period (the majority of works on the topic have been produced in the last five years).

However, the reference list of the selected papers was screened in order to be sure that we did not miss any relevant previous works. Some papers (with no limit as to the year of publication) were added later following a snowball method, based on citations found in the reviewed papers. In total, 175 papers were selected and analysed (see Annex I).

Because the combined list of papers discussing vulnerability in disasters and climate change studies produced a high number of entries, during the literature review four selection criteria were adopted to reduce the number of papers when necessary:

- **Geographical boundaries:** When it made sense, the geographical borders of the research were applied as a selection criterion, limiting the research to European case studies. These were extended in the event that non-European papers were considered relevant or there amount of papers in a European context was not sufficient. This geographical criterion was not applied, for example, in Section 4, because of the limited number of European cases identified discussing vulnerability and SMCS in disaster studies; otherwise, in other cases, we tried to extend the research to non-European developed countries, by considering potential elements of connection with the cases discussed in the project. This criterion was used in Section 3 for example, where a large number of scientific products are available on vulnerability in disaster studies;
- **Methodological boundaries:** In Section 3, the research was limited to review papers or papers that presented an innovative approach to the topic; this is because there are a great many works that discuss methodology for measuring social vulnerability, and they frequently apply the same method to different geographical contexts. Thus, in order to select them, we applied the criterion of *saturation*, according to which we excluded those papers that did not provide any new or significant data with respect to the papers already analysed;
- **Conceptual boundaries:** This limit was applied at the beginning, in agreement with the other research partners. We decided to focus mainly on the social dimension of vulnerability. Thus, the texts analysed were mainly social sciences papers, with the exclusion of papers discussing vulnerability as a physical factor only;
- **Impact factor of the papers:** (through the Web of Science). As already mentioned, considering the great number of works on social vulnerability, this criterion was applied in order to focus on the most relevant works that provided more innovative or interesting approaches to the topic.

To conclude, papers broadly addressing vulnerability in relation to climate change were included according to the method of saturation, while those papers addressing diseases or more focused on resilience, which did not provide significant updates to the discussion of the concept of vulnerability, were excluded.

A data Selection and Collection Sample Combining the Keywords 'Social Media, Social Vulnerability, Disasters'

Using the combination of words 'social media, social vulnerability, disasters', 164 papers dating from last 20 years were selected from the Web of Science. The abstracts were read to identify the most relevant papers. Those articles that considered hazard categories not included in the project were excluded. The 20 remaining studies were analysed in depth and used for the literature review in Section 4. Papers focusing on the broad topic of climate change were excluded in order to pinpoint papers based on specific hazards and disasters. This criterion was applied in this case given the distance of the topic covered by climate change papers with respect to the purposes of the project.

2.3 Data Analysis

The data were analysed in two phases. First, a table was put together in order to collect the main information contained in the papers. The table was structured to include the following information:

- Name of the paper
- Case study (main characteristics)
- Method employed
- Contents of the paper that fit with the purposes of the research
- Critical aspects identified
- Main definition provided for vulnerability
- Main references used to define vulnerability

The second phase was the conceptual framework. The analysis of the papers aimed to identify the most relevant variables for measuring vulnerability, especially in relation to the use of SMCS in disasters. The approach for identifying variables was limited to 'the concepts that support one another' articulating 'their respective phenomena' and establishing 'a framework-specific philosophy' (Jabareen, 2009, p. 51).

As per Jabareen's suggestion (2009) on how to build a conceptual framework, our work followed the next steps of:

- Mapping the selected data sources;
- Reading and extensively categorizing the selected data;
- Identifying and naming the concepts;
- Deconstructing and categorizing the concepts;
- Integrating the concepts;
- Summing up and making sense of everything;
- Validating the conceptual analysis;

- Rethinking the conceptual analysis (if necessary).

The drivers that (implicitly or explicitly) occurred more frequently in the papers were depicted and discussed in broad categories, as described in Section 3 (see also Wachinger et al., 2013).

To conclude, the validation phase has also seen the participation of the local practitioners (in particular the Italian partners) that have been consulted in two phases: in a preliminary phase with the aim of collecting existing knowledge about the cases (see also multi-level mapping results in D3.1: Section 5.3), and in a second phase with the aim of collecting their perspective on the results provided by this deliverable. Then, Italian practitioners have been invited to participate in two meetings to discuss in depth the two deliverables (each meeting focused on a deliverable). To follow, practitioners have been asked to contribute with their considerations on the issues emerging in the deliverable. The main results of the validation process have been collected and integrated in the practitioners' viewpoint boxes in Section 4 of this deliverable and they are useful to improve the effectiveness of the Vulnerability-Paradigm object of this deliverable.

PRACTITIONERS' VIEWPOINT

Throughout the first step of the analysis, (Section 4) boxes like this will provide a practitioner's viewpoint to supplement the findings from the research literature.

These boxes contain subjective reflections on how research findings match the everyday policy and practice of LINKS consortium partners and how these partners have approached the identified problems with concrete solutions.

2.4 Limitations

The main limits in the literature review are linked on one hand to the timeframe of the project, and on the other hand to the few available papers discussing specific aspects of vulnerability. Specifically:

- The deliverable is due in Month 6 (November 2020). Owing to the limited available time, it was necessary to focus the literature selection and collection phase on more specific aspects of the research;
- The relationship between the use of SMCS and the increasing/reduction of vulnerability. It is an understudied topic at the moment and this work represents the first attempt to discuss it. Only 20 papers that specifically discuss vulnerability and new technologies (not limited to SMCS) were identified in the last 20 years;
- Almost all the publications used for the previous literature reviews focused on natural hazards, due to the limited number of papers produced in relation to other kinds of hazards. The main conclusions of these papers could nevertheless also be extended to industrial and technological hazards;

- Papers that address SMCS, vulnerability and terror attacks/terrorism. No works were identified using this combination of words (the Web of Science gave 14 papers, none of which was relevant for this deliverable).

3. THEORETICAL FOUNDATIONS AND CONCEPTUAL FRAMEWORK

This section discusses the concept of vulnerability in order to lay the theoretical foundations for a DRPV methodology to investigate the use of SMCS in disaster studies, which is the output of Task 2.3 expected by Month 12. The discussion is based on a structured literature review (as detailed in Section 2).

The following conceptual discussion considers the different perspectives on vulnerability adopted in disaster and climate change studies. The intention is to understand the dynamism of the concept and identify the main conditions that influence it.

The idea at the basis of this section is that vulnerability is a dynamic concept and that in some situations conditions that are usually classified as responsible for vulnerability could become elements of resilience. Thus, vulnerability cannot be considered a lack of resilience; rather both concepts coexist. Accordingly, vulnerability is also addressed in D3.1 to analyse the question of entitlements in disaster resilience.

Thus, this section sets out to present the Vulnerability-Paradigm, that will be applied to the literature on SMCS and disaster studies in Section 4. Starting from the definitions provided in the selected texts, a clustering analysis was applied in order to identify the main conditions that influence vulnerability. The identified conditions will be used to structure the interpretative work on vulnerability as a dynamic concept in LINKS.

3.1 Introduction to the Concept

As Bankoff et al. (2004, p. 1) have highlighted, the initial question when looking at vulnerability is: 'What makes people vulnerable?' This question is at the basis of the large amount of literature on vulnerability that has been produced in recent decades in both the social and physical sciences, which has tried to understand what vulnerability means, its different levels and dimensions, and the factors that influence it.

Over time, the concept of vulnerability has been the subject of several discussions and there is no single interpretation in disaster and climate change studies. The first call to adopt a vulnerability paradigm emerged in the 1980s from different scholars engaged in political ecology, natural hazards and human ecology studies (see e.g., O'Keefe et al., 1976; Hewitt, 1983; Peacock et al., 1997; Weichselgartner, 2001; Alexander, 2002; Wisner et al., 2004). However, as Cutter et al. (2003) have reported, in the past less attention has been paid to socially created vulnerabilities and a lack of knowledge remains on how to quantify them. Nevertheless, some attempts have emerged in the last 20 years, in particular following Cutter's work, which have provided an increasing number of indexes to measure the socio-economic vulnerability of places in particular (see Section 5).

According to Kelly and Adger (2000; Adger, 2006), three main vulnerability perspectives exist in climate change studies today: the *end point*, *starting point* and *focal point*. Similarly Cutter (1996) identified three schools in disaster studies. The three schools are discussed below.

According to the *end point* perspective, vulnerability is mainly an 'outcome' (O'Brien et al., 2007), the chance of potential exposure to hazards (Cutter, 1996) which could emerge in the future owing to the choices made in the present. This approach is mainly based on the analysis of models and future projections. This is the dominant approach in climate change studies and in the Intergovernmental Panel on Climate Change (IPCC) reports in particular.

According to the *starting point* perspective, vulnerability is a consequence of the current capacity to deal with disasters and is strictly connected with access to resources. It is a place-based and human-security framing approach (O'Brien et al., 2007), whose aim is to answer the following questions: What can hinder a society in giving an effective response in the face of risks? What is responsible for the ineffectiveness of the system? The *starting-point* approach is more interested in understanding historical changes and their consequences and in studying vulnerability as a derivation of social conditions that are often distant from the hazard itself. What emerges is a conceptualization of vulnerability that is mainly based on local peculiarities and social power relations deriving from political and socio-economic processes (Birkenholz, 2012). According to this literature, vulnerability is mainly considered the result of demographic and socio-economic characteristics (i.e., age, race, health, income, employment, and so on). Other factors that are sometimes considered are coping capacity, risk perception, land tenure, neighbourhood characteristics, and governance (Rufat et al., 2015; Fatemi et al., 2017).

The last perspective, the *focal point*, sees vulnerability as a global issue, and it has a strong social perspective. According to this approach, vulnerability is always linked to exposure and specific kinds of hazards that do not leave room for generalization. This perspective mainly derives from disaster studies which consider vulnerability a function of biophysical risk and social response, observing how it appears in the local dimension or in the propensity of a place for danger (Cutter, 1996). This approach is considered propedeutic to the starting point perspective.

However, it is necessary to specify that in O'Brien et al.'s organization of the literature (2007), the *starting point* and *focal point* are considered together as contextual approaches to vulnerability, thus demonstrating that they are deeply intertwined.

3.2 Vulnerability as a Dynamic Concept

In recent years, disaster studies literature has increasingly converged on the idea that vulnerability is a dynamic concept.

Thus, Fordham et al. (2013) have explained that vulnerability not only lies in how a disaster 'affects various social groups, but also and most importantly, in how we actively and inadvertently

perpetuate the social disparities that give rise to certain differential risk between individuals and groups of people' (p. 12). Thus, the authors envisaged the need to go beyond the conceptual limit of vulnerability as a dimension that only exists in the face of risks and that is measurable in terms of susceptibility to disasters. In particular, they suggested seeking to understand the processes that can be responsible for the reduced capacity of some individuals and groups to cope with specific risks. Coming back to the initial question 'What makes people vulnerable?', we can change the perspective and instead suggest a discussion around: 'What reduces people's resilience over time?'

This is in line with the recent call to talk about 'disaster risk creation' (DRC), as suggested by Lewis (2012). Vulnerability is not a state acquired at birth, but a condition acquired over time that can be modified over time. To say that vulnerability can only derive from specific drivers is to make the concept static with potential negative consequences on the capacity to deal with disaster risk. Wisner et al. (2004, p. i) have written that 'an irony of the "risk society" [is] that efforts to provide "security" often create new risks'. At this point, we could say that it could have the same effect to identify specific conditions as the only drivers of vulnerability.

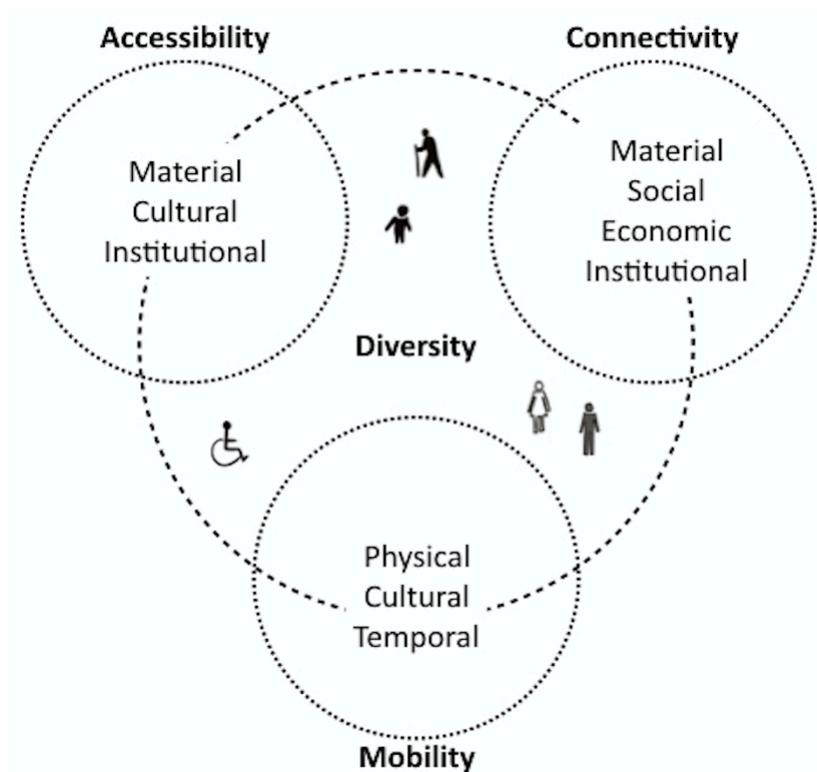
Following on from here, the dynamic dimension of vulnerability that is discussed herein is linked to the idea that a disaster can simultaneously produce experiences of vulnerability and resilience and that a contextual analysis is needed of the ways in which they interact. As Uekusa and Matthewman (2017) have revealed, for instance, immigrants and refugees, who are usually classified as vulnerable groups, are more used to acting in the face of challenging situations and to finding solutions, thus they could have a high level of resilience (Pulvirenti & Mason, 2011), also in terms of adaptation to the new circumstances that they encounter in the host location. However, this could be reduced by external factors, like racism and discrimination. Immigrants and refugees usually find themselves in a condition of great deprivation compared with other groups. However Uekusa and Matthewman's study showed that immigrants and refugees are usually resilient due to their previous experiences of deprivation and disasters, like wars and displacement. Moreover, they may already be prepared for situations of marginalization or exclusion. Furthermore, in the face of disasters, the communities studied in the work showed the strength to collaborate and organize themselves better, thereby fortifying their network.

Accordingly, four main properties were identified as the main outputs of this literature review, the aim of which is to explain the idea of vulnerability as a dynamic concept. These properties are **diversity, accessibility, connectivity, and mobility**. These concepts are useful to highlight the dynamicity of vulnerability and the interdependence between the concepts of vulnerability and resilience.

In particular, Annex III shows the most representative definitions identified in the analysed texts, in an example of the clustering process. The variables that emerged from the analysis are identified in column 3. The next sections provide a description of these conditions, while Figure 4 represents the

flow of relations that link them. Thereafter, this Vulnerability-Paradigm is applied in the analysis of SMCS and disaster studies in Section 4.

Figure 4: A Dynamic Perspective on Vulnerability



Source: Authors contribution

What emerges from the 'flow representation' of Figure 4 is the interconnectedness and interdependencies between all the concepts and especially the role that diversity has in driving the flow. In particular, accessibility, connectivity and mobility condition each other reciprocally and the lack of one of the conditions stops the flow, producing vulnerability. Moreover, diversity becomes a vulnerable condition when it has a negative relation with the other conditions. Alone, it cannot be considered a priori a condition for vulnerability.

3.3 Diversity

In line with this idea of vulnerability as a 'property in continuous transformation', Fordham (2007) has upheld that the practice of frequently labelling specific groups as 'vulnerable' freezes the concept and prevents an understanding of its evolution. Moreover, this labelling may lead to the risk of stigmatization for some groups, potentially reducing their capacity or their willingness to prevent or cope with risk. In particular, the author said: 'we must make a context-specific analysis

before assigning groups the potentially stigmatizing label of “vulnerable”. Furthermore, vulnerability must always be counterbalanced with capacity’ (p. 2). Providing an example, the author revealed that frequently women are labelled as a vulnerable group, ‘depriving’ them of the possibility of contributing to the community response. On the other hand, the idea that men are less vulnerable could expose them to higher risk. For instance, Peek and Fothergill (2008) have discussed how disasters are experienced differently by mothers of different ethnic groups according to the social role they assume, their knowledge of the place and their different access to resources. What the authors observed is that while some mothers, especially belonging to the middle class, were able to transform an evacuation into a vacation, for example, to grandparents or friends’ houses, low-income mothers, in particular African American women, were forced to take refuge in temporary shelters, exposing their children to difficulties and stressful situations. In this case, the vulnerability does not derive from a specific marker, but is the result of the intersection of class and race, which is associated with an increased likelihood of being exposed to environmental hazard (Wilson et al., 2012).

According to this, Fordham (2007) affirmed the need to include ‘diversity’ in DRM, and in particular the author wrote: ‘the priority for emergency managers is saving lives and reducing impacts to people and property. Adding the requirement to meet complex social needs to the obligation of saving lives and property has often been regarded as a luxury that diverts attention away from meeting the needs of victims’ (p. 1). This ‘tyranny of the urgent’ (to use the author’s words) ends up stealing space from other issues that are relevant and therefore risk not being taken into consideration. The gender issue is one of these. This lack of attention to diversity could have consequences on the effectiveness of the adopted measures, facilitating the creation of disaster risk.

Although the literature on disaster studies has mainly used the concept of diversity in reference to the gender dimension, we can maintain that diversity is a more complex concept. According to the definition adopted in the LINKS project, diversity is an individual aspect, characterized by personal markers, diversity awareness and different cultural belonging. This way to discuss diversity is at the basis of different risk perceptions and vulnerability maps. On the other hand, diversity is a range of capabilities, information and data resources, skills and knowledge (scientific and experiential) which systems can draw upon (LINKS Glossary).

Thus, diversity is based on the idea that ‘the varying experiences of vulnerability and resilience within a disaster are due to social differences within a community or country, making certain individuals and groups more vulnerable or resilient (Finch et al., 2010)’ (Dominey-However et al., 2014). Accordingly, different dimensions participate in defining the concept of diversity in relation to vulnerability. From the literature review, two dimensions emerge as dominant:

- **Diversity as a result of socio-economic characteristics:** The way in which disaster literature usually identifies the main vulnerable groups is based on a set of socio-economic

characteristics used as the main components to quantify vulnerability. They refer in particular to individual markers, that is, gender, age, religion, ethnicity, income, or level of education. Dominey-However et al. (2014) have said that the main social groups which disaster studies identify as most vulnerable are women, ethnic and racial minorities, the poor, the elderly, the young, and the disabled. The vulnerability literature recognizes socio-economic characteristics as useful to understand the level of people's susceptibility in the face of risks. However, these are not the only markers to be considered. They need to be interpreted in relation to the other variables in order to gain an in-depth understanding of their role in increasing or reducing vulnerability;

- **Diversity as human capital:** Human capital should also be considered when discussing diversity, that is, the sum of the skills, abilities, knowledge, and experiences that belong to each individual (see e.g. Becker, 2002). Although human capital is mainly used in economic studies, here it is interpreted beyond its economic value, as an individual capital of knowledge that can effect the capacity to deal with risks. In this connection, Bankoff et al. (2004) maintained that 'vulnerability is about people, their perception and knowledge', which is how people measure vulnerability around them. In particular, perception is useful to understand reactions and behaviours (for an in-depth analysis of risk perception, see D2.2). Thus, perception is an individual factor, although it is linked to other dimensions (see the multi-level analysis in D2.2). Hilhorst (2004) has categorized perception according to three different domains of knowledge: science, governance and local customs, and recognized their importance in understanding why people are vulnerable and what can be done to reduce this condition. Culture, also including subcultures, is one of the main variables that define individual perceptions. According to Alexander (2012), culture is a multifaceted concept in continuous evolution, and every individual is the result of different cultural contexts. Thus, Reid (2013) has upheld that culture is a relevant variable to include in the analysis of vulnerability, although it is extremely difficult to measure. For instance, it is very important to understand how messages are conveyed and perceived in relation to local cultures/subcultures and behaviours. Then McEntire (2001) highlighted how 'ideologies and the beliefs and daily activities of all citizens and organizations in the public, private and non-profit sectors have a – positive or negative – bearing on our degree of vulnerability (e.g., apathy shown towards prevention and preparedness measures, business practices that destroy the environment, dependency created through relief assistance, etc.) (Mileti, 1999; Wisner et al., 2004)'. Thus, risk perception can act by amplifying vulnerability and conditioning the risk of losses. As Jóhannesdóttir and Gísladóttir (2010) have stated, the meaning of risk changes significantly in different cultures and societies, as a result of the different ways the word is conceptualized and evaluated. Thus, it is fundamental to understand the social, cultural and psychological relations between vulnerability and risk perception if researchers and practitioners want to understand behaviours and attitudes in

the face of risk. Moreover, this could be useful to reduce potential social conflicts, for example during post-disaster emergencies.

3.4 Accessibility

Accessibility is strictly connected to the vulnerability of people and places. It can be defined as the ability to use those resources that ensure liveability, which depends on the socio-economic relations established in a society (Blaikie et al., 1994; Bryant, 1998). Access to resources derives from three different ways of interacting with nature: how and whether (eco)systems can satisfy people's needs, how economic activities change (eco)systems and how ecological and social systems respond to changes (Turner et al., 2003). In these terms, access is a condition.

Accordingly, accessibility is strictly connected to the level of development and power relations at the local and global scale. Thus, a large number of disaster and development scholars, especially from the school of political ecology, have recognized the relevance of marginalization in defining vulnerability (see e.g., Hewitt, 1997) as the unequal distribution of exposure to risk and access to resources. Among others, Susman et al. (1984) have defined vulnerability as the level of exposure of different classes in society, according to their different capacity to access resources. Moreover, Bankoff et al. (2004, p. 1) have stated: 'vulnerability is a much more precise measurement of exposure to risk from these disasters and a more accurate concept than poverty in understanding the processes and impacts of "underdevelopment"'. Thus, the system is responsible for 'differential vulnerability', as a consequence of the competition for resources at the local and global scale (Boyce, 2000). According to this perspective, the contemporary economic and power system, based on a global capitalist model, is the main factor responsible for disasters (McEntire, 2001) and the solution lies in overcoming it (transformation paradigm, see Pelling et al., 2015).

Thus, in disaster studies, it is possible to identify different levels of accessibility that condition the vulnerability of a society, connected to the possibility of accessing different kinds of resources:

- **Material accessibility:** Access to livelihoods, food and health insurance, as well as access to safe places. All these dimensions are linked to situations of marginalization, poverty and under-representation (see also institutional accessibility). For instance, as a consequence of spatial inequalities, low earners and minorities are usually the closest to risk-exposed places, such as hazardous waste dumps (Bullard, 1990). Moreover, as a consequence of under-representation, people with disabilities could have difficulties accessing safe places, due to a lack of adequate structures and procedures to support them;
- **Cultural accessibility:** Access to information, (scientific) knowledge (about this see also subcultures of disaster, Wenger & Weller, 1973; Bankoff, 2003; Gaillard et al., 2008) and education, as well as linguistic and intellectual accessibility. Accordingly, understanding the way in which societies interpret and classify vulnerability can provide information on

vulnerability, which can hence be used as a political instrument to establish who will receive (access to) assistance and who will not;

- **Institutional accessibility:** Access to political, economic and social systems, as well as power and representation. On this, Tierney (1999) has highlighted the high level of acceptability of exposed areas in low-income and minority neighbourhoods due to the need for a job or as a consequence of a 'constrained choice', resulting from a lack of political representativeness (Bullard, 1990, see also the concept of environmental racism, Holifield, 2001).

All these dimensions of accessibility are strictly connected and participate together in the production of vulnerable communities. They are also connected to the different phases of the DRCM, as well as to the variables which are discussed below, revealing the links between pre- and post-disaster situations. For instance, those who have difficulties accessing safe livelihoods, food and health supplies pre-disaster also have less capacity to access information and to be represented in the political and socio-economic systems, with consequences on their exposure and susceptibility during disasters. The consequence is usually a lower likelihood of being rescued during the emergency and of avoiding its negative consequences.

3.5 Connectivity

Liverman (1990) has distinguished between the vulnerability of geographical space and the vulnerability of social space. By the vulnerability of geographical space, the author means where vulnerable people and places are located, while the vulnerability of social space refers to the people who are vulnerable in that place. This distinction could be applied here to clarify the different dimensions of connectivity. Connectivity has a strong spatial dimension, represented by the degree to which places and people are connected at different levels throughout the space. On the other hand, today space is not only real but also virtual. Thus, connectivity has assumed an increasing role in relation to the diffusion of means to reach people and places, both physically and virtually.

As a concept that comes from resilience studies, Foley (2020, p. 257) has defined connectivity as (how) 'the capacity for connection, and how people experience the state of being connected, manifests at different spatial scales and in different forms, both material (e.g. roads, ferries, power and telecommunications infrastructure, etc.) and non material (e.g. familial and cultural links, governance structures, etc.).'

Thus, connectivity is also about context. What is meant by context is the combination of social, economic, political and geographical factors that condition the development of a specific place. The focus is on how processes/connectivities shape places and how this can have consequences in terms of the spatial distribution of vulnerability, as well as in producing marginalization. The concept is strictly linked to globalization and its consequences in terms of power relations among places. In this regard, Lewis and Kelman (2010) have suggested using an intra-scale perspective, according to which vulnerabilities derive from relations between places and the interdependence between scales

and their consequences on, for example, the level of development, the availability of resources and knowledge, and coping capacity.

Although vulnerability has primarily been considered as an individual factor, described through demographic characteristics (see diversity), Cutter et al. (2003, p. 243) have specified that it is:

Partially the product of social inequalities – those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond' and partially the product of the place inequalities, which the authors define as 'those characteristics of communities and the built environment, such as the level of urbanization, growth rates, and economic vitality, that contribute to the social vulnerability of places.

Thus, a fundamental step in the discussion on vulnerability is to understand the role that connectivity can have in activating a range of different responses. Moreover, the geographical scale adopted for the analysis is extremely relevant.

According to this, different dimensions could be included in the 'equation', contributing in different ways to understanding vulnerability in connectivity. In particular these are:

- **Material connectivity:** Infrastructures at the different geographical scales but also the availability and operativity of technologies;
- **Social connectivity:** 'An effectiveness of social networks will directly influence the ability of communities to cope with disaster events' (Wilkin et al., 2019). This category can include social capital, defined as the 'resources embedded in social networks and social structure, which can be mobilized by actors' (Dynes, 2002, p. 3). While human capital is something that belongs to individuals, social capital is found in the relationships and networks among social actors. It corresponds to the social space discussed by Liverman above (1990). Social capital also includes trust, knowledge sharing, level of freedom and power relations;
- **Economic connectivity:** economic connectivity is the capacity to participate in the economic system, interact with it and connect to the central business districts (Contreras et al., 2013);
- **Institutional connectivity:** According to Huck et al. (2020), there are three different institutionalized forms of connectivity, which are vertical, horizontal and cross-territorial. Horizontal connectivity is about different policy domains and infrastructure sectors; vertical connectivity refers to different policy levels; and cross-territorial connectivity concerns the cross-jurisdictional and territorial levels. In this case, vulnerability 'depends on the ability of the actors involved to break up existing policy silos and implement cross-boundary working relationships (Almoklov et al., 2012; Matyas & Pelling, 2015)' (Hulk, 2020, p. 102573). However, institutional connectivity is also addressed in D3.1 as a paramount for understanding the changing institutional conditions supported by SMCS.

Thus, for instance, linguistic knowledge is particularly relevant in facilitating or disrupting social connection (e.g., owing to the wrong use of words, offensive words, and so on). On the other hand,

vulnerability could be a consequence of the trust gap that the most disadvantaged and marginalized groups display towards institutions. This can lead them not to trust the information provided by the official public channels, with a consequent increase in group vulnerability (for an in-depth discussion on the role of trust, see D2.2).

To conclude, disasters have the potential to produce different consequences on connectivity: on one hand, they can disrupt connectivities, and on the other, they can intensify them, as a consequence of people's capacity to react in the face of challenges.

3.6 Mobility

Disasters have three potential consequences on mobility: they can disrupt an individual's mobility capacity; they can force people to move, e.g. leaving their houses; or they can push people to react, moving e.g. resources, ideas and volunteers. Thus, mobility has to be considered the movement of people, goods and ideas, which disasters could either interrupt or mobilize. It is strictly interlinked with the concept of connectivity, which is a pre-condition to mobility.

Associated with mobility is mobility justice, that is, according to Sheller (2020, p. 7) 'an overarching concept for thinking about how power and inequality inform the governance and control of movement'. The author has highlighted how the issue has been discussed according to different perspectives, like 'differential mobility', 'uneven mobility', 'motility' or 'potential mobilities' (Flamm & Kaufmann, 2006; Kellerman, 2012), 'mobility capabilities' (Kronlid, 2008), and questions of power, justice and mobility rights (Faulconbridge & Hui, 2016).

In particular, Sheller (2012, pp. 199–200) has said that 'mobility ethics suggest that ensuring mobility justice will entail moving beyond simply a politics of the *de jure* right to mobility, to instead ensuring that the *de facto* capability of mobility is protected and extended as a common basis for social justice'. Accordingly, the literature on mobility highlights that roads can stimulate social engagement but also intensify the social marginalization of those people who do not have access to mobility capital (see e.g., Featherstone et al., 2005; Farrington & Farrington, 2005 in Cook & Butz, 2015). Thus, mobility is strictly connected not only to the connectivity of a territory but first of all to the accessibility of resources. As defined by Cresswell (2010, p. 21), 'mobility is a resource that is differentially accessed'.

Especially in this period of the COVID-19 pandemic, mobility justice issues have received more attention in relation to risk situations. Some of the main questions are: Who is free to move? Where are we free to go? Who cannot move? But also, who continues to be forced to move? These questions are also associated with the lack of a place to stay, and the need to continuously move to reach a safe place. This condition is associated with illegal migrants in particular but also with the homeless. The issue of mobility/immobility is also associated with prisoners (e.g. Gaillard & Navizet, 2012), who cannot move even in situations of risk (see e.g., the case of COVID-19 in Italian prisons).

'Critical mobilities thinking has systematically linked differential mobilities to social exclusion: when people's capacity to move is hampered their ability to participate in economic, social, and political life is curtailed (Sager, 2006; Urry, 2008; Adey, 2010; Jensen, 2013)' (Cook & Butz, 2015, p. 2).

Thus, mobility could depend on internal or external factors. In the first case, the reference is to individual limitations, pre-existing the disaster or occurring during the disaster. On the other hand, external factors include infrastructural disruptions or physical or mental impediments resulting from the situation of risk. Furthermore, as already mentioned at the beginning, mobility also refers to a non-material dimension, such as ideas and cultures. Accordingly, this deliverable identifies three different perspectives on mobility and vulnerability:

- **Physical mobility:** Vulnerability is usually associated with the ability to move, especially in climate change studies. This is interpreted in physical terms, as the availability of means of transportation and the capacity to use them. Moreover, the ability to move is often considered a consequence of a status of vulnerability (see migrants and evacuation procedures), which forces people to abandon their houses (situations of forced eviction and displacement, e.g. Bonati et al., 2018; Forino et al., 2018). However, the more people are unable to move, the higher their level of vulnerability (Barnett & McMichael, 2018). Mobility can be temporary or permanent. It can be strictly related to the characteristics of the hazard, or to intrinsic individual conditions that create a permanent status of vulnerability. Orientation is one of the aspects that emerges when talking about physical mobility in post-disasters. The capacity to move is also associated with the capacity to orient oneself in the space and to know how to reach a safe place. This is associated with individual capacities and knowledge to read in order to move in the space, but also with cognitive difficulties associated with the loss of spatial reference points. After an earthquake, for instance, people could have difficulties understanding where they are, losing the visual capacity to find their way as a consequence of collapsed buildings or the dust from rubble. This is the same in the event of fires or volcano eruptions. In the event of floods, mobility could be reduced due to the impassability of roads. Then, in the event of terror attacks, people could be hurt and so unable to move their limbs or be physically or mentally unable to escape. To conclude, physical mobility also includes the concept of the transferability, for example, of information and knowledge (on this subject, see also knowledge sharing, Mercer et al., 2012);
- **Cultural mobility:** According to Parsons (2019), mobility is connected with the cultural and environmental context, and it is quite difficult to separate one from the others. Thus, mobility has been studied in geography not only as the act of moving but also as regards its meaning. The movement can be representative and the vehicle can be a message. Thus, another status of mobility identified in the literature is emotional mobility. According to this perspective, mobility is 'movement that produces cultures' (Jensen, 2009, p. 154). According to Parsons (2018), recent translocality frameworks have used the term to 'describe socio-spatial dynamics and processes of simultaneity and identify formation that transcend

boundaries (Grein & Sakda-polrak, 2013, p. 373).’ On this, Alexiades (2013, p. 28) has said that mobility is linked to the ‘profound, emotional, symbolic, or material links that people establish with place, the environment, or the life forms within it’. Moreover, cultural mobility can be also considered in terms of mobility/circulation of ideas, best/bad practices, and the participating to mobilize them;

- **Temporal mobility:** Mobility is not only a spatial property but also a temporal one. Thus, Cutter et al. (2003) have described vulnerability as a property that varies over time and space, and Lewis and Kelman (2010, p. 191) have suggested the need to get the idea over that vulnerability is a ‘contemporary snapshot of a group of people in a specific place’ (see also Bankoff et al., 2004; and the idea of ‘disaster as an historical event’ in Oliver-Smith, 1986, p. 96). On this, Bankoff et al. (2004, p. 2) have highlighted the historical consequences of political and socio-economic processes on the spatial distribution of vulnerability: ‘history reveals that vulnerability may be centuries in the making: societies and destructive agents are mutually constituted and embedded in natural and social systems as unfolding processes over time’. Accordingly, Lewis and Kelman have suggested adopting an intra-temporal, in addition to an intra-scale analysis (discussed under connectivity) on the transformations that occur in places in order to understand how they shape local vulnerabilities. According to the intra-temporal perspective, place vulnerabilities are the result of the transformations made by past generations which continue to influence contemporary vulnerability.

3.7 Section Remarks

What emerged from the literature review provided in this Section is that vulnerability cannot be considered a static condition that belongs to specific social groups, but rather depends on a number of different internal and external factors that may continuously interfere with it. Thus, vulnerability can be seen as a temporal mobile condition, as explained in Section 3.6.

The purpose the framework established here, is to highlight the dynamic dimension of vulnerability through the identification of four conditions: diversity, accessibility, connectivity, and mobility. The four concepts are strictly interdependent and yet their interaction is at the origin of the disaster risk creation/reduction. The way in which diversity interacts with the other three, in particular, can modify substantially the vulnerability of some groups. Moreover, the concept is useful because it offers a different perspective on vulnerability.

Although diversity plays an important role in understanding how social groups interact with different situations, thereby producing different levels of exposure and susceptibility, the other concepts are equally important to define vulnerability. Accessibility, in particular, is a pre-condition to the other two concepts (connectivity and mobility). However, as Figure 1 shows, they are presented in a cycle, where mobility could be a pre-condition for accessibility. For instance, the capacity to move, increases the possibility to access to relief or to safe shelters, thus it is a pre-

condition for access. On the other side, we cannot move if we do not have access to resources or means of transportation, such as to infrastructures (connectivity).

Thus the purpose of next section should be to discuss how these concepts could acquire a different meaning in relation with the virtual/digital space, and how this could change the dynamics among their interaction, starting with the question: could SMCS become tools to reduce vulnerability or are they tools that increase social disparities?

Key takeaways from Section 3

The four main properties on which vulnerability depends that have been identified in the literature review are:

- **Diversity:** This includes all the individual conditions that make a specific individual more or less vulnerable. They include demographic, social, economic and cultural characteristics, i.e., age, gender, social status, religion, ethnicity, health, culture, perception, knowledge, and cultural and social values.
- **Accessibility:** Accessibility refers to the possibility of accessing resources. It covers different levels: material accessibility, cultural accessibility and institutional accessibility. Accessibility is a condition that is strictly connected to the visibility of specific social groups and their possibility of being represented in the system.
- **Connectivity:** Connectivity is one the main steps in understanding the origins of risks and disasters, by trying to identify how places can shape the vulnerability of the different social groups, how the vulnerability of the same individual can change in the different places and how the adopted geographical scale can change the perspective on vulnerability. There are different levels of connectivity: material, social, economic and institutional connectivity. This category also includes social capital, as the sum of all the social networks and structures which can be mobilized by the stakeholders.
- **Mobility:** Mobility has to be considered the movement of people, goods and ideas, which disasters could disrupt. It may depend on internal or external factors, where by internal factors the reference is to individual limitations, pre-existing the disaster or occurring during the disaster, while external factors include infrastructural disruptions or physical or mental impediments resulting from the situation of risk. In addition, mobility can be physical, cultural or temporal.

4. STATE OF THE ART – SMCS AND THEIR ROLE IN VULNERABILITY

In recent years, SMCS technologies have been increasing their supporting role in disaster risk reduction (DRR) processes and response during disasters (on crowdsourcing see McCallum et al., 2016), as well as in disaster communication (see Imran et al., 2015; Wang & Ye, 2018; Zou et al., 2018; Wang et al., 2019). Ever since Hurricane Katrina (and especially after Harvey), the use of SMCS during emergencies has increased, especially among exposed people (Wang et al., 2019).

This section presents the state-of-the-art on SMCS in vulnerability studies, while applying vulnerability as a dynamic concept. The main scientific literature on the topic is presented critically and systematized according to the four dimensions identified in Section 3 (diversity, accessibility, connectivity, and mobility; see Table 2). A relevant part of this literature focuses on the social and geographical disparities that SMCS can produce in those places exposed to risks and the potential consequences on people's capacity to prepare and respond to hazards. The main results and inputs are discussed with the aim of identifying the role of vulnerability in Disaster Community Technologies (DCT), with a specific focus on the use of SMCS (for an in-depth discussion of the concept see D4.1). The final purpose of this section is to complete the interpretative framework to be applied in cases on the basis of the literature results on SMCS and vulnerability (for the list of works analysed see Annex 8.5). Thus, this deliverable aims to offer a tool able to move from a static vision on vulnerability to a dynamic one. The Vulnerability-Paradigm here suggested is thought to be used by different users, including the scientific community, practitioners, and policymakers, on the basis of which to structure qualitative and quantitative approaches for DM. The paradigm will be translated in a methodology in D2.3.

Table 2. The Vulnerability-Paradigm in SMCS and Disasters

Variables/Section	Physical/Material	Socio-economic/Cultural	Institutional
Diversity	(Section) 4.1		
Accessibility	4.2.1 Material Accessibility 4.2.1.1 Physical Limitations and Digital Disability	4.2.2 Information (Cultural) Accessibility	4.2.3 Institutional Accessibility
Connectivity	4.3 Material Connectivity	4.3 Economic Connectivity 4.3.1 Social Connectivity 4.3.1.1 Connecting Hate	4.3.2 Institutional Connectivity
Mobility	4.4.1 Physical Mobility (Mobility of resources/aid; Mobility of People Immobility) 4.4.1.1 Immobility	4.4.2 Cultural Mobility 4.4.2.1 Mobilizing Movements 4.4.2.2 Mobilizing Violence	4.4.3 Temporal Mobility

4.1 Diversity

In the LINKS project, diversity is addressed with the aim of understanding its role in engaging with DCT (see D4.1) and/or in terms of exclusion from the public debate on DRM, as discussed in the LINKS Ethics and Societal Impact Strategy (D1.5, Bonati & Morelli, 2020).

Moreover, diversity is recognized in Section 3 as one of the main variables that interact with vulnerability. Thus, the concept is challenged here in relation to new technologies, with the aim of providing inputs for the following phases of the LINKS project.

The greater part of the works on DCT addresses diversity with the aim of understanding the connection between demographic and socio-economic characteristics and the use of SMCS in the different phases of DMC, and especially in emergencies.

A work produced by Zou et al. (2018) has studied the social and geographical disparities in Twitter use during Hurricane Harvey. The premise of their study is that 'in the case of disasters, the social and geographical disparities on social media use could generate uneven responses and affect the long-term resilience of the communities' (p. 2). The study considered three phases of DMC: preparedness, response and recovery. The results showed that social-demographic conditions affect the use of disaster-related Twitter during all three phases. However, disparities mainly emerged in the response phase. The most significant socioeconomic variables taken into consideration in the study were average household income, portion of households without a vehicle, and percentage of employment. Thus, 'communities with better socioeconomic conditions had higher disaster-related Twitter use in all three phases' (p. 16). Moreover, Nicholson et al. (2019) have discussed the use of social media during Hurricane Harvey. The vulnerability characteristics of the different districts were analysed in relation to the use of rescue-request counts posted on social media. However, the authors noticed the persistence of the risk that vulnerable people could be under-represented in the social media data, and consequently that socially vulnerable groups could be left behind during a disaster. This leads to accessibility, discussed in the next section, according to which people with easier access to Twitter could potentially receive more attention from first responders and have more probability of being rescued during the emergency.

Then, even fewer studies (with the exception of those already mentioned) were identified that discuss the connection between the elderly, vulnerability and SMCS. In particular, Lai et al. (2018) identified differences between elderly smartphone and non-smartphone users. The second group

PRACTITIONERS' VIEWPOINT

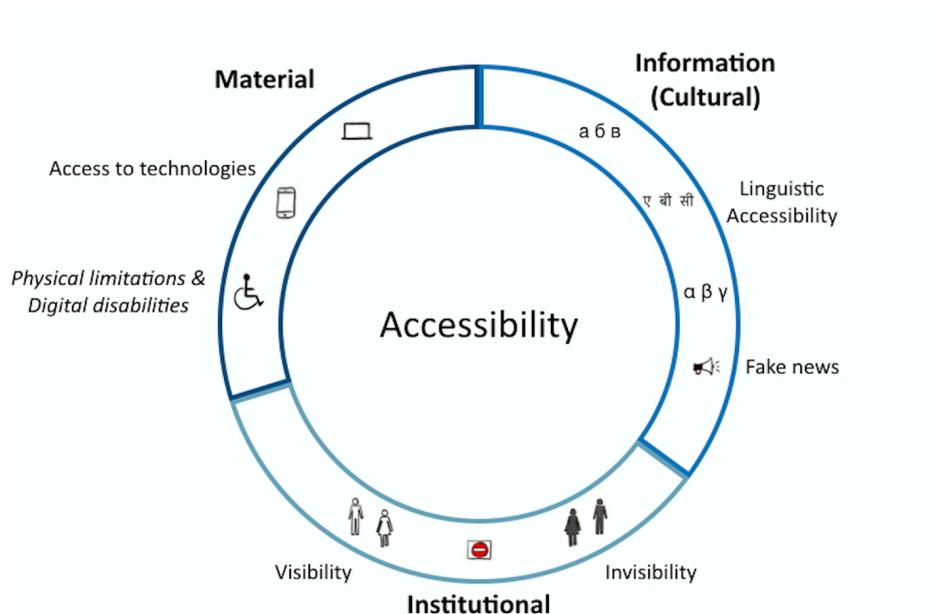
Currently in Netherlands, NL-Alert is the most important tool to inform citizens about the emerging crisis situation. NL-Alert works via cell broadcast, a service that can only be received by people with mobile phones. Hence, this app will be broadened in the near future, so that also those who have difficulties to access, like the elderly, will receive a spoken NL-Alert via their landline phone number.

proved to be more inclined to look for support in their social networks. According to their results, by itself, the variable of age cannot be considered a factor of vulnerability but it needs to be investigated in relation to other factors, such as health, social activism, confidence with new technologies, residence (urban or rural areas as already discussed, if they reside in the same place for long periods) and the level of engagement with disaster information repertoires. Then, according to Daddoust et al. (2018) the main factors that influence exposure of the elderly in the face of disasters are: individual characteristics; living alone, which increases the risk of social isolation, mental and physical health problems and difficulties in escaping or recovering; financial situation; place of residence; culture, e.g. indigenous beliefs to which elderly people could be more attached or life experience; but also lifestyles (the use of technological tools).

To conclude, other studies have shown how specific groups, especially immigrant women, could experience a 'double vulnerability', due on one hand to their condition of marginalization, and on the other hand, for example, to gender inequality, linguistic barriers and a limited social network (see Pongponrat & Ishii, 2018; see also Fussell, 2018; Fussell et al., 2018). Other problems could arise in the case of undocumented immigrants which could generate situations of racism, discrimination, exploitation and the fear of deportation (Méndez et al., 2020; see also Wilson & Tiefenbacher, 2012), which could move them not to ask for help or to flee from rescuers. Moreover, because diversity is a cross-cutting dimension, it must also be considered in relation to the variables below.

4.2 Accessibility

Figure 5: Accessibility and SMCS



Source: Authors contribution

According to the literature analysis provided in Section 3, accessibility emerges as one of the main components in understanding vulnerability in relation to SMCS in hazard-exposed areas. In particular, social and spatial disparities are mainly associated with limits on the accessibility of new technologies, as well as information and representation (see Figure 5). The main issue that emerges from the analysis is that accessibility is a pre-condition for the others.

4.2.1 Material Accessibility

In relation to SMCS, material accessibility is first interpreted as the access to communication and information systems, such as SMCS, and more generally to technological devices. Moreover, it refers to the role that SMCS could have in facilitating the access to relief systems. The starting assumption is that the lack of access to the virtual space can exacerbate an individual's condition of vulnerability (Lai et al., 2018), depriving him or her of the possibility of receiving information and being represented in the flow of rescue requests and the response.

Thus, a study on the access to SMCS and vulnerability must be included in the discussion, first of all, from the issue of access to technologies, in terms of social and spatial justice (Cutter et al., 2003; Chib et al., 2010). On this, Madianou (2015) has highlighted that low-income people have less opportunities to access social media, while Chou et al. (2009) has revealed that while Internet access is limited by factors relating to ethnic and health status disparities, these factors do not significantly affect the use of social media.

4.2.1.1 Physical Limitations and Digital Disabilities

Accessibility to resources is strictly connected to physical limitations. One of the social groups that could be more disadvantaged by the increasing use of SMCS during disasters are people with disabilities. They are often invisible during emergencies or excluded from the disaster response. For example, procedures may not consider their difficulty in accessing rescue and safe shelters. According to Lord et al. (2009, p. 11): 'all too often governments, humanitarian assistance agencies, and other policy makers fail to adopt a disability perspective in natural disaster humanitarian crises and situations. With distressing frequency, the disability experience is either neglected completely or lost when cast among other vulnerable groups.'

While focusing on disabilities and SMCS in disasters, as Kent and Ellis (2015) state, the lack of access to SMCS and technologies is becoming more and more complex and can increase life-threatening situations, augmenting the vulnerability of those who are excluded: 'as we are increasingly coming to rely on a social media mash-up of digital platforms to assist in communications during disaster

PRACTITIONERS' VIEWPOINT

Italian National Civil Protection Department launched a project called 'Able to protect' with the aim of addressing disabilities inside the emergency planning activities. The project tries to answer also to technological disabilities. <https://www.abiliaprotettore.net/>

situations, the issue of accessibility for people with disabilities is as dire as if it was high ground during a tsunami or transport during a typhoon' (p. 419). In particular, people with visual and hearing disabilities could be left behind. Ellis and Kent (2010) have shown that Twitter was inaccessible to people with a vision impairment, while MySpace was not accessible to many people with disabilities during hurricane Katrina in 2005. Thus, according to Boudreau (2011, in Ellis and Kent, 2010), the most popular social media platforms (e.g., LinkedIn, YouTube, Google+, Facebook and Twitter) 'exclude people with disabilities from participating'.

What is happening is that these platforms are supplementing and supplanting the traditional systems of communication in emergencies too. Accordingly, what Kent and Ellis (2012) have suggested is the need to expand the concept of disability and accessibility in disasters, including to the online environment. In these terms, disability should be defined as 'people's ability to access communications and the Internet', also corresponding to digital disability (see Ellis & Kent, 2016; Goggin & Newell, 2003). In some cases, digital disability could overlap with physical disability, increasing the risk of situations of discrimination (Hemingway & Priestley, 2009) and exclusion. Furthermore, 'the level of user sophistication in using smartphones could be a source of disparity' (Hargittai, 2002).

4.2.2 Information Accessibility (Cultural Accessibility)

Cultural accessibility is considered here as the capacity to access information, and is therefore connected with material accessibility. The starting assumption is that the 'individuals' possession of resources to gather information on potential risk influences how they respond to the danger and ultimately their protective behaviour (see a review in Dash & Gladwin, 2007)' (Lai et al., 2018, n.p.).

This is also associated to the difficulties to access to quality information. This exposes people with more willingness to use social media as a source of information, as well as individuals who have more difficulties in distinguishing between true and false information. The relationship of trust in sources of information, is a relevant issue, although marginalized groups are usually less likely to trust institutional information channels (see also D2.2).

PRACTITIONERS' VIEWPOINT

Save The Children Italy focuses much of its efforts on vulnerability issues linked to accessibility. Thus, SCIT works for providing spaces and access to technological devices in order to support people, like refugees and low-income families, that cannot access digital services. In particular, SCIT has provided channels to e.g. follow distance learning classes (see *punti luce*) during the Covid-19 emergency; to provide psychological support services; to answer supply

In connection, Lai et al. (2013) suggest that geographical context is one of the main variables that contribute to informational vulnerability. The literature, for example, has recognized that urban dwellers are more engaged in social media and reporting (see e.g., Harrison & Johnson, 2019). On the other hand, as Van Dijk (2006) has pointed out, people who have less access to and interest in using technologies, like rural dwellers, could limit their use of smartphones to basic functions, being excluded by the information flow provided through SMCS. On the other side, SMCS could be useful tools for minorities to find information accessible for them (for example in their language).

However, except for few examples (Lai et al., 2013; Lai et al., 2018), most of these works fail to tell whether social and geographical differences may increase the disparities in knowledge accessibility among certain social groups, such as people with a lower level of education or socioeconomic status (Viswanath & Finnegan, Jr., 1996). Information sharing and the willingness to discuss and facilitate the social construction of risk can help people to develop individual skills that are useful for coping with disasters.

4.2.3 Institutional Accessibility

Another dimension that emerges from the literature review is related to the access to representativeness, as part of institutional accessibility. In this context, SMCS could represent a way to reach situations of marginalization, give visibility to marginalized social groups, and (as told) receive information in a more accessible way.

While discussing access to representativeness, McKinnon et al. (2017) have focused on queer narratives in media disaster reports. Starting with the recognition that the media play a relevant role in influencing disaster management strategies, the authors highlight the lack of attention to the lesbian, gay, bisexual, transgender, intersex, and queer (LGBTIQ) experience in mainstream media disaster reporting. The authors included LGBTIQ people in marginalized groups and suggested that their marginalization in media communication could have consequences on their vulnerability level: 'those populations not included in media reporting may find their specific needs are not met in assistance efforts. [Moreover,] reporting which excludes minority populations may leave these populations further marginalized' (pp. 28–29). Thus, what they suggested was the need to examine LGBTIQ disaster narratives and to recognize 'the importance of social factors in disaster impacts, [so] that the relevance of sexual or gender identity becomes clear'. The authors provided some examples of the discriminatory consequences that could emerge if gender issues are not addressed in emergency management. In particular, issues could be linked to difficulties accessing evacuation centres and health care assistance, like in the case of a transgender woman who spent four days in

PRACTITIONERS' VIEWPOINT

In 2020 during the twofold economic and health crisis in Lebanon, UNHCR distributed smartphones inclusive of sim cards and internet bundles to Syrian refugees in order for them to continue accessing some of the key protection services provided to them on specific social media platforms services.

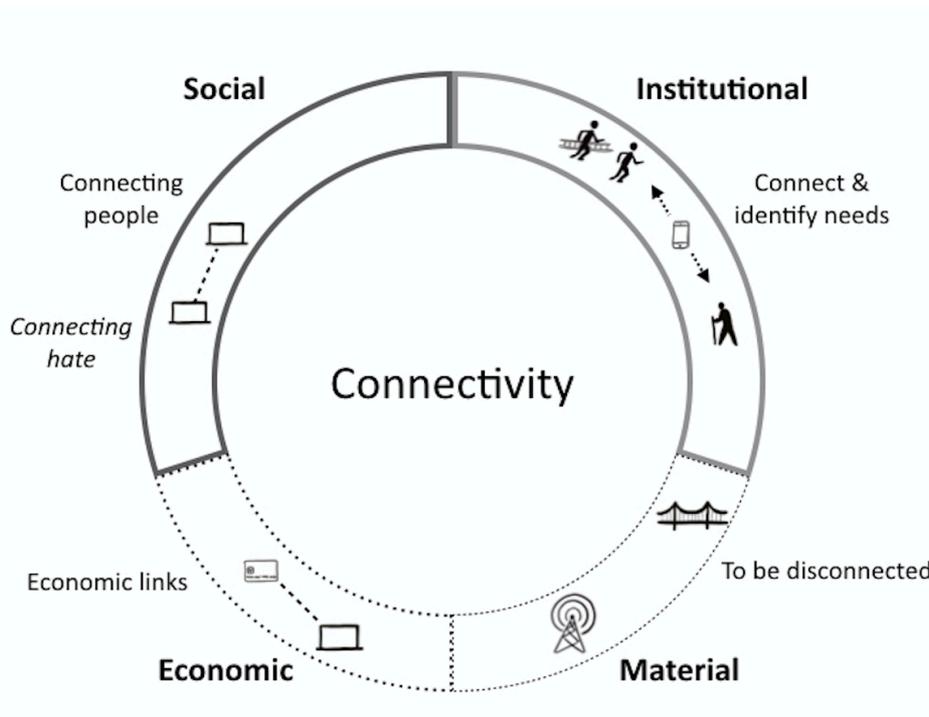
prison after Hurricane Katrina in New Orleans because she used women's shower facilities at an emergency evacuation centre (D'Ooge, 2008). Thus, what emerges is that the information provided using social media could give vulnerable groups more possibilities of being listened to. As McKinnon et al. (2017, p. 29) maintained about the LGBTIQ media, the same could also be true for social media platforms: 'the LGBTI media does offer a degree of representation and perhaps encourages a greater sense of belonging and shared experience than does the mainstream media'.

Further examples concern minorities. A paper worked by Rae et al. (2017) has discussed the role that social media, and in particular Facebook, have in collecting and sharing the self-represented witnessing of asylum seekers in detention centres. Thus, SMCS could be useful to divulge their experiences and increase their visibility in the system. However, as discussed below, SMCS could become for them also tools to amplify situations of exclusion and stigmatization.

However, what emerges is that visibility does not necessarily increase individuals' representativeness in the system. Visibility and representativeness are neither linked nor interdependent.

4.3 Connectivity

Figure 6: Connectivity and SMCS



Source: Authors contribution

In Section 3 four dimensions were identified under connectivity (material, social, economic, and institutional). However, two emerge as more relevant in the works that address vulnerability and SMCS: social and institutional connectivity (see Figure 6). Not many relevant works have been identified that address the other two dimensions, although some general considerations can be provided:

- **Material connectivity:** this is a necessary condition, without which other forms of connectivity could not be addressed. It is a consequence of the capacity of the system to keep infrastructures and platforms working. More studies are required about this capacity in specific social and geographical contexts. An hypothesis to explore could be that the most marginalized places may have less efficient infrastructures and services (as already addressed in accessibility), with a higher risk to see them disrupted (disconnected) during a disaster and consequently less opportunities to receive assistance. In particular, specific attention should be paid to those communities in remote or isolated areas, that are potentially underserved (Keim & Noji, 2011);
- **Economic connectivity:** this issue has been addressed in particular in relation with the post disaster, as a consequence of the situations of material connectivity and accessibility that could halt the economic life of a place. Further studies are required to understand how SMCS could help to maintain the economic links with other places and reduce the vulnerability of local economic activities.

PRACTITIONERS' VIEWPOINT

New technologies and social media can be really useful instruments for migrants. They, for example, improve the possibility of gaining access to credit; and enable to provide support to relatives. In particular, they can be used to send money, food, and hosting visitors, such as children for education purposes.

4.3.1 Social Connectivity

Shklovski et al. (2008; 2010) have analysed the role of technologies in reducing spatial distances. In particular, they have highlighted how new technologies are useful in reconnecting with others in particular to share common worries and, as Sutton et al. 2014 stated, especially with reference to social media platforms like Twitter, to pass on information. As for the first case, Veer et al. (2015) have investigated the potential of the Internet as a cathartic tool in post-disaster situations. Their study focused on the consequences of trauma on affected people and the potential increase in situations of vulnerability, such as the rise in domestic violence (see also the increase in the cases

of domestic violence during the COVID-19 lockdown in Italy, Istat, 2020²), difficulties in accessing services and assistance, and isolation. In this case too, the question is usually associated with the intersection of class and race or other factors that condition individual exposure. In these circumstances, SMCS could become important tools to support gender issues during emergencies, providing women with the possibility of escaping oppressive domestic situations or creating social relationships that could be useful in the event of emergency. Among others, the role of Facebook and WhatsApp groups for mothers, for example, could help to reduce the level of isolation to which some women are confined and to share their circumstances with others. In these cases, the Internet could become a therapeutic platform where emotions and experiences can be shared, 'as a means for victims to both access information as well as bring a community closer together through residents sharing their experiences' (Veer et al., 2015, n.p.). Nevertheless, it is hoped that further studies will be carried out on this issue in hazard-exposed contexts.

4.3.1.1 *Connecting Hate*

Another perspective that emerges from the literature is the risk associated with the spread of hate through SMCS. SMCS could become platforms that facilitate connections between people that practice or talk about violence and spread racist ideas, fostering on one hand an increase in verbal and physical violence and, on the other hand, the risk of terror attacks taking place. This second aspect is associated with the dark net and tutorials existing on the Internet, also on channels like YouTube which are used by children, that teach how to make weapons for example (discussed under 'mobility' in Section 4.4). In this connection, Figenschou and Beyer (2014) have discussed the role of a transnational online community of anti-Islamic people in inspiring the terror attack perpetrated by Breivik in Norway in July 2011. What emerges is that on one hand, the attack may also have been motivated by the support received on the platform, and, on the other hand, that after the attack, online platforms showed an increase in anti-immigrant and anti-Islamic voices. Although these voices were ignored by the mainstream channels, they reached their audience of people who usually ignore official channels which they consider to be 'a lost cause'. The potential consequence of this is that these 'echo chambers' or 'information cocoons' or 'cybercascades'

PRACTITIONERS' VIEWPOINT

In 2020, Save The Children launched via Facebook a program to respond to the needs of parents dealing with children's negative coping mechanisms with regards to the lockdown restrictions. Through this program, hundreds of beneficiaries were connected with each other to confront their views, to share opinions, and respond to their day to day needs, thus reinforcing their overall resilience.

SCIT has also activated projects to fight racial hate and disinformation through online channels (Underadio).

² <https://www.istat.it/it/violenza-sulle-donne/speciale-covid-19>

become more extreme over time, hence polarizing the discussion (Sunstein, 2007). Since they can hide their identity, people have more freedom to use radical language. However, at the moment there is a limited scientific production on the topic. It is hoped that more studies will be carried out, in particular on the temporary vulnerability to which minorities could be exposed in the aftermath of terror attacks, as a consequence of hate campaigns that could be circulated through social media platforms.

4.3.2 Institutional Connectivity

Institutional connectivity has been mainly discussed in D3.1 as a paramount for understanding the changing institutional conditions supported by SMCS, in terms of decision-making processes and inclusion of digital publics. However, some considerations can be provided also here. In particular, institutional connectivity should be addressed mainly with the aim of improving the capacity of the institutions to connect with the different social groups and to identify their needs.

Accordingly, institutional connectivity is discussed in the literature analysed in particular as the potentiality to connect people to the risk and rescue system, in order to provide aid. This is linked to the material accessibility discussed in Section 4.2.1. Moreover, it derives by the capacity of the system to facilitate communication among places and people and to solve disruptions to the infrastructures (material connectivity). According to Cantu (2017), during Harvey people preferred to use social media platforms to seek help, therefore bypassing the overloaded 911 systems. Moreover, Zhang et al. (2018) produced a cyberGIS-enabled multi-criteria spatial decision support system for flood emergency management. Social vulnerability indicators were combined in order to come to decision goals during emergency management. In particular, the authors observed the corresponding location of the tweets on the map to provide 'fine-grained location information' that could be used by rescuers to enhance the communication system.

However, the substitution of real people with a sort of 'avatar' and tweets from a smartphone can reduce some people's capacity to stay connected and be recognized by the system, beyond their macro-characteristics.

4.4 Mobility

Lai et al. (2018) have defined 'mobilization' as 'a situation where new technologies afford disadvantaged groups opportunities for social participation, whereas normalisation suggests that people who are socially advantaged benefit even more from technological progress (Chen, 2015)' (p. 735). In discussing mobility, it is not possible not to consider the interdependence existing, in particular, in relation to connectivity. The two conditions frequently overlap and this could create confusion as to their definition. This is more evident discussing the virtual space, where mobility is not only the physical movement from one place to another, rather it becomes the process of mobilization of resources, people, and ideas that could be 'moved' as a consequence of virtual forms

of activism and participation. Thus, this deliverable tries to suggest a distinction, by maintaining that connectivity is the ability to connect places or relate people to each other, while mobility is mainly focused on 'mobilization', that is, the step after connection. What we mean is that mobilization follows the connection phase, when the contact becomes a way to act out of or through the virtual space to produce effective initiatives and actions. Moreover, mobilization implies the force exercised to move, thus recognizing the capacity of the system, in this case the SMCS platforms, to urge to take action.

Thus, mobility in virtual spaces can refer to the following practices (although also others could be included, see also Figure 7):

- The participation in the rescue system, through, e.g. the use of crowdsourcing platforms to provide useful information;
- The monitoring of people during evacuations;
- The promotion and organization of groups, movements and initiatives to deal with risks and disasters;
- The providing of support in acquiring new skills and capacities.

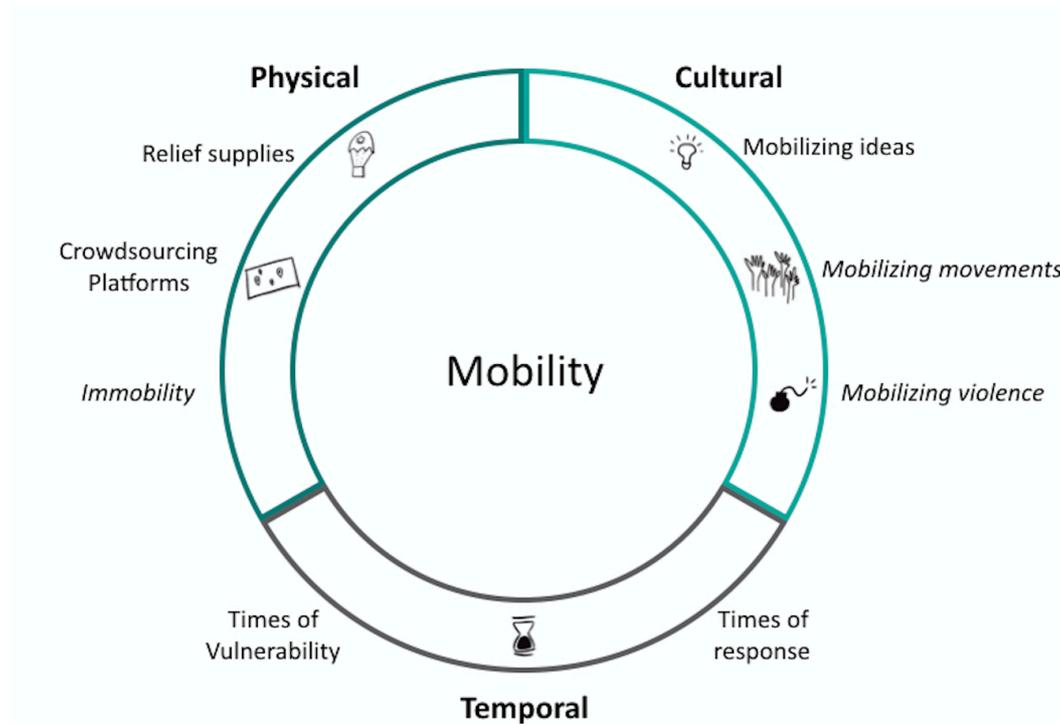
Vulnerability could derive both from situations of mobility, when a person is forced to move or to act against own interest, and situations of immobility, when a person cannot act or move. Thus, according to the levels of mobilization identified in Section 3, some considerations are here provided in relation to SMCS and vulnerability.

PRACTITIONERS' VIEWPOINT

In some cases, social media are crucial to ensure that the most vulnerable community members, (e.g. elderly people who were alone), were reached out with the distribution of basic needs items such as food.

Two weeks after the start of the "You are not alone" program, in response to the Covid-19 emergency, Save the Children had already reached 20,000 people in conditions of economic vulnerability and who have suffered serious impoverishment due to the crisis, activating the distribution of material aid and support for urgent expenses.

Figure 7: Mobility and SMCS



Source: Authors contribution

4.4.1 Physical Mobility

Physical mobility is mainly associated to the mobility of resources/aid, and the mobility of people. Thus:

- **Mobility of resources/aid:** Volunteered geographic information (VGI) tools, in particular, are playing an increasing role in supporting the official channels in relief work, as happened in the Haiti earthquake in 2010, Hurricane Sandy in New York in 2012, and the Kathmandu earthquake in 2015 (e.g. Norheim-Hagtun & Meier, 2010; Hu et al., 2019). Traditional supplies planning is usually based on census data. However, these data provide 'static' information that does not necessarily correspond to the new scenario that the disaster has created. Thus, social media and crowdsourcing could provide a more dynamic and realistic image of the local situation, helping rescue system to respond with effectiveness;
- **Mobility of people:** Other studies have used Facebook and Twitter to monitor people's reactions (Abel et al., 2012; Earle et al., 2012; Kongthon et al., 2012) and behaviour (Zou et al., 2018) during emergencies. In this connection, some studies have analysed the usefulness of social media, like Twitter, in evacuation procedures, concluding that these social platforms could be used to monitor people's awareness and willingness to act (Martín et al., 2017). Similarly, Martín et al. (2020) geotagged tweets to track population movements after

Hurricane Maria in Puerto Rico, with the aim of capturing information on displacement and returns.

4.4.1.1 *Immobility*

The other face of mobility is the risk that disaster can produce immobility. Immobility could refer to all the people that are temporarily not able to react, escape or access communication due to physical and/or psychological issues or also as a consequence of the impossibility to access to resources (see Section 4.2). For instance, the risk of psychological trauma that specific situations could produce may also make a person unable to respond, freezing their capacity to react. This could happen in the event of terror attacks. Some potentially vulnerable groups like single women with children have been associated with an increase in mental stress disorders during emergency situations (Zahran et al., 2011).

This opens a reflection on sensory perception in disasters, especially in relation to digital devices. 'Sensemaking' is defined as a 'process, prompted by violated expectations, that involves attending to and bracketing cues in the environment, it creates intersubjective meaning through cycles of interpretation and action, thereby enacting a more ordered environment from which further cues can be drawn' (Maitlis & Christianson, 2014, p. 67). In this regard, Svensson and Hallgren (2017, p. 307) discussed hearing and telephone use during emergency calls and in particular 'how emergency operators make sense of not only spoken words' and 'non-verbal cues may save lives' too, by focusing specifically on cases of sensory-deprived environments. One of the examples used by the authors is people who are unable to communicate due to an accident or a gunshot wound. In these situations of victim's immobility, 'cues such as background noise and emotional expressions provide information that operators can use to establish an account of events'. Other works, like that of Fele (2012), have shown that emergency operators use cues, such as emotional signs, to confirm understanding. This makes sense in particular in those situations of temporary disability or constriction that do not give the person the freedom to talk, as might be the case during a terror attack. These considerations open some questions: how can this work in the case of SMCS? How can these perceptions be activated? How can the loss of this information be replaced? For instance, the use of webcams could improve the efficiency of the communication between caller and operator; however, could the webcams not be turned on, this would reduce the reliability of the request.

4.4.2 *Cultural Mobility*

Under cultural mobility what emerges as most relevant is the mobilization of ideas and networks. Accordingly, two issues are identified and discussed below: how disasters mobilize ideas and people with the willingness to increase resilience of their communities; and how disasters can promote and move hate, and potentially violence.

4.4.2.1 Mobilizing Movements

The work by Checker (2016) has discussed how social media platforms may become tools to challenge the neoliberal politics that are deemed to be at the basis of environmental risks. In particular, the author presented the *Stop FEMA now* movement, which was created by flood disaster survivors and coastal homeowners, who organized their action through social media. These groups of people have been defined by the author as 'sacrificed citizens', in virtue of the neoliberal idea of 'shared sacrifice'. In this case, 'coastal residents were not only surrounded by ecological environments that have been sacrificed to neoliberalism, but they were also called on to shoulder the future costs of those environmental sacrifices. These cumulative layers of abandonment, responsabilization and vulnerability constituted coastal homeowners as sacrificed citizens' (p. 132).

The works that discuss the Occupy movement in relation to vulnerability go in the same direction. In particular, Fadaee and Schindler (2014) have maintained that the participants in the movement were connected at different levels by a 'feeling of vulnerability', interpreted by the authors as 'the inability to adapt to shocks and stresses of various sorts' (p. 2). In New York City, the movement evolved into a self-help organization to provide relief to people hit by Hurricane Sandy. In this case, the idea behind the occupation was to step in place of the government's responsibility to reduce the level of vulnerability of those communities left behind. The role of social media was also extremely important in coordinating the work of the Occupy Sandy members during the emergency.

Moreover, Napawan et al. (2017) studied social media as platforms for youth engagement in climate resilience planning, by concentrating on the pilot project #OurChangingClimate. Young people are considered among the most vulnerable groups owing to the future impact that climate change will have on their lives. Many examples in the literature and practice have shown the role that youth can have in improving community resilience (see Mitchell et al., 2008; Tanner, 2010; Tanner & Seballos, 2012). In this case, digital technologies are deemed to engage young people in building community resilience. In particular, #OurChangingClimate is a crowdsourcing experience that involves young people in exploring, documenting and sharing the local effects and experiences of climate change. The project is designed in particular for young people in vulnerable communities with limited access to political engagement. Through hashtags and digital narratives, young people

PRACTITIONERS' VIEWPOINT

The program "Rewrite the Future" was launched by SCIT to support schools, families, children and adolescents, through the creation of a community of 1,000 Volunteers for Education; tutoring was activated in individual online mode on a weekly basis. The focus of the program is on the learning loss to help children to reduce the learning gap caused by the closure of schools in the pandemic.

contribute by identifying vulnerable and resilient examples in their communities, while bearing in mind both social and environmental indicators and including other dimensions that they recognize as relevant. The main platforms used are Instagram, Twitter and Facebook. The works of Kent and Capello (2013) and Xiao et al. (2015) have gone in the same direction. The first confirmed that young people (aged under 18) may be a resource during disasters and that more valuable disaster-related information is generated in those places that are characterized by more young people, a denser population and higher awareness levels. The second study revealed that communities with more young, male and educated people were likely to use Twitter during Hurricane Sandy.

However, the discussion on the role of SMCS in activism is still open, considering that, in addition to techno-optimistic examples, such as the Sardine movement in Italy or the abovementioned Occupy movement in different parts of the world, there have also been examples of what Christensen (2011) called 'slacktivism', namely ineffective online activism where people can join campaigns just by clicking, without seriously engaging themselves in the struggle.

4.4.2.2 Mobilizing Violence

In the literature on terrorism in Europe, vulnerability is considered one of the factors that increases social conflict in marginalized places and could fuel the rise of radicalization (see Lobato et al., 2020). According to this perspective, vulnerable groups, like immigrants and minorities, could be hostage to criminal or radical groups with consequences on the likelihood of their radicalization (Chin, 2015). In this context, SMCS could assume a role. Regarding this issue, the United Nations Office on Drugs and Crime (UNODC, 2012) has published a report on the use of the Internet for terrorist purposes. The report identified six sometimes overlapping ways in which the Internet is used to promote and facilitate actions of terrorism: propaganda, financing, training, planning, execution, and cyberattacks.

However, this deliverable also set out to suggest another perspective that could be adopted to discuss the topic. In the aftermath of a terror attack, minorities in particular could be involved in situations of risk as a consequence of hate outpoured against people that belong to ethnic minorities or religions, or against people who might only have physical features that are, for example, associated with a terrorist profile. What emerges is the need to understand the role that social media platforms have in mediating information and potentially fomenting hate.

Furthermore, the political hate propaganda that most frequently associates migrations with terrorism, and that is spread most frequently online, especially using SMCS channels, may promote situations of segregation, discrimination and violence (see among other things, the 'web as a political weapon' in Castells, 2007). Then, the banalization of the communication promoted through SMCS (see the limits on the number of characters permitted in Twitter) facilitates a banalization of reality and phenomena. As a result, this reduces the propensity of the people that access this information to search for exhaustive information. (See more about hate speech online in D3.1).

4.4.3 Temporal Mobility

Mobility as a time issue has been addressed mainly in SMCS and vulnerability studies as the capacity to answer in time. Vulnerability could emerge by temporal situations of immobility of the system, that is not being able to react in time, as a consequence of disrupted connectivity or inability of the system to read what is happening. This could produce a delay in the rescue operations, increasing the risk of victims resulting from assistance received when it was too late.

Thus, how could SMCS be more effective tools in situations as this one? On this, Earle et al. (2012) have demonstrated that the use of Twitter in emergencies can reduce the time needed to identify the most affected areas and their needs.

However, temporal mobility has been addressed in vulnerability studies, as discussed in Section 3, mainly as the temporal variation of the condition of vulnerability over the time, as a consequence of external and internal factors. Although some initial answers emerged from the literature review, further studies are required to address the potential impacts of SMCS on vulnerability over all the phases of DMC, and not only during response efforts.

4.5 Section Remarks

The main result that emerges from the application of the framework to the SMCS and vulnerability studies is how SMCS could increase the dynamicity of vulnerability, opening a discussion on the static approach to vulnerability that systems for disaster rescue and relief typically apply. As discussed, some social groups that are usually considered vulnerable a priori, can become resilient actors, considering, e.g. their increased engagement in using SMCS, and their ability to interface with the virtual space. This is especially the case of minors, but also minorities, that are often viewed on the margins when they may be able to assist and support in different ways through SMCS.

Thus, the virtual space becomes on one side, a space where people can obtain more visibility, highlighting their needs but also their capacities, and on the other side, a space to reduce distances among people and to promote inclusion (see also D3.1). Of course, less positive situations are also identified, such as situations of hate diffusion, racism and exclusion promoted through SMCS.

A final point to consider is that new technologies are tools with a limited access, due to economic, intellectual and physical issues, thus their most systematic use by first responders and civil protection practitioners could potentially exclude from the system persons who cannot access them, increasing their vulnerability.

Key takeaways from Section 4

Some main points emerged in the analysis of vulnerability as a dynamic concept applied to SMCS:

Diversity:

- The individual markers identified as most relevant in the use of SMCS in disasters are income, level of education and residence;
- Urban dwellers show a higher level of engagement in SMCS than rural dwellers;
- Minors and the elderly are usually considered among the most vulnerable individuals in disasters. However, no direct correlations have been identified in relation to age or gender;
- Every diversity marker needs to be interpreted in relation to other factors which could significantly modify their effect on vulnerability.

Accessibility:

- Social and geographical disparities have been displayed in relation to access to the Internet and new technologies rather than the use of SMCS;
- The increasing role that SMCS are assuming in DMP can reduce the possibility of some people with disabilities accessing information and rescue;
- Several works have demonstrated that the risk exists of people with disabilities being left behind;
- The concept of 'disability' should be extended to also introduce the inability to use new technologies, or the temporary inability to (re)act;
- A part of the literature has highlighted the 'invisibility' of LGBTIQ and minorities rights in DMP. In this literature, the social media have been identified as a potential way to obtain attention and reduce their level of 'marginalization' in the emergency plans.

Connectivity:

- Connectivity is interpreted as the 'connection' or 'link' between individuals, mediated by a technological support/device, to create new virtual/real social relations and networks and promote transformation of the system;
- A part of the literature broadly discusses the role that the Internet as a social space can have in creating new linkages and reducing vulnerabilities;
- The social media are perceived as spaces of catharsis, psychological and social support, and aggregation;
- However, more works are needed in order to understand how, for example, SMCS could help women to escape from oppressive situations and especially how social media groups could reduce the condition of isolation experienced by some women.

Mobility:

- Some works on SMCS and vulnerable groups show the potential usefulness of SMCS in facilitating relief and rescue systems;
- It has also been demonstrated that socially vulnerable groups have less engagement with technologies during emergencies, with the resulting risk of being left behind by the rescue system;

- Several examples show how children can become promoters of preparedness initiatives and sensibilization in the face of risks, especially considering their confidence in using new technologies;
- Disasters can move hate, and potentially also violence and social media could facilitate this process.

5. RESEARCH METHODS EMPLOYED IN VULNERABILITY AND SMCS STUDIES

This section aims to provide a first overview of the main methods used in vulnerability and SMCS studies. This overview is a basis for the deliverable 2.3 that will be delivered by Month 12. As a result, this section will be integrated with Section 5 in D2.2 to provide the DRPV methodology.

5.1 Main Research Methods Used to Discuss Vulnerability: An Introduction

According to the literature review provided on vulnerability in disaster studies, three main methods of research have been employed:

- **Vulnerability indexes:** The indexes are used to give a 'measure' of vulnerability in specific places, and usually in relation to specific kinds of hazard. These models are frequently used, although little research has been done in European contexts. The main limits of these models are the subjectivity of the variable selection criteria, the scale of analysis adopted, and the way in which vulnerability is conceptualized (Rufat et al., 2015; Rufat et al., 2019; Fatemi et al., 2017);
- **Questionnaires and interviews:** These methods are mainly used with target groups, such as children. These tools are used frequently in research on vulnerability both to identify the main variables that affect individual vulnerability according to group perception and what vulnerability means for them (Fisher et al., 2012; Fisher et al., 2013; Sofronoff et al., 2011);
- **Participatory processes:** Like questionnaires and interviews, participatory processes are usually used to identify the main variables of vulnerability. Moreover, some vulnerability assessment processes have been tested in the literature with the aim of providing a more contextual analysis on vulnerability. These approaches are most able to give a voice to marginalized groups that could be involved in the process (Kowalski et al., 2009; Paneque Salgado et al., 2009; de Brito et al., 2018).

5.2 An Overview of the Research Methods Used in Vulnerability and SMCS Studies

From the analysis of the literature what emerges is that different methods have been applied with the aim of discussing vulnerability and SMCS in risk-exposed contexts (Annex IV). However, the number of papers detected is extremely low, which shows that this is a new field of study.

Most of the works have used SMCS mainly as a way to obtain information, especially by applying quantitative analysis. In particular, Mandel et al. (2013) used sentiment analysis to conduct a demographic analysis on the basis of the tweets sent during Hurricane Irene, while Fan et al. (2020) referred to Twitter geotags to discuss sociodemographic factors in relation to damage claims and

the use of social media during disasters (for further works see also MacEachren et al., 2010; Kibanov et al., 2017). Then, Lin et al. (2020) produced a big data-driven dynamic estimation model of relief supplies demand.

Remaining on the topic of quantitative analysis, vulnerability indexes and models are one of the main methods used to discuss vulnerability. Models and indexes are advantageous methods because they summarize and help to visualize the spatial distribution of social vulnerability (Rufat et al., 2019). Vulnerability indexes are usually built in an inductive way, using factor analysis to identify latent statistical variables (Cutter et al., 2003; Rygel et al., 2006; Rufat et al., 2019) and to assess social, socioeconomic and physical vulnerability as well as a combined index of the multiple dimensions (de Brito et al., 2018). Other systems are hierarchical models (see Chakraborty et al., 2005; Mustafa et al., 2011) and deductive models which use a linear combination of indicators (see Cutter et al., 2000; Wu et al., 2002).

However, qualitative analysis is also applied. Different methods have been detected in this case. For instance, some works use (n)ethnography (Veet et al., 2016; Checker, 2016). The aim of this kind of research is to analyse in-depth statements, conversations, debates, interactions and calls for action.

A second group of works use surveys with the aim of understanding the role/usefulness of the platforms. Among others, Bhavaraju et al. (2019) used a Twitter Sample Stream (Random Sample), while Lai et al. (2018) applied a purposive sampling survey to understand the implications of different access to mobile technology. Then, the works provided by Helgeson et al. (2013) and Enenkel et al. (2015) applied geospatial surveys, like Open Data Kit (ODK) and Geographical ODK (GeoODK), to record socioeconomic vulnerability in affected communities, and in particular data on local living, health, environment and disaster history. These works affirmed that mobile technologies are cost-effective and can be easily used over time, enabling the monitoring of changes in vulnerability and behaviours. Tools like ODK are open-source and can be easily used to collect and share data on socioeconomic vulnerability and disasters.

Lastly, a third group uses SMCS as potential tools to promote participatory action research, like in Cai (2020), who used photovoice to invite participants to document their lives and therefore explore vulnerabilities.

Although not directly linked to SMCS studies, it could also be useful to consider how new technologies are used to 'democratize research'; nowadays a lot of child friendly software is available, as used by Fallon et al. (2018), who employed computer-mediated role-play to investigate the social vulnerability of children aged 6, 8 and 10 years old. Indeed, according to the authors, if compared with more traditional methods in which participants may or may not be able to comprehend the task instructions, this method gives a better insight into children's true vulnerabilities and a better picture of the differences caused by age in social vulnerability. This computer role-play is also advantageous if compared to the 'paper pencil' vignettes or 'colourful

comic strip' described by Sivaratnam et al. (2012), because it is immersive, that is, it gives players a sense of 'psychological presence', of being there and of identity.

5.3 Limits and Challenges

Below we discuss the main limits and challenges considered in relation to the use of the aforementioned methods.

5.3.1 The Issue of Accurate Information

Many analysed works agree that the main challenge of using SMCS in research is linked to the difficulties in selecting useful data, considering the amount of information that SMCS platforms produce on a daily basis.

On information and misinformation as barriers to authorities' use of SMCS in DMP see D3.1.

5.3.2 Scale of Analysis

According to Bhavaraju et al. (2019), the disaster literature fails to study social media sensitivity to natural hazards by focusing on the vulnerability of the geographical contexts and how this could affect the results. For example, they found that the information produced from the frequent use of the county level in social vulnerability analysis indexes, and overlapped with tweets, could be too broad. Then, Wang et al. (2019) have explained that one of the main limits of the census data approach is connected to the subjectivity of the selection criteria applied to the socio-demographic census variables. In this case, the authors suggest that social vulnerability studies could be useful in helping to better identify these variables.

5.3.3 Phases of the DMC

As Wang et al. (2019) have explained, a further limit can be identified in the studies that investigate disaster-related social media data with census data. This limit is connected to the phases of the disaster; most of the studies do not differentiate social responses according to the different phases of DMC. In particular, pre-disaster is poorly investigated.

5.3.4 Geography of the Research

The first 'geographical' issue emerging in the papers analysed is that most of the works apply to the United States, especially the East Coast, and set out to discuss hurricane risk. A second group of works discusses the Asian context. No works have been identified that strictly address the topic in the European context.

This introduces the second issue, linked to the difficulty of realizing cross-cultural studies. One difficulty lies in finding comparable data, considering the different risk cultures. In addition to this, differences in concepts and procedures may mean that the same description words used to identify

variables could in truth represent (measure) different things (e.g., lack of homeownership is not necessarily an indicator of low income in some countries, according to their different cultures and social values). Methodologists have tried to get past the obstacle by using interpretative and procedural equivalence keywords (key criteria of cross-country comparison, see Steinfuhrer et al., 2018).

The third issue is linked to the risk of a mismatch between geotags and the location where the tweet is posted. This is a significant problem in terms of the reliability of the information and risk of misinterpretation of the data.

5.3.5 Kinds of Hazards Discussed

The majority of the works are about natural hazards, especially hurricanes. Other works discuss weather-related hazards, earthquakes, fires and floods. No works have been identified that discuss man-made disasters or terror attacks. Thus, more studies are needed that address vulnerability and SMCS in areas exposed to man-made hazards, terror attacks or that consider a multi-hazard approach.

5.3.6 SMCS Platforms

As for the sources of information, the main platforms used in the identified research have been Twitter and Facebook. Other works have used crowdsourcing and especially platforms for open-source VGI like Open Street Map.

5.3.7 Definition of Vulnerability

Another relevant limit that can be identified in the analysed literature is how the concept of vulnerability is interpreted. In this connection, Yue et al. (2019, p. 2) have studied the use of tweet information as an example to 'present a proof concept about assessing hazard-inducing risks and social-ecological vulnerability using social media data'. However, the main indicator used to identify the social dimension of vulnerability in this work was related to population density, therefore presenting a limited approach to the concept.

In connection with the previous limit, according to Toya and Skidmore (2018), few works have discussed how (the extent to which) ICT reduces disaster vulnerability. In their work, the two authors try to answer this question by evaluating access to and the use of cell phones during disasters in the period from 1980 to 2013. However, the work only examines vulnerability as the number of fatalities that occur during a disaster and the level of country development (income). Other data used for the analysis are the number of phones, GDP per capita, government consumption, openness and human capital. In these terms, cell phones are considered useful to reduce the risk of fatalities, facilitating the dissemination of warning information and the coordination of recovery efforts. No information is provided on the other variables of vulnerability, however.

5.3.8 Data Selection

The main variables used, especially (but not only) in quantitative methods, are demographic characteristics such as gender and age, and socioeconomic status indicators. Few attention has been given to other important drivers like health, coping capacity, risk perception, land tenure, neighbourhood characteristics, governance, public resources, provisions, disability, and special needs (see also Fatemi et al., 2017).

5.3.9 Uniformity

Another limit that emerges in quantitative analysis concerns the uniformity of the variables used to build the indexes. As Rufat et al. (2015, p. 470) have said methodology 'uniformity may result in misleading conclusions if dimensions of social vulnerability pertinent to specific hazards are excluded, or by contrast if weakly influential dimensions are overrepresented'. So, contextualization of the indexes emerges as a priority. On the other hand, the risk is of a gap between the complexity of contexts better represented in qualitative studies and the generalization offered by quantitative metrics.

Although many indicators and indexes are considered transferable, making comparisons among different countries officially possible, they risk, as Kuhlicke et al. (2011) have stated, giving too many 'false positive' answers as a result of the kind of data they use. This problem also emerges in the literature that uses models and indexes in relation to SMCS data. As discussed in the previous sections, the categories identified using statistical census data, for example, are not necessarily vulnerable in the same way throughout all the phases of the disaster cycle. This is the case of elderly people, women and children, for example. Moreover, statistical census data or data selected using inductive, qualitative techniques are not able to describe what Wisner (2004, pp. 184–188) called the 'situativeness of vulnerability', that is, the peculiarity of a specific place-time. This could foster stereotyped views of some specific groups.

5.3.10 Generalizing Conclusions

Another obstacle in quantitative methods, identified by Rufat et al. (2019), is linked to the difficulty of drawing generalizable conclusions as to the validity of the indexes used to measure vulnerability due to the diversity of configurations adopted in the validation studies.

Key Takeaways from Section 5

The main gaps that emerged in the literature review of the methods employed can be summarized as follow:

- Difficulties in accessing useful data. In particular, many analysed works agree that the main challenge of using SMCS in research is linked to the difficulties in selecting useful

data, considering the amount of information that SMCS platforms produce on a daily basis and the potential discrepancies e.g. in data source origin and content;

- Limits have been identified in those studies that use census data to evaluate vulnerability. The adopted scale, the subjectivity of the selected criteria of analysis, and the limited period studied could reduce the effectiveness of these works. Moreover, those studies that add information on social media, like Twitter, risk providing a misleading representation of the local situation, considering the different access to the Internet and SMCS platforms by different social groups;
- How studies define vulnerability. Most of the studies have a limited conceptualization of vulnerability, with a consequent underestimation of its relevance and of the number of variables that interact with it. Most of the studies limit vulnerability to the demographic dimension or number of fatalities.

6. CONCLUSION

This section presents the main results and final considerations, as well as gaps and future directions, stemming from the structured literature review provided in this deliverable. Thereafter it summarizes the next steps for the KB in LINKS.

6.1 Summary

The aim of this structured literature review provided in this deliverable is to discuss and challenge the meaning of vulnerability as a dynamic concept. In particular, the Vulnerability-Paradigm is applied to studies on SMCS in disasters.

Vulnerability is conceptualized in this document on the basis of the literature analysis provided in Section 3. Although there is a large body of literature that discusses vulnerability and natural hazards according to a social perspective, few papers address vulnerability from a social perspective in relation to technological/industrial hazards and terror attacks. In particular, different meanings of the vulnerability concept are identified between natural hazard studies and terrorism studies (see Section 4). On one hand, vulnerability is strongly conceptualized in natural hazards contexts, with the aim of identifying the most exposed and susceptible groups of people. Few studies discuss the concept in technological or industrial hazard contexts with a similar conceptualization. On the other hand, in studies on terror attacks, vulnerability is mainly associated with some individuals' condition of marginalization and misrepresentation, with the risk of fomenting forms of radicalization and xenophobia.

To link the different approaches to vulnerability, a conceptual framework is provided and four dynamic properties that influence vulnerability are defined, namely diversity, accessibility, connectivity, and mobility.

The first property is diversity and refers in particular to demographic, social, economic and cultural characteristics, that is, age, gender, social status, religion, ethnicity, and health, as well as human capital, cultures, and behaviours that refer to the role of knowledge, subcultures, beliefs, and perceptions in shaping the meaning of vulnerability in different places.

The second property is accessibility, which refers to the possibility of accessing resources, namely information, knowledge and education, livelihoods, food, health assistance, safe places and representativeness. Moreover, accessibility is a condition that is strictly connected to visibility as well as the possibility of having a voice in the system.

Then, connectivity refers to the contextualization of vulnerability in order to understand the origins of the risks and disasters, while trying to identify how places can shape the exposure and susceptibility of different social groups, and how their vulnerability changes in different places, as well as the role of different geographical scales.

The last property is mobility, that is, the capacity to move and mobilize resources, ideas and people. Most studies focus on mobility justice issues, concerning how inequality informs the governance and control of movement. In this connection, as well as being means of connection, roads as well as Internet channels have the power to stimulate social engagement and, in the opposite way, to increase social marginalization.

The conceptual discussion shows that the four properties are strictly interlinked, such that the lack of one of the properties interrupts the flow, creating the conditions for vulnerability. What emerges is the role of diversity in engineering a connection among the other three concepts. In particular, diversity becomes a vulnerable condition when it has a negative relation with one of the other properties.

The consistency of these categories are tested against the results of the literature review on SMCS in disasters. The results of Section 4 show that SMCS could be useful in planning and supporting relief and rescue systems, however, socially vulnerable groups are usually under-represented during emergencies, with the subsequent risk of being left behind by the rescue process.

Social and geographical disparities emerge as issues that need to be addressed in particular in relation to access to the Internet and new technologies, to avoid situations of further marginalization. On the other hand, the role of the Internet as a social space suggest its potentiality in increasing connections and reducing vulnerabilities. This is evident in particular in those groups that are less inclined to trust institutions, especially because they are situated at the margins of the system. In these cases, social media platforms can become spaces of catharsis, psychological and social support, and aggregation. Thus, connectivity is interpreted in SMCS studies as the 'connection' or 'link' between individuals, mediated by a technological support/device, to create new virtual/real social relations and networks, and to promote transformation of the system.

The literature considered also discusses if SMCS have the power to mobilize resources, people and ideas. Although some interesting examples are detected, the level of the system's mobilization capacity is still under discussion. Accordingly, another aspect of 'mobilization' that should be better addressed is whether SMCS platforms could become a means to facilitate and justify violence. This is the case of the spread of hate messages as discussed in Section 4.4.

While focusing further on the 'mobility' dimension, another point emerging from the analysis is the condition of 'immobility', as the inability to move, which could derive from the lack of the other conditions, such as connectivity and accessibility, with potential consequences in terms of vulnerability. Immobility could be a consequence of the inability to access technologies, and to interact with others, which could increase situations of marginalization and 'invisibility'.

Hence it follows that a relevant point in the discussion is how SMCS affect individuals' visibility/invisibility. Although some of the studies considered highlight the importance of obtaining visibility (see the case of LGBTIQ in disasters addressed in Section 4.2), on the other hand what

emerges is that visibility does not necessarily increase individuals' representativeness in the system. Visibility and representativeness are neither linked nor interdependent. Visibility could be one of the points to discuss, as well as how visibility can be translated into more representativeness or inclusion.

To conclude, in terms of increased vulnerability, most of the limits and challenges from the use of SMCS in the different phases of disaster are:

- Risk of further under-representation and increase in the invisibility of some groups that have less access to digital spaces.
- Spread of false information (misinformation and disinformation) particularly among those people with less trust in institutions due to their marginalized position.
- Risk of a misleading representation of reality, due to some vulnerable categories' limited access to the virtual spaces.
- Spread of extremism and radical views, with consequences in terms of further marginalization and social conflict.

6.2 Gaps and Future Directions

This deliverable has contributed both to implement the discussion on vulnerability in disaster management and to identify some first gaps that will be the starting point for the next phases of the project. In particular, the main gaps identified in D2.1 can be reduced to two macro-groups:

- **Methodological gaps**, that have been discussed in Section 5, and that can be summarized in:
 - Geographical gaps, few works have discussed vulnerability and SMCS in a European disaster contexts.
 - Disaster gaps, the main works focus on natural hazards, with poor attention to technological hazards and terror attacks.
 - DMC gaps, majority of works focuses on the response phase. Few works contribute to prevention and preparedness. Reconstruction is mainly discussed as digital activism.
- **Conceptual gaps** are identified, especially in the way the vulnerability concept is discussed. The static approach to vulnerability is dominant in SMCS and disasters literature, with the result that there is a lack of works that explore how vulnerability can effectively change in relation with the use of SMCS.

According to the results and the gaps discussed above, we provide two considerations that could help define the future directions of the research within the context of LINKS:

Connecting vulnerability and disaster risk perception in SMCS studies: One of the main purposes of this document was to provide a knowledge base on vulnerability that could be integrated with the DRP literature review provided in D2.2. Accordingly, this document takes vulnerability into

consideration not only as a variable in risk perception studies to understand how socio-economic factors impact on risk perception, but also to understand how different levels of risk perception can interact with the choices and conditions that are at the basis of vulnerability. By integrating the two analyses, LINKS aims to highlight potential spatial correlations that can be useful in terms of risk assessment and community resilience. Moreover, few studies that discuss both social vulnerability and risk perception out of the limits over identified have been discovered. Accordingly, WP2 will work with the aim to overlap this gap in literature. As this report has shown, the two concepts are interrelated and their impact on SMCS is relevant. However, considering the limited number of studies on both the concepts and especially on DRP (see D2.2), integration between the two knowledge bases could be useful to address future studies on the topic. Thus, starting from the analysis of the gaps identified in D2.1 and D2.2, the next step of the research should be to understand how to address them in the different contexts.

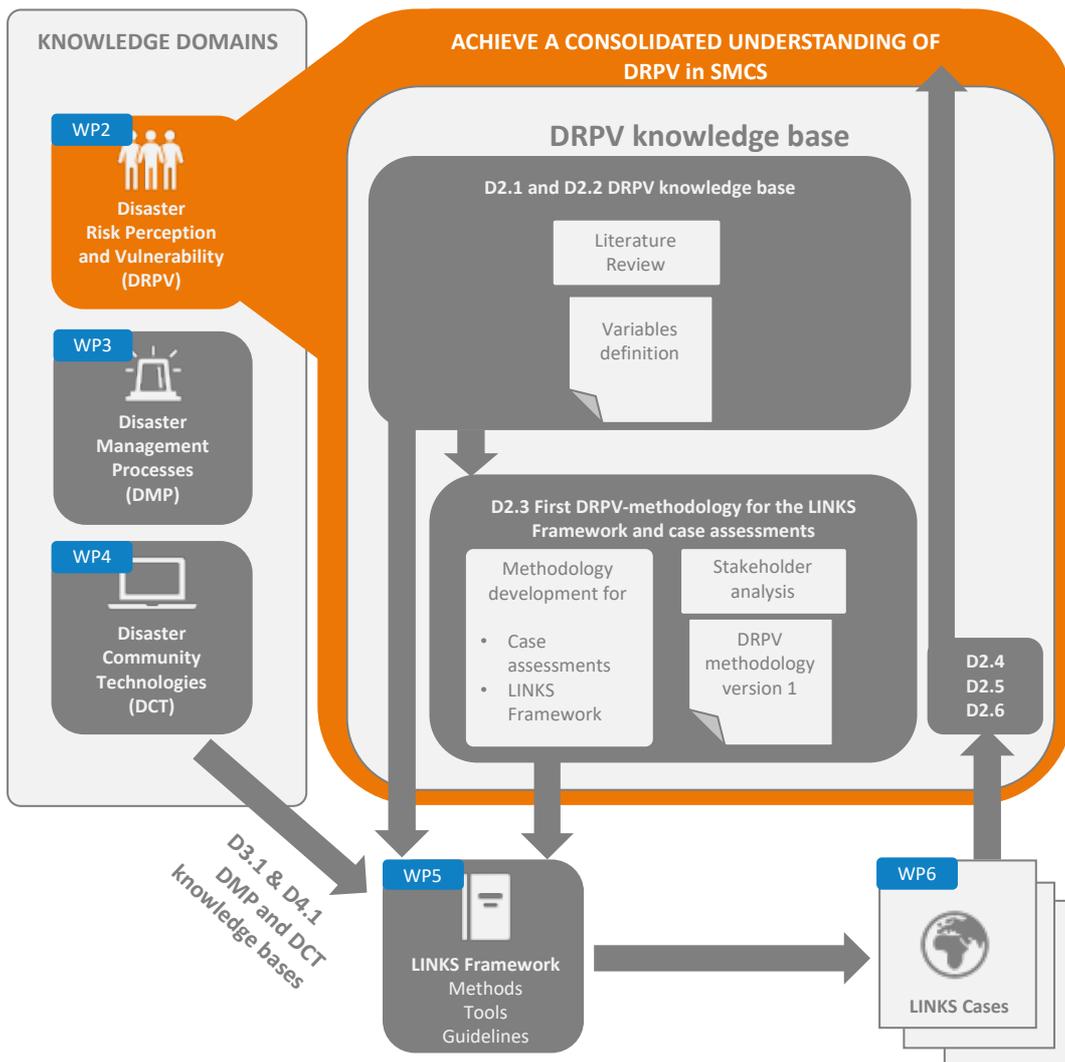
From vulnerability to resilience: a necessary shift in SMCS studies? In recent years, the concept of resilience has emerged as relevant in disaster studies (see D3.1). Although the shift of paradigm from vulnerability to resilience is evident in DRR literature as well as in the Sendai Framework for Disaster Risk Reduction 2015-2030, it could be dangerous to attempt to put the vulnerability paradigm 'on the bench'. A part of the literature maintains that resilience is the other side of vulnerability, and that there is an inverse relationship between them. However, the presence of vulnerability does not mean a lack of resilience or vice versa. Although there is no doubt that the two concepts are connected and interrelated, their relationship is not linear. This means that persons could be both resilient and vulnerable at the same time. However, there is not enough scientific work on how this dynamic approach can be useful for DM and this represent another relevant gap to be discussed in LINKS. In view of this debate, the emergence of a 'diversity paradigm', as suggested in the LINKS project, could be useful to put an end to the controversy, highlighting the dynamicity of the concepts and categories which, as Fordham (2007) wrote, risk establishing mental boundaries concerning the conditions of vulnerability and resilience. Thus, the two concepts, discussed in two different deliverables in this early stage of the project (D2.1 and D3.1), could be better integrated in the next steps of the project, especially by focusing on how SMCS challenge their borders, on how both can be defined in the 'virtual context' and on their main outputs in terms of the 'real space'.

This lacking focus on vulnerability in the existing research literature is confirmed by Nielsen and Raju (2020) in D3.1. Together, D3.1 and 2.1 thus point to a much needed discussion of how local vulnerabilities interact with SMCS and the attempt to strengthen resilience through the use of these platforms. This must be at the top of the agenda for researchers and practitioners working in the technology-governance nexus and who wish to properly address root causes to disasters.

6.3 Next Steps in LINKS

Together with D2.2, D3.1, and D4.1, this deliverable provides a foundation for supporting the development and evaluation of the LINKS Framework, and points to the need for integration between the knowledge bases when moving forward. The overview of how the DRPV domain is addressed in LINKS is provided below.

Figure 8: Workflow for addressing the DRPV Knowledge Domain within LINKS



Source: Authors' adaptation based on D4.1

This KB constitutes the conceptual basis on which to build the first iteration of the DRPV Methodology (D2.3) to be provided in May 2021. The state-of-the-art, the Vulnerability-Paradigm, and the gaps identified in this deliverable are the main results provided by this deliverable that will be used for developing the methodology. DRPV methodology will have the purpose to assess

specific assumptions and research questions in the cases, thus it will be built with the support of the local methodology responsables as identified in case assessment teams (CATs) for each case country (see D6.1). Accordingly, the local methodology responsables will be called to participate to a Methodological Taskforce that will be used as a consultation group to guide the methodology building and to have a direct contact with cases and local practitioners. The methodological taskforce is complementary to the CATs, the primary difference between the two is that the taskforce involves core partners across all cases, while the bi-lateral discussions facilitated, as needed, by WP6 involve the case assessment teams (CATs) in each country. Both are important to develop the methodologies for the case-based assessment of the Framework.

Thus, in the next step of the project, the purpose will be to apply the Vulnerability-Paradigm here suggested to the case-based assessment of the LINKS Framework with the aim of providing an interpretative tool for vulnerability in the LINKS project.

Ultimately the knowledge gathered within this KB must be translated into the LINKS Framework through various learning materials and for different sets of stakeholders within the LINKS Community. This will be done in iterations in three phases in the project (Figure 2). The knowledge must also be accessible to those stakeholders through the LINKS Community Center (WP7). This requires ongoing collaboration across all WP in the coming project phases to understand the learning needs and to enable learning potentials for different stakeholders through the refinements of the Framework and LCC. For a detailed overview of the next work plans for the Framework, cases, and LCC development, see D5.1, D6.1 and D7.1.

To summarize, the future steps of the work in WP2 will be to:

- Integrate knowledge bases on vulnerability and disaster risk perception with the aim of producing a DRPV methodology for the case-based assessment of the LINKS framework;
- Work in connection with the other knowledge bases, to challenge the concept of resilience and diversity in disasters in relation to SMCS and therefore inform the LINKS Framework;
- Inform the LINKS Community, by transferring the main results and outputs of this deliverable into learnable and operational outputs for different stakeholders, through the LINK Framework and LINKS Community Center.

7. INTRODUCTION TO THE ANNEXES

The purpose of this section is to guide the reader through the annexes contained in Section 9 and to provide some preliminary outputs. These annexes represent registries of the collected knowledge on the use of SMCS and vulnerability.

In particular, the Section 9 contains the following registries:

1. **Annex I: List of Academic Research.** the list is a bibliography that contains all the literature analysed to discuss vulnerability as a dynamic concept. This could be a useful basis for future literature reviews and conceptual discussions.
2. **Annex II: European Projects.** the table is constructed to identify potential linkages with other European projects that work(ed) on vulnerability and new technologies in disasters. The list could be a useful basis for future works and projects that aim to discuss the same topic.
3. **Annex III: Main Definitions and Variables of Social Vulnerability.** The table is a useful instrument that provides a first selection of social vulnerability definitions. This could be considered in relation with other works that made similar attempts as useful basis for future literature review discussions on the concept. Although this resource is mainly thought as a output for academic community, professors, researchers and students, it could be a useful for practitioners and policymakers, to have a further perspective on the concept and that could inform future measures and policies that aim to define/approach vulnerability in DM.
4. **Annex IV: Different Methodology Employed.** The table gives the reference to the main works that have discussed social vulnerability and SMCS, grouping them according to the methods used. The table is thought as a basis for D2.3 but it also provides a state-of-the-art for future researchers that aim to explore the condition of vulnerability in relation with SMCS.
5. **Annex V: Literature Review Grid.** the excel grid has been used to code the main papers on social vulnerability and SMCS. It has been a useful tool to analyse the documents and to build Section 5 of this deliverable. However, it can be a useful basis also for future research works that aim to discuss the topic. It provides also relevant information for practitioners and policymakers, that can obtain information on the geographical distribution of the main works, on the main disasters/hazards analysed, such as on the limits and potentialities of SMCS in DM.

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9. ANNEXES

9.1 Annex I: List of Academic Research

- Abel, F., Hauff, C., Houben, G.J., Stronkman, R., & Tao, K. (2012). Twitcident: fighting fire with information from social web streams. *Proceedings of the 21st International Conference on World Wide Web* (pp. 305-308). <https://doi.org/10.1145/2187980.2188035>
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9.2 Annex II: European Projects

Title	Project start	Project end	Project summary	Relevance to D2.1	URL
BuildERS	2019	2022	The purpose of the project is to enhance the resilience of all the community, starting with most vulnerable groups. The purpose is to fortify the social capital and resilience for the future.	D1.1 (unified theoretical framework); D1.3 (Segments of vulnerability country); D1.6 (Vulnerability and vulnerable groups).	http://buildersproject.eu
CapHAZ-Net	2009	2012	The main objectives of CapHaz-Net are to identify and assess existing practices and policies for social capacity building in the field of natural hazards and to elaborate strategies and recommendations for activities to enhance the resilience of European	Discussion of social vulnerability in WP4 (Tapsell et al., 2010)	https://cordis.europa.eu/project/id/227073/it

			societies to the impacts of natural hazards		
EmerGent	2014	2017	EmerGent regarded the positive and negative impacts and potentials of social media in emergencies for citizens and Emergency Management Services and how social media can be used during emergencies. Guidelines and tools were developed to achieve these goals.	Analysis of the use and impact of SMCS in disasters (Reuter et al., 2016; Reuter et al., 2019)	http://www.fp7-emergent.eu
MOVE	2008	2011	MOVE has been designed to produce results that are directly useful for recognising and characterising vulnerability to natural hazards and climate change in a European setting. It investigated the theoretical side of vulnerability to natural	The framework of the project and D4.2 (Kienberger et al., 2012)	https://cordis.europa.eu/project/id/211590/it



			hazards, the state of the art regarding vulnerability assessment and the means of developing new and enhanced tools.		
ENSURE	2008	2011	Purpose is to develop a new methodological framework for integrated multi-scale vulnerability analysis	The multi-disciplinary dimension of the concept of vulnerability	http://www.ensureproject.eu/

9.3 Annex III: Main Definitions and Variables of Social Vulnerability

Reference	Definition	Main variables
McEntire (2001)	The reversal of marginalization and discrimination, improvements in education, employment and health care, etc.	Proximity, location of human settlements, construction of buildings, technology, attitudes and behaviours, politics, demographic patterns, economic conditions, lack of resources, additional factors like education, mounting divorce, etc.
Cutter et al. (2003)	Social vulnerability is partially the product of social inequalities – those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond. However it also includes place inequalities – those characteristics of communities and the built environment, such as the level of urbanization, growth rates, and economic vitality, that contribute to the social vulnerability of places (p. 243)	Social inequalities, individual characteristics, place inequalities, Experience, socio-economic determinants, memory, urbanization, growth rates, economic vitality
Bankoff, Frerks and Hilhorst (2004)	At one level, the answer is a straightforward one about poverty, resource depletion and marginalisation; at another level, it is about the diversity of risks generated by the interplay between local and global processes and coping with them on a daily basis (p. 1)	Poverty, depletion, marginalisation, diversity, power relations, social and place inequalities
Wisner et al. (2004)	The characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of natural hazard (p. 11)	Socio-economic and demographic determinants
Kelman (2011)	Qualitative, subjective, proportional, contextual, a process with a past and future	Social and geographical context
Unisdr (2009)	Vulnerability to disaster is a status resulting from human action or from an inherent situation such as poverty. The degree of vulnerability depends on the condition of human settlements and their infrastructure, the way in which public policy and administration are engaged in disaster management, the level of information and education available	Socio-economic-demographic determinants, human settlements, infrastructures, public policy

	about hazards and how to deal with them, among other aspects	
Lewis and Kelman (2010)	The 'vulnerability process' refers to the values, ideas, behaviours, and actions that have led to characteristics such as fragility, weakness, exposure and susceptibility and that can perpetuate or absolve these issues (p. 197)	Social values, behaviours, fragility, weakness, exposure, susceptibility
Tobin and Montz (2011)	The context in which vulnerability has developed will vary from place to place (---) An important component of vulnerability is the understanding and interpretation of risk	Understanding and interpretation of risk, knowledge and experience
Bankhoff (2013)	Social systems generate unequal exposure to risk by making some people more prone to disaster than others and these inequalities are largely a function of the power relations (class, age, gender and ethnicity among others) operative in every society (p. 6)	Power relations, individual characteristics, social inequalities
Fordham et al. (2013)	Social vulnerability results from processes of social inequality and historic patterns of social relations that manifest as deeply embedded social structural barriers resistant to change (p. 12)	Social inequalities, historic patterns, social relations, social structural barriers

9.4 Annex IV: Different Methodology Employed

Methodology	Reference
Surveys: Purposive sampling survey Computing survey Geospatial survey Panel survey	<ul style="list-style-type: none"> • Lai et al., 2018 • Imran et al., 2015 • Fallon et al., 2018 • Enenkel et al., 2015 • Helgeson et al., 2013 • Chou et al., 2009 • Boyle et al., 2004
Semi-structured interviews	<ul style="list-style-type: none"> • Shkolovski et al., 2010 • Fadaee & Schindler, 2014 • Hargittai, 2002 • Harrison & Johnson, 2019
(N)ethnography	<ul style="list-style-type: none"> • Madianau, 2015

	<ul style="list-style-type: none"> • Fele, 2012 • Checker, 2017 • Veer et al., 2015
<p>Big-data analysis (Geo-tagged twits tracking; content-analysis; ...)</p>	<ul style="list-style-type: none"> • Martín et al., 2017 • Martín et al., 2020 • Lin et al., 2020 • Earle et al., 2012 • Chib, 2010 • Bhavaraju et al., 2019 • Andrade et al., 2018 • Li et al., 2013 • Nicholson et al., 2019 • Zou et al., 2018 • Xiao et al., 2015 • Kent & Capello, 2013 • Wang et al., 2019 • Kongthon et al., 2014 • Abel et al., 2012 • Fan et al., 2020
<p>Multi-approach</p>	<ul style="list-style-type: none"> • Pongponrat & Ishii, 2019
<p>Literature review Commentaries</p>	<ul style="list-style-type: none"> • McCallum et al., 2016 • Kent & Ellis, 2015 • McKinnon et al., 2017 • Fussell et al., 2018 • Fussel, 2018 • Viswanath & Finnegan, 1996 • Wang & Ye, 2018 • Svensson & Hällgren, 2017

9.5 Annex IV: Research Review Grid

Authors/date	It is from a project?	Project name	Empirical research	Stakeholders analysed	Phases of DMC	Method		Geographical area		Kind of hazards		Technology involved	Material available
						Multi-age	Comparative approach	Europe	Not- Europe	Hazards	Multi-hazards		
Lai et al. 2018	X		X	urban and rural citizens	Preparedness	X	X		South-East Asia	natural		mobile technologies	
Imran et al., 2015				social media community	Response							Social media	
Fallon et al., 2018			X	54 children from 6 to 10 years old			X					Computing role-play	
Enenkel et al., 2015				vulnerable communities	Mitigation					drought		crowdsourcing	
Helgeson et al., 2013			X	rural community	Response/recovery	X			Uganda	weather		smartphones	X

Chou et al., 2013			X	citizens	Prevention/mitigation	X			US	health	Social media	X
Boyle et al., 2004			X	citizens	Recovery	X			US	Terrorist attack	telephone	
Shkolovski et al., 2010			X	musicians	Response	X			New Orleans	Natural hazard (hurricane)	ITC	
Fadaee & Schindler,			X	Occupy movement		X			New York, Detroit and			
Harrison & Johnson,			X	Government officials	Response		X		Canada	natural	Social media	
Madianau, 2015			X	local communities and experts	Recovery	X			Philippines	Natural (typhoon)	Social media	
Fele, 2012			X	emergency center	Response		X	Italy		medical	Video analysis	X
Checker, 2017			X	Activists 'Stop FEMA now' movement		X			US	Climate change	Social media	
Veer et al., 2015			X	local community	Response/recovery	X			New Zealand	earthquake	Social media	

Martin et al., 2020			X	displaced inhabitants	Response	X				Puerto Rico	hurricane		Social media	X
Martin et al., 2017			X	displaced inhabitants	Response					US	hurricane		Social media	X
Lin et al., 2020			X	population	Preparedness/response	X				China	Natural (floods)		Big data	X
Earle et al., 2012			X	Twitter community	Response	X				US	earthquake		Social media	
Chib, 2010			X	121 participants	Prevention/response		X			Indonesia			ITC	X
Bhavaraju et al., 2019			X	Twitter community	Response	X	X			US	Tornadoes, wildfires, floods hurricane	X	Social media	
Andrade et al., 2018	X		X	immigrants	Prevention/mitigation		X			US			Social media	
Nicholson et al., 2019			X	local community	Response	X				US	hurricane		Social media	
Zou et al., 2018	X		X	Twitter community	Response					US	hurricane		Social media	

Xiao et al., 2015			X	Twitter community	Response	X			US	hurricane	Social media	X
Kent & Capello,			X	social networks users	Response	X			US	fire	Social media	X
Wang et al., 2019			X	vulnerable communities	Preparedness/response	X			US	Natural	Social media	
Kongthon et al., 2014			X	Twitter community	Response	X			Thailand	flood	Social media	
Abel et al., 2012	X	Twitcident		twitter community	Response						Social media	
Fan et al., 2020			X	local community	Recovery	X			US	Natural	Social media	
Pongponrat & Ishii, 2019			X	Thai women					Japan	Natural (tsunami)		
McCallum et al., 2016				social media community						Natural (flood)	Social media	
Kent & Ellis, 2015				people with disability	Response	X				natural	Social media	



McKinnon et al., 2017		X	LGBTI	Response				Australia and New Zealand	natural	X	(social) media	
Fussell et al., 2018			immigrants		X				natural			
Viswanath & Finnegan, 1996											Mass media	
Wang & Ye, 2018					X				natural		Social media	X
Svensson & Hällgren, 2017		X	emergency operators	response	X		Sweden				Telephone	