RiskPACC

INTEGRATING RISK PERCEPTION AND ACTION TO ENHANCE CIVIL PROTECTION-CITIZEN INTERACTION

Evaluation and SOTA Summary Report (Citizens)

Deliverable 2.1

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ABOUT RISKPACC

Increasingly complex and interconnected risks globally highlight the need to enhance individual and collective disaster resilience. While there are initiatives to encourage citizen participation in creating a resilient society, these are typically fragmented, do not reach the most vulnerable members of the communities, and can result in unclear responsibilities for building disaster resilience.

New technologies can also support preparedness and response to disasters, however, there is limited understanding on how to implement them effectively. Awareness of risks and levels of preparedness across Europe remain low, with gaps between the risk perceptions and actions of citizens and between the risk perceptions of citizens and Civil Protection Authorities (CPAs).
The RiskPACC project seeks to further understand and close this Risk Perception Action Gap (RPAG). Through its dedicated co-creation approach, RiskPACC will facilitate interaction between citizens and CPAs to jointly identify their needs and develop potential procedural and technical solutions to build enhanced disaster resilience. RiskPACC will provide an understanding of disaster resilience from the perspective of citizens and CPAs, identifying resilience building initiatives and good practices led by both citizens (bottom-up) and CPAs (top-down). Based on this understanding, RiskPACC will facilitate collaboration between citizens, CPAs, Civil Society Organisations, researchers and developers through its seven (7) case studies, to jointly design and prototype novel solutions.

The “RiskPack” toolbox/package of solutions will include a framework and methodology to understand and close the RPAG; a repository of international best practice; and tooled solutions based on new forms of digital and community-centred data and associated training guidance. RiskPACC consortium comprised of CPAs, NGOs, associated organisations, researchers and technical experts will facilitate knowledge sharing and peer-learning to close the RPAG and build disaster resilience.

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Executive Summary

Deliverable 2.1 illuminates how collecting and analysing data in novel ways is capable of generating new knowledge and stimulating new practices that are sensitive to the Risk Perception Action Gap (RPAG), as well as enhancing *community resilience* approaches. To frame this process of enhancing both disaster resilience (see also D1.2) and community resilience and bridging the RPAG, the extant literature is explored through predominantly desk-based research on three distinct but interrelated concepts: *community resilience, community risk perception and citizen generated data* in order to:

1. Lay the conceptual foundations of terms frequently used in the project, such as : community resilience, community risk perception and citizen generated data.
2. Produce working definitions of community resilience and of risk perception that will be adopted for the duration of the project.
3. Generate a knowledge-base of good practices and State-Of-The-Art regarding the utilisation of citizen genrated data and other digital technologies for bridging the RPAG and enhancing community resilience.

Following an introduction and proceeded by an overall concluding section, D2.1 is divided into three main conceptual chapters (2, 3 and 4), each focused on one of the three above mentioned major concepts.

In Chapter 2, *community resilience* is approached from an academic perspective, as a conceptual amalgam of previously presented epistemologies of resilience across different disciplinary and conceptual boundaries, constituting the ontological outcome of the 'social turn' in resilience scholarship. Building on this accumulated knowledge of resilience literature in academia and practice, and combining it with definitions of resilience (mainly disaster and community oriented ones) across a variety of EU-funded projects, we introduce a working definition of the term for RiskPACC, emphasising the key role of human agency and active citizenship while also highlighting the importance of communication channels and 'trust-ties' between communities and other local stakeholders. The working definItion of community resilence used for RiskPACC is:

> The capacity of communities and individuals to interact with their surrounding physical and built environment, comprehend risk and actively mobilise activities to enhance societal connectedness including the use of digital technologies, to co-produce knowledge and build two-way communication channels with the CPAs and other local stakeholders to cope with, adapt to, prepare for and recover from external perturbations or inherent stresses.

Following the introduction and consolidation of the working definition for community resilience, Chapter 3 explores *community risk perception* in extant academic literature and its transtition from a predominantly phychology-oriented to a more sociological concept, whilst illuminating the gap between how experts and lay people perceive risk. The relationship of community risk perception with place is also discussed, as well as its influence during the ongoing COVID-19 crisis,

eventually justifying the adoption of the European Environment Agency definition of the term as a working definition for RiskPACC :

> Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed are seen to resolve the problem.

Here, beyond specific aspects of risk perception, significant attention is also paid in the understanding of the risk context (events and policies) and environmental conditions and constraints, thus foregrounding the importance of situating people in their socio-political/community context, instead of merely viewing them as independent individuals. Moreover, the role of trust in influencing the degree to which citizens believe and act upon communications from CPAs is also emphasised.

Complementing this focus on local responses, Chapter 4 focuses on *citizen generated data*, including social media, and their potentialities for supporting disaster resilience (including improving disaster response) and enhancing community resilience. More specifically, VGI is prioritised as an emerging digital technological trend, while its relevance for engaging local communities in decision-making for disaster resilience, and bridging the RPAG, is also emphasised. The analysis in D2.1 has generated a robust knowledge-base that will support the development of the project's practical Framework (WP4) and digital tooled solutions based on new forms of digital and community-centred data (WP5), and will ultimately feed into the development of the "RiskPack" toolbox/package of solutions (WPs 5,6 and 7). Summing up, the key findings of this Report are the following:

- Community resilience is a contested term that emphasises human agency, mobilisation of social capital and the strengthening of communication channels and (in)formal institutions in the process of coping with, adapting to, preparing for and recovering from external perturbations or inherent stresses.
- Understanding, capturing and acknowledging community risk perception and aligning it with CPAs' conceptualisations of risk is fundamental for bridging the RPAG.

Digital technologies such as citizen generated data, VGI and social media can support the process of capturing risk perception and thus contribute to the bridging of the RPAG, enhancing community resilience and improving overall disaster resilience.

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TABLE 1.1: GLOSSARY AND ACRONYMS

Term	Definition/description
AI	Artificial Intelligence
BGS	British Geological Survey
BuildERS	Building Resilience of European Societies by reducing the vulnerability of the most vulnerable
CAS	Complex Adaptive System
CBRDM	Community-Based Disaster Risk Management
CNN	Convolutional Neural Networks
CPAs	Civil Protection Authorities
CSE	Cognitive Systems Engineering
Dapp	Decentralised Applications
DL	Deep Learning
DRIVER+	Driving Innovation in Crisis Management for European Resilience
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DYFI	Did You Feel It
EEA	European Environment Agency
emBRACE	Building Resilience Amongst Communities in Europe
ENGAGE	Engage Society for Risk Awareness and Resilience
EWS	Early Warning Systems
GEO-CAN	Global Earth Observation Catastrophe Assessment Network
GeoODK	Geographical ODK
GPS	Global Positioning System
HFA	Hyogo Framework for Action
ICLEI	International Council for Local Environmental Initiatives
ICT	Information and Communications Technology
IFRC	International Federation of Red Cross and Red Crescent Societies
IMPROVER	Improved risk evaluation and implementation of resilience concepts to critical infrastructure

IoT	Internet of Things
iVGI	inVolunteer Geographic Information
LINKS	Strengthening links between technologies and society for European disaster resilience
ML	Machine Learning
NLP	Natural Language Processing
ODK	Open Data Kit
OSM	OpenStreetMap
PADM	Protective Action Decision Model
PAR model	Pressure and Release model
RESILENS	Realising European Resilience for Critical Infrastructure
RESILOC	Resilient Europe and Societies by Innovating Local Communities
RESOLUTE	RESilience management guidelines and Operationalization appLied to Urban Transport Environment
RPAG	Risk Perception and Action Gap
SDGs	Sustainable Development Goals
SDI	Spatial Data Infrastructure
SES	Social Ecological System
SFDRR	Sendai Framework for Disaster Risk Reduction
SMCS	Social Media and Crowdsourcing
SMR	Smart Mature Resilience
SOTA	State of the Art
UNDRR	United Nations Office for Disaster Risk Reduction (former UNISDR)
UNISDR	United Nations International Strategy for Disaster Risk Reduction
USGS	United States Geological Survey
VGI	Volunteer Geographic Information
WPs	Work Packages

1 INTRODUCTION

1.1 RiskPACC and the Risk Perception Action Gap

RiskPACC focuses on increasing disaster resilience across society by closing the so-called Risk Perception Action Gap (RPAG). The project aims to provide an understanding of disaster resilience from the perspective of citizens and Civil Protection Authorities (CPAs) by identifying resilience building initiatives and good practices led by both citizens and CPAs. Research over many years and across many disciplines indicates that the risk perceptions of professionals and citizens differ (Meldrum *et al.*, 2015). Moreover, there also appears to be a mismatch between the risk perception of citizens and their subsequent actions (Margolis, 1996), as well as a misalignment between actual citizen action and the perceptions of the CPAs or response organisations related to the incident and the expected citizen response (Ropeik, 2012; Birkholz *et al.*, 2014). This disconnect between risk perception and action, and the risk perceptions of experts and lay persons, has been described in the literature as "the risk perception paradox" (Wachinger *et al.*, 2013) "an understanding gap" (Thistlethwaite *et al.*, 2018), and "the perception gap" (Slovic, 2012). Although risk perceptions and their associated motivations for behaviour have long been recognised as significant features of community resilience in the face of disaster events (Wright, Bolger and Rowe, 2002), these do not synch well with conventional and rationalist risk assessment approaches. Despite many governments implementing widespread 'warning and informing' risk communication approaches, research shows that citizen's risk awareness, knowledge, and preparedness across the EU remain low.

Increasing the preparedness actions undertaken by citizens and narrowing the RPAG, is the focus of RiskPACC. Citizens can prepare themselves to respond to a disaster by making a plan, creating an emergency grab bag, and identifying how to prevent, prepare, respond to (e.g., evacuation, shelter in place) and recover from different hazards. Such a requirement for citizen participation has been most recently illuminated by the COVID-19 crisis that has presented an unprecedented emergency crisis around the world. More than ever, municipal authorities have asked their citizens to respect hygiene requirements and lockdown rules, testing their resilience, awareness, and perception of risk. The crisis, and its management, has highlighted the problematic resource dispersion and risk communication, the multiplication of disconnected actions stemming from the differential public risk perceptions and an overall feeling of contradictory statements from the authorities; in other words, it has showcased the need to close the RPAG[1]. Arguably, all these consequences could have been reduced with more effective two-way communication and interaction between citizens and CPAs.

Mounting evidence suggests that the RPAG is not a result of a lack of citizen interest in preparedness and resilience building measures but is rather related to the divergent

[1] We further explore the ways citizens perceive risk in the context of the COVID-19 crisis in subsection 3.3.2 of this document.

ways in which risk is perceived and acted upon[2]. RiskPACC aims to fill this gap by (a) enhancing the understanding of the Risk Perception Action Gap (RPAG) and advancing conceptual and technical solutions for bi-directional communication between CPAs and citizens, and (b) integrating new forms of citizen-generated data with conventional approaches so as to recalibrate risk management practices in ways that enhance disaster resilience.

1.2 Work Package 2: Engaging citizens to expand understandings of risks, vulnerabilities and data collection opportunities

The first phase of the RiskPACC project consists of WPs 1 and 2 and aims at on establishing the scientific foundations for the development of the RiskPACC solutions, framework, and methodology. WPs 1 and 2 involve desk-based and primary research to advance understandings of disaster resilience from the perspective of CPAs (D1.1) and citizens (D2.1) and how these can be modified to influence the identified RPAG. Both WPs review the current State-Of-The-Art related to key concepts such as disaster and community resilience and risk communication and perception, proceeding with the development of working definitions for the project. Building on this, RiskPACC will develop a detailed understanding of the role of human factors, societal dynamics and organisational arrangements related to building all-hazard disaster resilience.

WPs 1 and 2 will subsequently also harness the knowledge of key stakeholders (D1.2 and D2.2) to identify and analyse international examples of both CPA and citizen-led practices designed to build resilience. Specifically, WP2 focuses on the different community practices and approaches that are currently used to close the RPAG. It examines the active role of communities in producing citizen-generated data, and how this might be integrated with official and conventional methodologies, risk models and datasets. Here, we approach citizen-generated data from a dialogic, critical pedagogical lens: citizen engagement is not merely a means to gather data, but also an opportunity for social learning (Coaffee, Porto de Albuquerque and Pitidis, 2021; Porto de Albuquerque *et al.*, 2021).

In this context, WP2 draws upon emerging conceptualisations of community's critical engagement with risk, which allow us to link to wider concepts of disaster resilience and risk management orthodoxies (see D1.1) with broader and localised contextual vulnerabilities and other factors that generate new community driven knowledge. Whilst conventional approaches to disaster risk management recognise the value of citizen participation in filling the gaps of existing disaster-related datasets, the role of citizens is often instrumental, as they are frequently framed as sensors confined to capturing pre-defined environmental signals. WP2 will identify and investigate local vulnerabilities which to date might be undetected and not accounted for by conventional risk monitoring approaches. Such mapping will thus include aspects of

[2] Indeed, there are many examples of citizen self-help activities and volunteering connecting to the associated actions of emergency professionals, many of which emphasize various factors in their assessment of risk.

human vulnerability and go beyond conventional "top-down" categorisations and views of risk regarding on the ground data collection.

WP2 involves a literature review (this deliverable 2.1: Evaluation and SOTA Summary Report (Citizens), a local exploration in the seven (7) case study areas of the project to map existing practices and signals the beginning of a recruiting process for citizens and community groups for WP3 (D2.2), as well as a gap analysis and progressive roadmap of key actions that will feed into the work of all subsequent Work Packages (D2.3). The collective output from WP2 will be a detailed and expanded citizen-generated data understanding on risk and vulnerability; critical consciousness about environmental risks, enhanced local capabilities and a better understanding of citizen-led practices regarding risk management, and local development at the community, and neighbourhood levels. This will not only feed into the RPAG framework, which will be developed in WP4 of this project, but also in the tool development and field validation phases that will follow in WPs 4 and 5.

This deliverable (D2.1) investigates the existing definitions of community resilience and community risk perception and evaluates the influence of these definitions. It establishes a set of general principles and highlights how these are increasingly being used to inform the management of a range of risks and hazards. Specifically, this predominantly desk-based deliverable defines and consolidates a common understanding of community resilience, risk perception and vulnerability in terms of their general applicability to disaster resilience policy at a range of scales and in relation to available guidance, standards and uptake, and existing knowledge from other EU projects. This deliverable also explores the utility of emerging approaches to volunteered geographic information (VGI), including social media and illuminates how analysing data in novel ways in order to generate new knowledge and stimulate new practices that are sensitive to the RPAG and which can improve disaster resilience approaches. Given the synergistic relationship between CPAs and citizens in relation to disaster resilience, this deliverable should be read in parallel with D1.1. Schematically, D1.1 focuses on the left-hand side of Figure 1.1, whilst this deliverable (D2.1) unpacks the citizen focused elements on the right with a view to better aligning the contribution of citizens to CPA's and enhancing overall disaster and community resilience.

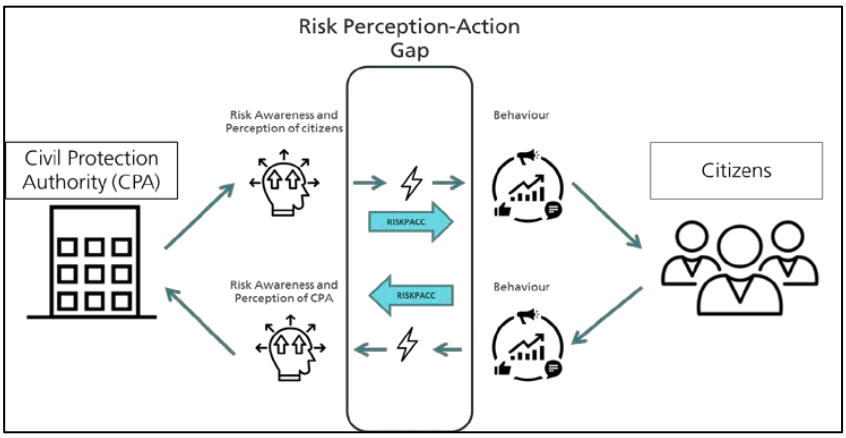

FIGURE 1.1: THE RISK PERCEPTION ACTION GAP

1.3 Outline of the Report

Following the introductory chapter, this report-type deliverable is divided into four main chapters. Chapter 2 constitutes the most substantial part of the report and focuses upon advancing a RiskPACC working definition of community resilience and relating this to wider approaches to, and definitions of, resilience and disaster resilience (see also D1.1). This draws on both academic and policy literature on community resilience as well as a review of prior and ongoing EU-funded projects. This analysis showcases existing gaps in the literature regarding both the extent to which risk perception is understood and the degree to which citizen generated data can help advance existing understandings and connotations of community and disaster resilience. Following on from this, in Chapter 3, the extant literature on risk perception is interrogated from a community and disaster risk management perspective with an overarching argument made that a more community-based and contextually informed approach is desired. The connection of risk perception with place, as well as its significance in the context of COVID-19 crisis, is also briefly analysed. Chapter 4 then focuses upon the practices and utility of citizen generated data, and specifically volunteered geographic information (VGI) and social media, in enabling greater citizen engagement in local disaster management and subsequently enhancing community resilience and overall disaster resilience. The Report concludes with a summary of the main findings, including a recapitulation of working definitions of community resilience and risk perception, and an explanation of how the work of RiskPACC will go beyond the current State-of-the-Art (SOTA).

2 THE SEARCH FOR COMMUNITY RESILIENCE

Community resilience as a term has dynamically entered the human geography, sociology, planning and disaster scholarship during the last two decades. However, the process of unpacking its ontological and conceptual characteristics needs to be preceded by a review of the evolution of the root term (resilience) across different disciplinary and conceptual understandings. In this way, we can elucidate the influence resilience as a term received through its etymological and conceptual journey (Alexander, 2013; Meerow, Newell and Stults, 2016), as well as showcase the organic emergence of community resilience ideas following a 'social turn' in resilience scholarship and its alignment with other previously existing resilience concepts.

The remainder of this chapter is divided into three interrelated parts. The first provides an overview of the evolution of resilience as a term, focusing on its understanding as a systemic trait, a continuous process and a strategic goal. Such an etymological journey has not been without critiques, the most prevalent of which we also briefly discuss. The second part focuses on the concept of resilience within disaster scholarship, following a sociological pathway through the de-naturalisation of disasters and the introduction of vulnerability paradigms that frame risk as a socially constructed concept and locate its formation in often inequitable political and economic processes. The third part of the chapter continues with an investigation of *community resilience* contemporary definitions in extant academic scholarship but also within the context of EU-funded projects. The chapter concludes with the introduction of a working definition of community that will be used across the different WPs and deliverables of RiskPACC. It should be noted here, that work in this chapter reflects discussions touched in D1.1, with the working definition of disaster resilience for RiskPACC (developed in D1.1), presented as well.

2.1 The evolving understanding of resilience

Resilience is not a new term in the scientific world. It has been widely used in several disciplines, such as engineering, ecology, psychology, business, geography, anthropology, national security *and disaster risk management*. The very term resilience has its roots in the Latin word for 're-bounce' (Latin: *resilire, resilio*); thus, the idea of bouncing back is focal for the definition of the term in many disciplines (Manyena, Siambabala *et al.*, 2011). Disaster expert David Alexander (2013) provided a thorough analysis of the term's evolution since its first use for scientific purposes by Attorney at Law Sir Francis Bacon in 1625 and until its re-emergence during the first half of the 19th century, where it acquired a broader meaning indicating flexibility and inconstancy (or fickleness). In some other cases the term has been also used to designate the ability to recover from the impact of a disaster through 'resourceful' thinking (Campanella, 2006).

Later, and tracking its scientific roots in engineering and material sciences, resilience was linked to the strength and ductility of materials, with utilisations of the term as the

ability to recoil or resist stress dominating (Rankine, 1858)[3]. Engineering resilience thus, set the conceptual ground for the adoption of the term by many other scientific fields, including ecology. The term's transition to these fields is also closely connected to a conceptual connection with general system theory (von Bertalanffy, 1950) as resilience ideas moved from describing properties of materials to analysing complex arrangements, and particularly ecological systems. According to Bosher and Dainty (2011) research on the concept of resilience primarily emerged with the work of Errington (1953) and Blum (1968) on the ways *'ecological systems cope with stresses or disturbances caused by external factors'* (Bosher *et al.*, 2007, p.7).

Around the 1970's, the Canadian ecologist Buzz Holling - often cited as the father of ecological resilience (Holling, 1973, 1992, 1996; Gunderson, 2000b) - expanded the study of resilience in ecosystems undergoing stress and change, paving the way for the introduction of the term to the social sciences, notably in psychology, anthropology and human geography. The importance of Holling's work lies not only in the association of the concept with the general systems theory, but also on a disengagement from the traditional engineering/mechanistic single equilibrium theory and the introduction of a holistic conceptualisation of multiple-equilibria states. The catalyst of this conceptual shift was the idea of complex adaptive systems and the inception of *'complexity science'* (Walker and Cooper, 2011). Holling, and those he worked with, focused on the inherent ability of ecological systems to absorb disturbance and sustain the same relationships among their populations regarding resilience as the persistence of relationships among system components (Gunderson, 2000a; Gunderson *et al.*, 2002).

Subsequent development of Holling's work in ecology led to the evolution of resilience's conceptualisation from a homeostatic reaction of a system[4] to its *adaptive capacity*. This was a pivotal shift, since researchers acknowledged the dynamic nature and uncertainty of current ecological environments. Here, instead of seeking a return to a previous optimal state, scholars started proposing continuous adaptation of the system to short stability stages, using feedback from previous perturbations in order to smooth the transition process (Gunderson, 2000a; Folke *et al.*, 2010). Further expansion of ecological resilience clarified some fundamental heuristics, such as the adaptive cycle, focusing on process of collapse, spontaneous reorganisation and system dynamics, and notably, panarchy - a hierarchy of adaptive cycles and nested systems of adaptive cycles (Gunderson and Holling, 2002; Folke, 2006). In such a panarchic system, adaptation and transformability were identified as the most important characteristics of ecological resilience incarnating the basic qualities of a system's conservation within an environment of constant transmutation (Walker *et al.*, 2004; Folke *et al.*, 2010; Walker and Cooper, 2011; Walker and Salt, 2012).

[3] Hence, it was in engineering and material sciences (and in particular mechanics) that the first scientific reference to resilience was made in an attempt to describe both strength and ductility of solids, using as an example of the resistance properties of steel beams.

[4] Homeostatic reactions refer to the self-regulating processes a system employs to maintain a state of equilibrium.

Resilience ideas were also applied in psychology with many arguing that such work facilitated the transition of the term into the social sciences (Alexander, 2013). Although some researchers argue that it was during the 1950's that the term was used for the first time in an anthropological context to describe psychosomatic conditions, the work by Norman Garmezy (1973, 1974) is regarded by the academic community as the starting point for *resiliency* (initially as competence) to be employed in contextualising the level of psychological vulnerability of adolescents and children after experiencing a disruptive event (domestic violence, bereavement, etc.)[5]. Garmezy's work collided with the idea of inherent vulnerability that was very popular in psychopathology at this time, and which accepted *resilience as a process* and not as a *static attribute* of an individual. This conceptualisation of resilience as a process instead of a systemic property was later adopted by social scientists and was applied in the study of social systems.

Resilience ideas have also been widely applied in disaster risk scholarship emerging most recently through the conceptualisation of disaster resilience. Disaster resilience was initially influenced by the engineering conceptualisation of the term, acquiring a 'bouncing back' rather than bouncing forward connotation. However, more recent researchers (Bosher and Dainty, 2011; Manyena, Siambabala *et al.*, 2011) have shifted the attention of disaster resilience research to the underlying vulnerabilities that amplify the impact of natural hazards as well as post-disaster recovery, incorporating a social and community dimension to traditional disaster risk approaches[6] (Chmutina and Bosher, 2017; Ruszczyk, 2019).

2.1.1 RESILIENCE AND SOCIO-ECOLOGICAL SYSTEMS

2.1.1.1 Overview

From analysing singular objects to dealing with complicated systems, resilience has been broadly encountered in literature as a singular systemic feature. The most influential portrayal for systemic resilience thinking application, has been in Social Ecological Systems (SES) and their depiction as Complex Adaptive Systems (CAS). In essence, CAS are self-organising systems, which practically means that changing some of their specific parts/components would not alter the way they are behaving; in other words, it will not cause a modification of their identity (Walker and Salt, 2012). A disturbance or change in a CAS's component may induce changes in other component(s) but the system as a whole has the ability to absorb the perturbation and self-organise around it in order to maintain its function (Biggs *et al.*, 2012). The system's response may be partly anticipated or totally unexpected, depending on the magnitude of the perturbation and the level of the system's internal cohesion, but a return to the original state is desired.

[5] Garmezy's work was largely influenced by the study of children raised by schizophrenic mothers, in whom he identified numerous examples of individuals who managed to cultivate robust adaptive patterns of social behaviour, despite being exposed to both a chronic stress (mental condition of the parent) and acute behavioural shocks induced by this mental condition.

[6] A robust and integrated analysis of this project's understanding of disaster resilience as a term is provided in the Deliverable 1.1 '*Evaluation and SOTA Summary Report (CPAs)*'.

Being involved in an endless process of reinvention in terms of their components and their interrelationships, CAS are seen to be in a constant dynamic disequilibrium state. Ultimately, there are no easy ways of predicting their behaviour in times of disturbance. Despite the systemic tendency to adapt when a larger number of independent variables interact in unpredictable ways, complexity emerges and prevents them from consolidating and returning to normal conditions (Sanders, 2008; Batty and Marshall, 2012). When CAS thinking is applied to techno-rational engineering systems, resilience is seen as a fundamental system property, and a determinant of its endurance, robustness or its capacity for absorption of stress in cases of disturbance (Lorenz, 2013). Resilience in this case is understood as resistance to external pressures and the goal of its implementation is the ultimate return of the system to a pre-defined former state.

By contrast to engineering perspectives, ecological framings of system resilience accept transformation to a *different* equilibrium state, achieved through the so-called adaptive cycle. The adaptive cycle consists of four different stages of change in structures and functions from which the system passes through, namely growth or exploitation, conservation, release and reorganisation, paying significant attention to feedback processes that operate at multiple scales and timeframes within the system. Despite the fact that such an understanding of resilience gives the best articulation of evolutionary resilience approaches (which are explained later), planning scholar Simin Davoudi has argued that this approach fails to account adequately for crucial social factors and that *'the adaptive cycle seems overly deterministic, not allowing for human intervention to break cycles through their ingenuity, technology and foresight'* (Davoudi *et al.*, 2012) (p.305).

In contexts like cities for instance, resilience has become a useful byword for systemic urban thinking. Initially it served as a catalyst for nurturing a proactive spirit among urban institutions and policy makers, while constituting both a macroscopic approach to guarantee the seamless operation of the city as an urban system and a regulatory framework for controlling the urban subsystems and their interrelations at the lower scales (see Pitidis and Coaffee, 2020). Utilising ideas of ecological and engineering-inspired systemic resilience to frame holistic and integrated city operations and aspects of urban life – from the built environment to the community and from economic transactions to environmental protection – is a relatively contemporary trend (Wilkinson, 2011). However, it needs to be pointed out that when more dynamic social and organisational factors are in place, equilibrist framings struggle to account for underlying factors that impede social systems to return to equilibrium

2.1.1.2 Limitations of equilibrist approaches

Engineering and ecology have largely dominated the resilience discourse for many years and especially during the latter decades of the twentieth century. Particularly in the new Millennium, scholars from other disciplines have adopted their understandings of resilience to analyse economic, organisational and technical phenomena, considering resilience as a system's quality representing the level of its flexibility to accommodate changes and remain functional in times of disturbance (Johnson and Blackburn, 2014; Ross and Berkes, 2014). However, the behaviour of systems

involving complex social dynamics, is not easily captured with theoretical models such as, SES or equilibrium-based resilience (Coaffee and Lee, 2016). A return to a former state of equilibrium or moving from one state to another is underestimating social complexity of human systems and their abilities to adaptively evolve instead of merely surviving (Chandler, 2014, 2019; Diprose, 2014).

Another challenge when migrating ecological resilience thinking to social systems is the analysing resilience of what to what (Vale, 2014; White and O'Hare, 2014; Cutter, 2016). In ecological systems, focusing on one, or a limited number, of the system's components usually entails a disregard to other components, and hence, overall system resilience is jeopardised. This can also lead to unintended or knock-on consequences at a spatial scale where attempts to improve resilience in one area undermines resilience in another. This is known in the literature as a resilience trade-off (Chelleri *et al.*, 2015) and has been shown to have significant implications in achieving equitable resilience (Anguelovski *et al.*, 2016; Ziervogel *et al.*, 2017).

This fundamental question of 'resilience for whom?' further reflects the political implications of resilience in the social realm. While in ecology and engineering resilience is a depoliticised pragmatic term (Chandler and Reid, 2016; Mckeown, Bui and Glenn, 2021) almost immune to systemic power relations, newer conceptions of resilience have seen such factors as paramount to understanding who benefits, and who does not, from resilience efforts (Cutter, 2016; Meerow and Newell, 2019). Consequently, when studying complex systems, resilience should be approached through a lens of social and spatial justice (see Soja, 2003) both in terms of the decision-making processes and in terms of allocation of benefits and duties. This is especially important when discussing issues of governance; a deeply political process that involves cross-sectoral collaboration and engagement of the local community, a process that we explore later in this chapter.

2.1.2 EVOLUTIONARY APPROACHES AND RESILIENCE AS A PROCESS

The interpretation of resilience as a process was initially utilised in the field of psychology, as mentioned above. Here, in contrast to ecology, psychological resilience was posited as a non-systemic process, often mistakenly understood as an inherent trait of individuals (Masten, 1994). From the 1970s psychology researchers started viewing resilience a descriptor of a particular process, or journey, an individual or group goes through, triggering the adoption of procedural approaches to resilience by the social sciences (Alexander, 2013).

The adoption of resilience in the wider social sciences grew during the 1980's, and was particularly focused on the ability of human communities to not only withstand external perturbations but also recover from the shocks such perturbations may inflict (Timmermann, 1981). Nonetheless, the term only became popular more than a decade or more later when it was regularly met alongside 'sustainability' and 'sustainable development', (Adger, 1997; Perrings, 1998; Tobin, 1999). Here, social and/or community resilience was commonly depicted as a process, or sometimes even as a precondition, for sustainable development, the desirable end-state (Cote and Nightingale, 2012).

The continuous accentuation of community's pivotal role in securing social resilience bequeathed the concept a more inclusive character in terms of the need for people to actively engage in adapting to a constantly disruptive world. Moreover, from a policy-making perspective, the variety of stakeholders needed to be included in system management to enhance resilience outcomes encouraged the wide integration of diverse participants, community members, institutions and ideas (Bahadur and Tanner, 2014). This came as an innovation in resilience scholarship, as initial approaches from ecology and psychology emphasised the ability to *'bounce back'* and focused on the management of endogenous stresses instead of *'bouncing forward'* and dealing with both internal and external stressors. Such evolutionary approaches – often portrayed as the binary opposite for equilibrium approaches – focus upon adaptability and flexibility with the function of restoration to a new normality and an increasingly complex and volatile world. As Davoudi (2012) noted: *'evolutionary resilience promotes the understanding of places not as units of analysis or neutral containers, but as complex, interconnected socio-spatial systems with extensive and unpredictable feedback processes which operate at multiple scales and timeframes'* (p.304).

In the emerging evolutionary resilience literature (see Coaffee and Lee, 2016), the relationship between adaptation and adaptability is perhaps key to understanding the ontological distinction between equilibrium conceptions and emerging notions of evolutionary resilience (Pickett, Cadenasso and Grove, 2004; Walker *et al.*, 2004; Pike, Dawley and Tomaney, 2010). While adaptation is understood as the ability of a system to swiftly return to a previous state following a designed path backwards, adaptability is characterised by weak couplings between systemic components and an enhanced capacity of the system to respond to uncertainty and unpredictable changes (Coaffee and Lee, 2016). From a governance standpoint adaptability mostly refers to the capacity of system components and actors in place to influence the overall resilience of the system and bring about transformation as opposed to maintaining a 'business as usual' approach (Pike, Dawley and Tomaney, 2010).

In summary, resilience among social scientists, is largely understood as a continuous non-linear process. It is driven by the appreciation of the dynamic and fluctuating nature of social systems while embracing the need to adapt. It also pays significant attention to the role of formal and informal institutions in driving the resilience building process by galvanising flexible governance arrangements and encouraging wide participation of stakeholders in decision-making. This is a key ingredient for the introduction of community resilience, which is highly dependent on the ability of communities to adapt and embrace change and transformation, ideas we explore in subsection 2.3.2 of this Report.

2.1.3 RESILIENCE AS A STRATEGIC DIRECTION FOR FACING COMPLEXITY AND UNCERTAINTY

The rapid expansion of resilience's utilisation has resulted into the extension of its functionality as a strategic goal or outcome. Increasingly, resilience is portrayed as an overall holistic praxis to manage complexity and uncertainty of dynamic, interconnected systems (Moser *et al.*, 2019). Perhaps, the most prominent field for the manifestation of such phenomenon is cities and the concept of urban resilience. Urban

resilience became a prominent idea for driving urban transformations, as it espouses constant risk as a norm and provides a framework for reducing vulnerability and exposure of both communities and the built environment, through process-driven and physical interventions *'to mitigate, prepare for, respond to and recover from a range of shocks and stresses'* (Coaffee and Lee, 2016; Coaffee *et al.*, 2018; Normandin *et al.*, 2018). Therefore, with resilience increasingly being treated both as a holistic approach to confronting risk and as a boundary object for dealing with complexity (Brand and Jax, 2007), its meaning has evolved to an operational concept. Here, viewing city operations (or those of CPA's) through a strategic resilience framework is seen as a bridging concept between ecology and planning, assisting in monitoring and measuring how social changes influence the environment and how environmental changes shape society (Ahern, 2011; Amin and Thrift, 2017).

As a result, many global organisations and philanthropic institutions, like the UNDRR[7] (UNDRR, 2017) and the Rockefeller Foundation (Rockefeller Foundation, 2018) respectively, have promoted projects and frameworks to advance resilience (Pitidis *et al.*, 2018; Pitidis and Coaffee, 2020). Milestone documents such as the 2030 Agenda for Sustainable Development (United Nations General Assembly, 2015), the New Urban Agenda (Habitat III, 2016), the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 (UNDRR, 2015), render resilience as one of the most important ingredients of future development policies. Notably, one of the UN's Sustainable Development Goals (SDGs), Goal 11, is specifically dedicated to *'Making Cities Inclusive, Safe, Resilient and Sustainable'* (United Nations General Assembly, 2015). With SDGs continuously becoming the core developmental directive agenda for global action, and undergoing constant and sustained monitoring (Ulbrich, Porto de Albuquerque and Coaffee, 2019), resilience has acquired a central place in driving transformations to sustainability (Davidson *et al.*, 2019).

One of the first dedicated resilience-focussed global initiatives was launched in 2012 by the UNDRR and was entitled *'How To Make Cities More Resilient'*. The project was directed towards city officials operating at different administrational scales and aimed at providing a generic framework for risk reduction by designating at examples of good practices already implemented in a number of cities worldwide (Molin Valdes, 2012). Although the theoretical conceptualisation of resilience was profoundly technocratic and disaster risk-oriented, perhaps without paying significant attention to underlying long-term socio-economic stresses or to horizontal and vertical governance arrangements, it greatly assisted in the integration of resilience into global sustainable development debates.

During the same year, the World Bank published the report *'Building Urban Resilience in East Asia'* in the aftermath of the 9.0 Richter magnitude earthquake that hit Japan in 2011. The report was an attempt to guide urban planning and policy towards

[7] Formally he United Nations International Strategy for Disaster Reduction Secretariat (UNISDR) was established in 1999 as the successor to the Secretariat of the International Decade for Natural Disaster Reduction.

confronting climate change and natural hazards in a very disaster-prone area by analysing hazard probability, vulnerability and exposure of Asian cities from a disaster risk management perspective, emphasising however on the importance of awareness and preparedness in providing buoyancy for confronting multiple urban disruptions (Jha and Brecht, 2012). Other similar initiatives focusing on disaster risk reduction and directed primarily to practitioners and local governments have been inaugurated worldwide, with the International Council for Local Environmental Initiatives (ICLEI) *Resilient Cities Congress Series* and *Annual Global Forum on Urban Resilience and Adaptation* having a central place among them (ICLEI, 2019, 2021).

2.1.4 CRITICAL VIEWS ON RESILIENCE

Despite its growth as a go-to term across a variety of disciplines and practices related to risk, crisis and uncertainty, resilience has also been widely critiqued. A first strand of criticism focuses on its practices to provide a truly transformative alternative for local communities. Here, critics argue that the concept is a mere transmutation of previously existing neoliberal urban governance approaches currently deployed as a means to de-politicise urban dialogues (Joseph, 2013; Welsh, 2014) and not inducing real change and transformation that challenges the current status quo. Views of resilience through this lens highlight the disproportionate focus on superficially dealing with the consequences of crises and subsequent recovery efforts without meaningfully dealing with the underlying factors that produced them. In other words, especially with its earlier engineering and ecological connotations, resilience simply leads to surviving and not thriving, as its rhetoric does not actively impugn social inequalities or the precarity of urban life (Diprose, 2014). Thus, with resilience simply reassuring people that the most important thing is 'surviving to fight another day', demands for resistance, change and transformation of current governance practices are silenced and calls for preservation prevail (Evans and Reid, 2013; Kaika, 2017). In the words of Julian Reid (2012, p.76), '*the human is conceived as resilient insofar as it adapts to rather than resists the conditions of its suffering world'*. A second critical view of resilience, predominantly relevant for discussions around communities and community resilience, relates to the increased attention paid in citizen responsibility as an integral part of disaster resilience (Chandler, 2019). Here, the 'responsibilisation' of local citizens is perceived as a method to devolve responsibility from the state to civil society, with ultimately resilience used as '*a vehicle for devolution of risks'* (Diprose, 2014, p.51) in an attempt to relocate responsibility for disaster response; yet, this devolution of responsibilities frequently does not correspond to a similar devolution of rights (Reid, 2012) with resilience acting as a protecting mechanism for national and local authorities. Such critical views on resilience render the distinction between disaster and community resilience, presented in deliverables D1.1 and D2.1 of this project, absolutely critical for stressing the divergence between seemingly similar concepts, which are, however, ontologically and epistemologically distinct.

2.2 Disaster Risk Management and Resilience

After a brief introduction to the concept of resilience and its journey across different disciplines and definitions, this section discusses resilience through a disaster risk lens, focusing on natural hazards. Natural hazards have been a frequent experience

throughout the history of human civilisation. In more recent times, particularly as global climate change intensifies, the frequency, unpredictability and impact of natural hazards is progressively increasing (IPCC, 2021). Several socio-economic and political phenomena of the modern age, such as rapid and continuous urbanisation, climate change and the precarity of modern life are increasing the catastrophic impact of natural hazards and turning many of them to disasters. However, while hazards are natural, disasters are not and this distinction between the two concepts needs to be highlighted and gradually espoused in the disaster risk management and resilience vocabulary, particularly across the European Union and EU-funded research. Below we analyse this distinction and briefly introduce the concept of vulnerability as a conduit for the transition from disaster to community resilience, which is then further explored in chapter 2.3. A more thorough analysis of the concept of disaster resilience and its implementation is provided in deliverable D.1.1 of this project.

2.2.1 DE-NATURALISING 'NATURAL DISASTERS': THE CONCEPT OF VULNERABILITY

For many years, disasters were perceived as 'natural acts of divine power' thrust upon human civilisation as punishment for its sins (Coaffee, 2019). It was not until mid-18th century that society started recognising that external factors, such as lack of preventive measures or underlying social inequalities, might exacerbate the impact of natural phenomena ultimately leading to catastrophic disasters. Even today, disasters are often effortlessly considered 'natural' or 'Acts of God', sometimes within the academic realm itself, ignoring the fact that their majority result from a combination of hazard severity, inherent social vulnerability, usually deriving from local hazardous conditions, and increased human exposure (Chmutina *et al.*, 2017; Kelman, 2020). Consequently, an emerging question from this discourse is how 'natural' are so called 'natural disasters' (O'Keefe, Westgate and Wisner, 1976)?

To provide a valid answer to that question, a clear distinction between natural hazards and disasters should be established. Bosher & Chmutina (2017, p.4) define hazards as *'dangerous phenomena, substances, human activities or conditions that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruptions, or environmental damages'*. By contrast, disasters occur as a repercussion of hazards and in cases when significant numbers of people, resources and/or social relations suffer severe damage or disruption and significant recovery of the affected community is required, as well as the replacement of physical infrastructure (Wisner *et al.*, 2004; Wisner, Gaillard and Kelman, 2012). Thus, a major distinction between the two phenomena lies in the preventive control the humans have over disasters as opposed to hazards, since stronger ties between social actors and more robust planning and construction mechanisms can minimise the impacts of hazardous events.

Despite this understanding, disasters inflicted by natural hazards such as earthquakes, floods, tsunamis or epidemics are often labelled as 'natural'. However, disasters are not natural or pre-ordained but occur as a result of social and political traditions and action that are rooted in the evolution of our social economic and political systems and enhanced inherent vulnerabilities. Many important human-induced factors, such as poor urban planning, ageing and low-quality building stock or poor

regulatory framework, contribute in turning natural hazards into disasters (Bosher and Chmutina, 2017). Disasters happen when social processes like marginalisation, discrimination and inequitable access to knowledge and resources are apparent, intensifying the vulnerability of citizens. Such vulnerabilities are further enhanced by side-effects of neoliberal policies including -but not limited to - deforestation, rapid urbanisation, environmental degradation, and climate change (Chmutina *et al.*, 2017). Hence, the root causes of disasters should not be blindly sought in the magnitude or severity of natural hazards but in the underlying social processes such as social discrimination, inequitable access to resources, social inequality, class and power relations (ibid). In short, words matter, and as the Head of the UNDRR noted in a media briefing in July 2021, '*using 'natural' to describe disasters can give people the impression that disasters are inevitable, and that human agency can do little to prevent or mitigate their impacts'* (Mizutori, 2021).

2.2.2 THE CONCEPT OF VULNERABILITY

Once the distinction between hazards and disasters is established, the related notion of vulnerability should be a further explored. Vulnerability emerged as a central concept for understanding disasters during the 1970's, especially after attempts to strip disasters of their natural dimension (O'Keefe, Westgate and Wisner, 1976). The detachment of disasters from natural phenomena, led to increased considerations of intrinsic vulnerabilities that exacerbate the effects of natural hazards, particularly in urban environments where the concentration of human and physical resources is significantly higher (Desouza and Flanery, 2013). Consequently, many disaster scholars and practitioners shifted their focus from natural hazards to social processes and social order; the root causes that increase disaster risk and render communities unsafe in the first place (Bankoff, 2019). The outcome of this paradigm shift was the greater adoption of the term 'vulnerability', which combined both the exposure to natural hazards and the capacity of affected communities to recover from inflicted losses (Pelling, 2003; Adger, 2006; Bankoff, 2019)[8].

The admission of vulnerability into the disaster risk discourse was followed by attempts to model the relationship between natural hazards and disaster risk and vividly illustrated that risk can be directly referable both to the magnitude and severity of natural hazards and to social factors and processes that set people and infrastructure at risk (Bankoff, 2019). This thinking gave birth to the established formula, risk = hazard x vulnerability[9], which has been utilised in a myriad of disaster risk models since. Perhaps the most complete among such attempts to model disaster risk, is the Pressure and Release (PAR) model (Blaikie *et al.*, 1994)[10]. The PAR model (Figure 2.1) conceptualises disaster risk as a composition of natural hazards and vulnerability that originates in the social factors and existing processes in place. At the same time,

[8] It is beyond the scope of this Report to provide a thorough and robust exploration of different vulnerability definitions, as such an analysis takes place in Deliverable D1.1 of this project.

[9] This pseudo-formula has been evolved during recent years. The determinants of risk were redefined with the inclusion of exposure in the equation (Cardona *et al.*, 2012).

[10] The PAR model was further refined and republished by Wisner et al 2004 (Wisner *et al.*, 2004) and Wisner et al 2012 (Wisner, Gaillard and Kelman, 2012).

vulnerability itself is reproduced over time at three spatial and temporal levels. The first of these levels, *'root causes'*, is a set of interrelated general processes within a society and the global economy and reflects political and economic systems, power relations and social structures. It is also temporally distant, as it engulfs ideologies, beliefs and social relations historically developed in the past and deeply embedded in the *modus vivendi* that are almost invisible and 'taken for granted' (Wisner *et al.*, 2004). The second level is called *dynamic pressures* and constitutes an intermediate level translating and channelling the effects of root causes into particular types of *unsafe conditions,* the third and final level of vulnerability. Dynamic pressures are more contemporary and immediate and include macro-process such as population change and rapid urbanisation, as well as lack of institutional arrangements and appropriate social capital. Finally, unsafe conditions illustrate vulnerability's specific form of expression in both space and time. Such conditions include - among others - people living in hazard prone areas lacking state protection, dangerous livelihoods, unprotected buildings and infrastructure. According to the model, higher pressures on social structures and people from either side, i.e. severity of hazard or increased vulnerability due to the described factors, leads to greater disaster risk.

Despite their techno-managerial nature and limited operational applicability, approaches like the PAR demonstrated the amplified attention progressively paid in the social components of disasters. The admission of vulnerability as an equal constituent of disasters assisted in 'de-naturalising' 'natural disasters' and shifted the attention of disaster risk scholarship and research towards the social processes underlaying disasters. This shift also generated a turn towards more proactive and holistic approaches and a move from disaster management to disaster resilience (Bosher and Dainty, 2011).

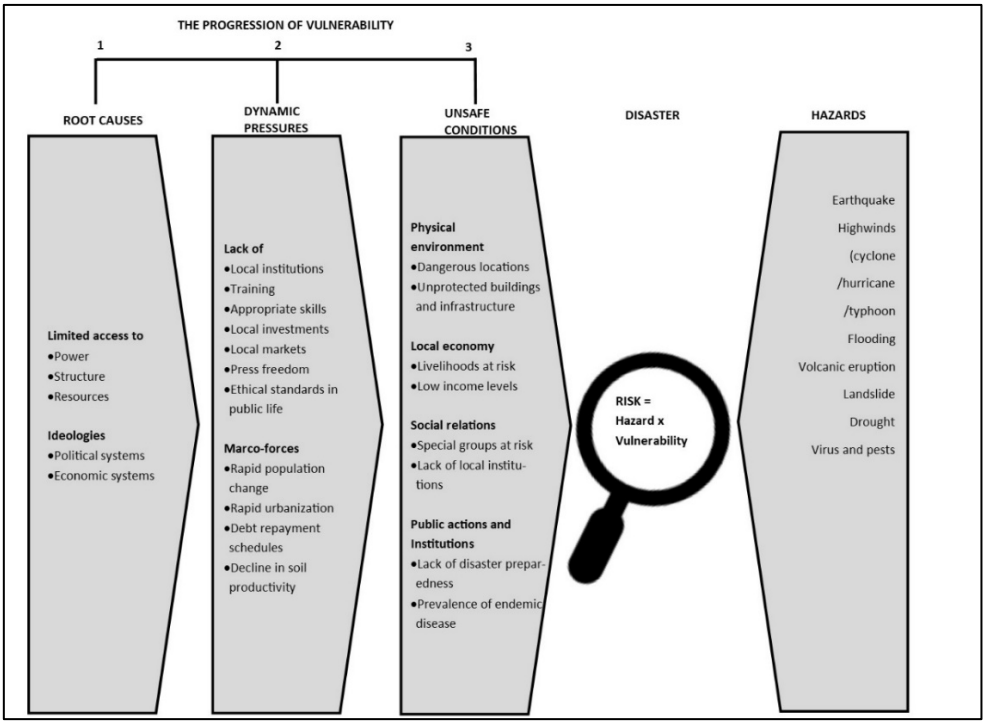

FIGURE 2.1: PRESSURE AND RELEASE (PAR) MODEL: THE PROGRESSION OF VULNERABILITY (ADAPTED FROM Wisner, Gaillard and Kelman, 2012**, P.51)**

2.2.3 FROM VULNERABILITY TO DISASTER RESILIENCE

Vulnerability and resilience are two related concepts in disaster scholarship sharing several commonalities (Klein, Nicholls and Mimura, 1998). Some scholars even suggest that they are not discrete concepts (Blaikie *et al.*, 1994; Weichselgartner, 2001), while others claim that they are simply different sides of the same coin (Blaikie *et al.*, 1994; Twigg, 2009; Manyena *et al.*, 2011) and others point out that the '*underlying ontology of resilience [..] is actually vulnerability*' (Evans and Reid, 2013, p.87). Thus, defining the actual relationship between them is a complicated endeavour as the multiplicity of definitions for both terms generate a myriad of interpretations. Properly understanding this relationship is a fundamental step to theorising the applications of resilience thinking in disaster risk management.

Although definitions of vulnerability to natural hazards predominantly derive from two distinct disciplinary perspectives, namely geography and natural sciences, there is a general consensus among disaster scholars that vulnerability is determined by a complex array of different actors. As Manyena (2006) argued: *"[…] vulnerability to disaster is determined not simply by a lack of wealth, but rather by a complex range of physical, economic, political and social factors or the predisposition of a community to damage by a destabilising phenomenon involving an interdependent natural hazard and anthropogenic pressures*" (p.440). Consequently, vulnerability is rather understood as an outcome of complex interrelated processes taking place within socio-ecological systems.

This outcome-oriented theorising of vulnerability constitutes its first fundamental distinction from disaster resilience. As argued above, vulnerability is better understood from an evolutionary perspective, as a continuous process focusing on the establishment and consolidation of strong ties among the system's stakeholders and the consolidation of robust formal and informal institutions. A second distinction is apparent in the emphasis paid by vulnerability analysis to systems' exposure and lack of resistance to natural hazards, as opposed to a dual focus on both preparedness, proactive action and post-disaster recovery that are central disaster resilience approaches (Klein, Nicholls and Thomalla, 2003; Davoudi, Brooks and Mehmood, 2013). Other differences between the two concepts can be traced in the negative connotation of vulnerability contrasting resilience's positive undertone or in the overwhelming emphasis vulnerability bequeaths to mitigation as opposed to the importance of adaptation and adaptability resilience foregrounds (Bankoff, 2019).

In short, it is safe to argue that the two concepts are more discrete than similar (Manyena *et al.*, 2011). Vulnerability refers to the underlying characteristics of the environment and the processes and that constitute a system or parts of it more prone to disasters. By contrast, resilience is more related to raising awareness and adequately preparing for hazards in a holistic manner, taking into account the underlying vulnerabilities and mobilising resources to address them. According to the National Research Institute of the United States (2012, p.12) '*disaster resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events'.* This definition, which has been adopted and utilised by the UN in the Sendai Framework (UNDRR, 2015), clearly denotes the pre-emptive focus or disaster

resilience, and its suitability in addressing the vulnerabilities and leading to gradual adaptation and ultimately to the recovery from internal and external perturbations.

Whilst initial ideas of disaster resilience focused on 'bouncing back' to a pre-disaster state in a timely manner (Holling, 1973; Manyena, 2006), providing a clear distinction from the notion of vulnerability, disaster scholarship increasingly begun to embrace a 'bouncing forward' approach. This gave greater emphasis to both post-disaster recovery through community agency and reorganisation of current institutions -or establishment of new ones- as well as to the goal of enhance local capacities to cope with the fluctuating nature of disaster risk. Disaster Risk Reduction (DRR) underlined the importance of community mobilisation and empowerment to *'tackle the underlying problems of poverty, marginalisation, environmental degradation and political abuse, with emphasis on participatory processes in Disaster Risk Management (DRM), capacity building, removal of the root causes of vulnerability and mobilisation of less vulnerable sectors in support of those in need*' (Bankoff, 2019, p.228). For DRR the priority was disaster prevention and risk reduction, through better understanding of risk, improvement of livelihoods and increasing of social mobilisation (ibid).

In summary, the focus of disaster resilience on recovery brings forward ontological debates around the discursive changes resilience thinking introduced to conventional DRM approaches. Traditional DRM approaches disproportionally emphasise the improving the physical infrastructure for effectively mitigating the impact of natural hazards. Resilience thinking by contrast, has emerged more recently as a holistic approach to managing the rising risk, focusing on confronting the underlying social problems of contemporary cities and aiming at mobilising and empowering local communities and promoting multi-stakeholder collaboration and partnership (Normandin *et al.*, 2019). Moreover, temporally, resilience approaches could be perceived as long-term strategies to mitigate future disasters (Manyena, 2006), focusing on building institutional capacities for preparing and mitigating shocks and stresses, whereas disaster risk management incorporates the short-term mitigation and recovery practices constituting a rather the reactive approach emphasising on the disaster response apparatus (Sellberg *et al.*, 2018). This distinction is even more visible as resilience puts more attention to the social aspects of disaster management, including social dynamics, local culture, social justice and tacit institutional and governing arrangements in contrast with DRM's more pragmatic and rational engineering direction (Sharpe, 2021).

2.2.4 DISASTER RESILIENCE MEETS GLOBAL SUSTAINABLE DEVELOPMENT

The resurgence of resilience in developmental scholarship has amplified the need for more effective integration of disaster risk considerations into developmental policies. The United Nations has played a leading role in the attempt to highlight the significance of reducing disaster risk by establishing in 1999 the UN Office for Disaster Risk Reduction (UNDRR)[11] to serve as a focal point for coordinating synergies and activities between the UN and local organisations. After all, *'UNDRR defines itself,*

[11] UNDRR office was formerly known as the United Nations International Strategy of Disaster Reduction (UNISDR).

through its multi-stakeholder coordination approach based on the relationships it has developed with national and local governments, intergovernmental organizations and civil society, including the private sector, and by its mode of operating through a network of global partners' (UNDRR, 2019).

2.2.4.1 The Hyogo Framework for Action (HFA)

This need to focus on disaster risk reduction and resilience has been explicitly expressed by the UN both in the *Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters* and in its successor the *Sendai Framework for Disaster Risk Reduction* (SFDRR) *2015-2030*. Both documents were outcomes of extensive consultations with a wide spectrum of stakeholders, including local authorities, governmental and non-governmental organisations, academics, practitioners and community organisations' representatives and emphasised the eminent need for more effective stance against disasters and reduction of risk posed by natural and human-induced hazards.

Adopted on January 22, 2005 the HFA signified a global commitment at the governmental level to reduce vulnerabilities and increase the resilience of nations and communities to natural hazards (UNDRR, 2005). The HFA provided a clear motivation to integrate DRR into developmental policies and further support the development of institutions, mechanisms and capacities to build resilience to natural hazards (UNDRR, 2005). It espoused a multi-hazard, interdisciplinary approach and prioritised the strategic goal and key activities to be operationalised for effective reduction of risk to natural hazards and adaptation to climate change. According to Manyena *et al.* (2011, p.422):

> The HFA clearly signals a move from a command-and-control environment to a community-based approach within an enabling policy framework. It seeks to promote an interdisciplinary approach to disaster risk reduction and gives a specific example by stating that this must promote the integration of risk reduction associated with existing climate variability and future climate change into the strategies for the reduction of disaster risk and adaptation to climate change.

2.2.4.2 The Sendai Framework For Disaster Risk Reduction (SDFRR)

Following the way paved by the HFA, SFDRR was adopted on March 18, 2015 at the World Conference on Disaster Risk Reduction in Sendai, Japan (UNDRR, 2015). Building on the experience gained by the implementation of the HFA and aspiring to enhance and advance the knowledge provided by the ten years of its implementation, SFDRR constitutes a more refined approach to dealing with multi-hazard risk. Its main objective is to *'prevent new and reduce existing disaster through the implementation of integrated and inclusive economic, structural, legal social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery and thus strengthen resilience'* (UNDRR,

2015), with resilience being defined as '*the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of the hazard in a timely and efficient manner, including through the preservation or restoration of its essential basic structures and functions'* (UNDRR, 2015). Despite this outcome-oriented conceptualisation of resilience, the SFDRR offers an integrated pathway to DRR applied to a range of administrative levels and temporal scales profoundly foregrounding the important role for better understanding of disaster risk and more efficient governance arrangements, *'moving away from disaster risk as a natural phenomenon and focusing on the inequality and injustice of human vulnerability to hazards'* (Chmutina *et al.*, 2021).

In a nutshell, the SFDRR is a non-binding strategic document delivering directions for sustainable development with DRR and resilience in the forefront, and along with the HFA, offers a solid rationality for integrated development approaches, urging national and local governments into taking resilience more seriously, while simultaneously also expressly consolidating the role of local governments in delivering resilience (Barnett and Parnell, 2016). The SFDRR emphasized a renewed commitment to promoting the local assessment of risk to disasters in order to enhance implementation of disaster resilience and to build back better. This framework also sought to stimulate concerted efforts to foster 'collaboration and partnership across mechanisms and institutions and enhance the implementation of equitable resilience policies and practices.

2.2.4.3 The Sustainable Development Goals (SGDs)

This consolidation of local action has been further manifested through the Sustainable Development Goals (SDGs). In 2015, the member States of the United Nations SDGs approved 17 *'integrated and indivisible'* SDGs in an ambitious effort to transform the operational framework and policy agenda of future global sustainable development (United Nations, 2015). The focus of different SDGs extents across 169 developmental targets while 230 indicators have been employed to monitor progress towards achieving them (Ulbrich, Porto de Albuquerque and Coaffee, 2019)[12].

Through the SDGs, the United Nations recognise and re-endorse the need to reduce disaster risk, already clarified and consolidated via the HFA and the SFDRR. Yet, recent research on the engagement of the SDGs with DRR indicates that it has not yet been translated into practice as promised. For example, Chmutina *et al* (2021) argue that not only SFDRR approaches for dealing with DRR are event/hazard-centric and not adequately focused on locating DRR processes within broader development, but also the SDGs and their accompanying indicators are not adequately engaging with DRR and vulnerability at the local level. Therefore, achieving many of the SDGs, and several of their specific targets, does not de facto presupposes consequent reduction of disaster risk. Having said that, the SDGs are taking the next step from SFDRR in managing disaster risk through some of their specific targets. Examples of such targets are presented in detail below and concentrate around limiting vulnerability

[12] The way these goals and targets are to be operationalised is not entirely clear and a dynamic process under discussion globally and according to many scholars depends highly on the appropriate choice of indicators (United Nations, 2019).

and exposure of poor people and communities to hazards, building resilient infrastructure and mitigating the impact of climate change, while a range of other SDGs and targets implicitly refer to actions that can contribute to reducing disaster risk.

Resilience is also explicitly and implicitly acknowledged in several of the SDGs and in a variety of different ways, including wellbeing, poverty alleviation and disaster risk reduction (Bahadur *et al.*, 2015; Ziervogel *et al.*, 2017). For instance, it can be is found in Goal 2 (Zero Hunger), Goal 9 (Industry Innovation and Infrastructure), and while it also represents the core of Goal 1 (No poverty) Target 1.5 (United Nations, 2015): *'By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.'*

Target 1.5 is fairly broad in terms of scope and seeks to address the impact of both shocks and stresses (Bahadur *et al.*, 2015). Limiting the focus of attention to natural hazards, Goal 13 (Climate Action) provides a more concrete view through target 13.1 *'Strengthen resilience and adaptive capacity to climate-related hazards and "natural disasters" in all countries',* where resilience could be discerned both as an outcome and as a process of adaptive capacity building. Nonetheless, the most explicit reference to the concept of resilience is undoubtedly encountered in Goal 11 *'Make Cities and human settlements inclusive, safe, resilient and sustainable'*. Notably, Goal 11 targets cities attempting to address all aspects of urban life. Among them is the reduction of urban disaster risk, mentioned in targets 11.5 and 11.b (United Nations, 2015):

- Target 11.5: '[…] significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations'.
- Target 11.b '[…] substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, develop and implement, in line with the Sendai Framework'.

The centrality of resilience in several SDGs alongside their categorical objective of enhancing urban resilience demonstrates the operational potential of the concept. The global UN developmental agenda with the SDGs in the vanguard, not only acknowledges the significance of resilience for the management of natural hazards and extreme events but also unlocks wider framings of resilience that move beyond disaster risk, towards addressing social inequalities, promoting social justice and reducing human vulnerability (Bahadur *et al.*, 2015; Klopp and Petretta, 2017; Ziervogel *et al.*, 2017). This social turn in resilience scholarship (Brown, 2014; Coaffee and Clarke, 2016) now places significant emphasis on implementing approaches that deliver resilience for all, by all (Coaffee, 2019) and targets the enhanced role of communities in mitigating their own risk and vulnerability and in broader approaches to overall disaster resilience.

2.3 The role of communities in the context of disaster resilience

The conceptual journey of resilience we have presented so far includes a variety of definitions across several disciplines and disciplinary boundaries including engineering, ecology, psychology, social sciences, humanities, and disaster risk scholarship. While the increasingly central role of communities and civil societies in defining the concept of resilience has been partially addressed above (see 2.1.2 and 2.2.2 in this Report) this subsection is dedicated to analysing the gradual transition in resilience conceptualisations from a technical to a community/social focus. Such a transition has been the outcome of discourses we have discussed above, such as the de-naturalisation of disasters and the increased importance of vulnerability, and the tendency to progressively localise disaster risk management and contextualise disaster response mechanisms, as they have been depicted not only in academia but also in global policy.

2.3.1 FROM DISASTER TO SOCIAL AND COMMUNITY RESILIENCE

Over the previous twenty years, interpretations of resilience, and disaster resilience more specifically, commonly related to previous ecological and psychological considerations towards understanding 'social' or 'community' resilience, in terms of rethinking the most appropriate ways to organise disaster management (see 2.1 and 2.2). In this context, social (or societal) resilience, a term commonly used interchangeably with community resilience in the literature, has been linked with ecological research, with resilience in 'socio-ecological systems', thus connecting ecology to social processes by assessing the 'adaptive cycle' and 'adaptive capacity' of a range of systems (Carpenter *et al.*, 2001). Neil Adger through his work in researching the links between social and ecological resilience, also argued that one way in which this can be encouraged is by '*focusing on the links between social stability (of populations within social systems) and resource dependency'* (Adger, 2000, p.351) - which yields a better awareness of how specific institutions as *'modes of socialised behaviour'* and *'more formal structures of governance and law'* (ibid) can be grounded in the local ecology.

In the urban environmental context, Mark Pelling (2003) in *The Vulnerability of Cities* further argued that the 'adaptive potential' of individuals and communities is related to two types of 'human response': first, coping strategies where social networks may be mobilised to reduce the negative impact of an event; and second, governance modification which *'aims to alter the institutional framework of a city using political influence to create political space for at-risk actors to argue their case'* (p.62). This latter response is of course problematic in situations where there is institutional inertia and a lack of willingness to change, or where change is moving apace, particularly linked to privatization and the hollowing out of the state. In summary, Pelling (2003) argued that:

> The retreat of the state and expansion of the private sector and civil society in cities worldwide has created an opportunity for new institutional forms and networks to be created that can enhance a city's ability to deal with vulnerability and environmental hazard (p.63-4).

Another key connection to be made across fields of enquiry, and a key contribution of the social sciences to the debate, can be found in the related concept of 'community resilience' where a number of researchers have attempted to model human responses to disasters. For example, Paton (2001, p.158) argued that '*the orientation of work in the area of disaster risk management has progressively moved from a deficit or pathological paradigm, to one emphasizing community resilience'*, with Tobin (1999) further arguing that community resilience is one of the 'holy grails' to obtain for successful disaster recovery. Since then, a large range of tools and methodologies have been developed for the assessment, modelling, measuring and visualisation of community resilience, utilising a variety of indices and measuring mechanisms (Sharifi, 2016; Nguyen and Akerkar, 2020).

However, measuring the levels of community resilience is a complicated and often intricate endeavour, as it involves social and cultural processes that are not adequately represented by quantifiable indices (Levine, 2014; Prior and Hagmann, 2014). Here, by adding the caveat of cultural and social processes to the discussion of community resilience, the balance of resiliency policy can be reoriented away from analysis of deterministic legislative and technological processes, and increasingly grounded in the more meaningful experience of the world by citizens, often absent from debates in the disaster mitigation literature (Durodié and Wessely, 2002). As Durodie (2005) noted:

> Policy makers and emergency planners must learn from the literature examining human behaviour in disasters. The relevant research shows that professionals should incorporate community responses to particular crises within their actions, rather than seeking to supplant these because they consider them ill-informed or less productive. […] Actions to enhance the benefits of spontaneous association, as well as to develop a sense of purpose and trust across society are, at such times, just as important as effective technical responses (p.4).

2.3.2 EXISTING APPROACHES TO COMMUNITY RESILIENCE

2.3.2.1 Approaches from academic literature

This progressive focus upon community resilience largely reflects the accentuated role of societies (and communities in particular) in reducing vulnerability and managing disaster impact, and echoes evolutionary understandings of resilience (Davoudi *et al.*, 2012) as the process of developing *adaptive capacity* to deal with complexity and uncertainty (Beilin and Wilkinson, 2015) in local communities, instead of merely the ability to increase the capacity for learning and adaptation (Berkes, Colding and Folke, 2003). The notion of adaptive capacity is inherently embedded in the understanding of resilience as a process, since it connects the idea of 'bouncing forwards' following a disturbance to the mobilisation of resources to prepare for confronting a range of known and unknown future risks and challenges. Many scholars have also referred to the concept of 'adaptive resilience' as a fundamental quality of sustainable social systems. For example, Duit, (2016) defines adaptive resilience as *'the extent to which a society or an organization is able to learn from past lessons and implement changes*

to increase its chances of withstanding future crises'. Others have extended this understanding to urban environments by underlining the contribution of community planning in the revitalisation of communities affected by destabilising shocks (Goldstein *et al.*, 2012; Berkes and Ross, 2013). Furthermore, in the context of environmental risk and disaster recovery, the potential of communities and individuals to mobilise and create social networks and reframe the traditional pathways of local risk management from a top-down to a bottom up approach, has been extensively emphasised by several researchers (Aldrich, 2012; Wagner, et al; 2014; Liu *et al.*, 2018). Such work has illuminated how civil society has played a key role in post-disaster recovery on several occasions, especially through efforts concentrated at the neighbourhood scale.

Accordingly, in many cases the introduction of resilience concepts to wider governance configurations has been inextricably related to changes in local emergency planning arrangements and has sought to embrace more community-focused efforts. Such efforts were part of a wider suite of approaches that emerged in the 1990s and endorsed local engagement in DRM, in response to the failures of top-down models of disaster management and included not only ideas of enhancing community resilience but also ideas of Community-Based Disaster Risk Management (CBDRM). Both ideas here originate from, and are organised by, local communities with their application aiming at responding to local problems and needs and capitalising on local knowledge and expertise.[13] According to Coaffee, Murakami Wood and Rogers (2008) local emergency planning was traditionally associated with '*social, political and cultural inertia tied to a series of questions raised by particular geopolitical circumstances, and grounded in both historical context and the requirements of civil defence and protection at different points in time*' (p.190).

More specifically, after 9/11, ideas of resilience increasingly became a central organising metaphor within the policymaking process and in the expanding institutional framework of national security and emergency preparedness. Responses to the events of 11 September 2001 served to emphasise the importance of sub-national and localised approaches to new security and risk challenges, which required analysis through a different frame of reference that placed the needs of individuals, localities and communities, at the centre of resilience implementation. From this perspective, building the resilience of the individual, institutions and the neighbourhood is the pathway to resilience of the whole. In the context of place and communities it is therefore the social consequences or '*the ability of communities to withstand external shocks to their social infrastructure'* (Adger, 2000, p.347) that is arguably of greatest significance and concern. In more recent times, other governance principles such as subsidiarity or 'new localism', that encouraged decentralisation of responsibility to the local community levels, emerged. Here, establishing and strengthening collaborations between local communities, private sector and local governments, paved the way for the introduction of a wider framework for resilience implementation at the local scale,

[13] Such approaches however, are highly localized and should not be seen as a silver bullet solution in all contexts, given the exogenous nature of risk creation (see Clark-Ginsberg, 2021).

particularly in countries like the UK, Australia and the Netherlands (Coaffee, 2013; Australian Local Government Association, 2021; Skrimizea *et al.*, 2021). This is not to assume complete state-level withdrawal, as in many cases state strategy, resources and leadership is seen as crucial in proactively responding to disruptive challenges. Thus, promoting community resilience cannot simply be left to communities themselves but requires steering, not rowing, from state level in some form of collaborative alliance to be successful (Coaffee, 2013).

In contrast with traditional approaches to disaster risk, which advocated a top-down mechanism for disaster risk management, relying on a narrow range of stakeholders (Coaffee *et al.*, 2018), community-oriented resilience approaches aspire to leverage a network of professional and community groups at a range of spatial scales, in preparing for and responding to (un)expected perturbations. Such mobilisation, which spans from locally coordinated systems to centralised and sub-national organisations, often requires the consolidation of so called 'trust ties' in order to form lasting relationships between CPAs and the civil society in a process to harness the power of social networking and advance community resilience to cope with crisis situations. Whilst past approaches to resilience and risk management have often been centred on physical infrastructure (see 2.1.1), these emerging approaches underline the need for investing in social infrastructure and social capital. Building in the extensive work of Daniel Aldrich (Aldrich, 2012; Aldrich and Meyer, 2015; Aldrich and Kyota, 2017) in researching a range of disasters from Hurricane Katrina in 2005, the triple disaster in Japan in 2011, and more recent work on the COVID pandemic, social capital here is understood as the 'trust ties' between individuals and has proven to be a catalyst in the amelioration of disaster impacts and the reduction of deaths during extreme weather events (Aldrich, 2012; Aldrich, 2012; Aldrich and Sawada, 2015). Further, as strong social ties allow for easier sharing of information, the overcoming of barriers to collective action, and informal insurance, better-connected communities show better recoveries after major crises (Iwasaki, Sawada and Aldrich, 2017). Focusing on social capital is pivotal for enhancing community resilience since social capital, like other forms of capital, can be strengthened and deepened, and hence local communities and organisers can invest in programmes that would nurture resilience to future shocks (Aldrich and Meyer, 2015; Aldrich and Kyota, 2017; Coaffee *et al.*, 2018).

Building upon the discussion on social capital and the need for establishing 'trust ties' among social, public and private institutions to enhance community resilience, but employing a top-down assessment approach, Parsons *et al.* (2016) emphasised the importance of two different types of capacities - coping and adaptive - for enhancing resilience locally. Here, coping capacity was understood as '*the means by which people or organizations use available resources, skills and opportunities to face adverse consequences that could lead to a disaster (p.1)*, while adaptive capacity was seen as *'the arrangements and processes that enable adjustment through learning, adaptation and transformation' (p.1).* Although such an approach was entirely top-down, it showcases the fundamental role of communication between institutions and the civil society as well as the significance of governance arrangements for enhancing community resilience.

By contrast, a more grassroots approach was adopted by Fitzpatrick (2016), for whom *'the term community resilience is used to describe the interconnected network of systems that directly impact human society at a grassroots community level, including the socioeconomic, ecological, and built environments' (p.58).* and a community is resilient when (ibid):

> [...] members of the population are connected to one another and work together, so that they are able to function and sustain critical systems, even under stress; adapt to changes in the physical, social or economic environment; be self-reliant if external resources are limited or cut off; and learn from experience to improve itself over time. (p.8)

In the context of disaster, Wisner and Kelman (2015), after providing a definition of community and resilience separately[14], further argued that '*community resilience, […], involves interactions among individuals, groups, and institutions that usually result in collective action to enhance the capacities for recovering from a disaster (p.355),* emphasising once more the importance of collective action and active citizenship in order to enhance community resilience. Similarly, Bosher and Chmutina (2017, p.32) define community resilience as '*a measure of the sustained ability of a community to utilize available resources to respond to, withstand and recover from adverse situations'*, although pointing out that determining actual risk awareness in the first place is a complex matter requiring contextual understanding of cultural, social and spiritual norms and perceptions.

Following a slightly different route, and deeply inspired by psychological definitions of resilience that focus on the individual instead of the community level, Berger (2017, p.5) identifies four needed interventions for enhancing community resilience namely (adapted from Fazey *et al.*, 2021):

1. Acceptance and expression of feelings in a safe, supportive environment.
2. Awareness of body reactions, as trauma is *'essentially a somatic experience" that must be dislodged physically'.*
3. Enhancement of self-competence by *'encouraging people to search for their own abilities and coping skills and to use them'*.
4. Promotion of hope and optimism by helping people to '*make sense of their experience and to create a narrative that will be meaningful for them'*.

Berger (2017) concludes by defining community resilience as "*the capacity of a community to deal with a major crisis by adapting and growing while minimizing causalities and preserving a fair quality of life for all its citizens and maintaining its core values and identity" (p. 7)*.

[14] 'Community is understood as people living in a locality and their extended networks elsewhere in space and time (Wisner and Kelman, 2015) (p.354) while resilience follows the etymological journey presented in subsection 2.1 of this Report.

More recent definitions of community/social resilience reflect the community-based transition in disaster studies as well as the 'social turn' of resilience studies (Brown, 2014; Coaffee and Lee, 2016). Some of them are quite broad and attempt to reflect the ontological fermentations on resilience connotation as described above. Hence, Imperiale and Vanclay (2021) refer to community/social resilience as a form of *'social learning*[15] *and transformation in society that leads local communities and external actors to learn from unexpected changes (crises, disasters, and other social disturbances) and to transform toward empowering local capacities, mitigating risks and impacts, and enhancing wellbeing and resilience at all levels of social-ecological governance (*p.5)', while community resilience for them is defined as the '*social processes (cognitive and interactional) that occur within places and that are put into action by local people to collectively learn and transform toward enhancing community wellbeing and addressing the negative risks and impacts they perceive and experience as common problems (p.5)*'.

Other definitions of community resilience are increasingly focusing on human-environment interactions, particularly as discussions around climate change are gaining more ground in academic and policy agendas. For instance, Fazey *et al.,* (2021) consider community resilience to be '*the ability of a community to adapt to different kinds of interconnected social, environmental and economic change and in ways that promote further change towards healthy community functioning'* (p.1732) building upon previous conceptualisations such that focused on the ability of community members to mobilise *'community resources and thrive in an environment characterized by change, uncertainty, unpredictability, and surprise'* (Magis, 2010, p.402). Summing up, in a systematic review of community resilience definitions from the extant recent literature, Patel *et al.* (2017), identified nine main concepts that emerge across a variety of publications on community resilience. Such concepts largely reflect both the community approaches we explored above, such as the importance of contextual knowledge, community networks, communication and governance, and the individual resilience concepts such as preparedness and mental wellbeing. The elements are:

1) Local Knowledge
2) Community networks and relationships
3) Communication
4) Health
5) Governance/Leadership
6) Resources
7) Economic investment
8) Preparedness
9) Mental Outlook

It needs to be clarified here that the community resilience definitions explored in this subsection do not constitute an exhaustive analysis or a systematic review of the

[15] Social learning here is defined as the individual and collective processes at the cognitive level that come from perceiving and/or experiencing the social and environmental context, including the negative consequences of past failures and crises (Imperiale and Vanclay, 2021).

plethora of definitions in existing in extant literature. Instead, they operate as a relevant conceptual and practical basis for the development of the working definition that will be adopted for the purposes RiskPACC.

2.3.2.2 Approaches followed in other EU-funded projects

Drawing on recent definitions, but also leveraging the previous knowledge advancements in resilience scholarship as explained above, several projects EU-funded projects have utilised definitions of resilience and community resilience to generate a framework for their activities (Table 2.1). RiskPACC belongs to a group of complementary EU-funded projects (LINKS, ENGAGE, BuildERS, CORE and RESILOC), funded under the same topic SU-DRS01-2018-2019-2020 – *Human factors, and social, societal, and organisational aspects for disaster-resilient societies,* following a legacy of previously completed projects focusing on enhancing resilience of cities, societies infrastructure etc (DARWIN, DRIVER, IMPROVER, ENGAGE, RESILENS, RESOLUTE, TACTIC, SMR). Therefore, after analysing a critical mass of different projects[16], the majority of resilience definitions utilised are derived from global frameworks as analysed above, and predominantly the UNDRR definition (RESILOC, BuildERS, DRIVER, ENGAGE) including a definition by the European Commission defining resilience as '*the ability of an individual, a community or a country to cope, adapt and recover quickly from the impact of a disaster, violence or conflict. Resilience covers all stages of a disaster, from prevention (when possible) to adaptation (when necessary) and includes positive transformation that strengthens the ability of current and future generations to meet their needs and withstand crises*'(BUILDERS).

Depending on their objectives and practical focus some projects used different approaches and conceptualisations of resilience from recovering and bouncing back from external shocks (IMPROVER, RESOLUTE. SMR) to the *'ability of the system or systems to survive and thrive in the face of a complex, uncertain, and ever-changing future'* in the context of critical infrastructure (RESILENS). Community resilience is directly addressed by some projects as well, mostly as the capacity of local communities to absorb the impact of external stresses and inherent conditions (IMPROVER) and mitigate, withstand, and recover from the impacts of a disaster or emergency, as well as to adapt or transform themselves to be less vulnerable to future disasters and emergencies (RESILOC). A very interesting and slightly different approach to the other projects was adopted by PREPARED, for which community resilience was conceptualised as the '*ability of society to adapt, e.g. take-up innovations; change behaviours etc., which depend as much on social mores, cultures, norms, practices and attitudes as on wealth'.* Finally, societal resilience was analysed in one of the projects (ENGAGE) as '*start[ing] with community involvement, but also with a pro-active approach at the level of public institutions, following and […] implies coordinated efforts and building synergies between multiple stakeholders (including decision-makers, local and national authorities, civil society, etc.), but also the population itself and the wider community*.'

[16] The majority of the SU-DRS01-2018-2019-2020 funded projects are still ongoing and hence for many of them the definition of resilience has not yet been communicated.

TABLE 2.1: DEFINITIONS OF RESILIENCE AND COMMUNITY RESILIENCE ACROSS EU-FUNDED PROJECTS

EU Project name	Focus of Project	Definitions of resilience and community resilience
RESILOC	1. Identify new strategies to better prepare communities against disasters and support policies on resilience 2. Increase the understanding of resilience in societies and communities 3. Innovate strategies to improve resilience	**Project definition of community resilience:** capacities of local communities as complex systems (involving the actions and interactions of local agencies, citizens, the built environment and critical infrastructures) to mitigate, withstand, and recover from the impacts of a disaster or emergency, as well as to adapt or transform themselves to be less vulnerable to future disasters and emergencies **SFDRR Definition:** the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of the hazard in a timely and efficient manner, including through the preservation or restoration of its essential basic structures and functions
BuildERS	1. Enhancement of European communities' social capital and resilience, in the face of the use of new technologies and media 2. Construct theoretical framework for how risk awareness, social capital, and vulnerability connect to overall work of resilience building. 3. Analyse the linkage between risk awareness, social capital, and vulnerability and the implications of those links on DRR and resilience.	**UNDRR definition**: the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of the hazard in a timely and efficient manner, including through the preservation or restoration of its essential basic structures and functions **IFRC definition:** the ability of individuals, communities, organizations or countries exposed to disaster, crises, and underlying vulnerabilities to anticipate, prepare for, reduce the impacts of, cope with and recover from the effects of shocks and stresses without compromising their long term prospects **EU definition**: the ability of an individual, a community or a country to cope, adapt and recover quickly from the impact of a disaster, violence or conflict. Resilience covers all stages of a disaster, from prevention (when possible) to adaptation (when necessary), and includes positive transformation that strengthens the ability of current and future generations to meet their needs and withstand crises **Project definition of disaster resilience:** processes of proactive and/or reactive patterned adjustment and adaptation and change enacted in everyday life, but particularly in the face of risk, crises, and disasters

DARWIN	1. Develop state of the art resilience guidelines and innovative training modules for crisis management Identify suggested and operational approaches to resilience	**No explicit definition adopted.** Over 300 definitions of disaster, community, urban and operational resilience mentioned in the Deliverable.
DRIVER+	1. Evaluate emerging solutions in three key areas: civil society resilience, responder coordination, and training and learning 2. Create a roadmap for innovation in crisis management and societal resilience	**UNDRR definition**: the ability of a system, community, or society exposed to a hazard to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.
emBRACE	1. Identify the key dimensions of resilience across a range of disciplines and domains 2. Develop indicators and indicator systems to measure resilience concerning natural disaster events 3. Model societal resilience through simulation experiments 4. Provide a general conceptual framework of resilience, 'tested' and grounded in cross-cultural contexts	**Project definition of community resilience (from a DRM perspective):** Community resilience is influenced by the processes and outcomes of disaster risk management activities (preparedness, prevention, response, recovery and reconstruction)
IMPROVER	1. Improve European critical infrastructure resilience to crises and disasters through	**Resilience:** capacity to bounce-back from external shocks, seeking to secure society from unpredictable systematic shocks by improving the evolutionary capacity, or fitness, of the population

	the implementation of resilience concepts 2. Use of social media and tech can to promote resilience	**Organizational resilience**: the capacity of organizations to make decisions and take actions as an organization in emergency situations. **Community resilience**: the ability of social system to respond and recover from disasters and include those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to reorganize, change and learn in response to threat (Cutter *et al.*, 2008) **Disaster resilience**: capacity of a system, community or society potentially exposed to a hazard to resist, absorb, accommodate and recover from disasters timely and efficiently
ENGAGE	1. Bridge the different ways of intervention to make communities more skilled in responding to disasters jointly 2. Make communities more resilient to disasters	**UNDRR definition**: the ability of a system, community, or society exposed to a hazard to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. **Societal resilience:** Societal resilience starts with community involvement, but also with a pro-active approach at the level of public institutions, following the paradigm that societal resilience implies coordinated efforts and synergies. Societal resilience implies coordinated efforts and building synergies between multiple stakeholders (including decision-makers, local and national authorities, civil society, etc.), but also the population itself and the wider community.
RESILENS	1. Increase societal resilience through the maintenance of CI functionality during a shock or stress event and contribute to the formulation and adoption of more resilient societal structures which can identify and respond to shocks and stresses. 2. Increase the ability of European economic and institutional systems to cope and respond in	**Project definition of resilience:** Resilience is the ability of the system or systems to survive and thrive in the face of a complex, uncertain, and ever-changing future. It is a way of thinking about both short and long-term cycles and long-term trends: minimizing disruptions in the face of shocks and stresses, recovering rapidly when they do occur, and adapting steadily to become better able to thrive as conditions continue to change. Within CI, the resilience process offers a cyclical, proactive, and holistic extension of risk management practices.

	the event of a disaster, attack or other security challenge. 3. Promote awareness of the importance of resilient CI in safeguarding economies, society and the environment.	
RESOLUTE	1. Develop a European resilience management guidelines to support the application of resilience in all CI sectors 2. Indexing the level of resilience and analysis of the resilience of systems at different special scales	**No explicit definition**: Resilience is a far-reaching idea and has attracted the attention of a wide range of scientific domains. The definition of the concept varies somewhat according to literature domains but bears on a common need to address high complexity, variability and uncertainty that increasingly challenges current risk management practices. Literature often denotes that within many of such domains the term resilience has been used mainly as leverage to re-launch previously existing arguments and views, under a merely renewed terminology. Nevertheless, literature shows that significant advances have been made in risk management approaches, tools and assessment, even if not always grasping the full extent of their implications towards coping with complexity and fast pace changing operations.
SMR	Deliver a Resilience Management Guideline to support city decision-makers in developing and implementing resilience measures in their cities.	**Project definition of community, societal or society resilience:** The capacity of individuals, communities or societies potentially exposed to hazards to adapt, be flexible, and bounce-back by resisting or changing behaviours, taking-up innovations, organising itself in order to continuously exist, reach and maintaining an acceptable level of functioning and structure. This capacity also covers the capability to combat social vulnerability, enhance perceived risk, sense of responsibility, and learn from the previous hazards which can be improved through education and training.
PREPARED 'Enabling Change'	1. Manage wastewater, drinking water and storm water more effectively. 2. Improve exploitation of existing infrastructures through real time control, new design concepts and guidelines.	**Project definition of community resilience:** The ability of society to adapt, e.g. take-up innovations; change behaviours etc., which depend as much on social mores, cultures, norms, practices and attitudes as on wealth

In general, community resilience in EU-funded projects has been largely analysed through a system-of-systems lens with communities understood as a component of a complex adaptive system. Adaptation and transformation are central in the conceptual understandings of community resilience, building on the foundations of ecological and resilience, while the importance of contextual characteristics of societies and cultural traditions and particularities are not explicitly addressed. However, while some of the projects, such as RESILOC, ENGAGE, SMR and PREPARED have clear definitions for community (or societal) resilience, many other projects merely analyse resilience in the context of their aims and objectives, thus frequently omitting a clear definition for more locally relevant resilience understandings.

In the context of RiskPACC, community resilience, along with disaster resilience and risk perception are fundamental terms, that need to be clearly and explicitly defined in order to secure the homogeneity of the project and the practicality and applicability of its outcomes. Therefore, in deliverable D1.1 we define disaster resilience as:

> the ability of an individual, community, region, or country to resist, adapt to, and recover from the impact of a hazard, either natural or anthropogenic. Enhanced resilience can be embedded into activities in all phases of the disaster cycle, and includes positive transformation that strengthens the ability of current and future generations to adapt to future crises, and survive and thrive as conditions change.

Here, we emphasise the fact that resilience covers all stages of a disaster and is not solely response and recovery, but also covers preparedness. In this context and following a thorough review of existing understandings of resilience in other EU-funded projects, we will attempt to move beyond existing definitions that either focus on local capacity building to enhance the ability to withstand and recover from adversities, or emphasise a relatively decontextualised system-of systems approach, to define community resilience. Therefore, RiskPACC's definition of community resilience, as it will be presented at this end of this chapter, will be strongly influence by ideas of human agency and active citizenship as well as the role of digital technologies in bridging the RPAG, and ultimately enabling local communities to respond to and recover from an external shock or inherent stress.

2.3.3 RE-DEFINING COMMUNITY RESILIENCE

2.3.3.1 Community resilience revisited

As individuals and communities are seen as the 'first line of defence against disasters', there has been a particular emphasis on advancing community capacities to cope with adversity. For example, inspirational stories of community resilience that emerged in the wake of Hurricane Katrina in 2005, perhaps most notably from the Vietnamese community, were used in the US National Academies *Disaster Resilience* Report (National Research Council, 2012) to illuminate how disadvantaged groups cut off from mainstream society can sustain strong internal ties that protect against some disaster impacts. It highlighted the importance of understanding culture and of working together to improve disaster resilience. Before Katrina struck, some 40,000

Vietnamese lived in relative isolation from US politics, culture and other local community groups in New Orleans and saw the storm as an opportunity to build on their already strong community bonds and make them even stronger. Before the storm, they had established community evacuation plans, coordinated through the local Catholic church, and after the storm the community worked together, drawing on collective skills to rebuild the area. This was in contrast to other surrounding areas that struggled to cope (Coaffee and Lee, 2016).

In more general terms this focus on the community level reflects ongoing rescaling and reconfiguration of resilience as a concept, practice and even a commodity. Resilience has becoming more civic, urban, domestic and personal and is having significant implications for the way in which disaster risk is managed (Coaffee et al 2008). However, current governance processes have largely excluded the ordinary citizen from feeding into discussions regarding new forms of community resilience. The public, until relatively recently, has been chiefly passive recipients within an increasingly controlled and regulated disaster response where the knowledge of professional and expert stakeholders appears to be overly privileged (Coaffee and Rogers, 2008). That said, with the reform of the strategic and technical aspects of emergency planning that in many locations proceeded September 11th almost complete[17], increased attention is now being paid to how individuals and a broad range of local communities might become more responsible for their own risk management. The common aim here, from a governmental perspective (including from CPAs), has been to develop 'community resilience', which might reinforce broader institutional security strategies. These have emerged based upon the more proactive concept of 'resilience' that placed a particular emphasis upon preparedness which stresses the need for *'anticipatory measures taken to increase response and recovery capabilities*' (McEntire and Myers, 2004, p.141).

For example, in the UK, and as a result of the 2004 Civil Contingencies Act (CCA), having a fit-for-purpose local governance infrastructure for resilience was made a statutory responsibility across all key public services. This involved not only the creation of Local Resilience Forums' but also a change in the way local government undertook emergency planning. Notably, viewed through the lens of community resilience, there was also a statutory responsibility for Government and their agencies to develop systems of communication for 'warning and informing' the public about the risks they faced and for helping develop 'community resilience'. Rhetorically this implies attempts to get citizens to play a role in developing their own resilience. For example, Paragraph 7.4 states that systems should be put in place to (House of Commons, 2004):

> maintain arrangements to warn, and provide information and advice to, the public if an emergency is likely to occur or has

[17] This was essentially viewed as a professional and technical response developed by 'experts' without any meaningful public debate

> occurred…(and) put in place arrangements to make information available to the public about civil protection matters'. [The Government believes] 'a well-informed public is better able to respond to an emergency and to minimise the impact of the emergency on the community. By informing the public as best they can, all organisations will build their trust. Part of this is also avoiding alarming the public unnecessarily.

2.3.3.2 From passive to active citizenship

Despite many municipal authorities and CPAs initially developing highly technical approaches to disaster resilience, over time far greater attention has been paid to attempts to increasingly develop a dialogue with individuals and community groups. Whilst this is increasingly seen by local level practitioners as a two-way process, much of the work at local levels has traditionally followed a more 'passive' model of the citizen as a 'subject' to be informed of appropriate actions rather than a stakeholder, with the same status as the partner agencies engaged in decision-making and response (Coaffee and Rogers, 2008). This assumption will be tested further as RiskPACC unfolds, through analysis in D1.2 and D2.2 and through the exploration of the seven case studies.

However, despite all the talk of how resilience will transform disaster risk governance and engage with local communities, resilience approaches are still often premised on a conventional command-and-control approach steered from central government, with an expressed aim of developing a better adaptive capacity to adverse events. Notably, in the UK enhancing community resilience was illogically driven from the top of government through a *Strategic National Framework on Community Resilience* that was released in 2011(Cabinet Office, 2011). Here, community resilience was projected through the lens of emergency planning with '*communities and individuals harnessing local resources and expertise to help themselves in an emergency, in a way that complements the response of the emergency services*'. This was also seen in terms of a '*commitment to reduce the barriers which prevent people from being able to help themselves and to become more resilient to shocks'*. Similarly, the Australian Local Government Association (2021) defines community resilience as '*the sustained ability of communities to withstand, adapt to, and recover from adversity'* arguing that *'a resilient community is socially connected and has infrastructure that can withstand disaster and foster community recovery'*

In contrast to such definitions, in Canada the responsibilisation of individuals has become significantly central for disaster response. Here, emergency preparedness guides ask people to *'be prepared to take care of yourself and your family for a minimum of 72 hours [if an emergency happens because] it may take emergency workers some time to reach you' (Canada, 2012, p.3)*. Similarly, US states such as New Hampshire and California have launched public awareness campaigns and websites to increase disaster preparedness activities, such as assembling household emergency kits (Patel et al., 2017).

As we have partly analysed in 2.1.4, the responsibilisation of citizens has been widely criticised by resilience scholars as the emphasis shifted towards citizenship being 'active' with the self-regulation of conduct within communities, where, in the development of community resilience or the 'responsible citizen' advice offered by public authorities are likely in the future to increasingly pass on the responsibility of emergency response to communities and individuals as a supplement to more detailed strategic and institutional strategies. Here, the way in which the State communicates risk to citizens has significant implications for harnessing or allaying fears about the current level of risk from multiple forms of disaster and disruption as well as inviting citizens to be involved in managing risk as a logical step towards ensuring our own safety (Mythen and Walklate, 2006, p.133). This is of course a huge challenge, and its difficulty should not be underestimated. As with mainstream community planning and community cohesion processes, the public is not homogenous to engage with and many conflicting viewpoints will emerge as to what is acceptable and what is not regarding countering risk. Engagement with the public in this sense needs to be sensitive to an array of different social contexts and be undertaken in a culturally appropriate manner. This will also have broader and important implications for the definition and framework of civil liberties and responsibilities within and through citizenship - both of state to citizen and citizen to state - in the context of complex loyalties and hybrid identities for key local communities (Coaffee and Rogers, 2008).

2.3.3.3 Community resilience in the context of RiskPACC

Ideas of active citizenship and horizontal and vertical communication between CPAs and community groups that challenge conventional top-down modes of disaster risk governance and one-way communication processes (such as brochures to inform citizens about existing risks and preparedness measures) constitute the spinal cord of RiskPACC. As we argue above, societal participation is moving towards the core of new approaches to resilience governance pushing for more holistic disaster risk management approaches. In this sense, overall disaster resilience is seen as a co-creation process involving a shared dialogue between different stakeholders, including local communities. The building of such resilience is about new forms of joined-up governance which will be '*most effective when it involve[s] a mutual and accountable network of civic institutions, agencies and individual citizens working in partnership towards common goals within a common strategy*' (Coaffee, Murakami Wood and Rogers, 2008). Involving citizens does thereby enhances capacities and capabilities of disaster resilience, potentially allowing for the empowerment and consideration of marginalised groups in the development and implementation of assessments and measures, and thus producing more just outcomes (Ziervogel *et al.*, 2017). In this context, the working definition of community resilience to be utilised in RiskPACC is:

> The capacity of communities and individuals to interact with their surrounding physical and built environment, comprehend risk and actively mobilise activities to enhance

> societal connectedness including the use of digital technologies, to co-produce knowledge and build two-way communication channels with the CPAs and other local stakeholders to cope with, adapt to, prepare for and recover from, external perturbations or inherent stresses.

This working definition especially emphasises human agency and active citizenship as well as the importance of communication channels and 'trust-ties' between communities and other local stakeholders. Moreover, it highlights the need for understanding risk and the leveraging digital technologies to support the disaster preparedness and response phases and is operationalised in RiskPACC chiefly through the bridging of the RPAG. This will require a more refined understanding of human factors and risk perception amongst CPAs (see D.1.1) and communities, to which we now turn.

3 THE ROLE OF COMMUNITY RISK PERCEPTION

3.1 Emerging approaches to Risk Perception

In RiskPACC, the analysis and integration of human factors plays a crucial role in (i) effectively incorporating citizen-driven approaches, (ii) closing the RPAG, and (iii) determining the effectiveness of translating risk awareness and perception into action in a range of contexts. Vulnerabilities to disaster risk differ among citizen groups and are related to *'economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in'* (PreventionWeb, 2015). For example, elderly populations are particularly vulnerable to heat waves (Cheng *et al.*, 2018), which has also been shown for migrant workers (Messeri *et al.*, 2019). The role of these human factors is also pivotal in analysing importance of risk perception for enhancing disaster resilience and aligning CPA policies and citizen needs on the ground.

As we have explored in the previous chapter, resilience is influenced by a range of different stakeholders in a given community. Whilst much psychological research has focused on individual perceptions (Grothmann and Reusswig, 2006; Zaalberg *et al.*, 2009; Bubeck *et al.*, 2012), actions and resilience enhancement measures, recently arguments have been made for the critical importance of collective risk awareness and perceptions (Becker *et al.*, 2012) as well as the effectiveness of collective action for improving community resilience (Wamsler, 2014). Moreover, risk perceptions can be viewed as a key contextual factor that CPAs should consider when deciding if a risk needs to be mitigated and if so, how this should be best done in conjunction with local communities.

Conventionally, studies of risk perception undertaken by psychologists on human behaviour have examined the judgments people make when they are asked to evaluate hazardous and dangerous activities and technologies. The goal has been to not only inform risk analysis and policy-making by better understanding and anticipating public responses to hazards, but also to enhance risk communication amongst the public, experts, and decision-makers. Such psychological understandings of risk perception theory have examined the particular heuristic approaches and biases individuals employ to interpret the amount of risk in their environment. Most psychologists agree that risk perceptions are common sense reasoning and are not completely irrational gut reactions, but instead based on *'relatively consistent patterns of creating images of risk and evaluating* them' (Renn, 2008, p.93). These largely cultural patterns - so called qualitative evaluation characteristics (Slovic, 1992) – further *'describe properties of risk, or risky situations going beyond the two classical factors of risk assessment, on which risk is usually judged (i.e. level of probability and degree of possible harm)'* (Renn, 2008, p.94).

Such qualitative evaluation characteristics also involve various social and cultural factors that lead to inconsistent evaluations of risk in the general public contributing to the gap between expert views of risk and public perceptions of risk across a range of contexts (Slovic, 2000). However, in the psychology literature there is disagreement

concerning which specific factors most determine risk perception. Some models of perceived risk assume that risk assessment is based on the calculation of outcomes nd their probabilities (Neuman and Politser, 1992; Jia, Dyer and Butler, 2008), but in everyday life such quantitative information about probabilities and consequences is rarely available or it is very difficult to acquire and process (Sobkow, Traczyk and Zaleskiewicz, 2016). Consequently, the perception of risk and risk-taking behaviour (action) is often viewed the result of gut feelings (Skagerlund *et al.*, 2020), past experiences (Traczyk and Zaleskiewicz, 2016), or anticipated emotions. As Renn (2008, p.21) confers, *'there is a clear consensus in the literature that the intuitive understanding of risk refers to a multidimensional concept that cannot be reduced to the product of probabilities and consequence'*.

The wider literature on how people think about and respond to risk, over a significant period of time, tells us that better understanding risk perception is a key factor in closing the RPAG. Arguably, a partial understanding of risk perception and subsequent action often leads to well-intended risk management and resilience policies that may, in practice be sub-optimal or ineffective. Understanding individual psychology and how it affects intention to act, and actual behaviour, must also be set in wider social contexts. This focus upon individual perspectives also showcases a weakness in such psychological approaches given the wide range of contextual and intuitive factors underpinning risk perception and the difficulty of aggregating individual preferences together in order to find common expected patterns that can inform resilience policy making (see for example, Jasanoff, 2004) Other factors that influence the propensity of individual or community members to act must also be accounted for combining psychological, psychosocial, sociological and cultural approaches and methods, none of which can solve this problem in isolation.

We know from many psychological and behavioural studies that prior experience of disasters has an impact on individuals' risk perception but there does not seem to be a causal relationship that links that risk perception to personal action; and that includes the risk perceptions of both citizens and CPAs that are often shown to be widely divergent, and impact subsequent actions undertaken on risk mitigation, reduction and adaptation. For example, Ashley Ross in her book *Local Disaster Resilience* (Ross, 2015) illuminated how perceptions of resilience amongst emergency managers on the U.S. Gulf Coast were often misaligned with realities on the ground. What is crucial here is a better alignment of risk perceptions between CPAs and the communities, in order for both the CPAs to become more aware of the adaptive capacities of local communities and how they understand their own risks and vulnerabilities, and for community groups to better understand how their actions can complement the actions of CPAs. As Ross (2015, p.172) noted the *'examination of the alignment of perceptions and realities of resilience can help us better understand the attributes of those communities that have greater potential for effectively engaging in the adaptive process'*.

The following section is divided into two main subsections, which explore how a greater understanding of risk perception can help in narrowing the RPAG. This will firstly highlight the way in which conceptualisation of risk perception in the extant

literature in disaster management has shifted from a focus upon psychological approaches towards psychosocial and sociological approaches, as better understanding risk perception in its social and cultural context has been seen as increasingly important. Second, we focus on the importance of risk perception for effective disaster resilience and the building of enhanced community resilience at the local level.

3.2 Risk perception and community disaster risk management

In his now classic (1987) paper on of risk perception - which he defined simply as *'the judgments people make when they are asked to characterize and evaluate hazardous activities and technologies'* (p.280) - Paul Slovic argued that psychological research on risk perception was conventionally based on empirical studies of probability assessment, utility assessment, and decision-making processes and led to '*the discovery of a set of mental strategies, or heuristics, that people employ in order to make sense out of an uncertain world'* (ibid, p.281). He however, highlighting that the validity of such experiments did not necessarily conform to real world experiences, arguing that:

> Although these rules are valid in some circumstances, in others they lead to large and persistent biases, with serious implications for risk assessment. In particular, laboratory research on basic perceptions and cognitions has shown that difficulties in understanding probabilistic processes, biased media coverage, misleading personal experiences, and the anxieties generated by life's gambles cause uncertainty to be denied, risks to be misjudged (sometimes overestimated and sometimes underestimated), and judgments of fact to be held with unwarranted confidence (ibid).

More generally, in the field of psychology, risk perception has been conventionally viewed as the subjective evaluation of risk and is as such the counterpart of 'objective' risk assessments through probability and consequences. Risk perception can be regarded as a (mostly subconscious) process formed by two broad types of input. *First*, there is a cognitive path to risk perception, which is informed by certain cues and information (for example through governmental information or in case of an event by visual signs like smoke and smell), background knowledge and actual contextual information. This path is typically used by experts who generally assess risks by calculating probability and consequences. However, much less is known about the *second* path; psychological determinants of people's affective reactions to risk (Slovic, 2000; Loewenstein *et al.*, 2001; Sobkow, Traczyk and Zaleskiewicz, 2016). Perceptions of lay-people are particularly influenced by this affective path: if one worries a lot about a particular risk for example, risk perception will be high. Both cognitive and affective paths can operate in parallel and have been shown to have distinct influences on behaviour. Overall, perceptions are not static but influenced by a range of factors such as hazards experience but also knowledge gained, for example, through risk communication as well as cultural context and belief about

responsibilities. For example, if people at risk believe that the state should be responsible for their protection, they are unlikely to take responsibility for preparing and protection themselves (Geaves and Penning-Rowsell, 2016).

Until recently, research on risk perception has remained largely in the domain of psychological sciences, with important contemporary contributions to our current understanding emerging from geography, sociology, and other social sciences, which Lechowska (2018, p.1342) emphasises as *'a sociological aspect of the phenomenon but its economic and spatial dimensions as well'*. In Lechowska's paper on flood risk perception, the definition of Bubeck *et al*., (2012) and Becker *et al.* (2012) is used, where *risk perception is defined as 'an assessment of the probability of hazard and the probability of the results (most often—the negative consequences) perceived by the society'*. By contrast, Wilson, *et al*. (2019) contradict this, arguing that *'decades of research identify risk perception as a largely intuitive and affective construct, in contrast to the more deliberative assessments of probability and consequences that form the foundation of risk assessment'* (p.1). This draws on a well-known critique of risk perception research that argues that this is a complex process as a result of the difficulties individuals have in interpreting low probabilities when making decisions, as well as how the media communications that can amplify or downplay risk.

To better understand risk perception, it is important to understand the definition of 'risk'. In the context of disasters or hazards, the UNDRR defines risk as *'the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity'* (UNDRR, 2020). Conversely, from a social science perspective, Dzul-Rosado *et al.* (2020) define risk as '*constructed through a process of perception, interpretation, understanding, and action from the immediate reality of persons' (p.1858)* (see also Douglas, 2013). In their paper on understanding the risk perception from traditional knowledge of Mayan farmers, Dzul-Rosado *et al.* (2020) further aligned this socially constructivist definition of risk with Montello's (1997) definition of perception as an '*implication of awareness in the sensory register'* arguing that risk is a cognitive or biological category with cultural and social origins (ibid). Pairing both risk and perception together, (Mañez *et al.*, 2016) also noted that risk cannot be truly understood without understanding it *'through the perception and meaning given to it by the people' (p.53)*. Risk perception is therefore not homogenous amongst populations, instead it is determined by a multitude of contextual factors as Figure 3.1 depicts.

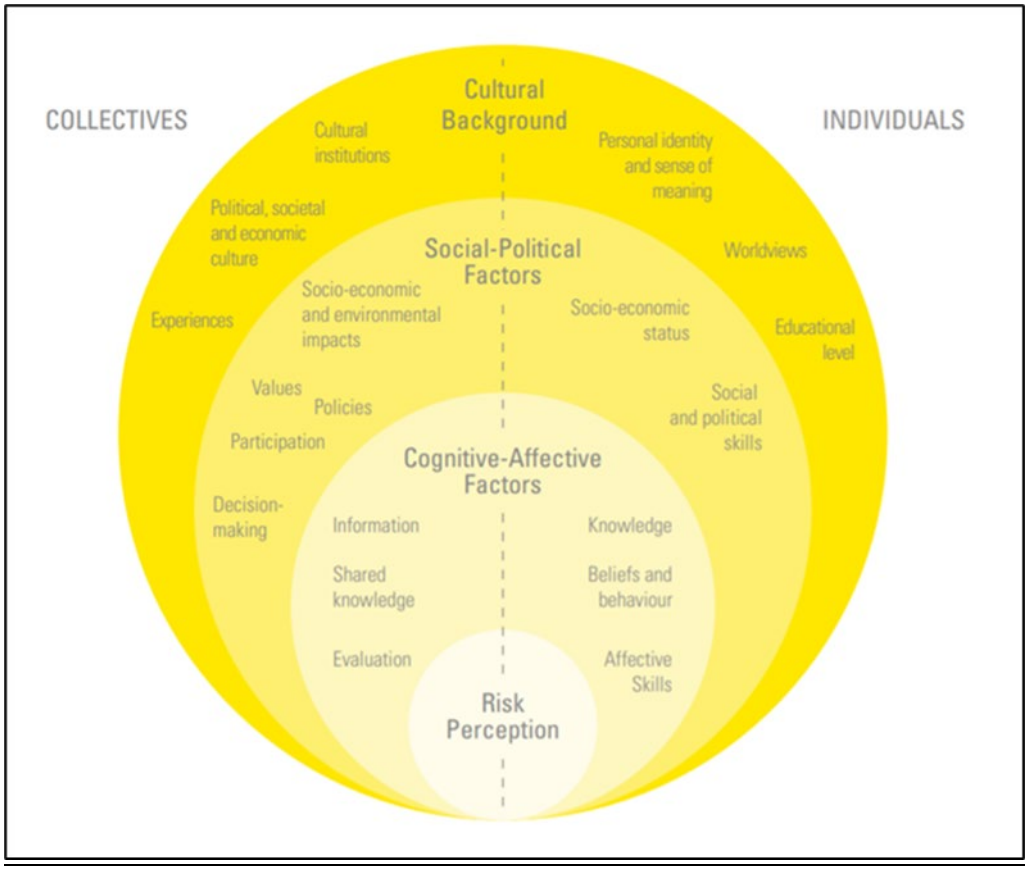

FIGURE 3.1: FACTORS THAT DETERMINE RISK PERCEPTION (Mañez *et al.*, 2016)

In sum, risk perception plays a role in the response to a threat and relates to the '*beliefs about potential harm or the possibility of a loss […] [it] is a subjective judgment that people make about the characteristics and severity of a risk'* (Darker, 2013). A combination of cognitive-affective (e.g., information/knowledge), social-political (e.g., socio-economic status, values), and cultural background (e.g., education, worldviews, political, societal and economic culture) factors at individual and community levels are suggested to influence risk perception (Mañez *et al.*, 2016).

However, it is widely accepted that risk perception alone does not influence citizens to take action in disaster risk management. The Protective Action Decision Model (PADM) advanced by Lindell and Perry (2004, 2012) (see Figure 3.2) is a framework outlining the different factors, in addition to risk perception, that influence the likelihood of a person undertaking protective (i.e., preparedness) actions. Research examining the PADM has resulted in recommendations for communication across the different disaster resilience phases to meet different goals (e.g., long-term hazard adjustment, encouraging disaster response), and communicate with ethnic minorities (Lindell and Perry, 2004).

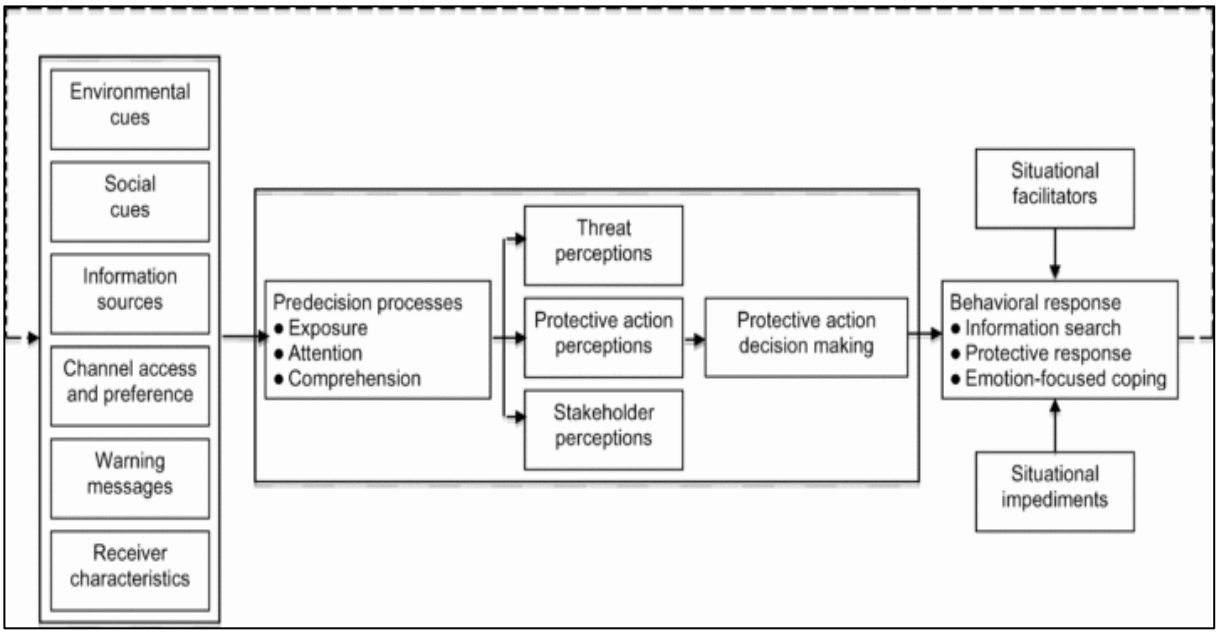

FIGURE 3.2 INFORMATION FLOW IN THE PROTECTIVE ACTION DECISION MODEL (**Lindell and Perry, 2012**)

Despite the utility of this model, the creators acknowledge that not all relationships among variables in the PADM have been rigorously tested and that *'there remain significant gaps in the research literature'*. Some aspects of hazard adjustment adoption have not been studied at all, and where findings have been reported, many have not been replicated. Thus the level of confidence that can be placed in empirical conclusions is lower than is desirable (Lindell and Perry, 2012). In subsequent RiskPACC deliverables and Work Packages (especially WP4) we will build on such literature and advance/stress test this model, notably testing it in a multi-hazard context and integrating with it existing practices and tools.

3.3 From psychological to sociological approaches

Within the emergent literature on risk perception, and especially those related to disaster management, there has clearly been a shift from psychological approaches to those emphasising social and cultural characteristics. Risk perception plays an important role in DRM (Mañez *et al.*, 2016) with the literature showing that it largely influences risk management (action) which as a result, determines whether disaster managers are successful in reducing vulnerability (Bubeck *et al.*, 2012). This is reiterated by Cori *et al.* (2020, p.2) who state that risk perception within the emergency/disaster management sector has become increasingly relevant with the recognition of '*beliefs, knowledge, values, and attitudes which influence not only decisions but also behaviours'*.

There are several recent critiques of risk perception which underpin this more sociologically-informed view and hence contribute to the RiskPACC approach. *One*, concerns the potential of risk perception to be reduced to mere psychologism in which social phenomena are understood in terms of the mental characteristics of individuals

(Gold, 2020). Here, risks are always situated in a social context with sociologists maintaining that society is a social phenomenon and not reducible to an aggregation of individuals (Lidskog and Sundqvist, 2012, p.1005). *Secondly*, risk is not reducible to an objective, technical/expert/scientific characterisation which is often placed in superior position to a lay understanding in many accounts (Wynne, 1996) and does not acknowledge socio-political and cultural contexts sufficiently (Lidskog and Sundqvist, 2012, p.1006), especially the uncertainties of late Modernity's 'risk societies' (Beck, 1992). *Thirdly*, Wachinger *et al.* (2013) note the paradox in the assumption that '*it is assumed that high risk perception will lead to personal preparedness and, in the next step, to risk mitigation behaviour. However, this is not necessarily true'* (p.1049). Appleby-Arnold *et al'*s (2018) study in Malta reinforces this view where '*disaster risk perception showed only weak links to preparedness intentions, supporting other published results. Focus group discussions revealed several cultural traits, most prominently strong family values and social cohesion' (p. 37).* Indeed, an early critique by Bunting and Guelke (1979) of a particular branch of perception research in behavioural geography, claimed *'[f]indings associated with the study of images, preferences, and attitudes to environmental phenomena show no direct or self-evident relationship to overt ongoing behaviour' (p. 455-456).* Despite this strong critique, Bunting and Guelke did not seek to reject perception work but rather to highlight some limitations and promote developments to address them. The often unacknowledged assumption of a simple causal link between perception and behaviour (action) is at the heart of the RiskPACC endeavour to close the RPAG where viewing disaster and community resilience as social constructions is promoted and interrogated (see for example Norris *et al.*, 2008; Lucini, 2014).

3.3.1 RISK PERCEPTION AND PLACE

There also appears to be a tangible, if largely unexplored, link between risk perception and place. More specifically, where people live and their attachment (or detachment) from that place can have an influence on their risk management perceptions and processes. Place attachment can account for seemingly paradoxical outcomes whereby some people at risk of flooding choose to stay and risk flooding rather than leave or be faced by flood defence structures which might separate them, even if only visually, from the landscape of their attachment (Fordham, et al, 1990); they make a risk-environment trade-off , for example by rejecting structural risk mitigation measures in order to preserve a sense of place (Fordham, 1991). Gold (2020) from a behavioural geography perspective further notes that *'response to natural hazards is mediated by culturally transmitted attachments to place...Symbolic and emotional attachments of these places, coupled with the economic advantages of living there, are more than sufficient to offset the risks involved' (p.228)*.

Recent research finds that although place attachments are threatened by disasters, residents often choose to remain in or return to their homes afterwards (Brown and Perkins, 1992; Binder *et al.*, 2013; Jamali and Nejat, 2016; Clarke, Murphy and Lorenzoni, 2018; Greer *et al.*, 2020). For example, after Hurricane Sandy, some residents were offered government home buyouts so they could relocate to places outside of typical hurricane paths, with the attachment to place being central to

residents' decisions on whether or not to relocate (Binder *et al.*, 2013). In such situations, *'place identity refers to the process wherein physical and symbolic aspects of a place unite in a person's sense of self'* (Woodhall-Melnik and Weissman, 2021, p.3).

In a different risk context, and taking local vulnerabilities into consideration, Bertoldo (2021) examined how local communities across the Mediterranean (in Italy, France and Morocco) have learned to adapt to their environment using tacit knowledge and in so doing highlighted the need to understand how risk is conceptualised by local communities, and how risk adaptation and preparedness make sense contextually (see also Solberg, et al, 2010; Joffe *et al.*, 2013; Luís, et al, 2018). Bertoldo (2021) also asserts that institutions which govern natural risk management fail to understand local perceptions of risk and instead generalise it, ultimately failing fully understand 'local psychosocial dynamics' related to:

1. Knowledge diversity;
2. Local history and trust;
3. Shifting risk rationalisations;
4. Risk objectification'.

Consequently, risk must be translated to a given context where resilience and preparedness already exist locally (Castro and Mouro, 2011). This echoes the classic work of Slovic on differential expert/lay-person risk perceptions, and Lupton on risk, where, she notes, *'through personal embodied experiences and expert knowledges one can observe how risk is embedded and understood within a community'* (Lupton, 2013, p.45).

3.3.2 Risk perception and the COVID-19 crisis

Most recently, and adopting a socio-cultural approach to contextualising risk during the COVID-19 pandemic, Lloyd and Hicks (2021) argue that placing emphasis on local communities and community boundaries further draws attention to how conceptions of risk are understood and shared, as opposed to individualistic views. More broadly, and in light of the ongoing global health crisis, Cori *et al.* (2020) observed that the COVID-19 pandemic has *'shaken the foundations of public health governance all over the world' and has driven a need for researchers to apply established theories of risk perception to improve health risk communication, build trust, and contribute to collaborative governance' (p.1).* Drawing on similar conclusions, Motta Zanin *et al.* (2020) suggests that the differing risk perception towards COVID-19 and any other biological hazards therefore plays a significant role in the response to health emergencies, which in turn impacts risk management and risk communication strategies. More specifically, they identified that the influence of the mass media (including social media) played a significant role in the public's perception of health risk. As people usually make decisions based on their risk perception as opposed to the effective risk, Motta Zanin *et al.* (2020) further argued that the influence of the media assisted in generating a greater sense of the public's perception of health risk, which in turn played a key role in the adoption and acceptance of safety measures, and the decisions the public made. This was

reiterated by Wise *et al.* (2020) who stated that clear communication of risk often aids the development of accurate risk perception, which in turn facilitates engagement in proactive behaviours. Similarly, Dryhurst *et al's.*, (2020) global assessment on the changes of risk perception of COVID-19 identified that experiential and socio-cultural factors explained the variance and changes in risk perception. This was consistent with existing literature on "risk as analysis vs risk as feelings", where having contacted the virus *'engages the affective experiential system which is known to be more dominant in processing risk under these conditions'* (Loewenstein *et al.*, 2001). This study further identified that gender also impacted risk perceptions of the virus. Similar to that of other studies on risk perception, gender and hazards (see for example, Kung and Chen, 2012), Dryhurst *et al*'s (2020) study also identified that males were uniformly associated with lower risk perceptions, despite being statistically at higher risk of contracting the virus.

3.4 Towards a better understanding of community disaster risk perception

While a transition in the study of risk perception from a psychological to sociological lens has taken place, most research to date still focuses on general psychological mechanisms of risk perception with far less attention paid to socio-economic and cultural aspects. Consequently, current DRM/disaster resilience practice is still far from reaching a point where practitioners can readily adapt operational strategies based on an understanding of the risk perception and awareness of particular communities. For example, it is widely accepted that improvements to knowledge (including factual information) can influence risk awareness, perceptions and behaviour in the pre-event phase. It is, however, only one aspect that determines whether people at risk are likely to actually take precautionary measures and to respond to emergency warnings (Weinstein, 1989; Grothmann and Reusswig, 2006; Siegrist and Gutscher, 2008; Bubeck *et al.*, 2012). Factors such as hazard exposure, education, income, age, gender, ability to understand the information being communicated, the assessment of the efficacy of specific behaviour, as well as the resources available for taking action also influence whether and which action is taken (see for example, Cutter and Emrich, 2006; Blaikie *et al.*, 2014; Shreve *et al.*, 2016). As Slovic (1987) illuminated over thirty years ago:

> Perhaps the most important message from this research is that there is wisdom as well as error in public attitudes and perceptions. Lay people sometimes lack certain information about hazards. However, *their basic conceptualization of risk is much richer than that of the experts and reflects legitimate concerns that are typically omitted from expert risk assessments*. […] As a result, *risk communication and risk management efforts are destined to fail unless they are structured as a two-way process. Each side, expert and public, has something valid to contribute. Each side must respect the insights and intelligence of the other* (p.285, emphasis added).

Here a key policy and risk governance questions emerges about how to think through and engage with risk perception when different actors and the public have differential opinions and viewpoints regarding risk, different degrees of risk acceptance, and hence divergence with regard to the appropriateness of risk reduction actions to take.

Within the forgoing context, and in harmony with the other WPs of RiskPACC (mainly D1.1) we therefore adopt the following European Environment Agency (2019) definition of risk perception as a working definition for RiskPACC:

> Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed are seen to resolve the problem.

Beyond a sole focus on risk perception in disaster and community resilience, a key component must be an understanding of the *risk context* (events and policies) and environmental conditions and constraints. Therefore, it is important to situate people in their socio-political/community context, instead of merely considering them as individuals. Through this perspective, we would be better able include in our analysis an understanding of the demographics of the location and the extent to which there has been change and disturbance such as in-migration, out-migration, the age balance of a community, gender, etc. that also contributes to the resources (natural/environmental, physical, financial, human, social, political and cultural assets/capital) available to people to act. More directly, it is also important to understand the historic and current risk reduction relationships between CPAs and the citizens they serve. Here, trust is known to influence the degree to which citizens will believe (and act upon) communications from CPAs; if there have been past failures to respond or deliver what citizens expect from CPAs, then this can colour how, and to what extent, citizens will engage.

The ways (tools and methods) that CPAs engage with citizens can also affect the level of response. Citizens are diverse and one method will not suit everyone. If CPAs are constrained by resource availability and by institutional culture to communicate in particular ways, then some citizens may be excluded or dissatisfied. Developing a constructive dialogue and participatory ethos can significantly aid overall disaster resilience. As Wachinger *et al.* (2013) argued in relation to what they referred to as a risk perception paradox, *'public participation measures are probably the most effective means to create awareness of potential disasters, to enhance trust in public authorities, and to encourage citizens to take more personal responsibility for protection and disaster preparedness' (p. 1063)*. In the next section we will explore some emerging tools and methods that enable the capturing and communication of risk perception from individuals and communities to CPAs and vice versa, facilitated by the accentuated digital revolution age we are experiencing.

4 CITIZEN GENERATED DATA FOR ENHANCING RESILIENCE

After exploring the extant literature on issues around community resilience and risk perception, the next step in bridging the RPAG for RiskPACC is to better understand the potential of digital technologies, and citizen generated data in more detail, to support this process. As we have already showcased in the previous chapters, the analysis and integration of human factors is central for the effective translation of risk awareness and perception into action, nurturing community resilience and ultimately enhancing disaster resilience. In this context, this chapter leverages the potential of citizen generated data with a view to incorporating this understanding in the inventory of tools and practices and the overall design of the framework and methodology. This builds on the RiskPACC co-creation approach in an attempt to ensure that human factors are not only analysed at the outset but are also central to the product design and implementation stages. This is especially important in the context of the enhanced use of social media and other digital technologies, which are widely used to engage citizens in a more active way, especially in the preparedness and response phases of the disaster risk cycle. According to Goodchild (2007) this engagement generally occurs through:

1. 'Pushing out' information from a central place or command-and-control centre to people in the field that are connected to it,
2. 'Pulling in' information, using its network of connected people to supply information or enhance situational awareness, e.g., on damage that has occurred, or current flood levels,
3. 'Crowdsourcing', to monitor the general situation by plugging into the world-wide online community and seeing what other people are talking about,
4. Volunteered Geographical Information (VGI), where data is provided voluntarily by individuals who often pursue micro-tasking as a process of breaking down large tasks into very particular smaller tasks. This can be, for example, the assessment of damage via pictures or tracking river levels.

The use of modern ICT technology and social media platforms has had an unprecedented impact upon crisis management and fundamentally changed how we prepare communities and support them in responding to and recovering from disasters (Anson, 2017). For example, they allow advanced system monitoring, improved analytical capabilities, better coordinated information flow between multiple public emergency-response agencies, and better and faster two-way communication with the public. Social media in particular, has proved an increasingly powerful tool for accessing, managing and controlling information and communication since the first 'social media disaster' - the Haiti earthquake of 2010 (Yates and Paquette, 2011; Camponovo and Freundschuh, 2014). In relation to crisis management, social media allow responders to either retrieve information from, or send information to citizens while they simultaneously allow CPAs to interact with a range of civil society groups,

and provide a monitoring and intelligence gathering function at all unfolding phases of a crisis (Alfarrarjeh *et al.*, 2017). In the face of communication breakdown social media can also serve as a substitute for community interaction (Le Roux and Van Niekerk, 2020), yet to be effective, their use, as well as the use of other digital technologies, needs to be woven into the fabric of daily routines so that if a crisis does occur, everyone is already familiar and comfortable to engage and make use of them. Furthermore, protocols and tools need to be in place to assess the veracity and reliability of the incoming data and determine the spreading of rumours or misinformation.

The use of crowdsourcing and social media for disaster risk response is growing within the context of EU-funded project landscape as well. For example, the LINKS[18] project published a detailed knowledge-base on disaster vulnerability, acknowledging the potential of Social Media and Crowdsourcing (SMCS) to help underrepresented groups become visible and less susceptible to disaster impact (Bonati, 2020). Building on this legacy, the scope of this section is to explore the different pathways and methods through which ICT and digital technologies in general can support citizen and community engagement and help bridging the RPAG with the CPAs, in accordance with the scope of RiskPACC. To achieve this, we begin by exploring different forms of citizen engagement and citizen generated data in existing literature, drawing on examples from humanitarian response (neogeography and Volunteer Geographic Information) and disaster resilience (gamification). Later, in this section we connect the utilisation of such digital technologies to the processes of enhancing disaster and community resilience.

4.1 Forms of citizen engagement and citizen generated data

Neogeography concepts of citizen generated data are revolutionising the way spatial information is generated. Traditionally, cartographic activities have been performed by the elite few with formal training and the bureaucratic authority to make maps (Monmonier, 2018). In recent times, supported by the advent of the internet and the development of and increasing access to web and mobile technologies, particularly Web 2.0 and Global Positioning Systems (GPS), citizens are no longer just consumers, but also producers of spatial content (Antoniou, 2017). Whilst citizen generated data have been employed in a variety of use cases, the accentuation of natural and anthropogenic hazard events has put additional emphasis on the need for improving community resilience through citizen engagement for effectively managing disaster risk. In this endeavour, the provision of accurate and comprehensive situational information to emergency agencies and CPAs about the reality on the ground is paramount for quick response and de-escalation of disaster impact. Citizen generated data has emerged as a significant source of information to support community resilience, and enable communities to resist and adapt to the uncertainty and precarity of modern life (Horita *et al.*, 2013). The term citizens here refers to the

[18] The full name of the project is: LINKS: *'Strengthening links between technologies and society for European disaster resilience'*.

altruistic individuals motivated to help outside the hazard-prone or affected areas, as well as to the affected individuals themselves.

4.1.1 DIFFERENT UNDERSTANDINGS OF VGI

First, it is imperative to address an existing terminology confusion within extant literature, as several terms are used to describe citizen participation in data generation. Citizen science, crowdsourcing and VGI are the most commonly occurring terms in the literature, and are often used interchangeably. Crowdsourcing is the overarching term referring to the input of expertise by several volunteers to jointly develop a product or solution. While citizen science and VGI are forms of crowdsourcing, the two main differences are that (i) citizen-science involves participation in achieving a set of predefined scientific objectives, while VGI does not have to be scientifically motivated, and (ii) VGI always involves spatial information, which is not mandated in citizen-science (Haworth *et al.*, 2018). In this chapter, VGI is adopted as an umbrella term for georeferenced information voluntarily created by citizens (Goodchild, 2007), categorised on the basis of their active or passive mode of collection (See *et al.*, 2016). Active modes of data collection involve participation with complete knowledge of contributing data for a specific purpose, while in passive modes, also referred to as involuntary Geographic Information (iVGI), citizens may voluntarily provide geotagged information (e.g., via social media), but are unaware of the complete usage ramifications at the time of contribution (Papapesios *et al.*, 2019).

In the past few years, we have witnessed the rise of innovative uses of passive VGI, predominantly in relation to social media, a migration from passive efforts to assembling a network of like-minded volunteers for a specific task, and the integration of passive VGI data to other data sources for more robust disaster risk management frameworks (Cervone *et al.*, 2017; Said *et al.*, 2019). Multimedia data (text, pictures and videos) derived from online social networking platforms like Twitter, Facebook, Flickr, Instagram etc. are utilised to perform geo-sentiment (Alfarrarjeh *et al.*, 2017), real-time and historic (trend) analysis by organisations such as PublicSonar[19], FloodTag[20] and MediaEval[21] to gage public perceptions and obtain a semantic abstract of the dynamics of disasters. Regarding the migration to more active VGI efforts, platforms such as Zooniverse[22], MapSwipe[23] and OpenStreetMap (OSM) Tasking Manager[24] coordinate the involvement of volunteers and collaboration of groups to perform tasks, foster active and broader networking of participants and accelerate people-powered research. Data derived from social media are often

[19] https://publicsonar.com/

[20] https://www.floodtags.com/

[21] https://multimediaeval.github.io/

[22] https://www.zooniverse.org/

[23] https://mapswipe.org/en/index.html

[24] https://tasks.hotosm.org/

integrated with other data sources, such as satellite imagery to augment vulnerability and damage information during and after disaster events, leading to faster, more concise and well-equipped responses (Cervone *et al.*, 2017).

Irrespective of the form of VGI practised, several limitations impede the efficient use and assimilation of citizen generated data. In more active forms of VGI, especially in scenarios where specialised expertise is required to complete a task, issues related to efficient ways of comprehensively instructing and training volunteers to create user-centred tool designs that would enable them to be more succinct in risk and damage categorisation and merge, authenticate, evaluate and translate information gathered by the citizens into actionable support, emerge. Kerle and Hoffman (2013) proposed the use of Cognitive Systems Engineering (CSE), to efficiently capture the core needs of the principal users of a VGI solution, optimise volunteers training methods and efficiently merge volunteers' data contributions into a holistic product, through an iterative process, involving relevant stakeholders (volunteers, CPAs, software engineers, cognitive systems engineers and instructional designers). Here, the resulting product should consist of intuitive user-centred designs and functionalities that capture data and information based on the required knowledge needs.

Another constraint often highlighted in literature is the difference in volunteer motivation between long-term and short-term projects. This trend has resulted to a comparatively low completion of projects demanding long-term commitment from citizens compared to short-term ad-hoc projects (Horita *et al.*, 2013). Such a phenomenon is seen as interest and motivation wane, rendering the retaining of proactive citizen engagement over an extended period of time problematic (Hicks *et al.*, 2019). Analysing the social behaviour of contributions to OpenStreetMap in the United Kingdom, Antoniou & Schlieder (2014) identified a notable difference between the accumulated percentages of created features and updated features, and low return rates to complete and update geographic features by even the most frequent contributors.

In this context, gamification is presented as a feasible solution to volunteers' commitment, or lack thereof, since games create and leverage the intrinsic motivation of a player to retain participation and potentially recruit new participants, without the need for extrinsic reward (Martella, Kray and Clementini, 2015). Tomnod is an example of an effort that has proven to be unsustainable, as after its initial prominent mapping campaign in 2011 it was ultimately discontinued in 2019. Similarly, the Global Earth Observation Catastrophe Assessment Network (GEO-CAN), despite attracting some 600 experts from 23 countries with a remote sensing background to respond to the 2010 Haiti earthquake, did not continue functioning, demonstrating the challenges of establishing long-term efforts for humanitarian responses (Ghosh *et al.*, 2011). While short-term VGI projects may suffer less from this drawback, nonetheless, the short duration of such use cases limits the prospects for methodological improvement, as well as the flexibility to adapt and upgrade initiatives as conditions change, prospects which long-term projects allow (Hicks *et al.*, 2019). Gamification is one promising option to tackle this problem, specifically through creating and leveraging intrinsic motivation via game elements. In this project, we propose a flexible tool that

would utilise gamification to communicate risk related information. Thus, while WP4 will develop material to guide CPAs and citizens on the framework to close the RPAG and advance general collaboration principles and the use of co-creation methodologies, WP5 will develop guidance on the technical solutions including the use of the repository and the application and use of the so-called 'RiskPack' toolbox. The material produced will encompass guidelines, gamified tests as well as demonstration and explanatory videos and will be used to guide test cases in WP6 during the last phase of the project.

4.1.2 VGI AND DATA QUALITY CONCERNS

What also needs to be remarked, is that data quality and accuracy issues affect the validity of citizen generated data. Hence, understanding the uncertainty that exists in the data is an important consideration for decision-makers (Haklay *et al.*, 2010). Essential quality components vary from positional and attribute accuracy to logical consistency, completeness, semantic accuracy, usage, purpose and constraints, and temporal quality (Camponovo and Freundschuh, 2014), while definitions of data quality often vary as well (Porto de Albuquerque *et al.*, 2019). From basic passive VGI applications to more sophisticated applications, such as damage mapping, assessing the efficacy of VGI activities and the value of the outputs is crucial. VGI via social media is particularly susceptible to data quality concerns, due to the easy penetration and rapid circulation of false information or "*fake news*" on many social media platforms. Fortunately, approaches to detect, evaluate and address misinformation in viral posts have been developed and commercialised by companies such as PublicSonar, which validates data by leveraging multiple real-time publicly available information from domain-specific sources. Furthermore, within the open-source community, principles of Linus's Law have been adapted as a viable solution to data quality constraints. This narrative argues that as the number of contributors increases so does data quality, as inconsistencies are more likely to be identified within a dataset of a higher percentage of correctness (Haklay *et al.*, 2010). This rationale is supported by its effectiveness in crisis and emergency situations, as having slightly incorrect data seems a fair compromise compared to the time investment needed to collect high-quality data (Fazeli *et al.*, 2015).

4.2 Enhancing resilience through citizen generated data

The realisation that effective disaster management cannot be achieved by exclusively focusing on the physical factors which influence the occurrence of hazard events has led to a more process-driven approach in understanding the environmental and socio-economic drivers of exposure and vulnerability that turn hazards into disasters and dictate the local capabilities of community resilience (Kankanamge *et al.*, 2019). Citizen generated data have abetted this shift as emergency management has moved away from traditional command-and-control approaches gradually becoming more collaborative, facilitating multistakeholder and intersectoral cooperation. This transition is emphasised through the concept of active citizenship and shared responsibility (see 2.3.3.1 and 2.3.3.2 in this Report).

4.2.1 VULNERABILITY ESTIMATION AND VGI

VGI contributes to the generation of risk-related information for the creation of spatially explicit risk maps, by gathering and analysing information about exposure, vulnerability and hazards at different geographic scales. Participatory citizen mapping of exposed critical infrastructure and private buildings enables the estimation of the perceived and actual impacts of hazards and disasters, respectively (Klonner *et al.*, 2016). VGI-aided vulnerability estimation, combining physical and socioeconomic aspects, determines the damage ratio and social cost generated by a hazard event, according to a specified exposure. These estimates are used as inputs during decisions about humanitarian responses, adaptation, mitigation, and forecast-based financing strategies. The use of vulnerability surveys platforms to map socio-economic vulnerability indicators, such as open-source Open Data Kit (ODK), Geographical ODK (GeoODK) and KoboToolBox, has been employed by numerous national CPAs to survey and validate community resilience levels (Nguyen and Akerkar, 2020). For example, in preparation for a flood event, Indonesia's SIBAT -a volunteer community-driven disaster preparedness agency- surveyed households from 21 communities with ODK to collect information on various vulnerability indicators, such as local living conditions, the number of persons per household, health status, environment, education levels, gender, income, and nutrition (McCallum *et al.*, 2016). To complement these participatory approaches, mobile phones and web platforms are increasingly being used for real-time data collection on hazards events, thus, providing information about which regions are most severely impacted by the hazard. Such information can be further used for the quick validation of the outputs of hazard models and complement and validate hazard mapping undertaken by other, more traditional methods (Pastor-Escuredo *et al.*, 2014). The United States Geological Survey's (USGS) "Did You Feel It?" (DYFI) project aptly exemplifies this, as it involves an automatic production of macroseismic intensity maps using data generated by internet users, regarding the seismic shocks and ensuing damages they experienced (Wald *et al.*, 2011). Dedicated mobile apps such as MyShake[25] and i-jishin[26] use less active participation utilising the onboard accelerometer of a smartphone to receive, analyse and store seismic shocks on cloud servers (Naito *et al.*, 2013)

4.2.2 EARLY WARNING SYSTEMS

Similarly, Early Warning Systems (EWS) offer a way to utilise VGI and other citizen generated data during pre-disaster stages. An objective listed by the UNDRR towards meeting the fourth priority of the SFDRR is '*investing in, developing, maintaining, and strengthening people-centred multi-hazard, multi-sectoral forecasting, and Early Warning Systems*' (UNDRR, 2015). Recognising the communication gap that exists between warning services and warning recipients (in RiskPACC's case CPAs and citizens), and the resulting protective inaction of the target audience, a people-centred approach was formulated to incorporate local knowledge regarding natural hazards,

[25] https://myshake.berkeley.edu/

[26] https://www.hakusan.co.jp/LABO/i-jishin/iJishin_en.html

promote and apply necessary affordable EWS targeted towards the exact vulnerabilities needs of a community, and broaden channels of communication (WMO, 2017). Local knowledge helps citizens and CPAs understand individual and community level exposure and vulnerability to imminent risks, a process that is instrumental in the operationalisation of preparedness, mitigation and response strategies (Haworth & Bruce, 2015). Conversely, VGI can capture local knowledge about the extent, severity, impacts and coping strategies of past disaster occurrences, and provide insight into local vulnerabilities that existing EWS do not consider (Adams, 2013). The ultimate goal is to formulate a risk management framework based on local knowledge of vulnerability, by understanding the risk perceptions, needs, experiences, capabilities and susceptibilities of all stakeholders (including citizens), and based on this understanding, communicate this information to relevant audiences during each stage of a disaster risk cycle (Harrison *et al.*, 2020). Additionally, data derived from VGI can be used as independent inputs into existing EWS for enhancing robustness and, eventually supporting scientific decision-making processes based on aggregated citizen-knowledge (Meissen and Fuchs-Kittowski, 2014). The British Geological Survey (BGS) exemplified such integration of collectively generated information by feeding multimedia tweets into the National Landslide Database to model hazard impacts (Harrison *et al.*, 2020).

Although the literature highlights the skewed usage of VGI in favour of the syn- and post-disaster phases (Horita *et al.*, 2013; Klonner *et al.*, 2016), numerous opportunities for the utility of VGI for pre-disaster planning and preparation exist (Horita *et al.*, 2013; Haworth and Bruce, 2015; Sevinç and Karaš, 2018; Harrison *et al.*, 2020). Through a prompt, accurate and complete exchange of locational information about relevant environmental variables, ex-ante hazards and consequent impacts and vulnerabilities between authorities and citizens, VGI can also substantially contribute to pre-disaster phases of disaster risk management. Social media has proven to be effective in this process, particularly through facilitating locally derived multi-directional – vertical and horizontal – communication, allowing for both crowdsourcing and broadcast warning, and enabling individuals at risk to get tailored information and advice regarding relevant preparation and mitigation strategies (Chan, 2013; Klonner *et al.*, 2016). This subsequently allows CPAs to gauge the spread of and response to their message, as well as update subsequent messages based on the feedback received from social media users. For instance, Grasso and Crisci (2016) analysed the use of codified hashtags on Twitter for regions in Italy expecting severe rainfall and found that tagged tweets contained useful information about citizen perceptions; those tweets were also used to update official data, showcasing the potential applicability of codified hashtags for improved information, dissemination and retrieval for CPAs.

During and after disasters, VGI has been used for fast damage assessment and optimised rescue, relief, and recovery assistance (Lue, Wilson and Curtis, 2014; Cervone *et al.*, 2017). Contributed data contain spatially and temporally consistent information that is uncharacteristic of many traditional data sources. Spatial video technology has been employed for rapid damage assessments via volunteered videos acquired with GPS-enabled cameras attached to citizens' cars, as they drive through

disaster-impacted neighbourhoods. The data obtained from this time- and cost-efficient approach is further reviewed and processed by more skilled volunteers to generate damage maps (Lue, Wilson and Curtis, 2014). Furthermore, dedicated platforms such as Tomnod[27], GeoCommons[28] and Ushahidi[29] provide functionalities for volunteered contributed data for emergency and relief efforts. In particular, the Ushahidi platform can be adapted to the particularities of specific use cases. For example, after the 2010 Haiti earthquake, the platform granted users on the island permission to report incidents via text messages. This information was then processed by volunteers, translated from Creole and utilised in infographics and report development, while was made available to disaster response agencies (McCallum *et al.*, 2016; Tapia-McClung, 2018).

4.2.3 LIMITATIONS OF VGI

The above-mentioned strengths do not negate the existing limitations of VGI in building community resilience. First, since many VGI solutions are technology-led, they naturally marginalise the less technology-savvy and socio-economically disadvantaged populations, further broadening the digital divide and inevitably supporting the argument that VGI cannot represent every citizen but favours those privileged with money, access, and time to utilise the technology (Mirbabaie, Stieglitz and Volkeri, 2016; See *et al.*, 2019). Second, the compartmentalisation of VGI solutions, which restricts its usage to single stages of the disaster continuum, and for a single type of disaster event, is a notable limitation. Taking a multi-hazard and multi-dimensional approach showcases the magnitude-frequency relationship of multiple hazards and their interrelated effects on the community's vulnerability and could potentially encourage sustained citizen participation in monitoring and recording environmental changes (WMO, 2017; Hicks *et al.*, 2019). Third, there is a need to shift from dominant technology-led designs of VGI solutions to adopting a multidisciplinary and multi-method approach that applies contextually appropriate, evidence-based methods across disciplines to create user-centred designs that meet the needs of CPAs and citizens. Finally, the practicality and effectiveness of utilising VGI for community resilience are undermined due to the exclusion (or inadequate inclusion) of important factors such as political and governance systems, institutional structures and unequal power distributions, when designing VGI solutions (Haworth *et al.*, 2018). This is especially relevant since governmental institutions hold the administrative power to encourage the standardisation and regularisation of VGI practices through the inclusion of VGI concepts in mainstream Spatial Data Infrastructure (SDI) frameworks (Haworth and Bruce, 2015).

[27] Tomnod was a project owned by Colorado-based satellite company DigitalGlobe that used crowdsourcing to identify objects and places in satellite images. It was announced Tomnod was no longer using crowdsourcing of images as of 1 August 2019.

[28] http://geocommons.com/

[29] https://www.ushahidi.com/

4.3 State of the art and emerging trends

Developments in disruptive technology applications, such as robotics, drone technology, machine learning (ML), big data analytics, artificial intelligence (AI) and blockchain have significant implications for research across the disaster risk cycle. The utilisation of disruptive technologies within disaster risk management has been facilitated by the surge of supporting infrastructure and devices, cloud computing, smartphones and wireless broadband networks. Such developments strengthen vital information dissemination, improve the understanding of disaster drivers, enhance data-driven models, evaluate impact through novel methods and widen the knowledge-base of social practices and economic impacts of disasters (Abid *et al.*, 2021).

Moreover, several disruptive technologies have contributed to the systematic improvement of pre-disaster efforts. Big data analytics using ML and Deep Learning (DL) algorithms have been used to process volunteered citizen generated data to determine the public reaction to imminent disaster risk and assess vulnerabilities and disaster-related information from the web (Qadir *et al.*, 2016). Social media data have been the major data source for the identification of the spatial, temporal and semantic context of disaster-related texts. Real-time information can be analysed and validated by AI algorithms to filter and classify information and make predictive analyses (ITU, 2019). The transferability and flexibility of sentiment analysis solutions to new crises and languages are enhanced through the increased availability of pre-trained Natural Language Processing (NLP) models (Ragini, Anand and Bhaskar, 2018; Khare, Burel and Alani, 2019).

In addition, the so called 'Internet of Things' (IoT) has contributed to real-time bi-directional communication between CPAs and citizens during pre-disaster stages. Developments in cloud computing, data analytics and software and hardware engineering sensors have led to the emergence of real-time, connected sensors widely known through the concept of IoT. IoT sensors are used to monitor hazard levels and alert CPAs and citizens about potentially hazardous situations, thereby creating communication channels and allowing CPAs to probe citizens about hazard levels in their respective locations, as well as disseminating relief measures for those already impacted (ITU, 2019).

Since many VGI applications are utilised during and after disasters, the use of disruptive technologies is also dominant in these disaster phases. During and after disasters, volunteered data processed using AI algorithms, have aided the coordination of disaster risk management activities, enabling data-driven decision making regarding the channelling of available resources to impacted locations. Based on information derived from crowdsourced data, drones and AI-powered robots are increasingly deployed for immediate response, rescue and recovery efforts. Drones and robots reduce the operational risks and time commitment for humanitarian emergency search-and-rescue operations and emergency items delivery, therefore increasing the protection and performance of response teams (Wankmüller, Kunovjanek and Mayrgündter, 2021).

The automation of damaged infrastructure mapping (such as buildings and roads) has also been powered by ML and DL algorithms. Many studies have experimented with the use of supervised and unsupervised Convolutional Neural Networks (CNN) for damage mapping using aerial and satellite imagery. The term DeepVGI was specifically coined to address the use of AI-based frameworks in the VGI context. DeepVGI methodologies enable speedy and accurate damage mapping, something critical in the humanitarian context, where time is a crucial factor when disasters unfold. In cases of incorrectly predicted outputs, volunteers are used as ground-truthing agents, a relatively time-saving approach compared to manual damage mapping by human analysts (Herfort *et al.*, 2019).

AI technologies are used to facilitate emergency calls, as Call Centres are often overwhelmed during and after a crisis. In addition to voice calls, emergencies are reported by text messages aided by AI-powered chatbots and speech-to-text functionalities. These technologies can interact with and interpret natural language, handle requests and quickly respond with relevant updates during an emergency, hence bridging communication and information vertical (between CPA and citizens) and horizontal (between citizens) gaps, assisting CPAs to gather analytics about vulnerability status and quicken response time and preserving human resources by eliminating the need for human agents on the ground (Tsai *et al.*, 2021).

Finally, blockchain technologies also provide another interesting field to investigation in the context of disaster risk management. Although the use of blockchain technologies is relatively understudied in the disaster scholarship, it could be a promising technology for investigation, particularly as it promotes transparent and accountable decentralised public participation and information control. The immutable nature of a blockchain-based participation platform eradicates monopolistic control over information and enhances co-decision-making governed by smart contracts, such as timestamping of participatory activities (Muth *et al.*, 2019). Farnaghi and Mansourian (2020) suggested that VGI solutions should be developed as decentralised applications (DApp) based on Ethereum blockchain technology to foster a completely open, transparent and accountable environment for citizen engagement via a peer-to-peer blockchain network.

In conclusion, although many developments have been made vis-à-vis the use of disruptive technologies for analysis of volunteered data, many of its uses such as of AI, Big Data and blockchain are still largely experimental (ITU, 2019). Facilitating large-scale impacts for community resilience requires additional research of ways these technologies can be leveraged across the entire disaster continuum. RiskPACC aims at exploring such ways, particularly subsequent WPs, as we detail in the final Chapter of this deliverable, along with a short overview of the previous chapters.

5 CONCLUSION – BRIDGING THE RPAG THROUGH COMMUNITY INTERVENTION

5.1 Summary

The main objective of this Report has been the exploration of the conceptual roots of community resilience across different disciplinary domains, as well as the definition and contextualisation of community resilience and risk perception in academic literature and practice, thus establishing - along with D1.1 - the scientific foundations of the project. In this context, we aimed at consolidating a set of general principles and highlighting how these are increasingly being used to inform the management of a range of risks and hazards, emphasising the critical role of understanding risk perception of local communities for bridging the RPAG. Moreover, we specifically focused on the utility of emerging approaches to digital technologies and specifically social media and VGI, from the extant literature and attempted to leverage the accumulated knowledge related to collaborative data generation, collection and collation in capturing citizen perceptions and understandings of risk for facilitating an enhanced two-way risk communication between citizens and CPAs.

Having this in mind, Chapter 2 started with a conceptual journey of resilience across different disciplinary contexts, ontological transmutations, and epistemological practices, ultimately leading to the emergence of the concept of community resilience. We particularly highlighted the role of communities in enhancing disaster risk management and response, following the 'social turn' in resilience scholarship and underlined the rooted social processes that turn hazards into disasters, ultimately advocating for the de-naturalisation of 'natural disasters' (subsection 2.2.1). Later, we briefly presented the concept of vulnerability and its connection to disaster and community resilience (see D1.1 for further detail) and completed this conceptual journey by discussing the emergence and consolidation of resilience in global disaster risk and sustainable development praxis, particularly through HFA, SFDRR and the SDGs. Then, we focused on existing approaches and definitions of community resilience, not only in the academic literature, but also across the EU-funded project ecosystem. Through this process, and taking into account a plethora of community resilience definitions we explored, we established an appropriate working definition of community resilience for the purposes of RiskPACC. This definition emphasised the role of active citizenship in comprehending risk and the role of digital technologies in facilitating communication of risk perceptions and co-production of knowledge. Hence, community resilience in RiskPACC is defined as:

> The capacity of communities and individuals to interact with their surrounding physical and built environment, comprehend risk and actively mobilise activities to enhance societal connectedness including the use of digital technologies, to co-produce knowledge and build two-way communication channels with the CPAs and other local

> stakeholders to cope with, adapt to, prepare for and recover from external perturbations or inherent stresses.

Community resilience is of course a fundamental part of disaster resilience; yet, ensuring community voices and actions can feed actively into CPA disaster response and/or preparedness is essential for ensuring that actions are deemed acceptable to local communities and more proportionate to their perceptions of risk. As we highlighted, in Chapter 2, understanding this relationship between CPAs and citizens – what Krüger and Albris (2020) have termed *'between control and cooperation'* – is crucial in planning and coordinating effective actions before, during and after disaster events. The case Krüger and Albris (2020) documented, showed *'a common tension in disaster response situations, namely the conflicts that arise from the convergence of first responders and volunteers offering their help on the one hand and the command-and-control logics imposed by state institutions on the other'* (p.12). In their detailed analysis of the 2013 floods that engulfed Dresden, these authors framed resilience as an adaptive process that was shaped by societal relations, noting a paradox at the heart of attempts to engage local communities. In more detail, some volunteers were 'uncalled for' and 'unwanted' and negatively impacted the official effort of CPAs, hence leading the authors to further highlight that *'this form of civil society grassroots-level resilience does not necessarily obey the behavioural expectations of public resilience policies, but questions, counteracts and eventually shapes them'* (p.2). This illuminated the need, identified through the conception of the RPAG, to better align the multiple perceptions and actions of CPAs and communities in overall disaster resilience efforts.

After the presentation of the working definition of community resilience, Chapter 3 analysed the concept of risk perception from a community standpoint, following emerging approaches to understanding contextual characteristics and localising disaster risk management. We explored the transition from psychological to psychosocial and sociological approaches in conceptualising community risk perception, particularly focusing on disaster risk management, while we also explored the connections between risk perception and place. Then, after a short discussion of the role of community risk perception in the ongoing COVID-19 crisis, we presented a working definition of the term for RiskPACC, which we adopted from the European Environmental Agency (EEA, 2019):

> Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed are seen to resolve the problem.

Finally, Chapter 4 provided a detailed introduction to citizen generated data and their potentialities for supporting disaster risk management and ultimately improving

disaster response and enhancing community resilience. The main focus of this analysis was VGI as an emerging digital technological trend and its relevance for engaging local communities in decision-making and disaster risk planning and response. Here, we started by clarifying the terminological confusion within existing literature, distinguishing terms like citizen science, crowdsourcing and VGI and briefly presented gamification approaches, which RiskPACC aims to employ as the project unfolds, in WP5. Later, we highlighted different tools and methods developed and implemented to support cultivation of community resilience and overall enhance disaster resilience, specifically discussing vulnerability estimation and EWS. However, the utility of VGI for bridging the RPAG does not come without limitations of the technology, predominantly related to data quality concerns and the involuntary participation of citizens. Other emerging but not yet extensively visited trends in crowdsourcing for the support of disaster risk management, such as ML and DL approaches, emerging discussions around IoT and blockchain were also discussed.

5.2 Connections with other WPs and Future Work

This deliverable, along with D1.1, will form the basis of understanding of community/disaster resilience, risk perception and citizen generated data, and clarify how RiskPACC can understand these concepts to address the RPAG. The establishment of the conceptual foundations and working definitions of these concepts will imbue the future deliverables and empirical work of the project and will particularly be used in the exploration of the 7 case studies that will follow. In more detail, in Deliverables D1.2 and D2.2, primary research and fieldwork will be undertaken to better understand how the adopted terms are operationalised *in practice* in our case study areas. In D2.2, we will bring together citizen groups and representatives of local communities and explore the ways they understand and relate to the concepts of disaster and community resilience, as well as how they perceive risk and the tools and methods they utilise to confront it and ameliorate its impact, with an emphasis on digital technologies, social media and other mobile applications. Later we will interrogate the findings of this exercise with the findings of D1.1, which will focus on a multi-disciplinary consultation with CPAs and other local stakeholders and conclude with the identification of community practices and approaches that are currently used to close the RPAG. Methodologically, we will conduct a suite of interviews to understand how CPAs and community groups in our case study areas understand resilience and risk, how they communicate with each other, and how they respond to risk and hazards. WP2 will be concluded with Deliverable D2.3, which will provide a gap analysis in current operationalisation of disaster and community resilience concepts across the case study areas of the project and will create a Roadmap for key actions to advance existing State-Of-The-Art, in conjunction with Deliverable D1.3.

The identification of gaps and production of a project Roadmap in Deliverables D1.3 and D2.3 will also constitute the basis for preparing and implementing the co-creation labs in the case study areas, an activity that will take place during the first phase of WP3. Moreover, building upon the conceptual basis established through the desk-based research performed in this deliverable, and in conjunction with the identified gaps discussed, RiskPACC will attempt to answer the question *'What works on closing*

the RPAG?', through the development of a conceptual Framework in WP4. This Framework will consist of both a knowledge-base of practices and tools, as identified in Deliverable D1.2 and D2.2, and a guiding methodology on how best to make use of it to build capacities for CPAs and citizens. This framework will assist in understanding risk perceptions, communications between CPAs and communities, and other factors that may exist behind the RPAG in different settings.

Finally, the presentation of the State-Of-The-Art in citizen science, crowdsourcing and VGI presented in Chapter 4 of this deliverable, will inform WP5, along with user requirement that will be identified in WP3, reflecting the gaps in existing tools and methods of communication between CPAs and community groups that will be set out D1.3 and D2.3, and contribute to the development of the 'Risk Pack' toolbox to bridge the RPAG. For reference, a schematic representation regarding the connections between the different WPs of RiskPACC is presented in Figure 5.1.

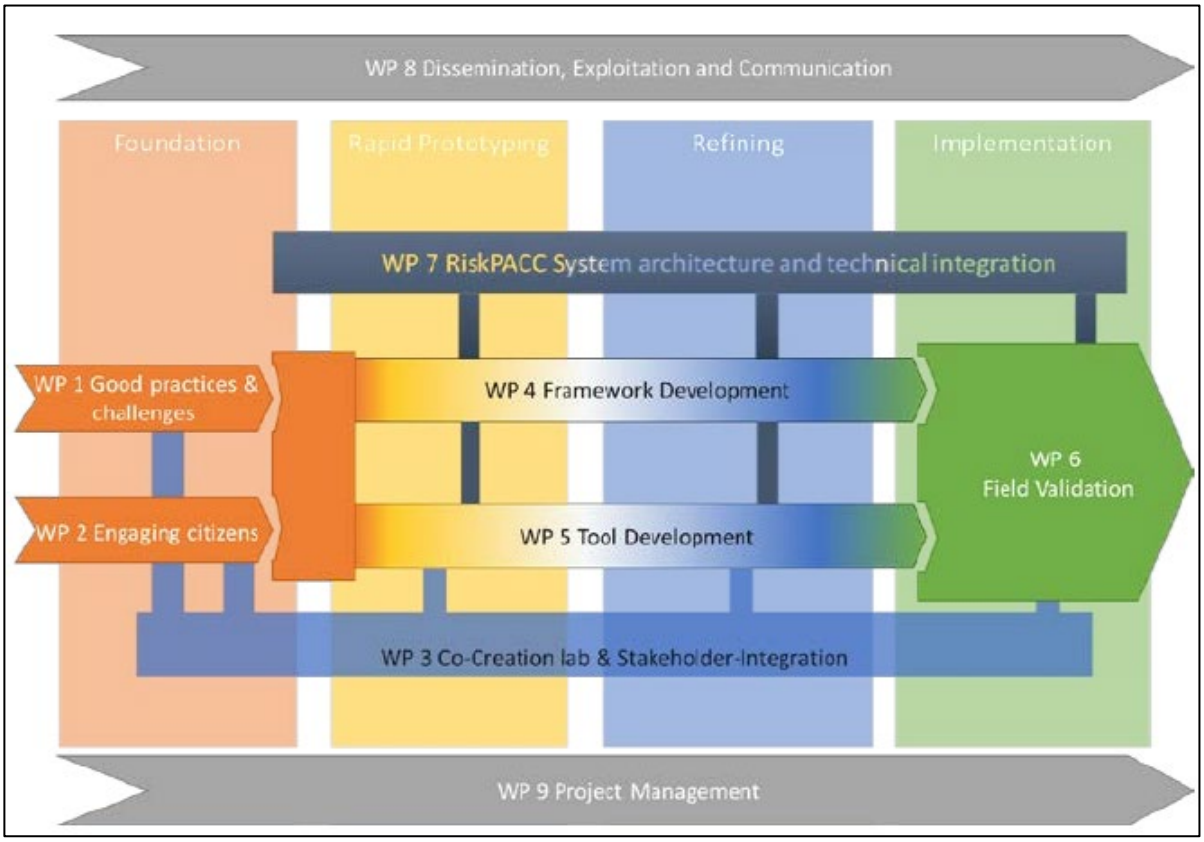

FIGURE 3.1: INTERRELATIONS BETWEEN THE DIFFERENT WPS OF RISKPACC

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