DISASTER RECOVERY AND RECONSTRUCTION: HARNESSING CAPACITY AND BUILDING RESILIENCE WITHIN COMMUNITIES AFFECTED BY FLOODING.

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List of Abbreviations

ABI	Association of British Insurers
ACT	Action with communities in Cumbria
ADPC	Asian Disaster Preparedness Centre
AEP	Annual Exceedance Probability
AONB	Area of Outstanding Natural Beauty
APELL	Awareness and Preparedness for Emergencies at Local Level
AWPR	Aberdeen Western Peripheral Route
BCC	Belfast City Council
CAB	Citizens Advice Bureau
CCC	Cumbria County Council
CEH	Centre for Ecology and Hydrology
CIO	Cumbria Intelligence Observatory
DRC	Democratic Republic of Congo
CRED	Centre for Research on the Epidemiology of Disasters
CVS	Council for Voluntary Service (Cumbria)
DAERA	Department of Agriculture, Environment and Rural Affairs
DCLG	Department for Communities and Local Government
DEFRA	Department of Environment Food and Rural Affairs
DfI	Department for Infrastructure
DM	Disaster Management
DMP	Disaster Management Process
DROP	Disaster Resilience of Place
EA	Environment Agency
EM-DAT	Emergency Management Database
EU	European Union
FAO	Food and Agriculture Organisation
FEMA	Federal Emergency Management Agency
FLAG	Flood Liaison Advice Group
FRG	Flood Resilience Group
FAG	Flood Action Group
FRM	Flood Risk Management
GLA	Greater London Authority
GSDRC	Governance, Social Development, Resource Centre
GFDRR	Global Facility For Disaster Reduction And Recovery
GRD	Growth and Resilience Department

HFA	Hyogo Framework for Action
IFRC	International Federation of the Red Cross and Red Crescent Societies
ISDR	International Strategy for Disaster Reduction
LA	Local Authority
LRF	Local Resilience Forum
LFRMP	Local Flood Risk Management Plan
LLA	Lead Local Authority
LLFA	Lead Local Flood Authority
LSOA	Lower Layer Super Output Area
NFRA	National Flood Risk Assessment
NFM	Natural Flood Management
NGOs	Non Governmental Organisations
NOAA	National Oceanic Atmospheric Administrative
OECD	Organisation for Economic Co-operation and Development
PERC	Post-event Review Capability
PDR	Post-disaster Recovery
PPS15	Planning Policy Statement 15
PVA	Potentially Vulnerable Area
QDA	Qualitative Data Analysis
RBMP	River Basin Management Plan
SEPA	Scottish Environment Protection Agency
SNIFFER	Scottish and Northern Ireland Forum for environmental Research
SPP7	Scottish Planning Policy 7
SNA	Social Network Analysis
SuDS	Sustainable Drainage Systems
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNISDR	UN Office for Disaster Risk Reduction
UNDP	United Nations Development Programme
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNWCDR	United Nations World Conference on Disaster Reduction
UNHCS	United Nations Centre for Human Settlements
WHO	World Health Organisation

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Abstract

Flooding related disasters are rising both in magnitude and intensity across the UK. As a consequence, significant attention is now being paid to understanding, managing and mitigating such events. While most of this attention has centred on government funded intervention and policy development, community-based resilience methods and approaches have assumed increased prominence in recent years. Community resilience is fundamental to the ability of communities to recover after an adverse event, by enabling them to harness their own capacity and become active, rather than passive, agents in the recovery process. Evidence, however, suggests that improvements in resilience have been inhibited by a lack of frameworks developed within the community, for the community and with a view to capturing resilience capacity over time.

Addressing this gap, this thesis focuses on enhancing awareness of resilience in post-disaster affected communities by developing a framework to enable capacity building. The study employs a mixed methods research design, combining a range of qualitative and quantitative methods including: secondary data analysis; social network analysis (including social media); and key stakeholder interviews. Interviews were conducted at the community, regional and national level to examine perceptions of resilience, drivers of and barriers to resilience, acceptable methods for enhancing resilience and validation of the proposed framework. The data analysis approach was twofold: firstly, network visualisation software was used to analyse social network data; and, secondly, a qualitative data analysis package was used to undertake a systematic and flexible ‘Framework method’ analysis of the interview transcripts.

While there were many substantial findings, the principal conclusions from this analysis illustrate the ability of communities to harness their own capacity to cope, adapt or transform in the aftermath of a flood event. In addition, the study illuminates nuances between how resilience presents itself at the rural and urban scale. The emergent use of social media was also found to play a valuable role in strengthening community resilience through information dissemination and galvanising the connectedness of communities. The research further highlighted the need for an integrated approach to planning and development decisions, between

all interested parties across the catchment. Finally, the research argues for the development of innovative resilience standards (including certificates, codes, and regulations), supported by the insurance industry, which adapt and respond to the increasing threat posed by flooding within the built environment.

Chapter One

Introduction to the thesis

1.1 Background to the research

This research was borne from first-hand experience practising as an architect in the post-earthquake city of Yushu in the Qinghai province of China. Reflecting on the top-down approach to post-disaster recovery and reconstruction prompted the author to investigate the potential of a more community-focused model. Research has shown that disasters, such as the Yushu earthquake, continue to escalate in frequency and magnitude worldwide (UN-Habitat, 2012). The international disaster database, Emergency Management Database (EM-DAT, 2013), shows that disaster occurrence for the period 2000-2009 rose sharply to 7,694 disaster events, relative to the period 1980-1989 (2,798 disaster events), representing an increase of 175%. In 2015 alone, over 20,000 people were killed in 376 disasters worldwide, costing an estimated $US65 billion (EM-DAT, 2016). Large-scale shocks, or the cumulative effects of small-scale repeat stresses, can negatively influence the development of a community (Global Facility For Disaster Reduction And Recovery (GFDRR), 2013). The above statistics represent a key concern for the global community, highlighting that the world is becoming increasingly prone to disasters. In addition, climate change, and its relationship to natural disasters, is closely aligned to the United Nations' (2011) prediction that the unprecedented scale and frequency of recent disasters is a trend that is set to continue.

Disasters of the type outlined above have been classified as either natural or technological (EM-DAT, 2016). Technological disasters include industrial accidents and transport accidents (Moe et al, 2007). Natural disasters, however, are typically divided into four principal categories, which are then subdivided into individual types and subtypes: geophysical (earthquakes, landslides, tsunamis and volcanic activity); hydrological (avalanches and floods); climatological (extreme temperatures, drought and wildfires); and biological (disease epidemics and insect/animal plagues) (EM-DAT, 2016). Research by the United Nations Office for Disaster Risk Reduction (2015) reports that 90% of the world's cost damages from natural disasters are generated from three categories of disaster, namely: floods, earthquakes and tropical cyclones. During the period 2005-2014, floods had the highest occurrence rate worldwide, accounting for 46.5% of natural disasters, followed by storms at 33.8% and droughts at 12% (EM-DAT, 2016). This evidence is consistent with reports that refer to 2013 as 'the year of flooding' (Munich Re, 2013), with the number of people killed by floods reaching 9,819 in 2013, representing 45% of global disaster mortality that year (EM-DAT, 2013). Flooding across Europe accounted for 13% of total disasters in 2015, claimed 48% of all disaster victims and constituted 57% of natural disaster costs (EM-DAT, 2016). In particular, two consecutive floods in the United Kingdom during 2015/2016 accounted for the costliest disasters across Europe. The December 2015 floods of Storm Desmond and Eva accumulated upwards of US$1.2 billion damage, with similar bills attributable to Storm Frank in January 2016 (EM-DAT, 2016).

Geographically, Asia suffered the highest proportion of disasters in 2015, standing at 44%, followed by the Americas (25%), Africa (16%) and Europe (7%) (EM-DAT, 2016). Guha-Sapir et al (2012) estimate that almost 80% of all disasters occur in developing countries, yet the cost of disasters is highest in the developed world, with hydrological disasters in Europe (2013) resulting in upwards of US$ 13 billion in damages, largely as a consequence of the severe flooding in South and East Germany (Thieken et al, 2016). The frequency of flood disasters in 2015 may have fallen by 13% below its decade average (2005-2014), however the impact on victims increased. For example, three floods across Europe (Macedonia, United Kingdom, Albania) in 2015 accounted for 81% of all disaster victims in Europe that year (EM-DAT, 2015).

Against that background, disaster management should not be viewed in isolation, rather as part of the ongoing Disaster Management Process (DMP). The disaster life cycle is an essential component of the DMP, ensuring that loss of life and property damages are reduced in a disaster event (Warfield, 2004). The life cycle describes the preparation and response of emergency managers to a disaster situation, and illustrates how they facilitate people and institutions to recover from them, mitigate their effects, reduce the risk of loss, and prevent further disasters (such as fires) from occurring (Federal Emergency Management Agency (FEMA), 2007). The on-going nature of the disaster process incorporates experiences as learning tools and constantly evolves depending on the situation, country and context. The process can be classified into four stages: mitigation; preparedness; response; and recovery, with reconstruction a sub-group of the recovery phase (Guzman, 2002).

Post-disaster recovery (PDR) therefore represents a phase and process within the DMP that begins with the stabilisation of the disaster situation and ends when the community has returned to its pre-disaster condition. The primary goal of PDR is to restore affected communities to the situation they were in before the disaster struck.

The economic benefits of investing in PDR has not been fully addressed in the literature, with very limited research into the opportunities that PDR can offer communities (Birkmann, 2010).

Research suggests that investment in PDR and mitigation amounted to only circa 1% of the $US150 billion spent in the twenty countries that received the most post-disaster humanitarian aid (GFDRR, 2013). This very limited level of investment calls for an analysis as to how the recovery and reconstruction phases can contribute to long-term recovery in affected communities. In particular, there is a need to explore the economic benefits of more efficient investment in PDR. The study, therefore, seeks to present the long-term benefits of investing in disaster resilience, ultimately creating a better understanding among donors, partner governments and multilateral agencies of how and what to invest in disaster resilience (GFDRR, 2013).

Beyond a loss of human life, the recent trend of natural disasters has resulted in significant human, property and environmental losses, as well as economic and social disruption. The cost of disasters was estimated by the United Nations Development Programme (UNDP, 2012) at more than US$2 trillion over the last two decades, with proactive investment in resilience measures considered to be inadequate (Emergency Response Management, 2012). The number of natural disasters during the period 2002-2012 increased threefold, in comparison with the 1960's, while over the same period the amount of economic loss has risen by a factor of almost nine (Munich Re, 2013).

The increased human, economic and environmental costs resulting from disasters demands an improved response from stakeholders. Historically, the focus has been on a reactive response (to mitigate downside), rather than on proactive, long-term sustainable solutions (Moe et al, 2006). The post-disaster response significantly affects fatality numbers, with timely reconstruction presenting an opportunity to reduce the wider economic and social damage through incremental design improvements and a rethinking of key infrastructures. International organisations, such as the UN, have responded to the increase in disasters by developing a 'Plan of Action on Disaster Risk Reduction for Resilience' (2013). This increased commitment from global institutions further highlights the severity and relevance of the disaster issue.

Research suggests that the recovery and reconstruction phase represents a window of opportunity, albeit created by a tragic situation, to help reduce future disaster risk by addressing existing vulnerabilities (Palliyaguru, 2010). Whilst much of the extant resilience research has been undertaken in developing countries (Global South), the effects of disasters are increasingly having a detrimental impact on the developed world (Global North) (EM-DAT, 2017). In any event, the principles of resilience recovery translate across communities, regardless of economic standing. Rebuilding in the aftermath of a disaster provides an opportunity for the physical and social conditions to be shaped for long-term recovery, thus facilitating a community's ability to mitigate and prepare for future disasters (Lizarralde et al, 2004; Paton et al, 2004).

In addition, it is important to understand the distinct phases of a disaster and their interconnectivity within the disaster lifecycle process. The use of disaster phases (preparedness, response, recovery and mitigation) (Guzman, 2002) has facilitated disaster managers and researchers to organise activities, systemise and codify research (Alexander, 2010). Disaster phases enhance the efficiency of disaster managers' capabilities (Baird, 2010), however, require advancement in its practical implementation. Research presented in this thesis seeks to build upon existing literature on these disaster phases in a bid to improve the theoretical and applied dimensions of the disaster context, and ultimately build more resilient communities.

Of the four DMP, the recovery and reconstruction phases have received the least attention in academic literature, with the majority of the research concentrating on the earlier stages of the disaster process. The recovery phase, which encompasses the reconstruction phase, is the least studied in the disaster literature (Rubin, 2007; Tootle, 2011), with stakeholders focusing on the emergency phase (Jayaraj, 2006). However, despite improvements in the emergency response to natural disasters, UN-Habitat (2012) argues that reconstruction is often inefficiently managed, uncoordinated and slow to get off the ground. The success of long-term development within affected communities relies heavily on making the most of the opportunities that the other phases present. Accordingly, this research seeks to establish a theoretical and conceptual basis for the issues related to post-disaster recovery and reconstruction through a detailed analysis of the identified phases.

This approach is consistent with arguments by authors, such as O'Riordan (2001) and Oudenhoven et al (2012), concerning the importance of understanding resilience at the community level before scaling to a regional, national or global level. Indeed, Adger et al (2005) and Wilson (2010) maintain that resilience can be implemented 'on the ground' in this way. Furthermore, empirical research shows that in the early stages of the response, it is the local community which in fact saves the most lives (Gilbert, 1998; Haghebaert, 2007). In addition, research suggests that external sources of aid relief save less than 10% of victims after a disaster (Bankoff et al, 2004). From a practical perspective, the community level is also scalable and more adaptable to change. Zakour and Gillespie (2013) reiterate the point that it is by working together as communities that real change will happen. Hence, the focus of the study is at community level, exploring capacity possibilities and facilitating bottom-up initiatives to stimulate 'building back better' (UNISDR, 2017).

Within the post-disaster recovery and reconstruction context, there is the argument that urbanisation can affects a disaster just as profoundly as disaster can affect urbanisation (Pelling, 2003). This highlights the importance that recovery planning has on the quality of the urban built environment. The World Bank (2014) has, for example, already emphasised its commitment to resilient reconstruction by stating that the challenges associated with reconstruction also present "opportunities to promote disaster risk management through integrated resilient recovery and reconstruction planning that will drive longer-term resilient development". An inherent component of resilience is the capacity for individuals and communities to recover from an external shock or stress and return to their original pre-disaster condition (Norris et al, 2008; UNDP, 2012). The framework proposed in this research is ultimately a tool to harness opportunities offered in the recovery and reconstruction phases, through the enhancement of capacity within post- disaster affected communities and the subsequent development of resiliency.

The aim of this study and the supporting objectives (Section 1.2) illustrate the focus of the research to address deficiencies in the recovery and reconstruction phases, in a bid to facilitate affected communities' ability to mitigate risk and prepare for future disasters. Ultimately, the thesis seeks to propose a framework that highlights the importance of the recovery and reconstruction phases for long-term community recovery. The objectives have been structured to reflect the development of theoretical insights into long-term development within the recovery and reconstruction phases. The theoretical element then paves the way for the subsequent empirical phase of the research.

1. 2 Aim and objectives

The aim of this research is to develop a framework to enhance community capacity and build resilience during the recovery and reconstruction phases of a disaster.

The aim of the research is accomplished through the following objectives:

1.2.1 to establish a theoretical and conceptual basis of the issues related to post-disaster recovery and reconstruction within the Disaster Management Process (DMP);

1.2.2 to define the properties that make a community resilient, exploring methods to facilitate capacity development for post- disaster reconstruction of the Built Environment;

1.2.3 to examine existing post-disaster frameworks, including the extent of integration between top-down planning and bottom-up demands from the recovery to reconstruction phase; and

1.2.4 to develop a framework to reconcile the gap between recovery planning and long-term recovery reconstruction.

1.3 Methodology

A research methodology represents a particular approach to research, and can be referred to as strategy of inquiry (Creswell, 2009). Many factors play a role in shaping an appropriate methodology, such as the research questions, research area and timescales of the study. The methodology also presents the rationale for the study, which informs the methods adopted (Crotty, 1998) to help meet the research objectives (Saunders et al, 2009). The research methodology chosen should also be informed by a combination of the researcher's theoretical perspective and how the data will be analysed (Gray, 2009).

In the context of recovery and reconstruction, the reality exists in the community's views but should also reflect views from practitioners and experts in the relevant fields. As such, the research philosophy integrates views from communities, practitioners and experts who are the major stakeholders in PDR and reconstruction. The overall philosophical assumption of this study is that of the 'critical realist', accepting both objective and subjective interpretations of the disaster context.

Based on the research questions posed and the defined objectives, a mixed-methods approach will be applied. Adopting Creswell's (2009) concurrent, mixed methods approach, the qualitative strategy of this study focuses on defining the observations, experiences, views and attitudes of all stakeholders within the post-disaster recovery and reconstruction process. The study adopts a comprehensive (bottom up) mode of research to allow patterns to emerge within the case-studies, which will inform the final framework. By contrast, the quantitative approach can be viewed as a more detached method to populate/inform the case-studies' findings

Following a comprehensive literature review, the research strategy was designed with the objectives of the investigation taken into account in guiding the process. The first two objectives (outlined in Section 1.2 above) were aligned to the literature review, with the latter two objectives aligned to an analysis of extant frameworks and the empirical study, which ultimately informed the output framework.

The unpredictable nature of the study necessitated a research method that allowed for the collection of contextualised data. In light of the objective and subjective philosophical position of the study, the case-study method incorporated a variety of research methods (document analysis, observation, semi-structured interviews and social network analysis). Creswell's (2002) interpretation of a case-study as an in-depth process of investigation forms an appropriate method of inquiry for this thesis, focused on community recovery to a 'specific' or 'bounded' disaster event (Merriam, 1998). The multiple case-study approach (incorporating three case-study regions) allows for the identification of patterns and relationships across case-studies. In doing so, it can enable more robust findings (Stake, 2000; Yin, 2003).

To summarise, the research approach (mixed methods) was chosen for its suitability to both empirical and theoretical knowledge on post-disaster recovery. The research adopts a multiple case-study approach in order to capture a wider set of experiences and contexts after a disaster event. Data collection for the case-studies comprised a two-phased approach (Phase 1 and 2), including the quantitative analyses of publically available official data sets, followed by more in-depth qualitative interviews and focus groups. The analysis of this data was carried out in line with the highly structured ‘Framework method’ of data analysis. The empirical results were subsequently used to inform the final framework output.

1.4 Thesis structure

Chapter 1 provides a general introduction to the research context, as well as outlining the overarching framework upon which the research is built. Chapter 2 explores the theoretical knowledge and understanding of disaster management globally. It does so by highlighting historic and current challenges facing the DMP, and the operational, strategic responses used to help reduce disaster risk. Chapter 2 closes by highlighting gaps in the DMP, which hinder the long-term, sustainable recovery of affected communities.

In Chapter 3, the contested nature of ‘resilience’ is discussed. The literature surrounding the definition and operationalisation of the concept is analysed and reviewed. The analysis traced the multi-disciplinary history of the resilience concept, its development and application in practice. Despite a lack of consensus on the concept’s definition, it is largely accepted that the term offers its greatest influence in development activities. The latter half of the chapter discusses the relationship between community resilience and the ability to withstand and recover from adversity. Chapter 3 concludes by highlighting the positive role community resilience can play in reducing the impact of post-disaster disruption in a resource limited environment.

Chapter 4 reviews the most relevant, existing resilience frameworks for the purposes of this thesis, providing a knowledge base for the development of the theoretical framework proposed by this thesis. In doing so, it reveals deficiencies and inconsistencies within extant frameworks. Further, it identifies the most prominent community resilience components, namely: risk; resources and capacities; connectedness; and learning. To help take these concepts from the theoretical to the practical, they are used as the constituent components of the thesis Framework. Basing the case-study analysis on these components, the Framework acts as an analytical tool capable of assessing resilience in practice. This chapter, together with Chapters 2 and 3, inform the theoretical underpinnings and provide the evidence base for the development and application of the proposed resilience Framework.

Chapter 5 outlines the methodological approach taken to apply and validate the Framework set out in Chapter 4. It begins by establishing the philosophical stance used to operationalise and test the resilience framework proposed. It follows by detailing the mixed methods research approach applied across the three regional UK case-studies. It outlines the main data collection methods and explains how these are applied to populate the research framework. Further, it details the analytical techniques used to draw information and explanation from the data. Chapter 5 closes by outlining the steps taken to ensure that research integrity and ethics were adhered to throughout the study.

Chapter 6 details evidence from the Northern Ireland pilot case-study, assessing the usability and effectiveness of the proposed Framework before extending it to a full-scale project. The chapter serves as a means to test the research instruments and identify logistical issues associated with the application of the research methods. Piloting the research instrument tests the appropriateness and practicality of the sampling frame and its approach to interviewee recruitment. Ultimately, the pilot study seeks to determine the feasibility of the case-study approach and research methods, in terms of their ability to deliver the richness of data required to populate the proposed Framework.

Chapter 7 presents evidence in respect of the first main case-study conducted in this research. The Cumbria case-study is outlined generally, together with an overview of the eight micro case-studies. Chapter 7 sets out the context of flood-affected communities, outlining the flood risk landscape in England and the stakeholders who operate within it. It follows by detailing the application of the Framework within the context of the 2015 winter floods. In doing so, it identifies resilience indicators that enhance and impede a community's ability to recover. In terms of social resilience, Social Network Analysis (SNA) was also undertaken to explore the role social networks play in the mobilisation of resources and capacities.

Consistent with the approach taken in the Cumbria case-study, Chapter 8 explores whether the Framework's applicability can be transposed successfully to a different location. The North East Scotland case-study seeks to substantiate evidence from Cumbria (Chapter 7), thus validating the framework. Together with Chapters 6 and 7, this chapter provides empirical evidence to inform the overall conclusions of the study in Chapter 9.

Chapter 9 concludes the thesis by evaluating the key findings from the research and presents conclusions. The key findings are presented in respect of the overall aim and objectives of the thesis. The thesis closes by presenting its main conclusions, together with areas for potential further research. Figure 1.1 shows how each of the chapters discussed above sits within the overall structure of the thesis.

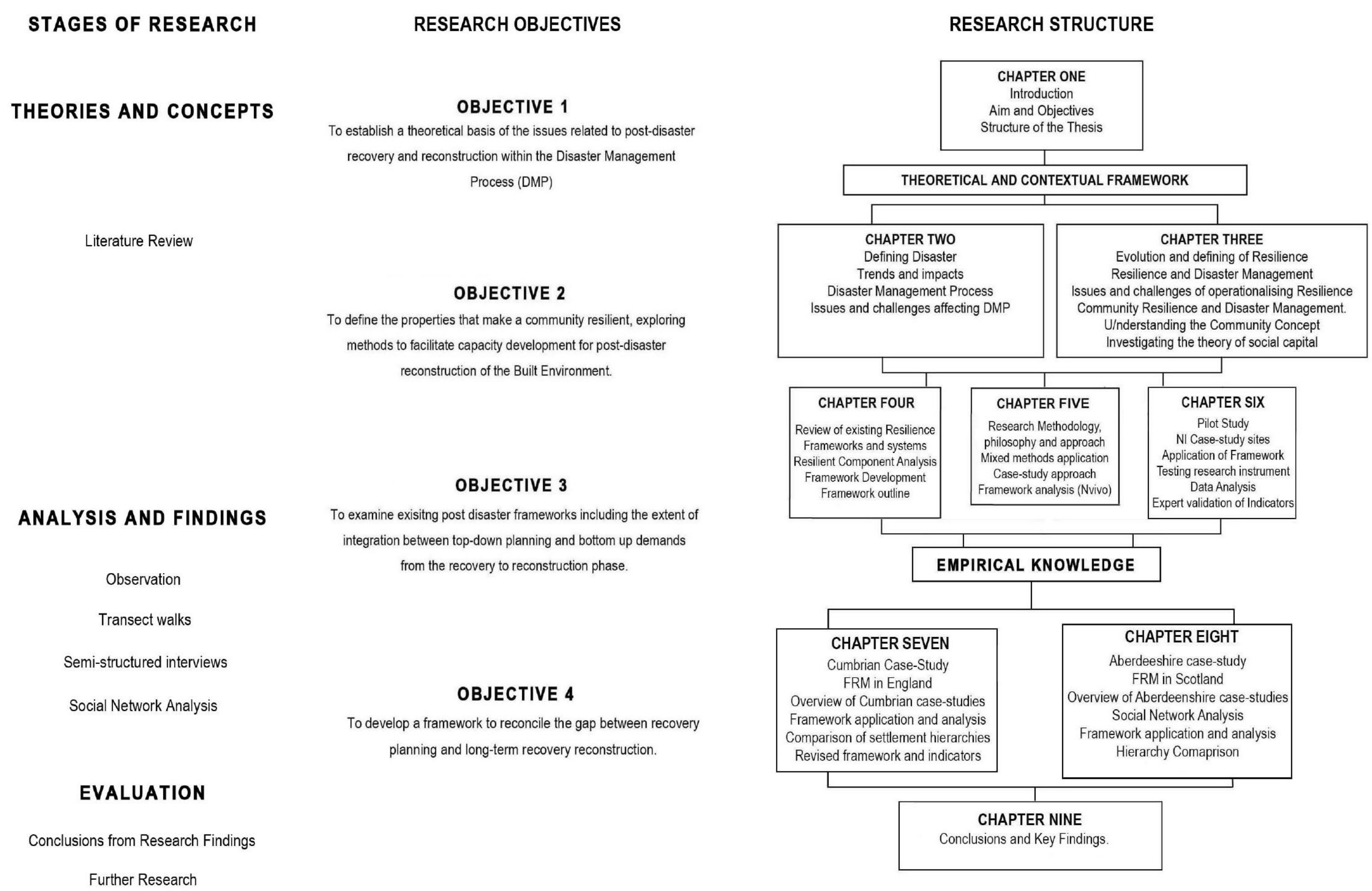


Figure 1.1 Organisation and structure of the research.

Chapter Two

Disaster Management

2.1 Introduction

Chapter 1 provided a general introduction to the research, as well as the overarching framework upon which the thesis is built. It did so by detailing clear aims and objectives for the study and outlining the rationale for the research scope and focus. Section 1.3 set out the research methods applied in both the theoretical and empirical stages, with Section 1.4 establishing the thesis structure. In doing so, the chapter provides a strong theoretical foundation from which the empirical stages of this thesis can be based.

Chapter 2 introduces the theoretical knowledge and understanding of disaster management globally. The chapter identifies historic and current challenges facing the Disaster Management Process (DMP). In addition, it also critically explores operational and strategic responses to these phenomena. In light of that review, it is clear that there is a definitional issue surrounding the term ‘disaster’. In order to understand disaster management it is first important to reflect on the significant definitional challenges that manifest themselves in the current literature base. Addressing the contested definition of disaster, it establishes a working definition of ‘disaster’ in Section 2.2. Further, it expands on disaster understanding in Section 2.3, where a significant analysis of historic disaster trends and their associated impacts are detailed. Section 2.4 moves beyond these challenges by demonstrating the operational disaster management and mitigation processes adopted (nationally and internationally) in order to minimise and mitigate the impact on society.

Efforts to reduce losses, provide prompt assistance to victims and achieve rapid, effective recovery are not always met through the implementation of the DMP (Section 2.4), meaning that communities often fail to return to a pre-disaster state. Section 2.5 investigates these issues and barriers to long-term recovery, which disaster management professionals frequently fail to address. The chapter closes with a conclusion in Section 2.6. Figure 2.1 illustrates the positioning of Chapter 2 within the thesis structure. It highlights how the chapter makes a specific contribution towards the fulfilment of objective 1.2.1. It does so by establishing the theoretical basis of the issues related to post-disaster recovery and reconstruction within the DMP.

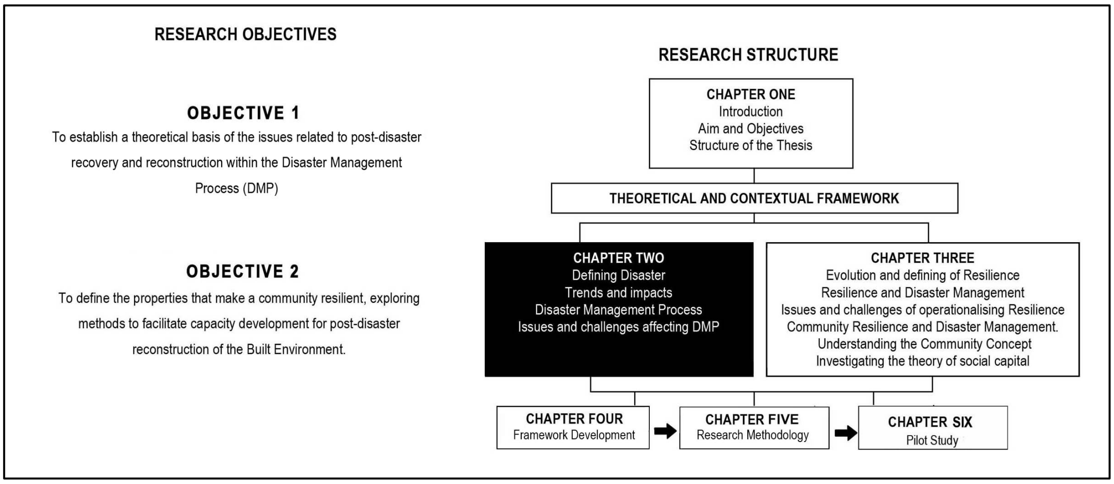


Figure 2.1 Position of Chapter 2 within the thesis structure

2.2 Defining disasters

A large body of research exists detailing the highly complex nature of disasters and their associated consequences on a global scale (Quarantelli, 2001; Schaluf et al, 2003; Furedi, 2007; UNDP, 2012; Von Meding, 2013). Nonetheless, the frequency and magnitude of such disasters provide significant challenges for national governments and their partners engaged in disaster management and mitigation efforts. Much of this complexity is a consequence of the relative inability to predict when disasters are likely to occur, although the multi-disciplinary nature of the management and mitigation process further contributes to the complexity. As a result of this multi-disciplinarity, there is significant debate as to what constitutes a disaster and, as such, no generally accepted definition exists. This poses particular challenges for government when developing both operational and strategic policies for disaster management and mitigation, particularly when disasters occur across more than one jurisdiction (Corriveau, 2000; Bullard et al, 2008). While definitional disparity across jurisdictions manifests itself as a fundamental issue, the complex nature of ‘understanding disasters’ is made even more difficult by significant thematic differences in definition across disaster management and mitigation stakeholder sectors.

A series of research studies (Krimgold, 1974; Cuny, 1983; Kreps, 1984; Quarantelli, 1995; Tierney et al, 2001; Perry and Quarantelli, 2005) support the notion that the absence of an agreed definition[1] has increased the challenges facing those tasked with managing and mitigating disasters. Below et al (2009) note that the absence of an accepted definition has led to inconsistency, unreliability and poor interoperability

[1] Definitional issues surrounding the term resilience are dealt with in more detail in Chapter 3.

of disaster management initiatives. Quarantelli (1995) supports this notion, arguing that until an agreed definition is advanced, there will continue to be challenges facing the development, implementation and delivery of disaster management and mitigation strategies. Given the complex cross-disciplinary nature of disasters, it is not surprising that the term ‘disaster’ has different meanings in different professions associated with the DMP (Perry, 2005). As a consequence, there have been concerted (but so far unsuccessful) efforts to align disaster definitions to conceptual themes in the literature base, with Lindell and Perry (2011) arguing that disasters are as much ‘social’ as they are ‘technical’ and ‘scientific’. The following section will discuss each of these three themes in turn.

Historically, disasters have been viewed as a ‘social product’ which defies simple interpretation (Fritz, 1961, Britton, 1986). Generally, the sociological research base suggests that disasters are, in the first instance, events that can be designated in space and time, which ultimately result in significant impacts on societies’ ability to function. In this regard, disasters possess a geographical dimension, delineated by the intersection between the geography which society inhabits and the geography which disasters impact upon. Consequently, the social element reacts and alters its responses to cope with these impacts (Kreps, 1995; Fischer, 2003). Indeed, Fritz’s pioneering definition in 1961 is still widely adopted in the literature today, describing a disaster as an event concentrated in time and space, where society is subjected to “physical harm and social disruption” and preventing the “essential functions of society” (Fritz, 1961:p655). However, to fully understand a sociological definition, it is first necessary to trace its origins and development throughout history.

The publication of Fritz’s widely read definition in 1961, paved the way for more detailed and diverse theorising on a sociological definition. The social thread of Fritz’s work was evident for decades, as many researchers adopted Fritz directly or referenced his work. Fritz has influenced much disaster research, including flooding (Perry, 1985) and bush fires (Wettenhall, 1979). The influence of Fritz’s definition is still evident in the work of 21st century researchers, with Fischer (2003) pointing out that sociologists actually study social change under disaster definitions.

Following in the footsteps of Fritz, Fischer’s (2003) definition focused on the ‘process of change’ which alters the normal functioning of daily life. Fischer discusses a shift from a priori social structure to a new temporary alternative state. Both Fritz’s and Fischer’s definitions recognise the impact ‘social’ (human) influences have on a disaster event, thereby highlighting the need for social/human intervention to withstand hazard events.

In this vein, McEntire (2007) argues that the extent of disaster impact is a product of the level of vulnerability within the social system. Beau (2002) holds that baseline conditions are not equal across case-studies and nations; however, the principles of resilience and capacity building are transferable across communities. Disasters are a worldwide issue and, as such, appropriate consideration is required to take account of the social, economic and cultural nuances associated with Global North and Global South communities. In this regard, Disaster Management is less to do with the hazard agent and more to do with the nature / degree of vulnerability within a particular community. This sociological understanding of a 'disaster' notes that concepts, issues and variables are not equal across cultures and systems (Peacock, 1997). However, the literature base argues that the principles of the DMP remain relevant and useful regardless of economic, social and cultural variations (Beau, 2002).

In summary, a sociological definition of 'disaster' is focused on the situation created and not the hazard agent (Fritz, 1961; Dynes, 1998; Kreps, 1998; Porfiriev, 1998). Dombrowsky (1998) notes sociological definitions do not describe natural or human-made 'disaster agents' (hurricane, flood waters, tidal waves), instead they focus on the disruption of everyday normal life caused by a hazard agent. Thus, a sociological 'disaster' definition concerns itself with how society reacts to the impacts and destruction caused by a disaster agent.

However, despite the attention paid to societal disaster definitions in the current literature, they often include immeasurable criteria, thus illustrating the need for a precise, scientific definition and system of categorisation. In this context, Sheehan (1969) was one of the first to assign figures to a disaster in order to bring clarity as to what constituted a disaster. Sheehan argues that disasters are events that caused at least one hundred fatalities, one hundred human injuries, or financial damages greater than or equal to USD $1 million. By contrast, Denis (1995) views 'major' as meaning more than fifty fatalities.

Whilst there is no consensus on an exact quantifiable and scientific definition, the most widely accepted and adopted definition in the literature is that from the "Centre for Research on the Epidemiology of Disasters" (CRED), Emergency Events Database (EM-DAT). International organisations such as the United Nations (intergovernmental), the World Health Organisation (intergovernmental) (WHO), and the International Federation of Red Cross and Red Crescent Societies (non-governmental) (IFRC), acknowledge the need for a scientific definition and accept the application of a system of categorisation. This required EM-DAT to put figures on what constitutes a disaster in order to be included in their database. Although broadly similar to the Awareness and Preparedness for Emergencies at Local Level (APELL) database, there are variations in the figures. To constitute a disaster and be entered into the database, EM-DAT states at least one of the following criteria must be met: ten (10) or more people must be reported killed; one hundred (100) or more people must be reported affected; a declaration of a state of emergency must be made; or a call for international assistance must occur (Vos et al, 2010).

In addition to ‘social’ and ‘scientific’ thematic definitions, a technical perspective can be found in the literature base. A disaster can be described technically as a sudden or unplanned event, which has scope to impact unfavourably on numerous people if not an entire community. Such a definition will take into consideration the scope of the event, the number of fatalities, lives impacted, destruction of property and economic disruption to business activities (Amartunga et al, 2011).

Technical definitions in the literature were found to characterise a disaster by its sudden, overwhelming and unforeseen nature (Mc Entire, 2000; Landsman, 2001; IFRC, 2008). Ruthenford and Boer (1983) emphasise the ‘overwhelming’ aspect of a disaster through its impact on resources, describing a disaster as a destructive event which due to insufficient resources can result in an inability to cope, coupled with significant casualties over a short space of time. Sundnes and Birnbaum (2002) reiterate resources as a defining element, by describing a disaster relative to the mismatch between resources available to perform the necessary tasks, irrespective of whether this mismatch is being caused by natural or avoidable man-made (non natural) events.

2.2.1 Further definitional issues: categorisation

Beyond the thematic definers presented above (social, technical, scientific), disasters can be characterised by their disaster agents, namely: natural; man-made; or hybrid (Shaluf, 2007) and classified into disaster types, sub-disasters, and disastrous events (Tables 2.1- 2.2). Natural disasters are hazards resulting from natural causes, where the human dimension and external hazard act upon each other in an interconnected relationship (Von Meding, 2013). Natural disasters are generally classified into four categories: geophysical; hydrological; meteorological and climatological, which are further divided into sub-categories (Table 2.1) (UNISDR, 2004; Guha-Sapir and Vos, 2012).

There is a growing body of research that suggests that humans interference with the natural environment may be affecting the frequency, magnitude and geographic distribution of precipitating events (Peduzzi et al, 2009; Guha-Sapir and Vos, 2012). An awareness of the community level is critical with respect to this relationship between human interference and external physical factors acting upon each other (Von Meding et al, 2012).

Table 2.1 Natural disaster classification. Adapted from Guha-Sapir and Vos, 2012.

NATURAL DISASTERS			
GEOPHYSICAL	**HYDROLOGICAL**	**METEOROLOGICAL**	**CLIMATOLOGICAL**
Earthquake **Volcano** **Mass movement** -Rockfall -Landslide -Avalanche -Subsidence	**Flood** -General Flood -Flash Flood -Storm Surge/ coastal Flood **Mass movement** -Rockfall -Landslide -Avalanche -Subsidence	**Storm** -Tropical Cyclone -Convection Storm -Local Storm	**Extreme weather** **Drought** **Wildfire** -Forest Fire -Land Fire

The diversity of man-made disasters makes them comparatively more difficult to predict than natural hazards (Smith and Petley, 2009). Man-made disasters include industrial accidents, transport accidents and accidents resulting from human error, negligence or malicious motives (as illustrated in Table 2.2). Essentially, man-made disasters occur as a consequence of human or organisational error, leading to system failure (Pidgeon, 2012). Some can be solely man-made whilst others can be the result of poor decision-making in already vulnerable areas.

Such events, where a natural force meets human error, are known as hybrid disasters. Smith (2001) rejects the idea that disasters are truly 'natural' hazards, emphasising that all disasters arise from a combination of physical exposure and human vulnerability. Thus, hybrid disasters are events which result from the overlap of natural and man-made disasters meeting a social process. At the root of hybrid disasters is the assumption that it is not the environment or technology which is to blame but in fact, human failings (Stout et al, 2008). This assumption highlights the potential human intervention has to positively or negatively influence disaster impact.

Table 2.2 Man-made disaster classification. Adapted from Guha-Sapir and Vos, 2011; Munich Re, 2014.

MAN-MADE DISASTERS		
INDUSTRIAL ACCIDENT	TRANSPORT ACCIDENT	MISCELLANEOUS ACCIDENT
Collapse Explosion Fire Gas Leak Poisoning Radiation Other	Rail Road Water Air	Collapse Explosion Fire Social unrest Terrorism

Regardless of its thematic definer, a disaster definition must consider multiple perspectives. This approach resonates with arguments proposed by Quarantelli (1994) that defining a disaster by a single concept is an attempt to capture too much. Further, it could be argued that it is not appropriate to attempt to place heterogeneous phenomena under a single label of 'disaster'. No definition is all encompassing, but what is important is clarity of the term within the context it is to be applied. Thus, the definition constructed below embodies the perspective of this study, incorporating characteristics identified throughout the above literature review. In particular, a definition appropriate for this study must refer not only to the physical agent and its impact on society, but also with an assessment of that physical impact on a vulnerable social dynamic. Synthesising the literature base, a succinct definition of a disaster suitable for the positioning of this study is as follows:

> *a sudden or unforeseen event, derived from a hybrid of a natural hazard and human intervention, causing physical and social disruption which exceeds the capacity of the affected community to function normally* (Source: Author).

2.3 Trends and impacts

The UN Office for Disaster Risk Reduction (UNISDR) (2011) state the first step towards reducing disaster risk for communities involves capturing the spatial distribution, composition and impact of disasters. Further, UNISDR highlight inconsistencies in historical disaster data collection, describing it as “ad-hoc”, i.e. reactively collecting it at the time of the emergency. In addition, the lack of a precise or generally agreed scientific definition has impacted the collection of systematic disaster data and led to variation in facts surrounding disaster occurrence figures globally (UN, 2013).

Unsurprisingly, disaster data has been criticised as being inconsistent and unreliable, providing limited interoperability (Below et al, 2009). However, advances in disaster data have been made through the introduction of databases such as ‘EM-DAT’ collection and management by The Centre for Research on the Epidemiology of Disasters; ‘Disaster Inventory System-DesInventar’ from the United Nations International Strategy for Disaster Reduction (UNISDR); ‘NatCatService’ by Munich RE, and ‘Sigma explorer’ by Swiss Re. Drawing on these databases, the following section outlines historic disaster trends (frequency) and their associated impact in terms of fatalities and monetary costs.

Research demonstrates that disasters continue to escalate in frequency and magnitude worldwide (UN-Habitat, 2013). A recent review of natural and man-made disasters by Swiss Re (2015) revealed that in 2015, 353 disasters were recorded, down from 336 in 2014 (Figure 2.2). Of those figures, 198 were natural disasters (down from 189 in 2014) and 155 were man-made (up from 147 in 2014) (Swiss Re, 2016). EM-DAT (2016) similarly notes an increasing long-term trend in disasters, reporting that over the period 1974 to 2015 the occurrence of reported disasters has increased steadily on an annual basis (from less than 100 in 1974 to 376 in 2015).

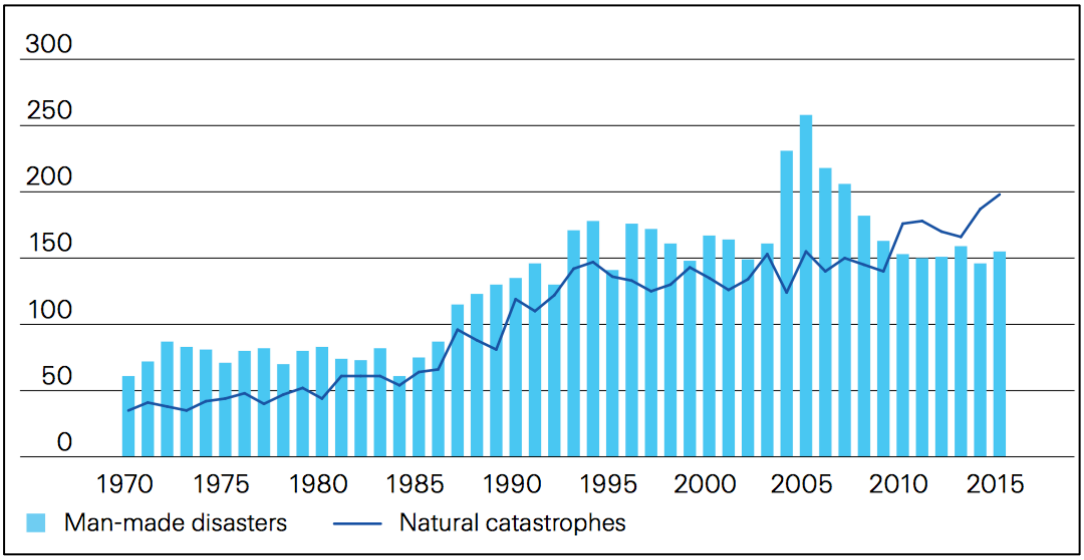


Figure 2.2 Trends in frequency of man-made and natural disasters. Source: Swiss Re, 2016.

That said, the frequency of man-made disasters has in fact reduced during recent years, down 40% since peak levels in 2005. Despite this declining figure in very recent times, the overall frequency of man-made disasters has been on an upward trajectory, rising from 60 in 1970 to 155 in 2015 (Swiss Re, 2016) (Figure 2.2). The recent reduction in man-made disasters is largely attributed to improvements in hazard minimisation processes that control fires and explosions.

Natural disasters outweighed man-made disasters by 21% in 2015 (Swiss Re, 2016). The evidence from Figure 2.2 suggests that the world is becoming more vulnerable to both natural and man-made disasters. Furthermore, research suggests that it is developing countries that suffer the most (Eshghi and Larson, 2008; Haigh and Amaratunga, 2011a; Guha-Sapir et al, 2012). Upwards of 80% of disasters occur in the developing world, with the result that the majority of research focuses on alleviating the impact of disasters in the developing world (FAO, 2015). Interestingly, Haigh (2011) argues that this focus has led to an imbalance in the literature on the developed world. In line with this, UNDP (2012) has called for further research into disaster impacts on the developed world, with particular emphasis on the socio-economic consequences.

The reasons for the historic increase in natural disasters are complex and multi-faceted, extending beyond the climate change argument (UNISDR, 2015). Guha-Sapir of EM-DAT attributes the increase recorded in part to improved disaster media reports and advances in communication, which have artificially inflated the figures. Another reason is that, at the start of the 1980s, agencies such as CRED and UNISDR became more active in their recording of natural disasters, thus inflating the figure of recorded disasters. On the other hand, many small and often repetitive disasters in rural locations go unreported (IFRC, 2014). These disasters are not reflected in global figures on losses but, when taken in aggregate, have a significant negative impact upon society.

In addition, researchers argue that the rapid urbanisation of vulnerable environments is, in effect, 'making disasters'. A World Bank report on 'Natural Disaster Hotspots' in 2005 states that increased urbanisation in vulnerable areas has created a situation where over 160 countries have more than 25% of their populations in high at-risk areas. Schneider et al (2013) notes that, by placing humans in a vulnerable environment, what was previously a natural event becomes a disaster.

Urbanisation coupled with climate change and natural disasters, further compounds the risk. The United Nations (2011) predict that the unprecedented scale and frequency of disasters in recent years, as a consequence of climate change, represents a trend set to continue. Rising global temperatures, which are currently projected to rise by 6.3 °C by the end of the twenty first century (United Nations Environment Program, 2009), is a cause for concern worldwide. The United Nations predicts that, even if countries achieve their climate promises, a temperature rise will occur nonetheless. This is expected to result in an increase in the number of tropical cyclones and heavy rainfall. Furthermore, the United Nations predict that sea level is set to rise by a metre, increases the probability of natural disasters in North Western European and other world regions, such as South East Asia.

Researchers suggest that, whilst climate change is not solely responsible for the increasing impact of disasters, it is to blame for the increase in frequency and magnitude of the precipitating event. Similarly, Eliscar (2010) argues that whereas disasters used to occur on an annual basis, climate change means that one event triggers another (or amplifies its magnitude) resulting in devastating effects. The evidence base indicates that, in addition to man's influence, climate change is a significant contributory factor, which has the potential to exasperate a disaster situation (Phillips, 2015).

However, despite the overall trend in increasing frequency of disaster events, overall fatality rates are on the decrease, standing below the annual average levels in the period from 1990-2015 (Munich RE, 2016). Of these disasters, typhoons, earthquakes, flooding and heat waves were responsible for the majority of deaths from natural disasters in 2015 (Munich RE, 2016). Maritime disasters, aviation and stampedes caused the majority of man-made disasters, for example a sinking migrant boat killed 800 people off the Libyan coast in 2015 (Munich RE, 2016).

Man-made disasters accounted for 7,000 deaths in 2015, up from 5,900 in 2014, but remained on trend for the decade average (Swiss Re, 2016). By contrast, the number of natural disaster fatalities had declined in comparison to the period from 2005-2014, which saw an average of 76,416 deaths per annum (EM-DAT, 2016). In particular, the high average (2005-2014) can be attributed to the three years (2004, 2008 and 2010) which saw almost 200,000 fatalities and 2003 and 2005 which saw 100,000 fatalities, the majority attributed to earthquakes. The 2015 EM-DAT data suggest that, whilst the number of 'disaster' incidents is on the increase, the sum of those killed and affected worldwide (101.3 million) is the lowest since 2005. The decrease is attributed to the lower human impact of hydrological and meteorological disasters, whose number of victims are 75% and 60% respectively below the 2005-2014 annual averages. Further, the decrease in fatalities is attributed to improved efficiencies in the response phase (UNDP, 2009), improved early warning systems and increased preparedness (Rogers and Tsirkunov, 2010; Kafle, 2017).

Whilst the number of fatalities is decreasing, this headline figure hides the fact that those injured, displaced or left homeless by disasters is actually increasing In this vein, Guha-Sapir (2011) highlights that reduced mortality rates can actually present new challenges, for example, by placing additional pressure on already depleted resources.

The negative economic consequences of disasters frequently impacts upon an affected community's ability to recover. Both natural and man-made disasters can have devastating effects on short and long-term economic growth and development (Munich Re, 2016). The cost of disasters in 2015 (USD $ 70.3 billion) was the third lowest since 2005, representing a 56% decrease to the annual average costs for the period 2005 to 2014 (EM-DAT, 2016). Of the USD $37 billion recorded insurance damages, only USD $9 billion were caused by man-made disaster, whereas USD $27 billion attribute natural disasters stemmed largely from hydrological disasters such as floods and extreme weather events in Asia, North America and Asia.

Research shows that, within Europe, natural disaster costs are rising at a faster rate than disaster frequency rate, yet man-made disaster damages remain on trend (Munich Re, 2015). While disaster damages have fallen in 2015, it was found that overall damage costs have increased from USD$50 billion a year in the 1980s to USD$200 billion in the last decade. This trend is set to continue, with the European Commission (2015) predicting that European flooding costs could increase almost five-fold by 2050. Evidence indicates that Europe saw losses of more than USD$13 billion attributable to natural disasters in 2015 (Swiss Re, 2016). The bulk of these losses can be attributed to flooding in the UK and south eastern France (Munich Re, 2016). In December 2015, heavy rainfall from Storm Desmond and Storm Eva flooded more than 3500 properties across the UK, damaging several bridges and other critical infrastructure (Munich Re, 2016). Incurring damages of around USD $2 billion, this figure depicts the considerable impact that a single disaster events can have on human society.

2.4 Disaster management process

Disaster management is the process of organising and managing resources and capacities to limit or avoid threats from hazards (Jaya-Kumar, 2000; FEMA, 2007). It is a collective term, incorporating pre-disaster planning and post-disaster responses to the social and physical impacts of disasters (Warfield, 2004; FEMA, 2017). Disaster management is synonymous with the complex organisation of all tasks and actors. In response, the DMP was developed in the 1970s, to meet the need for an organisational mechanism, to help manage disaster events and their associated impacts (Westgate and Wisner, 1975; Neal 1997; Kelman, 2007).

The DMP is itself illustrative of the iterative nature of responses to a disaster event. The process initiates or ends with the mitigation phase, followed by the preparedness phase. Both phases serve to improve disaster preparedness, for example, through better warnings and reduced vulnerability in anticipation of an event. A significant concept during these phases is “development”, i.e. enabling a community to better withstand the consequences of a disaster and prepare for a subsequent disaster. Post-disaster activities take place in the response and recovery phases. The response phase is heavily influenced by humanitarian actors in the immediate aftermath of a disaster event, followed by more long-term recovery and reconstruction efforts in the recovery phase (Warfield, 2004; FEMA, 2017)(Figure 2.3). The goal of the recovery and reconstruction phases is to return the affected community to a similar or improved stabilised state of normality (Davidson and Johnson, 2006). Thus, the overarching purpose of the DMP is to limit or avoid the potential losses from disasters, assure prompt and appropriate assistance to victims of disaster and achieve rapid recovery (WHO,2002).

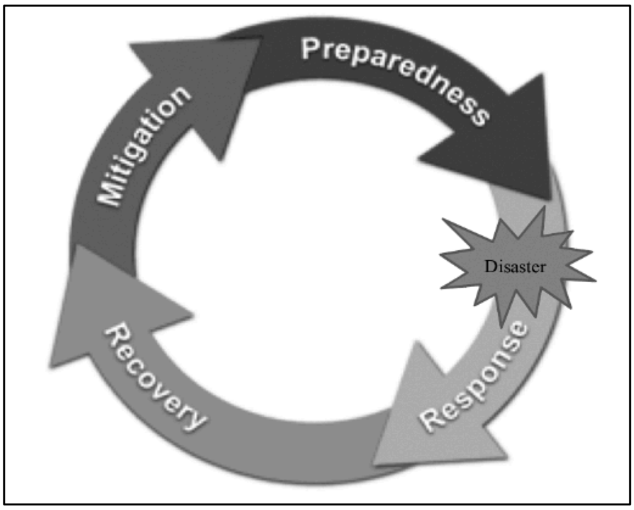


Figure 2.3 Disaster management process. Source: FEMA, 2017.

The DMP has the potential to serve as an organisational tool for those tasked with responding to the complexities of a disaster event. A well-defined and clear process aids the organisation and simplification of complex events by helping to prioritise critical tasks, particularly when operating in a restricted timeframe. In addition, the DMP differentiates between practical conditions and theoretical processes. This practical learning can inform and shape future disaster management plans. A further benefit for disaster managers is the use of the process as a tool to quantify disaster events (Shreve, 2014). Documenting the phases of the DMP can help develop a common understanding of the disaster process, facilitating improved integration between urgent response and long-term recovery strategies (Kelly,1998). The above- listed items highlight the potential for formal DMP to reduce disaster risk, by encouraging support and investment from outside organisations in the formalised process (Kelly, 1998).

Given that disasters are by their very nature unexpected and involve many actors, Warfield (2004) argues for the need to categorise the DMP into different phases according to activities. However, the simplification of the DMP into arbitrary phases is a contentious question within literature, fraught with inconsistencies (UNISDR, 2014). To understand the nature, purpose and boundaries of these phases, it is important to trace their development throughout history.

FEMA (2007) argues that the development of these phases allows actors to focus on each stage individually, achieving a more detailed study and better understanding of each distinct phase. In order to further clarify the phases, it is first important to identify precisely the temporal stages to which they belong. The phases are both logical and temporal and are defined as: pre-disaster, disaster and post-disaster (Figure 2.4). The pre-disaster period is concerned with the time before the disaster event, the disaster period looks at the disaster itself and the immediate aftermath, then the post-disaster phase refers to the period between the end of the disaster and the return to normality. The temporal stages have a logical relationship with disasters and thus, within the literature, mitigation and preparedness is contained primarily within the pre-disaster stage; response occurs in the disaster stage and recovery occurs during the post-disaster stage (Faulkner, 2001; McEntire et al, 2002; Mansor et al, 2004; Hwacha, 2005; Coetzee, 2012).

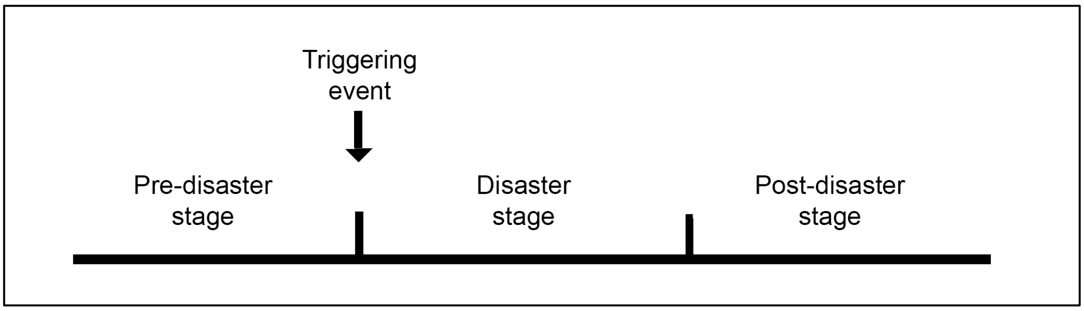


Figure 2.4 The disaster stages. Source: Author.

Tracing the origins, nature and differentiation of the phases through history offers a better understanding of the roles and benefit these phases can offer. Since its initial inception in the early 1900’s the DMP has evolved, varying in the number of phases it contains. The earliest attempt to describe disaster phases came from Carr (1932). Carr describes the initial phase as the ‘preliminary period’ during which the disaster agents responsible for the ultimate collapse present themselves. The ‘dislocation and disorganisation phase’ follows, referring to fatalities and loss incurred by the affected community as opposed to the disaster agent itself. The third phase was referred to by Carr as the ‘readjustment and reorganisation phase’. This phase concerns itself with efforts by the community to cope and adjust to disaster consequences. The phase focuses upon the leadership and morale of the affected community to cope with the complexity of the disaster event itself (Carr, 1932). Though basic, this early effort reflects an early shift in focus from the physical to the social consequences of a disaster.

Building upon an earlier study by Powell and Rayner (1952), Powell (1954) made a further attempt to define the disaster phases, dividing them into eight distinct phases. The first stage, 'pre-disaster conditions' refers to the existing environment and a community's attitude to a disaster. This follows with a 'warning stage' which in turn is met with the 'threat' stage, focusing on activities that enable communities to survive the impact. The 'impact' stage represents the understanding that considerable devastation may ensue. The fifth stage is the 'inventory' stage, which refers to the acknowledgement of the damage sustained. The incorporation of reactive efforts to assist those affected follows in the 'rescue' phase. The 'remedy' phase follows by listing the actors involved in emergency first response. 'Recovery' marks the final phase and represents attempts to assist the affected community return to a stable pre-disaster state (Powell and Rayner, 1952; Powell, 1954; Neal, 1997).

Stoddard (1968) followed with a similar six-stage process, namely: pre-emergency; emergency; evacuation; dislocation; relocation; post-emergency. A noteworthy development in this process was Stoddard's argument that different phases of disaster reflect different types of individual and group behaviour. The emergence of phases such as pre-emergency, emergency and post-emergency phases have been described by modern researchers as an insight into the future of the DMP (Coetzee, 2009). Stoddard's subdivision of the main disaster phases is representative of what can be seen in many subsequent DMPs.

From the above discussion, we can conclude that the roots of the DMP are strongly influenced by early disaster phase research. The isolated and 'linear' examples of disaster phases by Carr (1932), Powell (1954) and Stoddard (1968) indicate that the concept of disaster phases has long been embedded in disaster research. However, a criticism of these early efforts, is that they focussed heavily on the immediate preparedness and response phases, with little attention paid to long-term, post-disaster recovery. In addition, the shift from a linear to an iterative process requires further investigation as well (Kelman, 2007; Lewis, 2007; Wisner et al, 2007).

Developments in the historical analysis and categorisation of disasters led Barton (1969) to define a disaster in five stages, combining both the functional and temporal aspects of a disaster. The first 'pre-disaster period' was not described. The second phase followed with a description of the 'detection and communication of warning' for a specific threat. The third phase evolves around the immediate response efforts, focusing on the implications of the disaster impact. Barton extends the response phase to include a fourth social response period, lasting from a few days up to months or even years. The final phase considers a community's attempt to readjust to a more stable state of normality. Overall Barton's biggest contribution was his pioneering attempt to analyse disaster phases in terms of the organisational behaviour of both communities and wider disaster stakeholders.

Following earlier efforts (Carr, 1931; Powell, 1954; Stoddard, 1968; Dynes, 1970; Barton 1969), Mileti et al (1975) subsequently produced a process involving six phases comprising: preparedness; warning; pre-impact; early actions; post-impact; short-term actions; restoration (recovery) and reconstruction. Whilst offering a new codification effort, the categories lacked certain theoretical foundations, with the main rationale for their construction based on a direct interpretation of the tasks each phase comprises (Drabek,1986; Neal, 1997).

In 1979 the disaster management field saw a further development in codification efforts, through the National Governor's Association Report, which represented an important step in professionalising the disaster management discipline. Prior to this, disaster theory was limited to practical response and recovery efforts (Lewis et al, 1976; Twigg, 2004; UNISDR, 2004). Addressing this gap, the report proposed a holistic, integrated approach to disaster management with the output being a four phase disaster management process, which is still the most prevalent and widely used process to date (FEMA, 2007). Drabek followed in 1986 with an updated codification effort, focused on the impact and consequences of disasters. Adopting the four-phased process identified in the National Governor's Association Report, Drabeks's efforts included further sub-divisions of the process phases, placing a new focus on the social element of disasters.

The pioneering National Governor's Association report helped to clarify the purpose of the DMP phases. Acknowledging ambiguity surrounding disaster terminology, the report proposes a four-phased process, which directs attention towards the function and objective of each phase (Neal, 1997). As such, the report defines a phase according to its 'function' and the activities undertaken to deliver on this function. The four phases are considered part of a new universally accepted disaster language and are outlined in further detail in the following section (Neal,1997).

2.4.1 Mitigation

Mitigation is the initial phase of the DMP, which employs actions to reduce, eliminate or manage the long-term human and physical risk of disasters (FEMA, 1998). Dynes (1993) summarises the phase as human attempts to limit the potentiality of disaster occurrence. The focus of this phase is to employ long-term risk strategies in place of hitherto reactive temporary solutions, with a view to preventing disasters before they happen (Lindell and Perry, 1992). This proactive mitigation includes the reduction of vulnerability and the distribution of costs across the affected community.

Efforts to reduce threats to a community include actions such as updating building codes, risk assessments, land-use management, improved health care and education (FEMA, 2004; Warfield, 2004). It is worth noting, however, that without collaboration and participation from the community these actions will not effectively strengthen the disaster reduction. The inter-dependency of the phases is best represented through a disaster management process diagram, highlighting the overarching relationship between mitigation and the other phases (Figure 2.5).

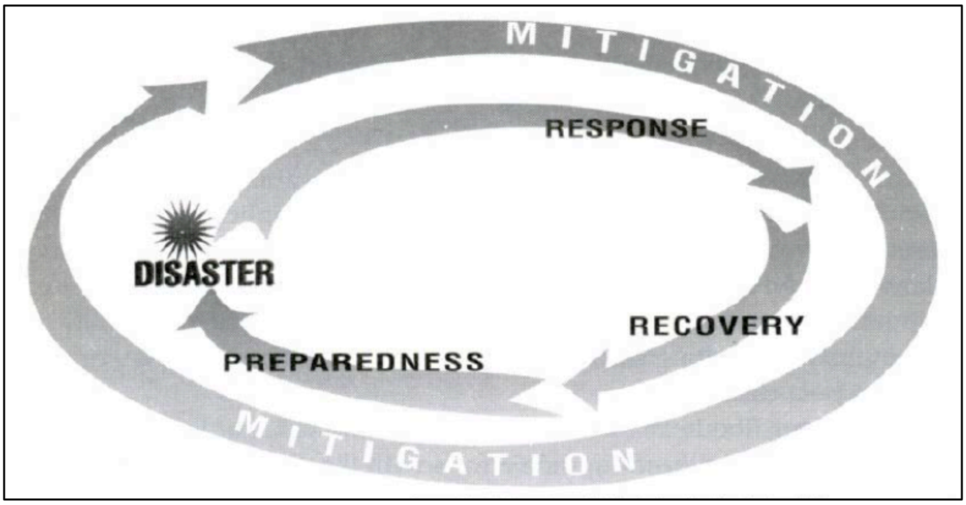


Figure 2.5 Disaster Management Process. Source: FEMA,1998.

Despite its importance in the process, the literature indicates that mitigation received the least attention amongst the resources devoted to disaster management (Roberts, 1994; GFDRC, 2013), highlighting a reactive approach to DM. By contrast, mitigation involves measures taken prior to the disaster event, which in combination with proactive investment (as opposed to a reactive response to an early warning sign), can significantly reduce disaster losses.

2.4.2 Preparedness

The second phase of the process, “preparedness”, pertains to disaster response planning designed to protect society by using available resources and capacities in an efficient manner, resulting in a more effective response (Federal Emergency Management Agency (FEMA, 2007). The preparedness phase acts almost as an ‘insurance policy,’ limiting the extent of disaster impact (Sutton and Tierney, 2006). The relevant pre-disaster activities are conducted within a limited timeframe and seek to equip the community with a sufficient level of readiness to reduce the disaster consequences (WHO, 2002).

The preparedness phase has been further categorised by the US FEMA into five sub-phases namely: plan; organise and equip; train; exercise; evaluate and improve (Figure 2.6). The “plan” phase centres around the integration of action plans within both regional and national policy, acting as a method for budget allocation (Bildan, 2003). The “organising and equip” stage comprises early warning systems, provision of health facilities, risk awareness programs, capacity building exercises and training (Von Meding et al, 2012). Finally, the “evaluation and improvement” stage incorporates hazard mapping and risk assessment with a view to outlining vulnerable areas and reducing the frequency, intensity and impact from disaster events (Von Meding et al, 2012).

Figure 2.6 Disaster management cycle within the preparedness phase. Source: FEMA, 2017.

Training is integral to the successful implementation of the preparedness phase. Training involves the practice and evaluation of disaster plans in a risk free environment. This, in turn, helps to establish roles and responsibilities for all actors involved in the phase. Successful implementation of this stage will highlight areas for refinement, capability gaps and opportunities, all of which can be fed back into the process as lessons learned for future improvement. Ultimately, enhanced preparedness as a result of these activities will help build capacity within the affected community (Bildan, 2003).

2.4.3 Response

The third phase of the disaster process is the response phase. It starts with the detection of an event and ends with a return to a stable state after the event (Lindell and Perry, 1992). A definition from FEMA lists the activities undertaken during this stage as: the provision of food, water, shelter and health services to those affected and the return of critical infrastructure (FEMA, 1998). The goal of the response effort is to implement preparedness measures as soon as a hazard is identified. Further efforts during this phase include the provision of emergency assistance and dealing with immediate physical effects. The final stages of the response effort focus on enhancing long-term recovery potential through damage assessments and the application of donations.

Focused on the direct aftermath, this phase is strongly characterised by a sense of urgency, less prevalent in other stages of the process (Neal, 1997). Lindell and Perry (1992) reemphasise the importance of a timely response, noting that in the immediate aftermath of a disaster, minutes can cost lives. As the sense of crisis dissipates the process enters into the recovery phase. Neal (1997) suggests an indicator of the transition from the response phase into the recovery phase is apparent when disaster managers begin wearing business suits again. This highlights the end of emergency measures and the commencement of the recovery process.

2.4.4 Recovery

The fourth phase in the DMP is “recovery”. The goal of this stage is to return all systems (formal and informal) to as normal a state as possible (FEMA, 1995). The phase focuses on the rebuilding of communities, enabling them to function without assistance. The phase should allow those affected to return to a pre-disaster state or even an improved situation (FEMA, 1994). Largely speaking, recovery efforts begin after the response phase, but are dependent upon the recovery measures in place. This means recovery efforts can run concurrently with response phase efforts. Of particular relevance to this thesis is the lack of recognition of the recovery phase in early codification efforts (Barton 1969). Ambiguity over the complex recovery process is represented in the numerous labels attached to the phase: restoration; recovery; rehabilitation; redevelopment; reconstruction. Certain descriptions within the literature divide the phase into short and long-term recovery (Baird, 2010). In this regard, Chapman (1962) describes recovery as the social and physical ‘rehabilitation’ of the affected community, focusing on the long-term aspect of recovery. Furthering Chapman’s division of the phase into short-and long-term recovery, Stoddard (1968) also followed with a divided recovery phase. Overall, the descriptions applied to this phase are more abstract relative to the other phases. For example, less emphasis is paid to the activities which define it, with the focus on the goals and desired outcomes of the phase. It could be argued that the ambiguity of this phase stems from the ill-defined responsibilities of certain of its aspects (FEMA, 1998).

2.4.5 Reconstruction

Although not recognised by theoretical literature as a phase in itself, reconstruction is a fundamental subdivision of the recovery phase and as such is pertinent to this study. Sitting within the recovery phase, it serves to bridge the gap back to disaster mitigation through activities which build-back affected communities, reduce risk and foster resilience[2]. The reconstruction element encompasses the rebuilding of affected areas in order to return to a stable state. It comprises activities including the restoration and rebuilding of critical infrastructure and a re-evaluation of building codes and land use regulations (Drabek and Hoetmer, 1991).

The media focus on reconstruction has traditionally been around the provision of shelter (Davidson et al, 2007). Given the chaotic context of a post disaster situation, reconstruction efforts are often characterised by urgency and poor quality of workmanship. Disaster managers acknowledge however that a disaster in fact presents a window of opportunity for long-term development. Such development will require reflective discussion and consensus building, in order to effectively act upon lessons learned. The UN recognises this ‘window of opportunity’ and encourages national government decentralisation so as to allow community-driven, context-specific responses to emerge (Birkmann et al, 2009).

2.4.6 An alternative view

There is consensus within literature that the phased approach to DMP is a useful means to manage disasters (Kelly, 1998; Alexander, 2002). However, implementation of the DMP is not without its difficulties and issues (Neal, 1997; Kelly, 1998; Cebulla, 2004; Von Meding et al, 2012). The complex nature of the discipline prompted some researchers to apply a generalised, phased approach to disaster management, placing the focus on individual events, with the aim of clarifying principles that can be applied to all types of hazards and subsequent disaster events (Checkland, 1999; Skyttner, 2005; Becker, 2009).

However, the literature also presents a contrasting school of thought, which argues that the unique nature of disasters cannot be dealt with in such a generalised homogenous manner (FEMA, 1995; Neal, 1997). Managing disaster is a long-term, iterative process over a prolonged period of time. The lifecycle of this process

[2] Definitions of resilience will be reviewed in detail in Chapter 3.

requires adaptable phases that meet the array of demands a disaster presents, including: appropriate strategies to plan and mitigate against hazards, respond to threats and recover from the physical and social impacts (FEMA, 1993; WHO, 2007). Neal (1997) raises further challenges with the concept of "phases" in an article titled 'Reconsidering the Phases of Disaster', where he highlights the ambiguous interpretation of phasing amongst researchers and practitioners. With Neal's article acting as a backdrop, the following section investigates the challenges and problematic themes evident in the existing unclear processes which populate the literature.

The varied interpretation of a phase as being defined by 'time' or 'functional activity' is a contentious issue in the literature. Waugh and Tierney (1997) refers only to 'activities' and 'functions' in their description of disaster management, disregarding the need to discuss the temporal nature of phases in the description. Constredt (2002) cautions that defining phases by function alone makes the elements of each phase appear 'action' based with less emphasis being assigned to social dimensions. This can lead to a misrepresentation of the process 'action' oriented, with an emphasis on the hazard rather than its social consequences (Constredt, 2002).

Adopting the 'function' interpretation of phases, Waugh recognises that whilst phases exist in the process, there is a growing acceptance that activities can overlap and inhabit multiple phases at any one time. Alexander (2002) takes this point further, stating that disaster responders are required to take measures to facilitate recovery whilst simultaneously adopting preparedness strategies to mitigate against the next disaster. Similarly, Dynes (1981) discusses the simultaneous existence of activities and their overlapping nature within phases, when responding to different sets of disaster demands.

The use of 'functions' as a phase definer is also used by Haddow (2008) in his chapter on 'recovery'. By referring to phases as functions, Haddow raises a theoretical debate over the 'timing' of these phases. In particular, Haddow questions the point of transition from the completion of the response 'function' to the commencement of the recovery 'function'. Despite a lack of consistency in terminology, the above sources agree on the circumstances or 'functions' having precedence over a 'temporal' definer.

Ambiguous terminology in respect of timing of the phases compounds the confusion. The notion of “continuum” is used throughout the literature, describing the successive disaster phases as linear, cyclical, iterative or a phased process (Kirkby et al, 1997; Neal,1997; WHO, 2002; Warfield, 2004). A pioneer in relation to the temporal definition of phases was Dynes (1981), who argued that an understanding of the mechanics of disaster developments and their associated activities was essential before temporal phase thresholds could be defined. Dynes uses the process to illustrate the pragmatic implementation of humanitarian efforts in a sequential manner from response through to preparedness. Debate has arisen over the sequential nature of the process, with Bolin (1982) describing the process as iterative not linear. Integral to the iterative approach is the fact that an individual can experience a ‘phase’ at a different time to another individual or community. As such, differences in the time taken for affected communities and individuals to transition from ‘phase’ to ‘phase’ can be dependent upon factors such as social class or ethnicity (Quarantelli, 1982).

In a similar vein to Waugh and Tierney (1997), Dynes acknowledges the overlapping nature of the phases, describing the boundaries between phases as “arbitrary”. Dynes states that the phases are often misrepresented and wrongly described as acting in isolation. As mentioned previously, the disaster management process is characterised by a very wide range of actions, equipment, agencies, individuals, and events (FEMA, 1995). In this regard, the overlapping phases require resources and input from actors at multiple stages across the DMP.

As such, a strictly linear interpretation of the phased process is frequently challenged within literature. Whilst adopted in many policy documents, the construction of arbitrary barriers between the phases implies a clear delineation between the phases. However, in practice the temporal nature of the phases is not equal, with the recovery and reconstruction phases often requiring a much greater length of time (USAID, 2013). It can however be seen that the phases do not work in isolation, nor are they static. Rather, they are interrelated within the process, operating concurrently in response to disaster demands.

The above discussions make clear that many variations of the disaster management process exist. The four-stage disaster process adopted is not ‘better’ than any other ‘process’, however it is the most accepted interpretation in the literature. The notion of phases is widely contested within literature, however once practitioners remember that phases are not mutually exclusive but in fact interrelated, the pragmatic four-stage process can arguably act as a useful tool to guide disaster management (Neal, 1997). Further, phases are not characterised by time alone and thus should not be regarded as strictly temporal. Instead they are more significantly determined by circumstances of disaster demands, that require certain activities to fulfil phase goals (Warfield, 2004; Haigh, n.d). It is the fulfilment of these goals, which ultimately draws a line between one phase and the next.

Figure 2.7 acts as a summary of the DMP, highlighting the three main stages of a disaster event and further illustrating the main phases comprised in the DMP (Baird et al, 1975; Khan et al, 2008). All phases are shown to operate concurrently, with overlaps reflecting the inadvertent relationship between those phases. The process also includes the reconstruction phase, given its significance to this study and this is represented as running concurrently with the recovery phase (Khan et al, 2008).

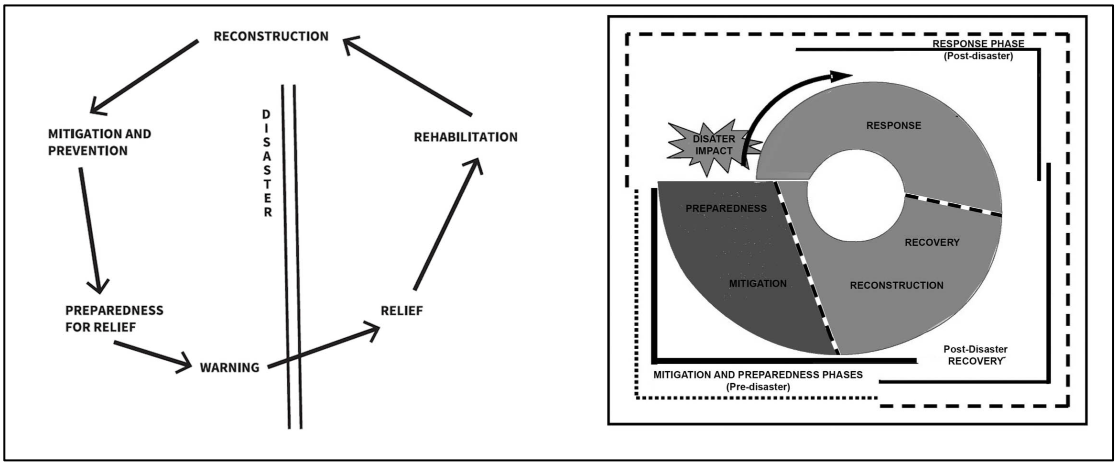


Figure 2.7 Original DMP and its reinterpretation. Source: Baird et al,1975; adapted from Khan et al, 2008).

2.5 Issues and challenges with the DMP

The disaster management discipline is a changing landscape (Rosenthal, 1998; Kouzmin and Haynes, 1999; Comfort, 2001; Smet et al, 2011), shifting from a focus on relief response towards an approach based on holistic long-term development. The view that disasters are ‘one offs’ and rare is now outdated, meaning that mitigation efforts can no longer work in isolation. Instead they are part of an iterative process of preparation ahead of the next disaster. As such, the challenge for practitioners is to move preparedness efforts from ‘reactive relief’ efforts towards more proactive activities during the recovery and reconstruction phases, building the foundations for long-term development and improvement. However, the complex nature of the DMP is currently characterised with inefficiencies and challenges, impeding long-term recovery. This section analyses key issues common to all phases and details specific challenges to positive resilience action during the recovery and reconstruction phase.

2.5.1 Communication and information exchange

The effectiveness of the DMP is heavily dependent on the information surrounding potential disaster risks and availability of resources to mitigate, then recover from such risks. In this regard, knowledge sharing has been described by researchers as an “underutilised” communication tools (Zhang et al, 2002; Marincioni, 2007; Patnaik et al, 2007:p200). Further, Hidayat and Egbu (2010) attribute the lack of information and knowledge sharing between actors as one of the major causes of poor disaster preparedness. Further compounding the issue, the literature highlights a failure to adopt new communication technologies to assist knowledge sharing within the community (Palen et al, 2007). Consequently, information flows are heavily underutilised as a result of resistance to move away from conventional information management approaches (Mersham, 2010). In addition, Haigh et al (2006) attribute the absence of a detailed communication strategy as a contributor to the ambiguity in the roles of actors in response efforts, impeding long-term sustainable recovery.

2.5.2 Co-ordination of actors

The complex network of actors involved in disaster response has made their coordination problematic (UNOCHA, 2012). In a multidisciplinary context, coordination requires a flexible and agile strategy (Kaynak, 2014). In any disaster situation, actors can include international and local NGOs, national and multilateral donors, disaster practitioners and the affected community. Evidence of competition and rivalry for resources is illustrative of the lack of collaboration amongst actors. The UN (2011) has identified this issue and called upon governments to support local level agency by decentralising recovery and reconstruction efforts. Such efforts will enable greater community participation, foster capacity building and promote long-term resilient development.

Further, the literature reports that strict adherence to the disaster phases promotes a silo mentality, thereby widening the gap between preparedness and long-term recovery actions. Breaking down the traditional siloed approach to disaster phases would promote a more collaborative relationship between preparedness and

response activities (OECD, 2013). Working in parallel, the two phases can help bridge the gap between preparedness and long-term recovery.
Research also indicates that the silo mentality is hampering information dissemination, for example through poor awareness and application of lessons learned (Fenwick, 2009). In contrast, collaboration between phases and organisations, can lead to a positive shift away from segmented, siloed perspectives towards a more holistic view of long-term development. A survey in 2008 commissioned by the International Strategy for Disaster Reduction (ISDR), revealed that humanitarian and development departments are operating within the same United Nations (UN) agency, yet operate in isolation. This disjointed approach prohibits fulfilment of holistic, long-term development strategies, and calls for a movement away from siloed boundaries and improved inter-agency cooperation.

2.5.3 Community participation

The misinterpretation and limited extent to which community participation is integrated into disaster management presents a further challenge. Traditionally, community participation within preparedness activities focused on capacity building in the sense of developing skills. However, this skills-based approach neglects the development of social and adaptive capacities (Carpenter, 2013; UNISDR, 2014). Participatory practices are now gaining recognition within preparedness activities, viewing a community preparedness and empowerment as central to future development (Carter, 2008). The United Nations Educational, Scientific and Cultural Organisation (UNESCO) notes that communities possess local knowledge which is 'invaluable' to a preparedness programme, driving development forward (Hiwasaki et al, 2014). This marks a movement away from a view of 'community capacity' as function-based towards a broader view of capacity, underpinned by resilience and adaptability (Hemond and Robert, 2012). Carter (2008) summarises the situation by stating it is the capacity of the communities themselves that creates resilience, acting as a bridge between the preparedness and response phase.

Further, to meet the demand for urgent post-disaster reconstruction, the labour shortfall is often left to international agencies and private investors to deal with. Alexander (2002) argues that this approach impinges on local capacity. In a competitive market, international actors are reported to poach local level government thus weakening the response effort and reducing a community's ability to cope independently. The involvement of private enterprises is a similarly contentious issue, with reports of 'disaster profiteering' closing the window of opportunity for the local community to participate and benefit from reconstruction (Mutter, 2015).

Another contested issue is the degree of community participation, most specifically in the reconstruction phase (Davidson et al, 2007). Many disasters are repeat events (UNDP, 2012), therefore the use of local knowledge based on previous disasters can represent an effective mitigation strategy. Alexander (2008) highlights this point, stating that the first problem in disaster management is a failure to implement existing knowledge based on lessons learned. The failure to implement knowledge sharing represents a key challenge to the reconstruction phase (Koira, 2009). In this regard, the UN recognises that all disasters, regardless of scale, happen first in communities.

2.5.4 Poor planning

It is well recognised within the literature that a lack of timeliness and urgency in response efforts surrounding a disaster can exacerbate the challenges (UNISDR, 2011). Humanitarian agencies are invariably called upon to respond in an efficient, timely manner, however a lack of planning during the preparedness phase and inexperienced leadership have been cited as two major challenges inhibiting the ability to meet the immediate needs of the affected community (Lindell, 2003; Allen, 2006). Further, UNISDR (2012) highlights the importance of acknowledging and learning from past mistakes (for example, building in flood plains), to inform robustly designed planning measures. In other words, the failure to act upon past mistakes can jeopardise a community's long-term sustainable development (Alexander, 2005; Evans and Elphick, 2005).

2.5.5 Issues pertaining to the recovery and reconstruction phase

The post-disaster phases seek to bridge the gap between resilience planning (mitigation) and long-term development. However, Lyons and Schilderman (2010) criticises its practical application, claiming the phases often fails to deliver its key objectives. Despite the emphasis on pre-disaster planning outlined in the mitigation and preparedness phase, post-disaster action remains invariably reactive (UNDP, 2011; UNISDR, 2014). The post-disaster phases reveal the inadequacies of historic development policies, offer new knowledge for improved reconstruction and are characterised by an increased awareness of potential risk (Thurairajah et al, 2008; UNDP, 2011). However, instead of proactively mitigating against future disasters, researchers describe the phases' associated actions as ad-hoc and lacking strategic coordination (Drabek and Hoetmer, 1991; Shaw et al, 2003). Consequently, this leads to slow, expensive and inefficient reconstruction efforts (Shaw and Sinha, 2003).

When construction begins, balancing urgency and quality reconstruction is a significant challenge impeding long-term reconstruction (Haigh and Sutton, 2012). For example, reconstruction in a chaotic environment is beset with challenges, particularly when disaster stakeholders are already stretched and under-resourced. This situation often ends in a failure to implement critical long-term development plans. During the strained reconstruction period, construction work is often outsourced to meet unprecedented demands. However in doing so local knowledge is often overlooked in favour of timely reconstruction (Bilau et al, 2017).

Challenges typically associated with reconstruction work are cost overruns, insufficient labour and the supply and quality of resources (Bilau et al, 2017). In a difficult disaster situation, these issues are magnified. A lack of resources requires NGOs to work beyond their expertise which has been noted in substandard works (Koira, 2009). Hayles (2010) reiterates the point of NGOs working outside their expertise, stating that their funded projects are often inappropriate due to their lack of local knowledge on environment and materials, which is further exacerbated by their lack of expertise (Moe et al, 2006; Koira, 2009; Von Meding, 2013).

The literature highlights how a lack of project benchmarking has the potential to limit its reconstruction performance. The assessment of a project's success is varied and as such 'success' is subjective. Ahmed (2011) contributes this inconsistency to the lack of globally accepted project standards or guidelines in this field. Emphasising the diversity of perceived project success, Chang et al (2010) propose resource and labour availability as a key success factor. By contrast, other researchers focus on front-loaded planning (Tatum and Terrell, 2012), community-centred approaches (Ophiyandri et al, 2010), coordination and communication amongst stakeholders (Ika et al, 2012), and effective time management (Ismail, 2014). As such, the literature suggests that the lack of reconstruction performance criteria or project benchmarking can impede a disaster manager's ability to assess project success.

2.6 Conclusion

This chapter presented an understanding of the theoretical knowledge surrounding disaster management globally. It did so by highlighting definitional issues around the term ‘disaster’, and how it has been defined thematically as a ‘social’, ‘technical’ and ‘scientific’ issue. In particular, the discussion focused on how disasters can be defined by the situation created rather than the ‘hazard’ or precipitating agent. As such, disasters can be described as ‘social events’, with the focus being the disruption to the functioning of everyday life. As a first step towards identifying solutions for resilient communities, the chapter moved towards assessing current trends, impacts and spatial distribution of disasters globally. The evidence was clear that disasters are increasing in frequency and magnitude worldwide, in particular, hydrological disasters.

At the European scale, it was found that hydrological disasters, such as floods, were both the most frequently occurring disaster as well as the costliest in terms of economic damage. In response to this increased risk from disasters, recent disaster management paradigms have shifted from a disaster relief orientation towards a holistic development, focused on disaster preparedness and mitigation. However, the DMP was found to be held back by poor co-ordination, communication and a lack of planning. In particular, the recovery and reconstruction phases were limited by a lack of clear project performance standards, resources and the struggle to balance urgency and long-term sustainable development. The chapter concludes that greater collaboration at the local and regional level and across disaster phases could bridge the current gap between disaster preparedness and long-term recovery. Having established the theoretical knowledge and understanding of disaster management in this Chapter 2, the following Chapter 3 examines the concept of community resilience as a potential means to reduce disaster risk.

Chapter Three

Resilience and Community

3.1 Introduction

Chapter 2 set out the theoretical background and understanding of disaster management globally, identifying a number of historic and current challenges facing the disaster management process. Further, it critically explored the operational and strategic responses to hazardous events. The chapter concluded by highlighting a series of matters, which the disaster management process fails to address, thereby impeding long-term recovery.

A key component of the 2015 UN World Conference on Disaster Reduction (UNWCDR) was to highlight the need for increased momentum through resilience action as a response to the increased frequency of disasters. As such, resilience is heavily integrated in The Hyogo Framework for Action 2005-2015 (HFA) (UNISDR, 2011). In line with this, the last decade (2005-2015) has seen increased focus on what affected communities can do for themselves in terms of preparation and responsiveness to disasters (IFRC, 2014). Objective 2.1 of this thesis aligns itself with this thinking through its search for the properties which make a community resilient.

As noted already, the lack of clarity around the resilience concept risks compromising its realisation through community level initiatives and policy. The ambiguity attaching to the concept of resilience is often attributed to the multiple disciplines the concept spans. Section 3.2 of this chapter addresses the ambiguity surrounding the term, focusing on the evolution and definition of the concept. The definition of resilience will be described under three main themes. The first of these focuses on the outcome of the resilience process (Mallak, 1998; Coleman and Hagell, 2007; Ramutsindela, 2007); the second focuses on the processes which assist in the building of resilience (Doron 2005; Woods, 2006; Wreathall, 2006); and the third focuses on the transformation or evolutionary potential of resilience (Bahadur et al, 2014)(Section 3.3.1-3.3.3). Ultimately, advancing clarity around the definition and aspects of resilience can positively assist in its operationalisation.

Despite advances in resilience thinking, there remains inconsistency as to how the concept of resilience is applied in theory, policy and practice. As a result, there is a need to critically examine the conceptualisation of resilience and its application within a post-disaster context. Section 3.4 critically analyses resilience thinking within a disaster context, analysing a shift in the resilience paradigm from a reactive ‘bounce back’ approach to a more proactive, transformational ‘bounce forward’ analysis.

The latter half of the chapter builds upon these interpretations of resilience, focusing on the capacity of human agency to foster proactive, innovative interventions. The development of this agency has the potential to sustain and/or build resilience in a post-disaster context. Section 3.6 highlights the role and importance of community-level efforts in a post-disaster situation and the benefits which can be derived from community participation. It is anticipated that a clearer understanding of the ‘community’ construct and its associated definers (presented in Section 3.7- 3.7.2), will assist in highlighting the value of social connections within resilient communities (Section 3.8). Section 3.9 concludes the chapter by presenting a summary of the important role social connections play in leveraging community resilience.

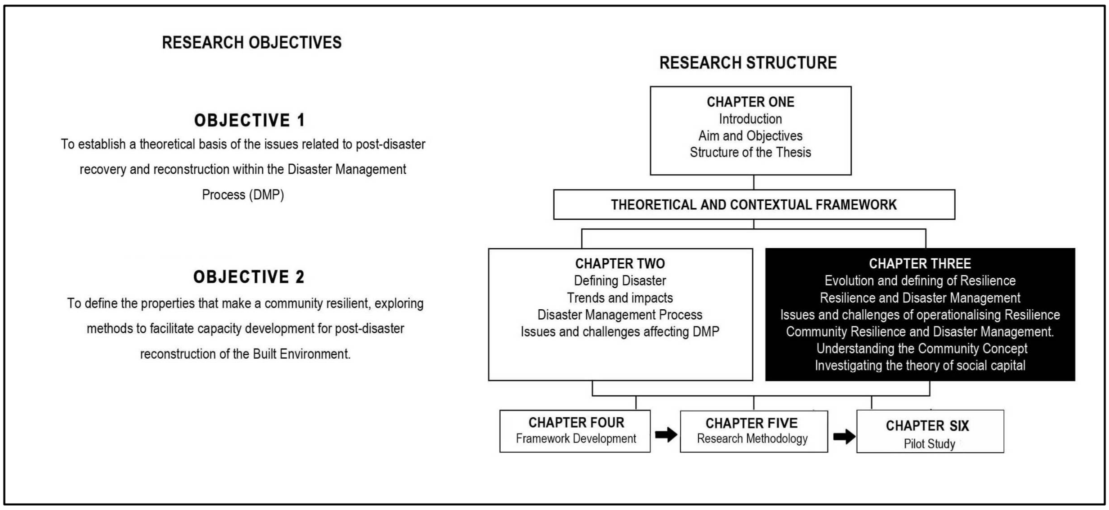


Figure 3.1 Position of Chapter 3 within the thesis structure.

3.2 The evolution of resilience

Building resilience through the human response to disasters has gained increased currency within the field of disaster management in the last decade (2005-2015, UNISDR, 2009). The emerging resilience discourse has focused on the shift towards what affected communities can do to strengthen their capacity to overcome disaster events (IFRC, 2014). This focus is echoed by the UK Department for International Development (DFID) through humanitarian development programmes such as ‘Building Resilience’ in Ethiopia, Kenya and the Democratic Republic of Congo (DRC). Further, DFID has expressed its commitment to this resilience approach by declaring its intention to build the concept into all its programmes by 2015 (DFID, 2011). Evidence of this commitment is demonstrated through the

Growth and Resilience Department (GRD's) operational plan 2011-2015 and ongoing research into the topic, for example, "Defining Disaster Resilience: A DFID Approach" (DFID 2011).

Despite growing acknowledgement of the potential for this resilience approach, the current issue facing disaster managers remains the ambiguity surrounding the resilience concept. This ambiguity is attributed to the varied academic definitions of the concept and its application across multiple disciplines, resulting in confusion around its exact characteristics (Paton, 2005; Sapountzaki, 2007). This ambiguity has led researchers to question whether the concept is merely an 'ideal state', which calls for further refinement before it can be operationalised (Manyena, 2006; Cote and Nightingale, 2012).

According to Klein et al (2003), the resilience concept stems from the Latin word "resilio" meaning "to bounce back". Research surrounding the early use of the term found the concept had its roots in the sciences, including both physics and mathematics (Holling, 1973; Brand and Jax, 2007). In this context, Pimm (1991) argues that the term describes the capacity of the system or material to return to a stable state or "equilibrium" after disruption. The physics approach to resilience holds that, no matter the extent of the initial disruption or displacement, resilience is more concerned with the speed with which a stable equilibrium can be achieved. This concept of resilience equilibrium influenced Holling's (1973) pioneering ecological definition.

Holling (1973) first applied the term resilience within an ecological context in his seminal publication "Resilience and stability of ecological systems". Holling proposed that a resilient socio-ecological system exists in an area that is ecologically, economically and socially sustainable. The Resilience Alliance (2006) expanded on Holling's initial thinking by characterising 'resilience' by reference to three main determiners. Firstly, the extent of change the system can withstand disruption whilst still maintaining a stable state. Secondly, the self-organising capacity of the system and thirdly, the ability of the system to build and enhance its capacity by learning and adapting to change (Waller, 2001).

A psychological interpretation of resilience emerged from studies to determine the development of psychopathology. In particular, these studies focused on the ability of at-risk children to cope with family conflicts and poverty (Masten, 1999; Rolf, 1999). Studies in that field focused on risk and impacts sustained by children as a consequence of life disturbances such as divorce and abuse (Waller, 2001; Johnson and Wielchelt, 2004).

3.3 Defining resilience

Despite the various different definitions across the disciplines, certain similarities are evident within the resilience discourse and these can be grouped in three main branches: outcome-orientated; process-orientated; and transformation-oriented. Holling (1973) was the first to introduce the distinction between resilience and stability within ecological systems, arguing that a system can remain resilient whilst also being in a state of non-equilibrium. Pickett et al (2004) differentiate between the conceptual models of "outcome" (social equilibrium) and "process" (social non-equilibrium) resilience. Outcome resilience is demonstrated by the ability to return to the original state after a disaster event, whilst process resilience manifests itself through change and adaptation in response to a disruption. By extension, transformational resilience comprises multiple-equilibrium, [3] acknowledging the ability of a resilient system to 'transform' or flip into a new stable state (Walker, 2004; Davoudi, 2012). Research suggests the boundaries of these ambiguous definers (outcome, process, transformation) need to be clearly outlined (Gunderson and Holling, 2002; Davoudi, 2012), or resilience stakeholders may fail to reach minimum consensus on what exactly 'disaster resilience' comprises in practice (Quarantelli, 1995).

3.3.1 Resilience as an outcome

Resilience definitions which adopt the 'outcome' approach are framed in the following terms: 'cope' (Pelling, 2003), 'bounce back' (Wildavsky, 1991), 'withstand' (Miletti, 1999; Resilience Alliance, 2006), 'absorb negative impacts' (Cardona, 2003) and to return to 'normality' (Cardona, 2003; UNISDR, 2005) as quickly as possible. Such a reactive view of resilience is more in line with a physics definition of resilience, where a material can bend, stretch and compress itself before returning to its initial state (Shaikh and Kauppi, 2010).

A return to a stabilised 'normal' state, is perceived in the literature as an 'outcome' in its own right (Coleman and Hagell, 2007). This vague definition however lacks practical clarity as it fails to differentiate between an active demonstration of resilience and the potential to be resilient. Certain resilience outcomes are often

[3] Transformational resilience rejects the idea of a single resilient state, rather it assumes the existence of multiple stable states (Davoudi, 2012).

viewed as intangible (for example, empowerment and self-efficacy), meaning the resilience level of a community is difficult to quantify.

Mallak (1998), in his study on the measurement of resilience in the healthcare system, highlighted six outcomes of resilient communities which can serve to represent intangible “potential resilience”. Mallak considers that such resilient communities are goal driven and actively seek adaptive solutions. They are further characterised by critical thinking, allowing them to use information effectively. The ability to interchange roles and access resources within a chaotic environment was also noted. Such communities also tend to be sceptical of new situations which could be potentially disruptive. Furthermore, beyond scepticism they also demonstrate a preference to use multiple sources when assessing the reliability of data. Mallak’s study is particularly relevant to this thesis as it shows that indicators of potential resilience can be displayed through a wide range of factors. Whilst this is useful in itself, Mallak’s study lacked an opinion on whether these characteristics are useful on an individual basis or whether they need to be considered collectively to provide a resilient outcome.

The downside of viewing resilience as an outcome is that this reinforces the traditional reactive stance (McEntire et al, 2002). In this regard, resilience approaches can be viewed as “paternalistic”, derived from supply not demand (Chandler, 2014). Furthermore, outcome orientated disaster resilience programmes tend to adopt a rigid “command and control” approach (Alexander, 2002). This rigid approach focuses on risk to life and return to a state of normality as soon as possible (Manyena, 2013). However the UNDP (2014) argue the objective of resilience should be to enhance community capacity not reinstate the status quo. An approach designed to simply reinstate the status quo stifles long-term community development, and fails to meet the long-term aspirations/needs of the community (UNDP, 2014; Saunders and Becker, 2015).

3.3.2 Resilience as a process

The outcome orientated approaches included above focused on an equilibrium model which is characterised by a return to the original state after a disruptive event (bounce back). In contrast, the non-equilibrium model does not simply seek to return to the previous state, rather it focuses on demonstrating resilience through an adaptive process of change in response to disruptive events (bounce forward). Doron (2005) infers that adaptive capacity is critical to the creation and strengthening of resilience on multiple levels; personal; family; social; and organisational. In this context, Doron argues that adaptive capacity fosters a sense of belonging, control and positive perspective after a disaster event. The willingness to change in the face of a disruptive event is seen to promote a culture of 'betterment' through learning new skills, greater self-efficacy and more developed support systems (Patel et al, 2017).

UNISDR (2011) highlight that a resilience building process is required to adapt to disturbances exceeding a community's "normal adaptive capacity" (Woods et al, 2006). Woods maintains that, by identifying a baseline level of competency, attention can be directed toward building upon and beyond that baseline. Exceeding the status quo (resilience baseline) marks a shift in resilience thinking from evaluating hazards (reactive) to viewing disaster events with a resilience capacity 'lens' (proactive) (Egan, 2014). In this manner, attention turns towards harnessing existing and potential resources/capacities to absorb and adapt in response to disruptive impacts.

The use of 'adaptation' as a resilience descriptor is indicative of the process of change that is inherent within a resilient process (Folke et al, 2010). An adaptive process acknowledges the inter-relationship between human and natural systems and is underpinned by lessons learned from past experience (Berkes, 2007). Adaptation must no longer be thought of as an add-on to existing development programmes (Walker et al, 2004), rather, adaptation must be ingrained in our daily decision-making and treated as an integral component of development (O'Keefe et al, 2008).

Ultimately, enhancing process-orientated resilience requires a system with the capacity to adapt in order to cope (Folke et al, 2010), whilst maintaining core attributes or assets (Berkes, 2007). Individuals, communities and institutions possess an inherent degree of resilience, however of critical importance is who benefits from this resilience (Pelling et al, 2005). For example, a top-down approach to forced settlement after the Yushu earthquake (2010) on the Tibetan border in China (Tibetan Heritage Fund, 2010), successfully restored functionality for the community but eroded the core values of Tibetan culture and built heritage, traditional values and also their livelihood. Analysis of humanitarian action can lead to lesson learned, however this is unlikely to yield significant benefit unless the essential values and capacities of human agency are reflected in resilience development.

3.3.3 Resilience viewed as transformative

Moving beyond the stable states of outcome (single equilibrium) and process orientated resilience (multiple equilibrium), the literature notes the emergence of socio-ecological or transformative resilience. Scheffer (2009) initially questioned the nature of the stability resilience domain. Through her socio-ecological thinking, Scheffer proposes that people and nature are distinct (albeit interdependent) systems. Rather than accepting a simple ‘bounce back’ or ‘return to normality’, this viewpoint acknowledges the potential for socio-ecological systems to cope, adapt or transform when confronted by hazards (Pendell et al, 2010). This perspective of resilience bears similarities to Holling’s presentation of the ‘adaptive cycle’ in 1986.

For ‘transformative’ resilience to be successful, it is imperative that a community learns to live with change, uncertainty and risk, with a view to absorbing disturbance (Folke et al, 2011). Moench and Dixit (2004) argue that the experience gained from living through risk will enhance a community’s ability to manage risk. As such, transformative resilience is characterised by a long-term (proactive) approach to constant adaptation. This multi-equilibria approach allows greater scope for future adaptive change (Gunderson and Folke, 2011). The concept of different stable states (multi-equilibria) accepts different outcomes and promotes transformational change towards an improved, ultimately more sustainable state (Walker, 2014). However, despite acknowledgement of the benefits to multiple stable states (UNDP, 2012), a risk averse preference for a stable state (return to status quo) restricts the promotion of constant adaptation to unforeseen hazards.

Transformational resilience is also referred to in the literature as ‘socio-ecological’ resilience, due to its merging of both human and ecological elements (Folke et al, 2010). Transformational resilience holds a broader, long-term perspective on adaptive change, relevant to situations characterised by complexity and increasing uncertainty (Béné, 2012). The long-term resiliency approach, however, is not only focused on promoting constant adaptation to disturbances. It also seeks to foster a ‘betterment’ through innovation and the implementation of lessons learned (Birkmann et al, 2013). As such, these aspects (betterment, innovation and lessons learned) are critical to the successful functioning of transformative resilience. This advancement and sense of change is facilitated through experimentation, learning, and innovation and is often referred to as ‘adaptive change’ or ‘pro-active resilience’ within the literature (Sousa et al, 2006; Birkmann et al, 2013). Existing research proposes multiple definitions of adaptive change, however, the most applicable to this thesis is that of Smit and Pilifosova’s (2001), which refers to human capacity rather than a focus on natural systems (hazards). Smit and Pilifosova’s description focuses on the capacity to adapt (transform) as opposed to the ability to cope by returning to a pre-disaster stable state.

The terms ‘cope’ and ‘adapt’ are frequently used interchangeably within the literature (Levina and Tirpak, 2006), however while closely linked they are two distinct processes with separate objectives (Eriksen et al, 2005; Agrawal, 2010). For example, Dover and Handmer’s work (1992) differentiates between the two processes, describing the former as short-term, reactive resilience (coping capacity) and the latter as proactive, long-term resilience (adaptive capacity). Reactive resilience focuses on a reinstatement of the status quo, buffering against potential threats and resisting system change (Klein et al, 2003). This form of resilience is closely aligned with the ‘outcome’ orientated form of resilience. On the flip side, a proactive resilience stance is more concerned with the inevitability of change and attempts to create a system that has the potential to adapt to new circumstances. This is a significant broadening of the traditional interpretation of resilience, moving beyond robustness of the system towards a more transformative interpretation. In order for adaptive capacity to be successfully implemented, emphasis needs to be placed upon learning through experimentation and innovation. The ‘learning’ element highlights the importance of an integrated system including feedback around the implementation of lessons learned (Folke, 2006).

The relevance of further proactive resilience properties (i.e. ‘adaptive capacity’ and ‘self-organisation’) is highly debated within literature (Folke et al, 2010). Self-organisation in this context refers to the collaborative process of co-ordinating, adapting and learning in order to fulfil a common goal or objective (Mehrota, 2013). However, including adaptive capacity and self-organisation within resilience strategies may cause ambiguity opposite to the distinction between resilience and structural stability (changes in the stability landscape-vulnerability). Gallopin (2006) argues that the idea of ‘adaptive capacity’ disconnects resilience from the notion of multi-stability (state shifts between domains of attraction) or indeed from stability itself. Despite this view, there is a body of literature which holds adaptive capacity as a core tenet of resilience (Walker et al, 2004; Carpenter and Brock, 2008;

Manyena, 2013). Folke et al (2010), however, takes a different stance, drawing the resilience argument away from its persistence or robustness to disturbances. By contrast, he directs attention towards the opportunities which can emerge from a disaster event, in terms of heightened engagement by stakeholders, renewal of the system and the potential to transform into more sustainable trajectories. In this respect, disasters create opportunities to learn, improving society's ability to respond to future disasters. Consequently, communities are left in a better position ahead of the next disaster. In this, disaster events provide the impetus for communities to utilise their capacity and transform unsustainable ecological, economic or social structures into resilient structures (Walker et al, 2004).

The move towards socio-ecological resilience, which this thesis adheres to, requires further explanation of the transition into a new more sustainable trajectory in response to unpredictable change. In this regard, Holling (2002) introduced the metaphor 'the adaptive cycle', which seeks to explain the different types of change and variables in resilience. The cycle handles a range of paradoxes associated with complex resilient systems. Gunderson (2000) describes the first of these four paradoxes as the risk averse preference for "persistence versus change". The second paradox focuses on the need for "flexibility versus efficiency". The third presents "connected versus adaptable" and finally the fourth addresses "resilient versus transformational". The four phases of the cycle (as represented in Figure 3.2) can be explained as beginning with a period of rapid growth in exploitation (r) which in turn leads to the accumulation and conservation/consolidation of structure, during which time the system tends toward rigidity and declining resilience (k). The system then suffers a rapid breakdown and release of accumulated potential through restructuring (*Ω)* and is followed by renewal and the opportunity to reorganise (α) (Quinlan, 2003).

The speed of change between the phases is represented by arrows. In Figure 3.2, the short arrows represent a fast pace of change whereas the longer arrows are represent a slower, incremental change. The adaptive cycle comprises two axis. The x-axis indicates the level of connectedness influencing the variables, while the y-axis indicates the accumulated resources inherent within the system. When potential is not harnessed, the possibility to exit is indicated by the exit arrow, suggesting a potential shift into a less sustainable system (Gunderson and Holling, 2002).

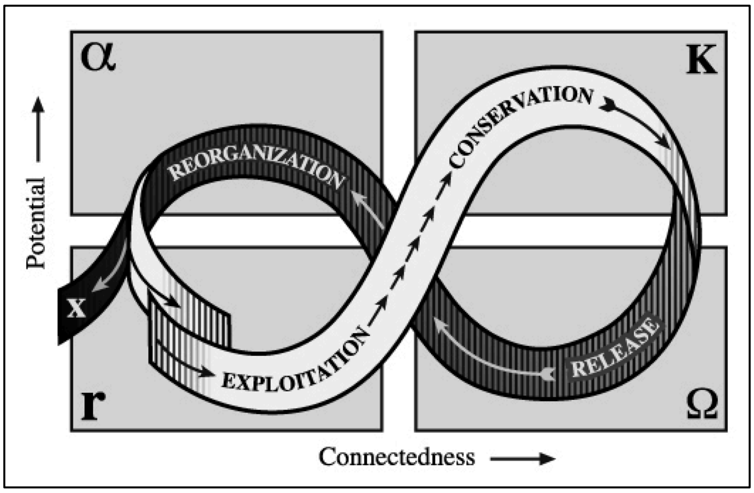


Figure 3.2 Adaptive cycle. Source: Gunderson and Holling, 2002.

The four phases occur in hierarchical cycles, with the phases 'nested' one inside each other across "space and time scales" (Holling, 2001:p396). Similar to the Disaster Management Process discussed in chapter two, it functions in a non-linear manner (non-sequential) which can skip a phase and (for example) move directly from (r) to (*Ω*). Furthermore, it is important to note that a cycle does not occur in isolation, rather it interacts at multiple scales across the "nested" adaptive cycles (Peterson et al, 1998). The scales are determined by size and speed. As such, in complex adaptive systems, there are continuous interactions between cycle size (small and large) and speed (slow and fast). Growth and accumulation of resources is represented by the "slower and longer" processes operating at a larger scale. Whereas the "shorter and faster" cycles, representing re-growth and renewal, occur at smaller scales. An integral part of the success of the adaptive cycle is the ability of the system to self-organise (fast) and maintain resilience (slow). However, caution must be applied to the risk of getting 'locked in' to the conservation stage (k), demonstrating a reluctance to move through the cycle and thus becoming vulnerable to future disruptions (Lew et al, 2017).

The need to exploit the potential for 'change' is integral to the concept of transformational resilience. The transformational interpretation of resilience rejects the acceptance of simply maintaining equilibrium after a disaster, and instead concentrates on the dynamic interplay between "persistence and adaptability" (Folke et al, 2010:p20) in order to transform into a more sustainable trajectory (Adger, 2000; Folke et al, 2010; Walker, 2014). The following section seeks to unpack the components of positive change, leading to transformational resilience, and serves as the bridging concept between the social and ecological worlds.

3.4 Resilience and disaster management

For decades, social scientists have emphasised the importance of adaptability in responding to and recovering from disasters. Folke (2006), for example, maintains that addressing resilience is not solely concerned with preserving systems and retaining their existing function. Rather, transformational thinking seeks to create opportunities for renewal and transformation into an improved state, particularly when the old ecological and social structures were unsustainable. The argument around the need to exploit the potential of 'change' is a critical component of this thesis. In this way, resilience is imbued with an element of potential and optimism (Comfort, 1999) brought about through a system's ability to anticipate change and the inevitable need to respond. In doing so, an opportunity for innovation presents itself. Similarly, Dynes (2002:p14) has advocated for a flexible "problem-solving" approach that he contrasts with the more rigid "command and control" approach that has historically characterised the disaster management field.

Despite the established view among social scientists that adaptability is an integral component of disaster resilience, this approach is not typically shared by government (Handmer and Dovers, 1996). For example, national-level structural and policy changes following the earthquake in Hiati in 2010 resulted in a more bureaucratic system of emergency management. The historical trend towards reactive, 'outcome'- orientated concepts of resilience necessitates a re-evaluation of whether disaster strategies should be focused on adaptability or robustness/persistence.

The latter approach, with its emphasis on resistance and buffering against threats, leaves little room for reflection and the potential for 'betterment' through innovation and experimentation. Such an approach, with its emphasis on efficient reinstatement of the status quo (Cutter et al, 2009), has been heavily criticised in the disaster literature (Davoudi, 2012; Walker and Salt, 2012) as it conceptualises disaster resilience as static (Holling, 1996). The failure to recognise the evolving nature of disasters inhibits the possibility of dynamic interaction leading to transformation (Holling, 1996).

Furthermore, 'risk' perception influences a disaster manager's decision to buffer risk through resistance (reactive) or to reduce risk through adaptation (proactive). A purely reactive response to a disaster focuses on a quick return to normality, but fails to exploit the opportunities which disasters present. A resilient community, seeking to transform into a more sustainable enhanced state, possesses an acceptance of risk and reacts to unexpected change in a flexible and adaptive manner. The following section investigates how a community's perception of risk directly influences its ability to successfully operationalise transformational resilience.

3.4.1 Risk and disaster management

Within a disaster management context, risk is defined as "the probability of harmful consequences, or expected loss resulting from interactions between natural or human induced hazards and vulnerable/capable conditions" (Asian Disaster Research Centre (ADRC), 2015:p41). A more simple understanding of risk is the potential for undesirable negative impacts as a consequence of a hazardous event (Von Meding, 2013). Calculating risk is in turn predicated on the estimation (Clarke et al, 2000) and quantification (Cutter et al, 2003) of future potential disruptions. Calculating risk in the scientific sense can be explained through the equation "Risk = Hazard x Vulnerability/capability" (UNISDR 2002:p41). Cutter et al (2003) reiterate the relevance of viewing risk from a scientific viewpoint, arguing that the manifestation of risk is a consequence of hazards or vulnerability, as the level of impact is inextricably linked to the force of the hazard and societies level of vulnerability. However, according to Haque and Etkin (2007), quantifying risk (objective) has proved ineffective since it neglects a wide range of disaster impacts (subjective), such as social disruption which is known to increase vulnerability. Such a calculation must therefore take account of risk probability, its potential impacts and the level of exposure or vulnerability (Human and environmental) at the time of exposure (McEntire, 2005).

Extending the above argument, an interdisciplinary approach to risk (Cutter et al, 2006; World Bank, 2012) takes the focus further away from the physical and scientific, and instead argues for the incorporation of a human centric approach to risk decision-making. This human perspective is referred to as perceived risk. Perceived risk equates to how people make sense of the uncertain world (Slovic, 1987). People's perception of risk is influenced by how they think, feel and make judgments about what they consider an acceptable level of risk. Eiser et al (2012) proffer that peoples' perception of risk is influenced by their past experiences, personal values and cultural beliefs. Anderson-Berry and King (2005) reason that the empowerment of communities is a useful strategy in risk management. This empowerment is achieved by understanding the diverse nature of risk and sharing local knowledge with other stakeholders.

The concept of risk perception embodies elements of subjectivity, however it can also provide insight into the complexities of public perception more generally towards risk (Vasvari, 2015). In this respect, risk perception is actively used to identify issues related to disaster events, which vulnerable and affected people endure. For example, a study on flood hazards in Scotland conducted by Werritty et al (2007) at the household level affords in-depth insights into the vulnerabilities of affected communities based on their perception of flood risks. The findings revealed that greater understanding of community attitudes (for example views on flood defences) and behaviour (flood ownership) at the local level, can inform 'what works' for each individual community. A further study by Terpstra (2011) in the Netherlands found that emotions related to recurrent flooding disasters influenced the community's perception of risk, causing them to enhance their adaptive capacity in anticipation of future disasters.

The above discussion suggests that, in order to reduce vulnerability, an understanding of several risk factors is required. Firstly, the magnitude and dimensions of the risks facing the community needs to be considered. Secondly, decision-making is strongly influenced by the understanding and perception of risk held by the community. Lastly, reducing vulnerability requires an understanding of what actions the community decides on or the behaviour it wishes to adopt to minimise their exposure to risk.

Ultimately, the impact of a hazardous event is not only dependent on its severity or force, but also on the vulnerability of people and their living conditions (Marskrey, 1989). Referring back to Blackie's scientific equation of risk, the emphasis is taken away from the hazard itself, with the focus now being on the state of vulnerability in the community, the economy and the spatial built environment (Kasperson et al, 2001). The shift of focus from the hazard towards community vulnerability and capacity to withstand a disaster speaks to the flexible and adaptive responses inherent in transformational resilience. Von Meding (2013) argues that risk is a constant factor which, when coupled with inadequate systematic efforts (capacity), lessens the resilience of a community. In this regard, the need to review attitudes towards perceived risk and accept risk as part of the adaptation process is imperative (IPCC, 2012). By fostering capacity building as a response to accepted hazards, resilience can ultimately lead a transformational path.

3.4.2 Vulnerability and disaster management

Risk perception greatly influences the decision to respond to a disaster in a reactive or proactive manner (Pelling, 2011). It has been argued that an unwillingness to accept risk leads to a reactive approach to resilience. Willingness to accept risk is in turn influenced by the ambiguous relationship between resilience and vulnerability (Paton, 2006). The term vulnerability first became part of disaster management vocabulary in the 1970s with O'Keefe (1976:p566) proposing that there was a need to take the "naturalness out of disasters", stating disasters were not determined by natural agents but rather a consequence of socio-economic vulnerability. O'Keefe emphasises the vulnerability element of the community, describing it as 'the real cause of disaster'. As outlined in Section 3.2, the resilience thinking approach accepts risk and disturbances as elements of the adaptation process, and does not believe they contribute to vulnerability (Anderson, 1989; Blaikie, 1994). Resilience thinking needs to accept that risk is inevitable, and resilience should focus on the ability to adapt to (rather than control) the inevitable (Slootweg and Jones, 2011).

Resilience and vulnerability are interrelated concepts within the disaster management field, however interchangeable use of the respective terms can lead to confusion (Klein et al, 1998; Adger, 2006; Berkes, 2007). Davis et al (2004) view resilience as a function of vulnerability, in that a lack of capacities or assets increases vulnerability, which in turn reduces resilience. In this light, the two concepts co-exist, with resilience only emerging when required during times of adversity (Naom, 1996; Winderl, 2014). Additional clarity on the relationship between the two terms, (both theory and practice) will act to assist in the defining of the meaning, implications and application of resilience to other related concepts such as long-term development (Miller et al, 2010).

Through his seminal work, "Vulnerability, Resilience and the Collapse of Society', Timmerman (1981) highlighted the close relationship between the concepts of resilience and vulnerability. Ambiguity surrounding the definers of vulnerability was found to limit consensus on the particulars of vulnerability theory (Watts and Bohle, 1993). Timmermann (1981) describes vulnerability as the capacity of a system to absorb and recover from disturbances. Similarly, Comfort's (1999) analysis of resilience refers to a lack of capacity as a factor of vulnerability by reducing a system's ability to respond. These definitions and others indicate an apparent relationship between vulnerability and the level of existing capacity within the community (Blackie et al, 1994). Accepting this viewpoint leads to the assumption that resilience stands as a positive attribute of community development and recovery, with vulnerability at the negative end of the reference framework (Abolghasemi, 2013). An advocate of this stance is the Resilience Alliance (2006), which views low vulnerability as a consequence of high resilience within the system. In this regard, vulnerability is a contributory factor of resilience, with increased vulnerability attributable to reduced resilience.

Viewed differently, vulnerability can also be characterised in terms of its 'threat' (Green et al, 1994) or "exposure", making "people or places vulnerable to hazard (Cutter, 1996; Adger, 2006:p270). In this respect, the terms vulnerability and resilience can be categorised as separate constructs with no relationship to each other. Definitions by Downing (1991); Blackie et al, (1994); and Comfort (1999) view vulnerability in terms of the degree of potential loss as a consequence of a disruptive event. Watts and Bohle (1993) further describe the form of potential loss as social, economic, political or technical. The broad nature of 'vulnerability' definitions introduces ambiguity and, more significantly, creates a barrier to its application within a practical resilience framework.

Paton (2005), notes that societies can possess characteristics that leave them vulnerable, whilst simultaneously holding characteristics that display a capacity to adapt. As such, Paton posits that resilience and vulnerability should be viewed as discrete constructs. Similarly, Mallak (2005) argues that a lack of vulnerability does not necessarily equate to a more resilient society. Indeed, the consensus within literature is that resilience is not the opposite of vulnerability (O'Keefe, 2004). While resilience and vulnerability are two separate concepts, they both influence how we understand a system's recovery from a disruption. As such, resilience and vulnerability are both central concepts within this thesis, framing analysis of societal change to a disruptive event in a complementary but distinct manner. Resilience thinking accepts risk and disturbances as part of the adaptation process but does not attribute it to increasing vulnerability (Bahadur et al, 2010:p15).

Disturbances are an inevitable force impacting upon resilient systems. The system's capacity to respond is as important as its capacity to control. A focus on resisting vulnerabilities leads to a reactive, short-term view often favoured by politicians. This is evidenced by Donahue et al (2006) through her report commissioned by homeland security, “Lessons we don’t learn: A Study of the Lessons of Disasters, Why We Repeat Them, and How We Can Learn Them”. Donahue et al illustrates this argument by describing unsuccessful government responses to disaster events such as Hurricane Katriona in 2005 and Hurricane Andrew in 1992. Indeed, they advocate for a push beyond reinstating the status quo and shifting the focus towards adaptive capacity in response to accepted hazards. Donahue et al argues this approach allows resilience to pave a transformational path. However, they acknowledge this path is not easy for politicians with an eye on short-term stability. Similarly, Handmer and Dovers (1996) warn that while resisting threats may be more politically acceptable, it also leads to potential system collapse.

3.4.3 Typologies of resilience in disaster management

In addition to risk perception, adopting ‘specified’ or ‘general’ resilience also influences the decision to take a reactive or proactive response to a disaster. A rigid or ‘reactive’ approach is frequently referred to in the disaster literature as ‘specified’ resilience, whilst a more flexible approach is referred to as ‘general’ resilience (Constanza et al, 2011). In socio-ecological resilient systems, ‘specified’ resilience refers to resilience against a specified threat, at a particular point or ‘snapshot’ in time. In this vein, Carpenter et al (2001) refers to specified resilience as “Resilience of what, to what?”. For example, resilience of a community to earthquakes. Evidence suggests however, that there is a danger of becoming too focused on resilience to certain disturbances (e.g. a flood), at the cost of reducing overall resilience to other parts of the system (e.g. resilience to all extreme weather events) (Cifdaloz et al, 2010). Carson and Doyle’s (2000) presentation of the HOT (highly optimised tolerance) theory illustrates the ability of systems to resist a known, frequently occurring disturbance (specified resilience), as distinct from infrequent disturbances (general resilience). Summarising the above argument, Walker (2014) concludes that increasing resilience to specific hazards at one scale can in fact reduce ‘general’ resilience at other scales.

‘General’ resilience represents a less rigid approach which does not define either (1) the part of the system that may cross a threshold or (2) the kind of disruptions the system has to endure (Carpenter, 2012). General resilience focuses on adapting to expected and unexpected disruptions. Unlike the ‘specified’ resilience, ‘general’ resilience seeks to broaden options for dealing with unexpected disturbances and limiting the likelihood of new forms of instability. General resilience relies on disruptive events to drive change. For example, socio-ecological resilience thinking proposes that disruptive events create the opportunity to re-assess the status quo, prompt social engagement where necessary, and promote learning and innovation ahead of future events. In this regard, general resilience is appropriate for the development of adaptation and has the potential to lead to transformation, which is critical for long-term disaster recovery.

In a post-disaster environment, however, governments and institutions frequently rely on the rigid approach to 'specific' resilience in a bid to 'manage' uncertainty, making this the predominant approach in the past (Handmer and Dovers,1996). As mentioned previously (Section 3.3.1) transformation is sometimes viewed as undesirable and a system failure from a risk management perspective (Walker, 2014). However, the transformational resilience perspective, views 'system failure' or an unsustainable trajectory as an opportunity to transform into a new improved state (Pelling, 2011). In this regard, transition and change is viewed as a positive influence on resilience. In this light, socio-ecological resilience regards adaptation as a necessary form of continuous process, involving the realisation of transformative potential. A transformative system encourages change, creativity and learning in response to inherent uncertainties and risk (Davoudi et al, 2012).

The idea of 'potentiality' and 'positive change' arising out of adaptation, underpins the under-utilised transformational (socio-ecological) dimension of resilience (Holling, 2001; Seville, 2009; Davoudi et al, 2012). In this light, resilience is viewed here as a fixed asset (robust) whilst also including an adaptive, transformative element (Davoudi et al, 2012). The notion of opportunity emerging from a disaster event is not a new one, with various academics suggesting that a post-disaster context presents the opportunity for positive change (Adger, 2000; Folke, 2006; Davoudi et al, 2012; Walker and Salt, 2012; Mannakkara and Wilinson, 2014; Mochizucki and Chang, 2017). In addition, Holling's (2001) definition of resilience incorporates the positive elements associated with change and development through the 'adaptive cycle'.

The concept of the adaptive cycle as proposed by Holling is critical to transformational resilience theory. The cycle captures the different phases systems evolve through in order to transform into a more sustainable trajectory. However, too much connectedness and order in the system can reduce the adaptability in the system. This reveals an apparent paradox whereby the more connected a system is internally, the more rigid and inflexible the system becomes. The ecological model of ‘adaptive cycles’ seeks to reconcile this contradiction through the idea of ‘panarchy’ (Figure 3.2; 3.3). The panarchy model illustrates how no system can be understood or managed by focusing on a single scale. All systems, and, in particular complex adaptive systems (such as a disaster event), function at varied scales across “space, time and social organisation” (Robbins and Judge, 2007:p1496).

Gunderson and Holling (2002) categorise the change element into three distinct types, all of which can lead to innovative processes, namely; “incremental”, “spasmodic” and “transformational”. The adaptive cycle acknowledges transformation through its inclusion of opportunities for learning and innovation at different stages. However, Gunderson (2010) argues that this change is fundamentally reorganisation within the same system. Referencing the conceptualised panarchy diagram (Figure 3.3), the front loop represents the potential for incremental learning growth (r) until a level of conservation (k) is achieved. Similar to single loop learning, the system has the potential to learn from past experiences and improve routines (Gupta et al, 2010). This front loop can comprise incremental learning, as the system constantly seeks to innovatively enhance existing ideas. By contrast the reorganisation phase of the backloop is characterised by spasmodic learning. This form of learning is associated with radical innovation whereby new ideas enable the system to function in an entirely different manner (Biggs et al, 2012). Estimating the probability of success can be difficult however as there can be resistance to new ideas or processes that challenge the broader institutional framework (McKeown, 2008). Triple loop learning undergoes a number of levels of ‘panarchy’ change in order to transform the system.

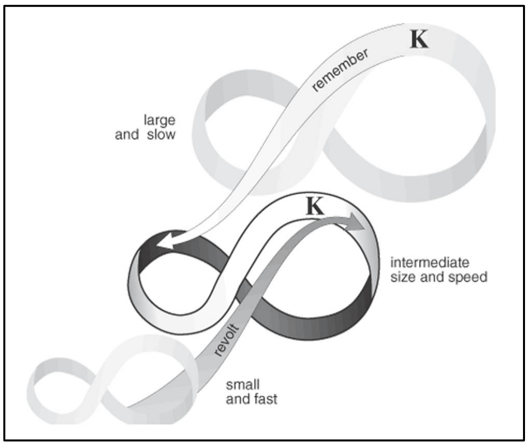


Figure 3.3 Panarchy: Nested Adaptive Cycles. Source: Gunderson and Holling, 2002.

Within the disaster management discourse, resilience definitions frequently comprise a 'learning' element. However, there remains ambiguity as to what precisely qualifies as 'learning' for these purposes. Recurrent disasters are seen as situations to learn from in preparation for the next disaster. However, it is unclear from the literature how much communities in fact learn from disasters (Birkland, 2006). The literature links the learning element to the transformative version of resilience, tying innovative and experimental adaptation results to a 'bounce forward' outcome (Shaw and Maythorn, 2012).

Despite the benefits of the panarchy (ecological) model, the system lacks the foresight and intentionality, typically associated with socio-ecological systems (Walker, 2014). The existence of human capacity within socio-ecological systems would enable the model to anticipate and plan ahead for future disruptive events (Walker, 2014). While knowledge and awareness will not of itself prevent a disaster event, human agency embedded within the panarchy cycle of adaptive change, has the potential to do so (Folke et al, 2011).

3.5 Issues and challenges of operationalising resilience for disaster management

Innovation, adaptation and learning should be fostered as integral sources of resilience (Swartling et al, 2011). However, in an increasingly bureaucratic system of disaster management, there is a strong pressure to revert to the rigid, command and control response to disasters (Handmer and Dovers, 2006). A key criticism emanating from the 'Prevent, Prepare, Respond, Recover' framework (Greater London Authority (GLA), 2007) is the lack of attention paid to lessons learnt from past disaster experiences. This criticism may be attributed to the fact that research surrounding the consequences and impacts of disaster is more difficult to compare than the statistical probability of future disaster events (Dao et al, 2012). Further, Manyena (2016) argues the lack of innovation is a consequence of communities being viewed as passive participants, rather than as active agents in disaster adaptation. As such, the valuable resource of community narrative and memory that drives social learning is restricted.

Social resilience can be defined as the capacity of people in a group (formal and informal) to face up to post-disaster challenges (Keck, 2013). It incorporates both collective and individual resources accumulated across the community from social interaction (Pelling et al, 2015). Social learning involves the understanding of the availability of capacities and resources already existing in a community, which can be harnessed in the event of a disaster. Further, ‘participation capacity’ can play a vital role in assisting communities to self-organise and adapt in the face of adversity (Voss, 2010). ‘Participation capacity’ has the ability to build softer capacity skills, such as, trust and shared understanding, which would not be typically developed through more traditional/rigid scientific processes (Folke, 2011). Engagement from all stakeholders is a core component of transformative resilience building. However, translating concepts such as social learning and community participation into practical resilience strategies remains a significant challenge within current disaster response efforts (Berke et al, 2015). Consequently, these issues will be further investigated under the umbrella of human agency and social capital in Section 3.8.

Disaster resilience is a discipline where the gap between research theory and practice frequently reveals itself. On the one hand, disaster researchers have identified adaptability as a source of resilience. On the other hand, the practice of disaster management has moved in a more inflexible direction, with an emphasis on standardisation and procedures (Folke et al, 2012). In order to bridge the divide between research and practice, there is the need for an approach that simultaneously fulfils (1) the need for structure and (2) the demand for innovation in the post-disaster environment (Underwood, 2010). For example, Harrald (2006:p256), has called for an approach that provides both “agility and discipline”. Similarly, Webb and Chevreau (2006:p66) suggest the need for “planning to improvise” and McEntire et al (2013) have developed the concept of “spontaneous planning” to capture the dual needs of stability and flexibility in responding to disasters. If this drive for preparedness as a core component of resilience is acted upon, potential opportunities as well as threats will be identified, addressing the strategic shortcoming of missed opportunities.

Shifting the emphasis from a ‘bounce back’ to a ‘bounce forward’ approach, has the potential to radically transform the disaster response/management process into a more desirable trajectory. In order for this transformation to be achieved, a community’s capacity needs to be focused as much upon finding opportunities as identifying potential threats (Alexander, 2012). The latter half of this chapter moves the discussion from resilience towards the human agency component of resilience. This perspective views people as active participants in disaster adaptation, as opposed to mere passive recipients of protective measures. Starting with an examination of the community construct, the following sections seek to evaluate the positive influence of social connections in a resilient community. It is anticipated that a review of the literature will identify the potentiality of leveraging community connections to build capacity and assist in the creation of more adaptable and resilient communities.

3.6 Community resilience and disaster management

Disasters not only cause losses of life, economic cost and environmental damage but also (in many cases) derail community development (Tsuda, 2001; UNISDR, 2013). This can leave the affected community most vulnerable to the impacts of disasters (Sen, 1999; UNDP, 2014). In a disaster context, safety of the community should be the primary issue (IFRC, 2011). Accordingly, these issues should be discussed and determined by the community (World Bank, 2012). As such, disaster recovery concerns itself with the physical reconstruction of the built environment as well as the reconstruction of the whole community (Shaw, 2014). Although little can be done to minimise the magnitude of the event itself (World Bank, 2014), its impact can be substantially reduced by acknowledging the vulnerabilities within the community and building community capacity to withstand the effect (UNDP, 2014).

Against that background, communities are increasingly being recognised as the critical component required to reduce the impact to their social infrastructure (Adger, 2000; Amartunga and Haigh, 2009; Genapati 2009). Shaw and Goda (2004) highlight the importance of community level disaster strategies, stating that government resources are often over-extended in times of disaster and require the support of the community to fill any capacity gaps. Accordingly, the valuable role the community can play in disaster management has gained currency within literature and policy in recent years (2010-2015). In this vein, the United Nations International Strategy for Disaster Reduction (ISDR, 2013) has put forward a vision to “enable all communities to become resilient to the effects of disasters.” The push for community level inclusion within the disaster process is further evidenced in the National Research Council report by the Committee on Private-Public Sector Collaboration to Enhance Community Disaster Resilience (2011). This highlights the need for the ‘full fabric’ of the community to be included in disaster decision-making. In its simplest form, effective recovery and reconstruction after a disaster are significantly influenced by community involvement (UNDP, 2014).

Despite growing acknowledgment of the community resource, the reality is that the community is often an untapped resource within a post-disaster context (Alexander, 2012; UNDP, 2014). Evidence of the potential of the local level community resource is widespread in the literature (Gillard and Texier, 2010; Jha et al, 2010), with increasing emphasis now being placed on the underexploited role and value of the community in post-disaster situations (Alexander, 2012). Community networks, local knowledge, resources and participation are now regarded as the pivotal drivers of community resilience (UNDP, 2015; Audefroy, 2017). It is argued that, by effectively harnessing local capacities and resources within existing localised social support systems, we can better inform effective post-disaster resilience strategies (Linnell, 2013). In doing so, the most valuable assets of affected populations (human; social; and natural), are more likely to be protected (World Bank, 2014).

Active inclusion of and participation from the community can also assist in combatting the feeling of isolation and abandonment that occurs after a disaster event (Goyet, 2006). FEMA (2011) emphasise this point by stating that community participation in disaster recovery and reconstruction goes beyond the provision of essential coping needs. Participation ensures that the community's voice is heard, that community needs are at the centre of reconstruction efforts and carried out in a way that reinvests in the community's future (Alexander, 2012). Further to the cost advantages of using an existing resource (Goyet, 2006; UNDP, 2011; Shreve, 2014), this participatory approach facilitates an authentic dialogue with the community and empowers the community to identify the needs and the existing resources that can be harnessed to address its vulnerabilities (Cutter et al, 2009).

As noted above, the benefits of incorporating and promoting community level initiatives are many: utilisation of local knowledge, resources and capacity; cost effective, project ownership and empowerment, (UNDP, 2013). Despite these identified benefits, the practical realisation of resilience thinking is fraught with issues and complexities (Seneviratne et al, 2012; UNDP, 2013; Victoria, 2015). The main challenge arises when complex resilience theory is applied within a rigid, inflexible policy environment, where uncertainty and adaptation are not valued (Schwab, 1998; Berke and Campanella, 2006; Alexander, 2012). A safer command and control approach is frequently preferred by government which can in fact result in making vulnerable conditions worse (Barstein et al, 2010; Pasteur, 2011). Garschagen (2013) echoes this point, commenting that theoretical models of resilience cited in the literature do not fit within rigid policy, and consequently stand to impede community level inclusion in resilience strategies.

Buckle et al (2001) argue that by failing to take into account the needs and demands of the local community, ‘one size fits all’ government-led models (Davis, 2016) often prove wasteful and inappropriate (Vale and Campanella, 2005), falling short on objectives and under-utilising the community resource (local knowledge, skills and resources) (La Trobe, 2008; Alexander, 2011). Reporting on reconstruction efforts in Banda Aceh, Indonesia, Lyons and Schilderman (2010) evidence the need to put the community at the centre of reconstruction efforts. They describe past government led efforts as ‘notoriously inappropriate’, failing to acknowledge the bespoke needs of individual communities. The key challenge associated with government driven reconstruction can be likened to John Turner’s (1972) description of the differentiation between what a house ‘is’ and what a house ‘does’. In this context, Turner was differentiating between the core function of a ‘house’ (to provide shelter) and the intangible benefit of a ‘home’ (to improve standards of living through “social, political, physical, human resource” benefits). Similar issues were also evidenced in a study on reconstruction efforts in post-earthquake Haiti. Skarbek (2010) found that government strategies, which failed to consult with the affected community, led to an inadequate response, neglecting the needs and desires of the community in Haiti and even led to abandonment in some new developments (Cox et al, 2011; Lie et al, 2011).

Arbon (2014) propose an alternative community-centred approach, wherein the government assists the local community to participate in disaster strategies. This reduces many of the mismatched needs/resources, which often characterise conventional top-down programmes (Cox et al, 2011). By harnessing local knowledge and capacity, the use of local resources is maximised, facilitating community-led initiatives to achieve a lot more with a lot less (UNDP, 2012) in a manner befitting the needs of the community, thus improving overall resilience (Da Silva, 2010).

3.7 Understanding the community concept

As identified in Section 3.1, resilience is a fundamental concept in this research, however its manifestation at the community level is where this research has its particular focus. Communities are the people most affected by disaster impacts (UNDP, 2012) and, as such, there is a need to unpack the multiple interpretations of the ‘community’ concept before successfully applying it to the resilience concept.

In the early part of the 20th century, the 'modern traditional' community emerged as a key concept in community theorising (Buckle et al, 2001; Amit, 2002; Day, 2006). Tönnies' (1957) publication of "Gemeinschaft and Gesellschaft" (Community and society) is frequently cited as the most influential text surrounding the community debate of its time. Tönnies' discussion of the relationship between community (Gemeinschaft) and the broader associations of society (Gesellschaft) revealed an interpretation of community founded on tight-knit, family-centred connections. Tönnies' description of a "traditional" community is one where there is "perfect unity and balance of wills" between individuals within the community (Tönnies, 1957:p37). The workings within a traditional community were shown to have a focus on shared entertainment, common goals and relationships (Tönnies, 1957). Similarly, Jane Jacobs (1961) in her classic study 'The Death and Life of Great American Cities' highlights the value of tight-knit social connections to society, which are fostered through everyday interactions within traditional urban forms.

As the twentieth century developed, so too did interpretations of community, with particular emphasis on the diffuse nature of 'traditional community' boundaries (Frankenber, 1969; Anderson, 1983; Crow and Allen, 1994). This discourse led Anderson (1983) to develop the concept of 'imagined' community, which differed from a traditional community as it was not founded on daily human communication and interaction. Anderson puts forward the concept that a nation is a socially constructed community, "imagined" by those who have an affinity or perception of belonging to that particular community. For example, Anderson explains how affiliation to a particular nation during the Olympics is a mental image of the 'imagined community' you associate yourself with.

Clark et al (2003) claims that 'traditional' communities, bounded by geography, are characterised by strong locally specific (close-proximity) social networks. In the event of a disaster, these face-to-face connections add value by enabling communities to harness their adaptive capacity. However, such traditional communities have been eroded in the last decade (Putnam, 2000) as communities shift away from traditional inner city neighbourhoods towards 'modern', globalised and mobile technological communities located on the periphery of the city (Stein, 1960; Jacobs, 1961; Albrow, 1997; Putnam, 2000). On the other hand, dispersed rural communities take advantage of similar technological communication methods, in order to increase connectivity (Stern et al, 2011). In this vein, Crow and Allen (1994) question the 'traditional' concept of a community arguing against community being bounded by geography. Instead they propose that today's modern community is 'abstract' and cannot be delineated by an arbitrary boundary. Substantiating this view, technological advances such as the internet has enabled 'modern' communities to engage in long distance communication, allowing community members to "belong" to a community unrestricted by geography (Eade, 1997:p24).

Further refinements to the 'community' concept started to emerge towards the end of the twentieth century, signifying an attempt to renew the traditional concept (Delanty, 2003; Day, 2006). More recent viewpoints discard positive notions of community "justice and fairness" and instead define "modern" communities by the level engagement in social processes (Delanty, 2003; Davoudi, 2012:p306). In contrast to the harmonious "unity and balance" described by Tönnies in 1957, modern communities accept diversity and individualism amongst members (Bauman, 2001; Amit, 2002), acknowledging that communities are not homogenous.

This section has established an understanding of the evolution of the complex community concept over time. The following section seeks to critically evaluate the definers of a 'community' within a resilience context, thus informing a working definition appropriate to the context of this thesis.

3.7.1 Framing a 'community'

The variety of definitions and thematic definers of 'community' which are evident in the literature over the last sixty years (1955- 2015) only serves to exacerbate the lack of clarity surrounding what a 'community' comprises. The following section traces recent developments in the framing and conceptualisation of the 'community' concept. It goes beyond presenting the different 'types' of community, namely: geography, circumstance and practice. In addition, it investigates inconsistencies in the concept's application. Finally, the section concludes by framing a community within a disaster context.

Adding to the complexity, it is clear from the development of the 'community' concept (Section 3.7) that the term is constantly evolving both in theory and in practice (Crow and Mah, 2011). In particular, the most contested aspect is that of community boundaries. In an age of globalisation and growing reliance on technology to communicate, Papacharissi (2010) argues that 'internet communities' have no boundaries. In this regard, geographical boundaries are rendered "defunct" in the eyes of some researchers (Boellstorff, 2008). As such, defining communities by geographical boundaries or administrative area (such as county, town or village) does not hold the same relevance today as it did back in 1957 when Tönnies' first proposed it.

In practice, however, disaster responses are frequently organised by reference to administrative boundaries, such as a local government area. Unfortunately, "broad-brush" disaster management with a focus on administrative boundaries runs the risk of overlooking local differences (Buckle,1998:p6). Further, disaster events often occur cross borders and do not obey artificial geographic boundaries (Stoltman et al, 2007). As such, a lack of cross-border communication can lead to significant challenges opposite the coordination, planning and operationalisation of cross-jurisdiction resilience activities.

Geographic proximity is a less influential factor in modern communities, which are now becoming less geographically defined due to the availability of technological or 'virtual' connections (Larsen and Axhaussen, 2005). Interestingly, research into the commonalities between 'virtual' and 'physical' communities revealed less differentiation between their defining characteristics than the researchers expected (Rheingold, 2000; Boellstorff, 2008). Their similarity reaffirms Buckle's premise that community should be defined by their *needs* rather than arbitrary geographical boundaries.

Irrespective of whether a community is viewed as geographically bounded, communities are built on networked individuals (Clark, 2007). In a disaster context, a community can be categorised into those either responding to a disaster or those affected by the disaster (Brennan, 2006). The responding community may well form part of the 'modern' community connected by mobile or 'virtual' means even where they are not bound by the geography of the disaster event. Nevertheless, the affected community is characterised by the disaster event as it directly impacts the geography of their community.

While 'communities of geography' may hold less relevance in today's virtual society (Delanty, 2003), 'place' still remains a key unifier of 'communities of circumstance'. Such communities are brought together by sharing an experience, such as a flood. However the literature cautions that amalgamation by circumstance does not necessarily constitute a community, rather an artificial geographical construct (Buckle et al, 2001; emBRACE, 2012a).

A further shift in thinking is the view that community characteristics, such as “cohesive” and “tight-knit”, do not always positively influence community behaviour (Mooney and Neal, 2008). In contrast to the community ideals, such as “balance and unity” proposed by Tönnies (1957), ‘community’ can also be associated with social problems, exclusion and “problem populations” (Mooney and Neal, 2008; Crow, 2012). Unlike Tönnies’ earlier interpretation (1957), later research reveals an acknowledgement of the social and cultural diversity embedded within communities (Goodson et al, 2016). Modern communities are characterised by their diversity and adaptability, with individuals often belonging to multiple communities (Buckle, 1998). Whilst diversity widens access to resources and capacities, the literature cautions that this can lead to social exclusion and inequality (Crow and Mah, 2012). Further, the distribution of capacity within a contested ‘community’ concept can lead to exclusion or unequal distribution of resources (Davoudi, 2012).

A further community theme, known as ‘communities of practice’, is drawn from a common interest or goal (Wenger, 1998). In a disaster context, an example of a ‘community of practice’ could include ‘resilience groups’. These groups are formed with the aim of sharing knowledge and experience related to disaster preparedness and recovery (Cabinet Office, 2016). Resilience groups act as a conduit for members to learn from each other, galvanise and build upon existing capacities through collaborative participation (Wenger, 1991). Empirical evidence shows the benefit these groups offer in terms of capacity building (Chandra, 2011). However, the literature cautions that ‘Community’ should not be considered a panacea for all complex development activities (Chitambo, 2002). In this regard, Wallace (2010) argues that in practice and policy often the “rhetoric” and the “reality” of “community” is not interconnected.

To summarise the above discourse on community, it is apparent that strong connections created by people through social interaction are the cornerstones of community development. In this regard, ‘community’ can be viewed as an emergent body of group behaviour created through social connections, face-to-face or virtual. With the advent of improved technologies and globalisation, the evolving community concept has rendered the ‘traditional’ community of place less relevant in today’s society.

In a disaster context, community is characterised both by geography (place) and interest. Disaster communities share common interests and goals, in particular to reduce risk against potential threats. Community involves the coming together of both the affected community (geographical) and responding community (geographical and virtual) for the common good of risk reduction. A disaster community is not homogenous, accepting individualism and diversity among members, and is characterised by an ability to adapt to uncertain environments. The review above acknowledges that the concept of 'community' is a contested subject. It recognises that the concept is constantly evolving and that consensus on a universally accepted 'framing' of the concept is not possible. However, what is clear is that any definition of the concept should reflect its intended application. In doing so, the "rhetoric" and the "reality" will remain connected. Like resilience, there is 'no one size fits all' community.

3.8 Social connections and social capital

Social connections consist of networks of individuals or groups related to one another through connections such as family ties, friendships, similar interests and other types of common interest (Carpenter, 2013). Social connections are considered the foundation of social capital and described in the literature as investments in relationships with expected returns (Lin et al, 2001). The literature argues that strong social connections and ties assist in building trust and ultimately lead to the creation of social capital (Putnam, 2000). Social capital is closely aligned to the social and participatory nature of cohesive communities (Sundet and Mermelstein, 1996; Norris, 2008). It refers to interaction between community members in pursuit of a shared goal, demonstrating the synergistic capacity of collaborative communities (Bourdieu,1986).

Historically, the concept of social capital within the literature focused on a community and its connections (Simmel and Wolf, 1950; Tonnies, 1957). Social capital and its related connections capture the dynamic capabilities of a community to self-organise and respond, adapt and recover from a disaster event (Meyer, 2013). Despite its positive potential for community resilience, social capital is often overlooked and excluded from policy (UNDP, 2011; Aldrich, 2012). Aldrich attributes the intangible, non-physical nature of social capital as the reason for its underutilisation in a disaster context. Aldrich claims the immeasurability of connections and human capital makes it difficult to define (Aldrich, 2012; GSDRC, 2013).

A theoretical understanding of the attributes and benefits of social capital may however assist in a better understanding of its definition and its influence on community resilience. The discussion below begins with an investigation into social capital theories presented in the literature. In particular, it focuses on the contributions to social capital theory by two key authors, Bourdieu (1986) and Putnam (1993).

3.8.1 Investigating the theory of social capital

There is no real consensus on a 'social capital' definition throughout the literature base, which includes interpretations from fields such as economics, sociology and politics (Schuller et al, 2000; Woolcock, 2001; Field, 2008), each with their own contrasting viewpoints. The concept's application in diverse fields has led to definitional problems, linking it to responsible citizenship, reciprocity, social networks, human capital, trust, norms, values and economics (Bridger and Luloff, 2001; Tuan, 2002; Stocker, 2004; Bhandari et al, 2009). An examination of Bourdieu's and Putnam's work highlights how involvement and participation in groups can have a positive effect on the community (Portes, 1998). Bourdieu focuses on an academic interpretation of the social network based approach, whilst Putnam's focus is on the norms, trust and a more civic-based approach.

Bourdieu's theoretical underpinning of social capital is located within Marxist thinking, suggesting that social capital arises through the construction of social resources (labourers) with a durable network of institutionalised (capitalist) relationships (Lin, 1999; Coradini, 2010). Bordieu's stance was concerned with the unequal distribution of resources and maintenance of power (Field, 2008). Accordingly, Bordieu identified four types of capital: cultural, social, symbolic and economic (Bordieu, 1986). Bordieu presents social capital as a dynamic and participatory concept embedded within social connections. This dynamic and participatory interaction can generate other forms of capital, leading to (for example) greater economic opportunities (Granovetter, 1983).

In line with Bourdieu's interpretation of social capital, Lin (1999) posits that social capital is essentially comprised two interacting elements: a durable social network and the accessibility of resources passing through the connection ties. A key concern for disaster managers adopting this interpretation of social capital is the effect social ties have on resources and the level of assistance these connections can offer (Nakagawa and Shaw, 2004; Murphy, 2007).

In contrast to Bordieu's social network approach, Putnam (2000) describes social capital in relation to connections between individuals and social networks. In particular, Bordieu focuses on relationship attributes, such as reciprocity and trustworthiness, arising from these connections. Putnam's theory features aspects of social organisation applied to groups and communities rather than to individuals (Woolcock, 2001; Bhandari and Yasunobu, 2009). Putnam posits that cohesive communities, who interact well during normal circumstances, have a greater potential to interact effectively during a disaster. FEMA (2011) validate this thinking by stating that the many features of a cohesive community are also features that may foster disaster resilience.

3.8.2 Social connections and disaster resilience

Following a community disruption people come together to assist each other, and it is this demonstration of social capital, which is referred to as the "core engine of recovery" (Aldrich, 2012). Strong social networks help survivors access information, support and recover faster (Von Meding, 2013). Similarly, the Committee on Disaster Research in the Social Sciences of the National Research Council (2009) highlights the integral role social capital plays in bolstering a community's resilience. It details the ability of social capital to galvanise existing relationships of trust, assist community problem solving and limit conflict (National Research Council, 2009). Norris et al, (2008) further emphasises the importance of psychological social capital to resilience. Norris highlights that social bonds have the ability to foster a "sense of community", "place attachment", and "citizen participation".

Having highlighted the benefits of social capital to disaster recovery, Carpenter (2013) argues for the need to strengthen social connections. Galvanising social connections should be a key objective of disaster interventions, rather than a mere by-product (Carpenter, 2013). Alexander (2012) believes social networks provide an informal safety net during difficult times, assisting communities to mobilise essential resources promptly after a disaster. However, the challenge remains on how best to alter the mindset of stakeholders towards prioritising and strengthening social capital as a key objective of all interventions (Gannon, 2013).

Social capital has also been described in terms of its positive influence on resilience change (Aldrich, 2012). Field (2008) argues social capital based on trust is the 'social glue' holding post-disaster communities together. This 'social glue' is founded on feelings of responsibility, participation and concern for others (Woolcock and Narayan, 2000; Roberts and Lacey, 2008) and is instrumental in helping people cope with and recover from disaster (Cutter et al, 2003). Patterson et al (2011) demonstrate that strong social connections facilitate the creation of bottom-up responses and the organisation of community resources. Social networks are consistently highlighted as an important factor in community resilience, and attempts to operationalise the link between social connections and resilient communities have not waned (Cutter et al, 2003; Paton, 2003; Patterson et al, 2011).

3.9 Conclusion

The literature review has highlighted a growing concern surrounding the issue of the increasing frequency and magnitude of disasters worldwide. The ability to enable communities to become more resilient is a key thread evident in the literature. This realisation has created the impetus to include the entire fabric of the community within the disaster process. Whilst the literature has historically focused on the disaster response phase, the recovery and reconstruction phases offer unique opportunities for the community to go beyond rebuilding the status quo. By contrast, these post-disaster phases seek to transform the community into a new trajectory, by building back better. Harnessing local capacity in this manner can significantly improve resilience in the face of a future disaster.

The literature review supports the notion that socially engaged communities display higher resilience than those who are not connected. By fostering social capital, communities can harness their own capacity more easily, enabling them to not only recover but also ‘build back better’. The recovery and reconstruction process is not just about physical recovery but equally about the social recovery of the community. The literature review has highlighted that social and physical reconstruction efforts are inextricably linked. The physical structure of the built environment has the potential to serve a facilitating role in the creation of greater social connections. It acts as backdrop for social interaction, facilitating the mobilisation of resources and capacity to expedite disaster recovery. The desire to ‘build back better’, instead of reinstating the status quo, is imprinted in resilient communities.

Chapter two and Chapter three have examined the theoretical and contextual components of this research and provide the basis for a hypothesis to be developed and tested during the empirical phase of the investigation. Chapter four follows with an evaluation of existing resilience frameworks, in order to inform the development and application of a resilience framework appropriate to the context of this thesis.

Chapter Four

Framework Development

4.1 Introduction

Resilience is a diverse term, adopted across many disciplines (Alexander, 2013). Chapter 3 highlighted how its many interpretations have led to a lack of consensus surrounding the term. It is however largely accepted that the concept offers its greatest benefit within development work (Schoon, 2005). Increasingly, it is recognised that resilience plays an integral role in expediting post-disaster recovery (UNDP, 2012). In particular, Chapter 3 highlighted the value of community resilience activities within a resource limited environment (Alexander, 2012). Despite the recognised value of community resilience, operationalising the concept remains a challenge (Bahadur, 2015).

The literature review (Chapter 3) identified factors likely to contribute to community resilience. However, discussion on the precise components has been rather broad and lacking the specificity required for implementation (Bene, 2013). Meeting Objective 3 of the thesis, this chapter seeks to enhance the limited understanding of the core drivers of resilience, which can act as “levers” for building resilience. However, the resilience concept is fraught with complexities associated with ‘systems thinking’ which adds to the complexity of the task (emBRACE, 2012a). For example, challenges such as cross-scalar interaction and non-equilibrium dynamics have been found to complicate the transition from theoretical to practically implemented frameworks (Bahadur et al, 2013; Quinlan, 2014). Further, many of the frameworks appear to be new, rather than built on earlier research. As a result, many of the frameworks do not benefit from the lessons learned in previous iterations.

To help address this gap, the chapter undertakes a review of the extant resilience frameworks (n=77) is undertaken in the following Section 4.2. ‘Frameworks’, in the context of this research, refers to a roadmap designed to systemise the concepts and components of resilience into an operational process. The review highlights tensions, commonalities and differences between existing frameworks (Section 4.3), In doing so, the analysis informs the creation of a ‘resilience lens’ to be applied across a list of 33 frameworks in Section 4.4. The list of 33 frameworks is limited to the context of this thesis and, as such, comprises only those frameworks which are: (1) located within a disaster context; and (2) practical in nature.

The ‘resilience lens’ identifies five criteria for evaluation across the distilled list of frameworks. These were: (1) holistic systems approach; (2) dynamic capacity; (3) multiple scales; (4) empirical grounding; and (5) mixed methods methodology. Informed by the framework analysis (Section 4.5), Section 4.6 starts the framework development process by identifying the integral components/assets of resilience common across existing frameworks. This section differentiates between 'dynamic' and 'inherent' resilience and outlines the four 'community assets' comprising Phase 1 of the Framework. Section 4.7 follows by outlining the four key components emerging from this analysis of 'dynamic' resilience (Phase 2). This section examines these four components, (namely: risk; dynamic resources and capacities; connectedness and learning), by reference to their operation within existing frameworks. Further, it describes the process of analysis used (within qualitative analysis software NVivo) to identify appropriate sub-components within the four core components. Section 4.8 closes the chapter by presenting an overview of the proposed thesis Framework. Figure 4.1 below illustrates the location of this chapter within the overall context of the thesis.

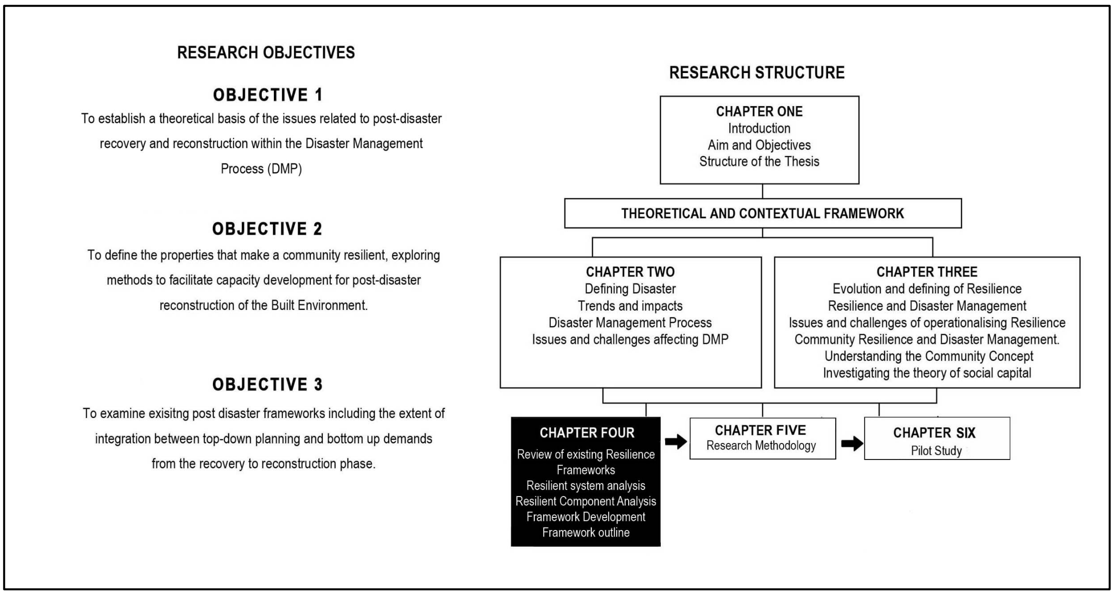


Figure 4.1 Position of Chapter 4 within the thesis structure.

4.2 Overview of existing frameworks

The intention of this section is to analyse a broad variety of resilience interpretations and assessments currently employed in order to contextualise resilience in practice. The analysis used key search terms to scan extant frameworks within international, academic, electronic databases (Scopus; Taylor and Francis Online; Wiley Online Library; Science Direct; and Google Scholar). The search was based on the title, keywords and abstract. Multiple search words were used, including (community)

AND (resilience) AND (disaster) AND (crisis) AND (emergency) AND (framework) AND (analysis) AND (evaluation) NOT (plant OR forest OR fish). As the focus of resilience is on socio-ecological systems, the "NOT" category was included to avoid solely ecological systems. Grey literature was included as it comprises a significant portion of operationalised resilience frameworks. A process of discriminative snowball sampling followed, whereby further relevant literature was highlighted from within the initial data sources (Denzin and Lincoln, 2005). The qualitative analysis software NVivo was employed to filter and organise the sources into a resilience matrix table. This outlined the year, author organisation, geography, resilience focus and applied level of the framework. In total 77 frameworks were identified for evaluation.

In line with these categorisations, the following section reviews the frameworks in respect of their: (1) resilience focus; (2) frequency trends; (3) geographical location and (4) level of analysis. In the first instance, it was necessary to define the focus of the analysis, which Yin (2014) refers to as the 'parameters of the system'. Adopting inductive parameters of analysis, 'open coding' (Strauss and Corbin, 1990) was conducted through an iterative process of analyses, categorisation and comparison of data into themes within 'nodes' in NVivo. Subsequent 'axial coding'[4] created sub-themes within nodes through the identification of relationships among the open codes (Strauss and Corbin 1990). Finally, selective coding identified core variables by merging and synthesising overlapping themes (Lawrence and Tar, 2013). For example, health and well-being resilience were included under the theme of 'vulnerability'. Figure 4.2 below illustrates the dominant and overlapping resilience themes emerging from the framework data set within this research. In order of frequency of occurrence, they comprised: disaster, community, resilience measurement, urban and, to a lesser extent, climate change, poverty, food and vulnerability.

[4] Axial coding is a process involving inductive and deductive analysis, where coding themes and categories are compared and synthesized into a distilled list of codes..

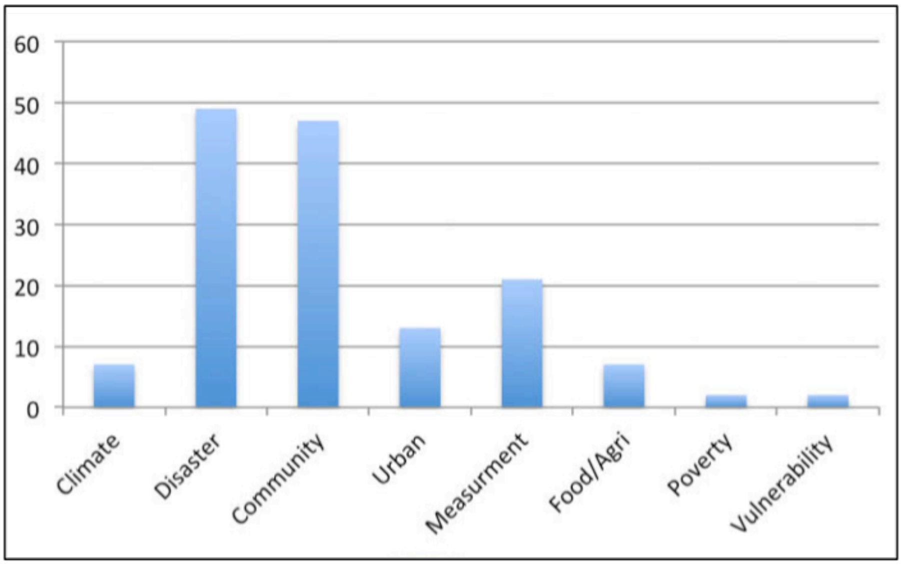


Figure 4.2 Resilience focus of 77 framework dataset.

A review of the framework data set indicated that 'resilience thinking' has gained traction across geographies, as illustrated in Figure 4.2. An analysis of frequency trends revealed a growth in framework output from 2007 onwards (Figure 4.3). A peak in 2010 was attributed to increased output from larger international organisations, such as the American and Canadian Red Cross, United Nations and Arup (Arup Group Limited). This growth in 'resilience thinking' may be attributed to the resilience agenda embedded within the Hyogo Frameworks for Action (HFA), published in 2005. The knock-on influence of the HFA could be seen through the emergence of seminal works on resilience frameworks, including: Twigg (2007; 2009); Cutter (2008; 2010); and Norris et al (2008). These pioneering works created a foundation for many subsequent frameworks. It was important to note that, whilst an author may develop a framework in one country, its intended application may be for an entirely different geography (Figure 4.4). For example, it was found that some frameworks developed in the United States were actually designed to be applied within an African context (DFID,2000). Consequently, it was important to analyse frameworks not only by their affiliated author but also by the region of study or the geography of its intended application.

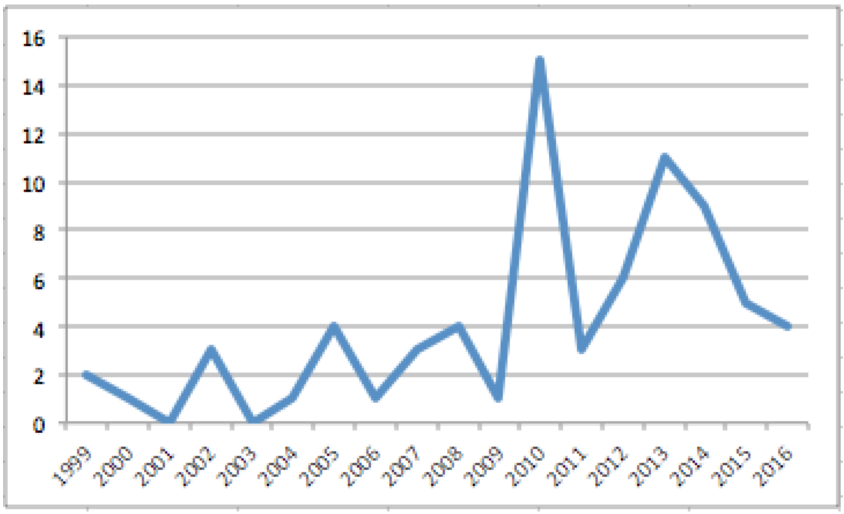


Figure 4.3 Frequency of framework output.

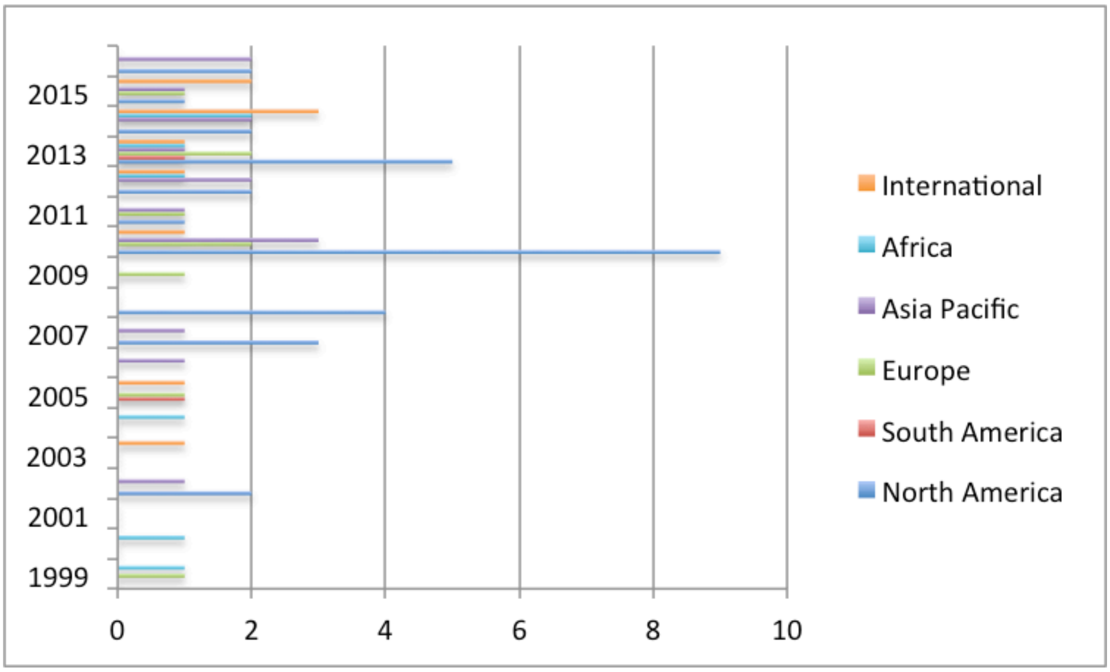


Figure 4.4 Geographical representation of intended implementation of frameworks according to year and frequency produced.

With respect to the geographic origin of the frameworks, the analysis revealed developed countries contributed the bulk of the knowledge concerning resilience. In total, 61% of authors were either independent authors or affiliated with research centres in the developed world. The remaining frameworks from the developing world dealt with Africa (9.5%); South East Asia (8%); and South America (3%).

As regards to the applied frameworks, the highest percentage of implemented research is located in Asia (15.5%) and Africa (13%). North America produced the greatest output of resilience frameworks, however not all frameworks were designed for implementation within North America. Research focused on the International perspective accounted for 15.5% of all papers. It was found that 42% of all papers were theoretical in nature and presented no empirical analysis.

Interestingly, it was noted that the majority of research in respect of the developing world was actually conducted in developed countries. The majority of academic literature originated in developed countries, which raises questions as to how accessible this research is to the developing world. By contrast, practically-orientated grey literature originated mostly in the developing world. This may be attributed to the greater demand for practical frameworks in the developing world. These findings suggest that improved promotion and dissemination of research in the developing world, (in particular South America, Africa and South East Asia) is required, in order to advance/promote academic research in the developing world. This evidence is in line with findings from the GSDRC Governance, Social Development, Humanitarian Knowledge Services (2013), who report on the limited geographic scope of extant frameworks. Table 4.1 outlines an overview of the 77 frameworks reviewed. The community focus of the analysis is highlighted by the fact that 83% of these frameworks are located at the community level.

Table 4.1 Resilience dataset of 77 frameworks.

Framework	Year	Organisation	Geography	Resilience Focus	Level
Climate resilience Framework.	2016	Union of concerned scientists	North America	Climate	Community
Top down assessment of Disaster Resilience	2016	Parsons et al.	Asia Pacific	Disaster	National
Community Resileince Framework	2016	Emergency Management Victoria	Asia Pacific	Disaster, community	Community
Resilience Framework	2016	Christian Aid	Europe	Disaster, community, poverty	Community
Climate resilient toolkit	2016	National Institute of Standards and Technology NIST	North America	Community,urban	Community
Community Flood resileince measurment	2016/2015	Keating et al; Zurich et al.	Europe	Disaster, community, measurment	Community
Measurment of Community Disaster Resileince	2015	Yoon et al	Asia Pacific	Disaster, community,measurment	Community
Urban Risk Resilience	2015	Earthquake and megacities initiative	International	Disaster,urban, community	National
Framework to Enhance Community Resilience Using Social Capital	2015	Pfefferbaum	North America	Community, social	Community
Disaster Resilience Scorecard for Cities. Based on the "Ten Essentials"	2015	United Nations International Strategy for Disaster Risk; Sands	International	Urban	Community
Resilience Conceptual Framework	2014	Food and Agriculture Organisation,FAO	Africa	Food	Community
Federal Emergency Management Agency's Hazus tool	2014	FEMA	North America	Disaster	National
Resilience Index for Natural Disasters	2014	Kusumastuti et al,	Asia Pacific	Disaster, measurment	National
Community based resilience assessment (CoBRA) conceptual framework and methodology.	2014	UNDP	Africa	Community	Community
Framework for Communtiy Resileince	2014	IFRC	International	Community, disaster	Community
City Resilience Framework	2014	Rockefeller Foundation; ARUP; Silvia and Morena	International	Urban	National
Geographies of Community Disaster Resilience'	2014	Cutter et al	North America	Disaster, Community	Community
Disaster Resilience Scorecard for Cities	2014	UNISDR	International	Urban, disaster	Community
Major Principles and Criteria for Development of an Urban Resilience Assessment Index	2014	Shafiri	Asia Pacific	Urban, measurment	Community
People centred resilience'	2013	OXFAM	International	Agriculture, climate, community	Community
AID Community Resilience: Conceptual Framework and Measurement Feed the Future Learning Agenda	2013	US AID	North America	Food, poverty, community, measurment	Community
Assessing Adaptive Capacity within Regional Climate Change Vulnerability Studies	2013	Schneiderbauer et al	Europe	Cimate change, vulnerability	Community

Framework	Year	Organisation	Geography	Resilience Focus	Level
Climate resilience framework: Putting resilience into practice (CRF)	2013	Institute for Social and Environmental Transition-International	North America	Climate change, operationalisation	Community
Localised Dsaster resileince index	2013	Orenda and Fujii	Asia Pacific	Disaster, community, measurment	Community
Community Resilient System	2013	Community Regional Resilience Institute (CARRI)	North America	Community	Community
Oregon Resilience Plan	2013	Oregon Seismic Safety Policy Advisory Commission (OSSPAC)	North America	Disaster	Community
Tufts Livelihoods Change Over Time (LCOT) Model	2013	Maxwell	Africa	Disaster, community	Community
FAO adapted in Nicaragua	2013	Ciani and Romano	South America	Food	Community
Coastal Resilience Index	2013	National Ocean and Atmospheric Administration (NAOAA)	North America	Disaster, community, measurment	Community
"Mind the Risk: A Global Ranking of Cities under Threat from Natural Disasters	2013	Swiss Re	Europe	Disaster, Urban	National
Developing a model and tool to measure community disaster resilience	2012	Torrens Resilience Institute, Arbon et al	Asia Pacific	Disaster, community, measurment	Community
Resilience to avoid and escape chronic poverty:	2012	Barrett, C. B. & Constas, M. A.	North America	Poverty, measurment	Community
Building Resilience to Recurrent Crisis	2012	USAID	International	Disaster, community	Community
Communities Advancing Resilience Toolkit (CART)	2012	Pferrerbaum et al	North America	Disaster, community, measurment	Community
Characteristics of a safe and resilience community.	2012	IFRC	International	Community, disaster	Community
Enhancing resilience to food security shocks	2012	Frankenberger et al	Africa	Food	Community
ResilUS: A Community Based Disaster Resilience Model	2011	Miles	North America	Disaster, community, measurment	Community
From Vulnerability to Resilience: A Framework for Analysis and Action to Build Community Resilience	2011	Practical Action; Pasteur	Asia Pacific	Community, vulnerability	Community
Defining Disaster Resilience	2011	Department for International Development (DFID).	Europe	Disaster, community	Community
Measuring disaster resileint communities	2010	Palang Merah Indonesia (PMI) and Canadian Red Cross (CRC)	Asia Pacific	Community, Disaster, measurment	Community
PEOPLES A holistic framework for defining and measuring disaster resilience	2010	Renschler	North America	Community, disaster, measurment	Community
Measuring Capacities for Community Resilience.	2010	Sherrieb	North America	Community, disaster, social,measurment	Community
Building Resilient Communities: A Preliminary Framework for Assessment	2010	Longstaff, et al (Homeland Security Affairs)	North America	Community, Disaster	Community
Integrating Development and Disaster Management Concepts	2010	Sanderson, D	Europe	Disaster	Community
Strengthening Climate Resilience	2010	Bahadur	Europe	Climate change,	Community
Indicators of Community Resilience	2010	Pooley, J et al	Asia Pacific	Community	Community
CBDRR Household Guide and Assessment Tool	2010	American Red Cross	North America	Community, disaster	Community
Coastal Resilience Index	2010	NOAA (National Oceanic Atmospheric Administrative)	North America	Community, disaster	Community
Disaster Resilience Indicators for Benchmarking Baseline Conditions (BRIC)	2010	Cutter et al	North America	Community, disaster, measurment	Community
Urban Resilience	2010	Arup	International	Community, disaster, measurment	National
Hyogo Framework for Action	2010	American Red Cross	North America	Community, disaster, development	National
Measuring Community Resilience:	2010	Canadian Red Cross	North America	Measurment, community, disaster	Community
Climate and disaster resilience initiative	2010	Shaw et al	Asia Pacific	Disaster, community	Community
Disaster Resilience Scorecard for Cities.	2010	United Nations International Strategy for Disaster Risk	North America	Urban, disaster	National
Characteristics of a Disaster Resilient Community	2009	DFID, Twigg, J.	Europe	Community, disaster	Community
San Francisco Urban Renewal SPUR Methodology	2008	SPUR	North America	Urban, disaster	Community
Critical Infrastructure, Interdependencies, and Resilience	2008	O'Rourke	North America	Disasters, urban	Community
Sustainable livelihoods manual	2008	TANGO International	North America	Food	Community
Set of networked adaptive capacities	2008	Norris et al	North America	Community, disaster	Community
Hyogo Framework for Action	2005	UN ISDR and UN OCHA	International	Disaster, community	Community
Understanding and Applying the Concept of a Community Disaster Resilience : A capital -based approach	2007	Mayunga	North America	Community, disaster,measurment	Community
Manual on evaluating coastal community resilience to hazards	2007	IOTWS	Asia Pacific	Community, disasters	Community
City Strength in Times of Turbulence: Strategic Resilience indicators.	2007	Normandin et al	North America	Urban, disaster,measurment	Community
4R's Framework	2007	Bruneau et al	North America	Disaster, community, urban	Community
Critical guidelines of community-based disaster risk management	2006	Asian Disaster Preparedeness Centre, ADPC	Asia Pacific	Community, disasters	Community
Mainstreaming Disaster Risk Reduction	2005	Tearfund	International	Disaster	Community
Sustainable livelihood approach for assessing community resilience to climate change	2005	Elasha et al	Europe	Community, climate change	Community
The Risk Management Index measures	2005	Carreño, et al	South America	Disaster, measurment	National
Defining and Measuring Economic Resilience to Earthquakes	2004	Earthquake Engineering Research Centers Program MCEER	North America	Disaster,economic	Community
Index of social vulnerability for climate change for Africa	2004	Vincent,	Africa	Climate change, measurment	Regional
PAR Pressure and Release model	2003	Wisner et al	North America	Disaster,community	Community
Global Vulnerability Analysis	2003	Turner et al	International	Disaster, community	National
Building Back Better: Creating a Sustainable Community After Disaster	2002	Monday	Asia Pacific	Community, disaster	Community
Household Livelihood Security Assessments.	2002	CARE, Frankenberger	North America	Food	Community
The Community Resilience Manual, increasing capacity.	2002	Community Resilience Project Team	North America	Community	Community
Climate shocks and pastoral risk management in northern Kenya	2000	DFID	Africa	Climate change,	Community
Sustainable Livlihoods guidance	1999	DFID	Europe	Community, social	International
Mexico City Vulnerability Index	1999	Puente	South America	Urban, disaster	Community

The above section has outlined the extant framework data-set (n=77). In order to analyse the frameworks in more detail, it was first necessary to develop a 'resilience lens' to guide the analysis. The following section explains the process used to develop this 'lens'.

4.3 Development of a framework for analysis

The varied interpretation of resilience has led to the development of numerous frameworks and methodologies to assess and analyse the concept. When taken together, the various conceptualisations of resilience within the frameworks (n=77), suggest that resilience is a comprehensive and robust concept. However, the diverse range of interpretations also points to the challenges that arise when the concept is operationalised. In particular, a 'one size fits all' framework approach, accommodating all facets of the varied disciplinary divides, appears to be idealistic and unfeasible (Bahadur, 2011; National Research Council, 2015). As such, an explicit outline of the rationale to/for a resilience assessment is a critical prerequisite to an appropriate assessment in practice.

When devising a lens for analysis, it was important to determine the key tensions and core characteristics of a resilient system. To this end, NVivo's 'query' function was used to identify frequently occurring words, phrases or concepts within the framework data set (Figure 4.5). In total, five core themes emerged as influencing resilience systems, namely: holistic systems thinking; static and dynamic resilience; multi-scalar; mixed methods; and empirical assessment. These five themes formed 'cases' in NVivo, where coded text could be stored for analysis. The following section provides detail of these five 'themes' and outlines the key criteria/ tensions within existing frameworks. The section concludes with a set of five criteria to analyse frameworks in a rigorous/structured manner.

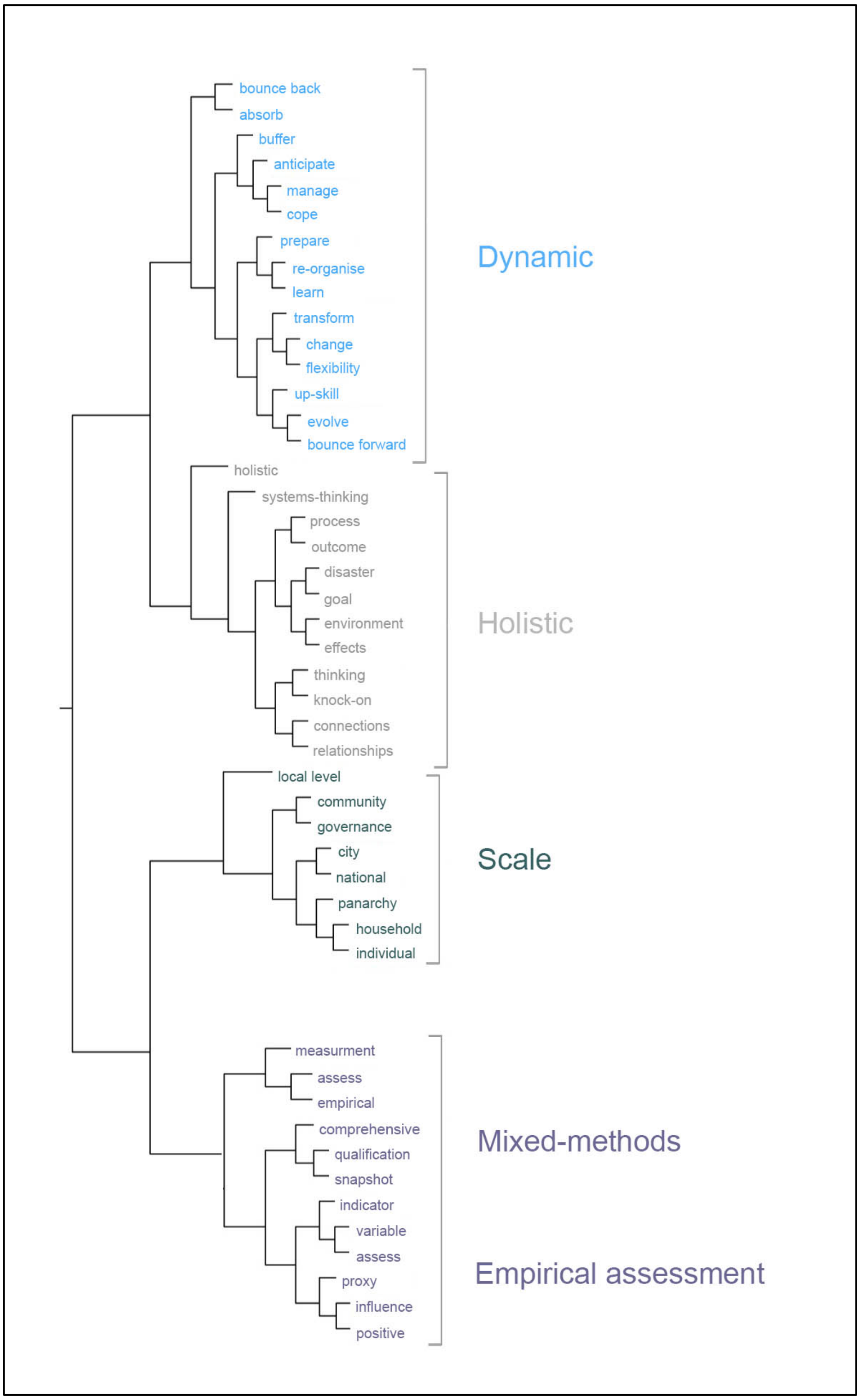


Figure 4.5 NVivo text query results.

4.3.1 Holistic resilience approach

The above-mentioned themes form the lens through which the framework dataset will be reviewed in this section. Taking each theme in turn, this section begins with the first theme ‘holistic systems thinking’. Despite various interpretations of the resilience concept, it is apparent that the definitions within the frameworks adhere to a 'systems approach' to change (Folke, 2006; Wisner et al, 2007). However, despite this commonality, the absence of a clearly defined, systematic approach towards conceptualising a resilient system, is impeding operationalisation (Pasteur, 2011; Practical Action, 2014).

Of the frameworks reviewed, 45% partially adopted a resilient systems approach, while 55% fully accounted for the inter-connectedness between resilience systems. The primary objective of a systems approach is not to focus on 'specified' resilience to a particular threat, rather, it looks to build the adaptive capacity necessary to deal with a range of disturbances across the system. 'Systems thinking' seeks to combine a portfolio of strategies, resources and actors to address potential uncertainty in the system (UNDP, 2007). The Livelihoods Framework, as proposed by TANGO (2007), argues that the overarching objective of a 'holistic' resilience approach is to inform stakeholders (local, regional, national level) of the myriad of factors and processes that can impact upon a system's resilience level.

4.3.2 Static or dynamic interpretation of resilience

Addressing uncertainty requires a multi-dimensional and dynamic capacity within resilient systems (Bene, 2012). The dynamic response to increasing uncertainty makes it difficult to capture the transformative characteristics of resilience at any one point (Armitage et al, 2012). Indeed, the review of 77 frameworks revealed that only 33% of the frameworks addressed the interaction between different dimensions of resilience (Table 4.4), and it is this process of interaction that is integral to an understanding of transformational resilience (Walker et al, 2004).

The review also indicated that the inter-connected relationship between vulnerability and resilience strongly influences the choice to adopt a 'static' or 'dynamic' interpretation of resilience (Constas and Frankenberger, 2013). As discussed in Chapter 3, 'resilience' and 'vulnerability' are concepts in their own right, however there is substantial debate as to whether and how the two concepts are distinct (Constas and Frankenberger, 2013; Gall, 2013; Cutter et al, 2014). Disaster literature has however witnessed a shift in thinking, where communities are now viewed in respect of their ability to transform in the face of adversity, as opposed to the traditional interpretation of a community as vulnerable to disaster events (Constas and Frankenberger, 2013). From this perspective, disaster recovery assessments no longer focus on static stressors such as exposure and sensitivity, formerly associated with vulnerability (IPCC, 2008). Instead, focus has shifted towards the community's dynamic capacity (resilience).

Beyond the vulnerability/resilience debate, this section also differentiates between frameworks which view resilience as a *process* of adaptive change rather than simply a static *outcome*. The premise of socio-ecological systems is that the system embraces change in order to absorb shocks and undergo a process of development when required (Holling, 1973; Mayena, 2006). The level of behavioral change required has been framed in terms of its dynamic positioning on the continuum of resilience (absorb-adapt-transform) (Speranza, 2013). First steps in resilience change may be interpreted as a system's ability to resist or buffer threats. For instance, Walker and Salt (2006:p164) refer to resilience as the ability of communities to 'absorb' or 'withstand' shocks and disturbances, such that the "system remains within the same regime, essentially maintaining its structure function and feedbacks". Further along the continuum, resilience can be framed in terms of its ability to embrace change and adapt in the face of adversity (Norris et al, 2008). Finally, Folke (2006) frames the concept not only by reference to a system's ability to incrementally adapt over time (multiple equilibria) but also, past a certain point, the system's capacity to transform into a more sustainable trajectory (Gunderson, 2010). As such, instability within the status quo may demand that the system transform into a new more sustainable trajectory.

A recent example of a dynamic approach to resilience assessment is offered by Christian Aid (2016). Adopting a "holistic, adaptive and integrated approach", the framework focuses on building resilience as a process rather than an outcome (Christian Aid, 2016:p2). The framework describes itself as a "community-led process", which seeks to "empower communities to manage risk", thus leaving the community in an improved position relative to its pre-disaster state (Christian Aid, 2016:p2). By building capacity within communities, the framework seeks to enable communities to mobilise their resources and capacities to anticipate threats, self-organise and absorb or adapt to uncertainty (change) when required. Overall, the framework describes resilience as an iterative, capacity-building process to enable to communities to adapt and change in response to uncertainty.

Understanding how a system changes internally, in terms of its ability to withstand disturbances and its capacity to absorb, adapt or transform, is integral to resilience building (BRACED, 2017). In particular, understanding how the different phases of change progress along the continuum of resilience (adsorb, adapt, transform), ultimately informs the timing and nature of management interventions (Alexandra, 2012). Investigating interactions between different dimensions is a necessary prerequisite to analysing how the different components and resources shape community resilience (Burton, 2012).

4.3.3 Defining multiple levels and scales

The second theme recognises 'scale of analysis' as a critical aspect of how a system is defined (Renschler et al, 2010). It does so by analysing the importance of 'multi-scalar relationships' within frameworks. As discussed in Chapter 3 (Section 3.3), scales are interdependent and rely on the dynamic relationship between one another (panarchy) in order to cope, adapt or transform (Renaud et al, 2010; Quinlan et al, 2016). Garchagen et al (2011) reaffirms this thinking, noting that component shifts at one scale can affect what happens at other scales. For example, individuals operate within a household unit, which operates within a community, which in turn operates within a wider system of governance (Barrett and Constas, 2012).

Managing a resilient system, therefore, requires an appreciation of what is happening at multiple scales (Burton, 2012). This underlines the importance of capturing multi-scalar dynamics in order to attain a true assessment of resilience. In particular, Bene (2012) points out how the promotion of multi-scalar general resilience can enhance long-term resilience through support at the local, regional and national scale.

4.3.4 Metrics and indicators

The ability to assess or measure resilience empirically is a fundamental step in seeking to operationalise the concept (UNDP, 2012). The analysis revealed that less than half of the 77 frameworks reviewed were grounded in empirical evidence. Furthermore, many of the resilience frameworks reviewed have not yet been empirically tested. This is particularly true at the urban level, where data and sources of information remain very limited (Bosetti et al, 2016). Indeed, Thomas Windel of UNDP (2014:p19) stated that "no general measurement framework for disaster resilience has been empirically verified yet".

Many framework examples such as Mayunga's (2007) heavily cited "Capital based approach" are not founded on empirical data, drawing only on an analysis of existing concepts. Nevertheless, Mayunga's work has acted as a foundation for more recent frameworks. One such example is the 'Resilience score' by Zurich et al (2016), which uses Mayungas' 5 capitals' approach as a foundational platform, but includes an additional empirical element. A further attempt to address the lack of empirically tested frameworks was devised by Silva and Morena (2014) through their "City Resilience Framework" (Rockefeller Foundation/Arup). This framework compiles empirical data and was informed by a combination of interviews, focus group discussions and workshops across 6 cities worldwide. It stands as a pioneering step towards bridging the empirical gap within existing resilience frameworks.

The above review of frameworks highlights issues in respect of resilience assessments which neglect the dynamic nature of resilience (Burton, 2012; UNDP, 2012; UNDP, 2014; Bahadur, 2015). The review found that measuring resilience in a traditional manner, through quantifiable indicator data, presents a significant challenge (Pelling, 2011). It was found that quantitative indicators only present a static snapshot of resilience and fail to capture the dynamics of the concept in practice. Despite the difficulties attached to standardising a dynamic concept and process, attempts have been made to develop an indicator-based approach to assess and measure resilience (ODI, 2011). To this end, extant frameworks highlight the ability of indicator proxies to provide a flexible approach to collect and assess data across multiple scales (Cutter, 2008; Arup, 2014; Bahadur, 2014).

4.4 Analytical approach

This section outlines the application of the resilience lens developed in the previous section. To enable a more in-depth analysis, the data-set of frameworks was refined to a manageable number of frameworks. The focus of this research is on operationalising the resilience concept. As such, the following analysis was restricted to those frameworks which were of a practical nature and situated within a disaster hazards context. Consequently, further refinement of the initial data set in NVivo reduced the number of frameworks to 33 (Table 4.2).

Table 4.2 Review of 33 operational frameworks to evaluate components.

Frameworks	Organisation/researcher	Year	Abbreviation
Community Resilience Framework	Emergency Management Victoria	2016	CRC
Measurment of community Disaster Resilience	Yoon et al	2015	MCDR
NIST	NIST	2015	NIST
Community Flood Resilience Measurment	Keating et al	2015	CFRM
CoBRA Community based resilience assessment	UNDP	2014	CoBRA
Disaster Resilience Scorecard for Cities	UNISDR	2014	CRS
City Resilience Framework	Rockerfeller Foundation	2014	CRF
People centred resilience	OXFAM	2013	PCR
CARRI Community Resilient System'	Community Regional Resilence	2013	CARRI
Oregon Resilience Plan	OSSPAC	2013	Oregon
Coastal Resilience Index,	NOAA	2013	CRI
Communities Advancing Resilience Toolkit (CART)	Pferrerbaum	2012	CART
A Framework for Community Safety and Resilience	IFRC	2012	CS&R
ResilUS: A Community Based Disaster Resilience Model	Miles and Chang	2011	ResilUS
From Vulnerability to Resilience: Building Community Resilience	Practical Action, Pasteur	2011	V2R
Urban Resilience	ARUP	2010	UrbanR
Community Resilience Index	Scherrieb	2010	CRI
Strengthening Climate Resilience	Bahadur	2010	SCR
BRIC: Disaster Resilience Indicators for Benchmarking Baseline Conditions	Cutter	2010	BRIC
PEOPLES resilience Framework	Renschler	2010	PEOPLES
Characteristics of a Disaster Resilient Community	DFID, Twigg	2009	CDRC
Critical Infrastructure, interdependencies and Resilience	O'Rourke	2008	CIIR
Urban renewal Methodology (SPUR)	SPUR	2008	SPUR
Hyogo Framework for Action	UNISDR	2008	HFA
Set of networked adaptive capacities	Norris	2008	NAC
Manual on evaluating coastal community resilience to hazards (IOTWS)	IOTWS	2007	IOTWS
4 R's Framework	Bruneau et al (MEER)	2007	4R's
A capital –based approach	Mayunga	2007	CC
Critical guidelines of community-based disaster risk management (ADPC)	ADPC	2006	ADPC
PAR Pressure and Release Model	Wisner et al	2003	PAR
Global vulnerability analysis	Turner et al	2003	GVA
The Community Resilience Manual	Community Resilience Project Team	2002	CRM
Sustainable livlihoods	DFID	1999	SLF

Distilling the current state of knowledge on frameworks in this way will inform the framework design of this thesis. Applying the lens outlined in Section 4.3, the following section describes the current state of knowledge and application of frameworks in relation to the five analysis criteria. It is anticipated that analysis of practical frameworks (n=33) will highlight gaps within extant frameworks and inform the design of the proposed thesis Framework. The 'resilience lens' analysis criteria are listed in Table 4.3, then applied and discussed further in the following section.

Table 4.3 Proposed analytical lens for framework analysis.

Analysis criteria	Description
Holistic resilience approach	Systems thinking
	Cross-scalar dynamics
	Resilience thinking is systems thinking
Dynamic Capacity	Frameworks ability to capture the absorptive, adaptive and transformative capacities of the system
	Resilience or vulnerability
	Outcome or output
	Asset or process
Multiple scales	Defining multiple levels, states and scales
Empirical	Empirical grounding
Mixed Methods	Qualitative or quantitative (combined methods)

4.4.1 Holistic resilience approach

Chapter 3 identified a shift in thinking within research, such that disasters are no longer viewed simply as ‘Acts of God’ (hazard), rather they are a function of human influence. As such, resilient systems now recognise both the ‘social’ (human) and ‘ecological’ (hazard), aligned with the socio-ecological interpretation of resilience. In this vein, the importance of “systemic thinking” emerged strongly across the majority of reviewed frameworks, particularly those encompassing a socio-ecological approach (Turner et al, 2003; Arup, 2010; USAID, 2013; IFRC, 2014; Keating et al, 2015; NIST, 2015; Emergency Management Victoria, 2016). An example of this paradigm shift towards holistic system frameworks is reflected in Arup’s City Resilience Framework (Rockefeller Foundation, 2014), which underlines the importance of adopting systems thinking. In particular, Arup argue that resilience is applicable to cities “…because they are complex systems that are constantly adapting to changing circumstances”. Acknowledging the interaction between the social (human) and the environmental (city), the framework embodies this strand of resilience thinking in a more tangible way by including seven qualities and twelve indicators of resilience that fall into four separate categories. It is argued that these elements are nested within each other and come together in different configurations to determine the resilience of particular urban contexts. Arup’s framework emphasises the inevitable interconnection between different elements of a resilient system. As such, this framework acknowledges the need for concurrent change across human and ecological systems, which characterise holistic resilience thinking (Ramalingam, 2008).

4.4.2 Static or dynamic interpretation of resilience

The analysis found a number of frameworks which do not explicitly align with the key assumptions of ‘systems thinking’. Instead, they provide a static list of issues or vulnerabilities that have the potential to reduce resilience without discussing how the interplay between these vulnerabilities influences resilience levels (Mayunga, 2007; IOTWS, 2007).

Despite the increasing relevance of ‘resilience thinking’ (discussed in Section 4.4), many frameworks were still found to hold a vulnerability focus (DFID, 1999; Turner et al, 2003; Wisner et al, 2004; Cutter, 2010; Pasteur, 2011). One of the more recognised frameworks is the Pressure and Release (PAR) framework (Figure 4.7), which focuses on a social interpretation of resilience (Wisner et al, 2004). Wisner's framework is based on the idea that the extent of disaster impact has more to do with the vulnerability (low capacity) of the affected community than the hazard agent. It argues that inherent vulnerability within a community affects its ability to respond and recover from an adverse event. As such, if a hazard occurs in an area but there is no vulnerable community, then there is no disaster. Figure 4.6 illustrates how a disaster situation is worsened by three levels of processes, namely: root cause of vulnerability; limited resources; and an uncertain environment. The figure indicates that if these three processes (left of figure) meet a hazard agent (right of figure), then disruption and disaster will occur.

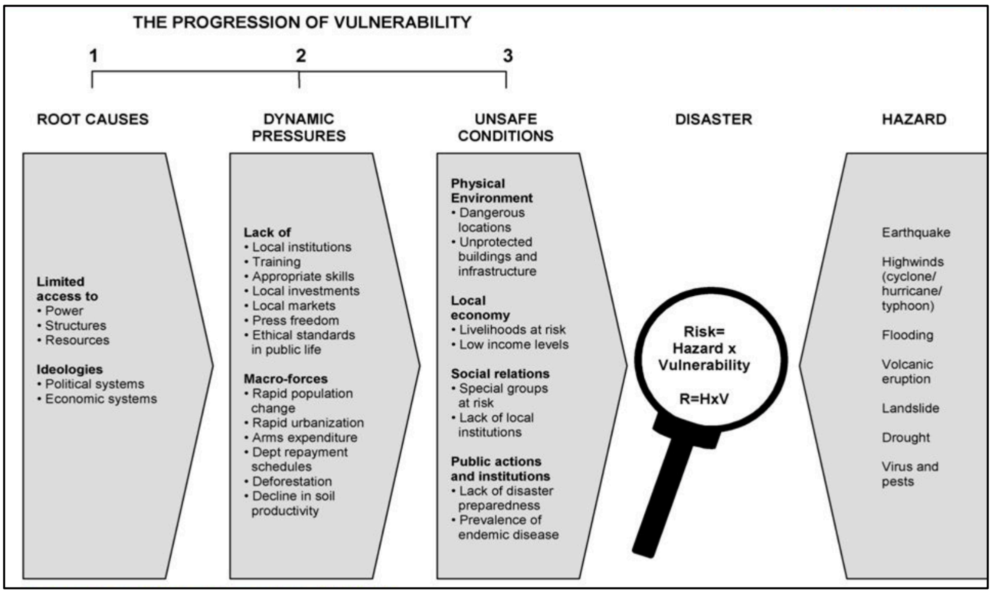


Figure 4.6 Pressure and release (PAR) model. Source: Wisner et al, 2004.

Turner et al (2003) seek to re-address the 'static' interpretation of resilience. Taking on a pioneering, holistic approach, their framework examines resilience through a 'systems thinking' lens. In doing so, it evaluates resilience from both a human and an ecological perspective. The overarching aim of the framework is to limit the long-term vulnerability of the system to future uncertainty (Figure 4.7). As such, the framework focuses on the dynamic interplay between the five core community assets (social, physical, environment, economic and political) and system vulnerability (Birkmann, 2006). Unlike the Pressure and Release model, this conceptual framework takes into account the concept of adaptation. Turner views change as an integral element of systems thinking, which positively impacts resilience levels. This marks a step towards accounting for the dynamic attributes of resilience, and marks a shift away from the focus on vulnerability and hazards, towards a more holistic approach to resilience.

Accepting that resilience requires dynamic adaptation, Bahadur (2015) highlights the need for 'systems thinking' within 'resilience thinking'. A 'systems thinking' approach moves away from a 'static' focus on vulnerabilities towards understanding and developing capacity to adapt to uncertainties. Systems thinking was found to incorporate strategies that enable a community to advance along the continuum of resilience, by either absorbing, adapting or transforming in response to disturbances (Bene, 2012). In relation to the frameworks reviewed, a significant proportion concentrate on the 'absorb' element of resilience (IOTWS, 2007; Twigg, 2009; DFID, 2011; Tulane University, 2012). Twigg's (2009:p8) "Characteristics of a Disaster Resilient Community" is one such framework, which seeks to capture the absorptive aspect of resilience by describing resilient communities' capacity to "absorb potential stresses or destructive forces…. and maintain certain basic functions… or 'bounce back' after an event".

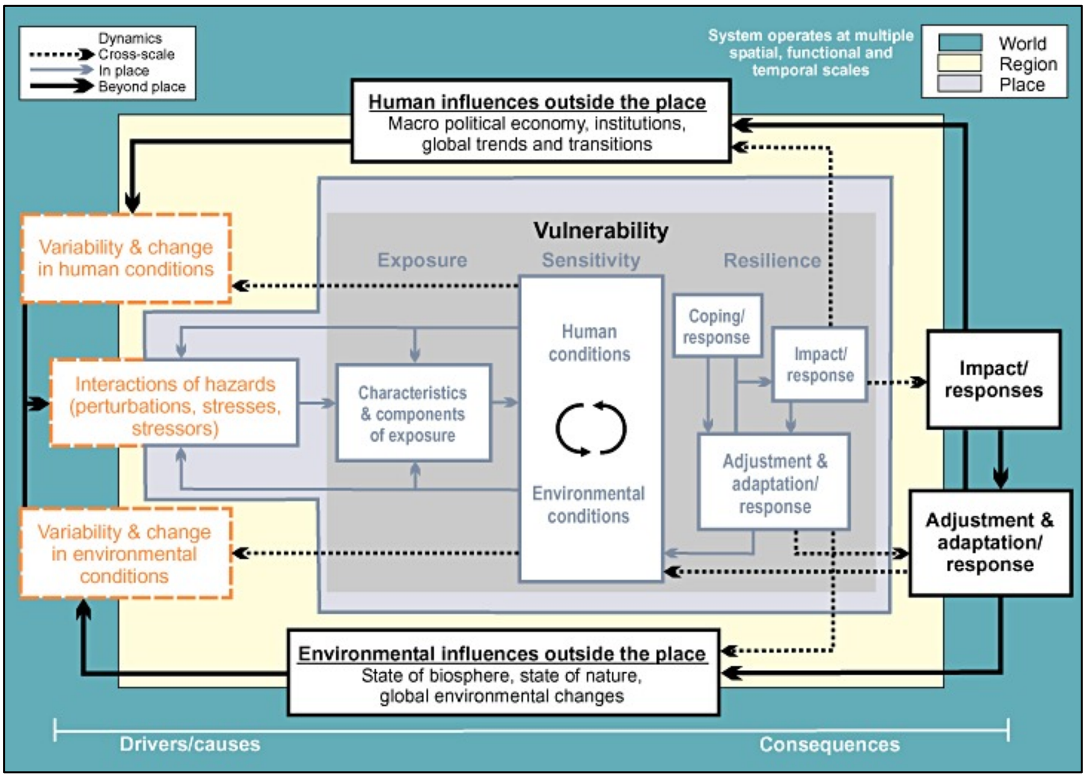


Figure 4.7 Turner's Global Framework. Source: Calgaro and Lloyd, 2008.

On the other hand, the 'Baseline Resilience Indicators for Communities' (BRIC) Model for understanding community resilience, developed by Cutter et al (2010), moves one step further on the continuum of resilience towards ‘adaptive’ capacity. Despite concentrating on system recovery after a shock, it also incorporates medium-term learning and social adaptation in response to changing patterns of risk. Other frameworks within the reviewed data-set (n=33) highlight the importance of adaptive capacity towards building resilience including: IOTWS, 2007; Renschler et al, 2010; Bahadur, 2010; Cutter, 2010; Rockefeller Foundation, 2014; UNDP, 2014; Emergency Management Victoria 2016 (Table 4.2).

An attempt to move further along the continuum of resilience (towards transformation) was devised by Tierney and Bruneau (2007) through their 4Rs framework. Their framework sets out what they view as the four core components of an adaptive and resilient system, namely: robustness; rapidity; redundancy; and resourcefulness. Bruneau refers to ‘robustness’ or persistence as the ability of a system of a system to be able to buffer or “withstand” a disruption whilst still maintaining the essential function of the system. ‘Redundancy’ refers to excess capacity, which enables a system to maintain essential functions despite a disruptive event. ‘Resourcefulness’ (referred to as ‘adaptation’ in other frameworks) refers to a system’s ability to adapt and respond when faced with adversity. This flexibility enables the system to exploit the opportunities that disasters present by positively adapting into a more sustainable trajectory (Tierney and Bruneau, 2007; Alexander, 2012). Finally, ‘rapidity’ refers to the time dimension of the system and the capacity to achieve goals on time. The 4Rs framework makes a valuable contribution to the development of long-term resilience by presenting an understanding of the key system components and dimensions required to develop transformational resilience.

The above examples have largely dealt with the levels of change/adaptation on the continuum of resilience (absorb, adapt and transform), as isolated and excluding capacities (Bene, 2012). Conceptualising resilience in this manner excludes the potential for synergy between the three states of change. For example, absorption or maintenance of the status quo alone is not a desirable end state; whereas, absorptive and adaptive capacity combined can ultimately lead to transformational resilience (Kahler, 2013). Frankenberger (2012:p4) sums up the importance of inter-connectedness between ‘states’ (absorb, adapt, transform) by referring to the capacities and components of resilient systems as “mutually reinforcing”, and existing at “multiple levels”.

4.4.3 Scale of analysis and multiple states

Despite advances in holistic adaptive capacity, the omission of 'scale', as a fundamental aspect of any resilience assessment, has been criticised in the literature (Frankenberger, 2012; emBRACE, 2012a). Overall, the review found that more than half of the subject frameworks partially addressed the issue of scale and only a quarter accounted fully for the issue. The concept of multiple-scales and levels is important within system-based frameworks, as the parameters that affect communities may change from community to community (Renschler et al, 2010; Community Regional Resilience, 2013). Frameworks were found to operate at multiple scales and on a cross-scalar basis (Community Regional Resilience, 2013; Schipper, 2015). Similarly, Garchagen et al (2011) highlight the importance of component shifts in systems, recognising that what happens in a system at one scale can have a knock-on effect at higher or lower scales.

Results from a study on resilient living in Africa by Tufts University Feinstein International Centre revealed that previous attempts to assess resilience focused on an isolated, stable state of "equilibrium". Further studies, such as the example of FAO's sustainable livelihoods research in Uganda in 2016,

The review revealed that previous attempts to assess resilience primarily focused on an isolated, stable state of "equilibrium" (coping). By contrast a limited number of the frameworks focused on the "dynamics" of resilience analysis (DFID, 1999; ADPC, 2006; Miles and Chang, 2011; Community Regional Resilience, 2013; Keating et al, 2016). These frameworks focused on identifying how livelihoods adapt and change over time (rather than one particular state) in response to uncertainty.

A frequently cited example of a framework operating across multiple-scales is the 'Sustainable Livelihoods Framework' shown in Figure 4.8 (DFID, 1999). The framework reflects the interdependency of its components at the human and environmental level. The framework recognises both the need for humans to be dynamic as well as the approach to learning and adaptation (Kollmair et al, 2002). Presenting the SLA approach, the asset pentagon illustrates that communities possess inherent resilience actions that can be drawn upon to allow communities to achieve their own objectives. The assets listed in the framework comprise: human, natural, financial, social and physical. The framework recognises the influence that social (human), institutional and governmental (policies) environments have upon the mobilsation of these assets. The framework was designed on the basis that the relationship between these three players (social, institutional, political) influences the manner in which communities mobilise their assets to build resilience.

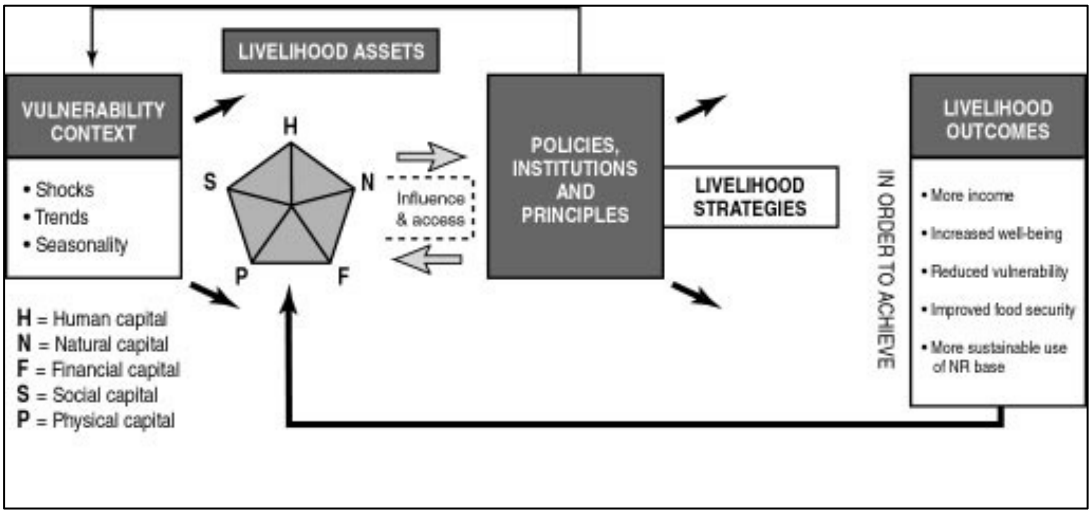


Figure 4.8 Sustainable livelihoods framework (SLA). Source: DFID, 1999.

The preceding section outlined how a meaningful resilience assessment needs to account for cross-scalar (multiple stable states/equilibrium) dynamics between both humans and assets (Barrett and Constas, 2013; Bene, 2013). The section highlighted how resilience is inherently a multi-scalar phenomenon (absorb, adapt, transform) and any effective assessment needs to capture data at each scale concurrently Bene (2013).

4.4.4 Metrics and indicators

Identifying the most appropriate approach and method to capture cross-scalar and dynamic attributes is a common source of tension within framework literature (Bene, 2012; UNDP, 2014; Bahadur, 2015). The choice between qualitative or quantitative indicators was found to be an important consideration when designing an appropriate resilience framework (Bene, 2012). Of the frameworks reviewed, 19/33 adopted some form of mixed-methods approach (Twigg, 2009; Miles and Chang, 2011; NOAA, 2013; Community Regional Resilience, 2013; OXFAM, 2013; Rockefeller Foundation, 2014). The remaining 14/33 were either theoretical (non-empirical) in nature of favoured a wholly qualitative or quantitative approach (Table 4.2). Qualitative indicators in the framework literature are found to be helpful in highlighting characteristics of a resilient community. The flexible nature of qualitative data collection allowed indicators to be grounded within a case-study approach (Twigg, 2009; emBRACE, 2014; emBRACE, 2015b). In this regard, qualitative approaches are suitable in situations where a particular community has been identified, together with a clear conceptualisation and interpretation of resilience (Bene, 2012). Of note, however, is that the specificity attached to this approach reduces its potential transferability (Gall, 2013).

As mentioned previously, Twigg's (2009) "Characteristics of a Disaster Resilient Community" is a pioneering framework that outlines (in broad terms) the core characteristics, components and the enabling environment that shape resilience. Although not fully developed, Twigg's framework provided a foundation for researchers to build upon and refine. The indicators proposed in the framework are both outcome and process orientated, and sit under broad thematic headings, including: risk; funding; preparedness; social and economic capital; information and communication and infrastructure. Overall, Twigg's framework highlights the importance of creating an enabling environment to help build resilience.

Qualitative approaches, such as Twigg's, offer an effective means of assessing the multi-scalar characteristics of resilience. The flexibility of the qualitative approach allows assessment of the human and, often intangible, disaster recovery process. As such, the dynamic approach permits analysis of factors beyond tangible resources and assets, to include intangible resilience characteristics embedded within communities. In doing so, the assessment of a resilient community reflects not only the physical resilient conditions, but also the social factors that help to develop social capital and to mobilise resources and capacities (Ostadtaghizadeh et al, 2015).

In contrast to the above, the quantitative approach to resilience indicators sees resilience as a "set of networked adaptive capacities" (Norris et al, 2008). The framework quantitatively assesses the interplay between the networked capacities. The framework proposes that the effective interplay between these five components/networked capacities (social, economic, community, institutional, environmental) will produce a strategy for long-term disaster readiness. However, Norris's more rigid (quantitative) approach to disaster readiness has been criticised within the literature, as it does not fully account for the dynamic and intangible aspects of community resilience. The literature argues that over-emphasis on the five stand-alone networked capacities, overlooks the intangible subtleties of resilience (emBRACE, 2012b; Sharifi and Yamagata, 2016). In this regard, the multi-faceted character of resilience is limited to a ‘static snapshot of resilience’, focused on resilience outcomes, paying scant attention to the overall resilience process (Kim-Cohen and Turkewitz, 2012; Cutter et al, 2014). In a similar vein, Tyler (2014) argues that a quantitative ‘snapshot’ cannot fairly represent the complexity of resilience. Restricting assessment to a certain point in time fails to recognise that resilience is an *outcome* of a complex *process*, which only presents itself through interaction and development over time (Kim-Cohen and Turkewitz, 2012).

Another frequently-cited quantitative approach is Cutter’s DROP model (2008) (Figure 4.9). As discussed previously (Section 4.4.1), this framework adopts a holistic, systems thinking approach. Cutter views the community as a holistic system, within which vulnerability and resilience are inherent. Uniquely, the framework assesses both inherent resilience (ability to operate during non-disaster times) and adaptive resilience (ability to function during and after a disaster event). Addressing the first form of resilience (inherent) required the collection and analysis of 29 variables using predominantly open-source data. Whilst Cutter’s quantitative methodology is known for its holistic and comprehensive nature, it remains reliant on national data sources. In this regard, Cutter’s selection of quantitative data-sources is criticised in the literature as being ‘out-dated’ (lagging effect), and insensitive to the nuances of the community scale (Ostadtaghizadeh et al, 2015).

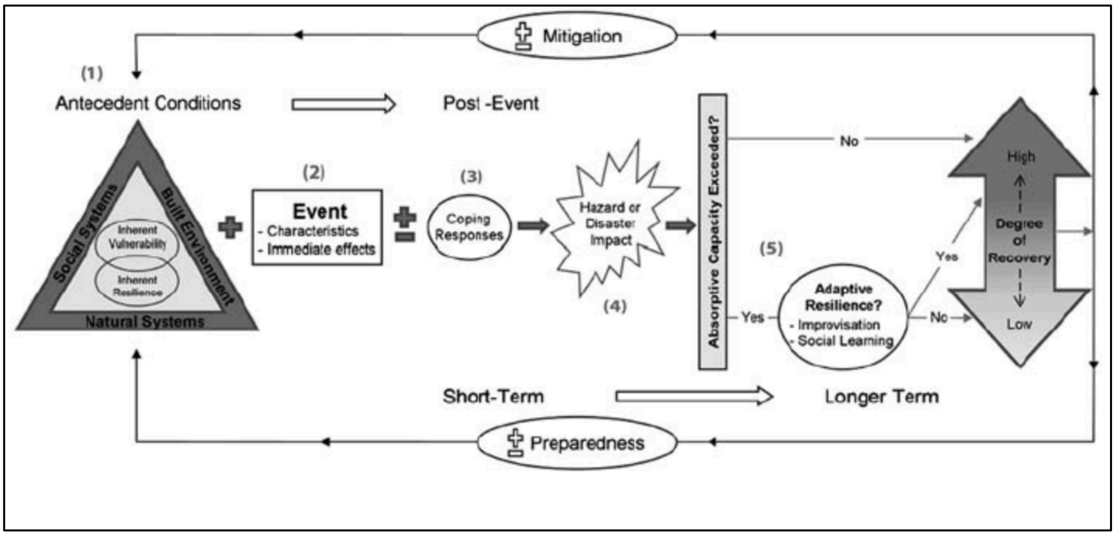


Figure 4.9 Disaster resilience of a place (DROP) model. Source: Cutter et al, 2008.

Table 4.4 below further reflects the difficulty assessing resilience, highlighting that a minority of frameworks reviewed did not attempt to assess the resilience concept empirically. Ultimately, both qualitative and quantitative indicator methods have their merits depending on the context and objective of the resilience framework.

4.5 Key insights going forward

The review of existing frameworks provided insights into the assessment, evaluation and framing of resilience, which in turn underpins the proposed framework. Systems thinking and the multi-dimensional aspect of resilience were threads carried through most of the frameworks. 'Systems thinking' was embraced holistically and meaningfully by some frameworks, whereas others highlighted the core tenets of resilience but only discussed its application briefly in practice.

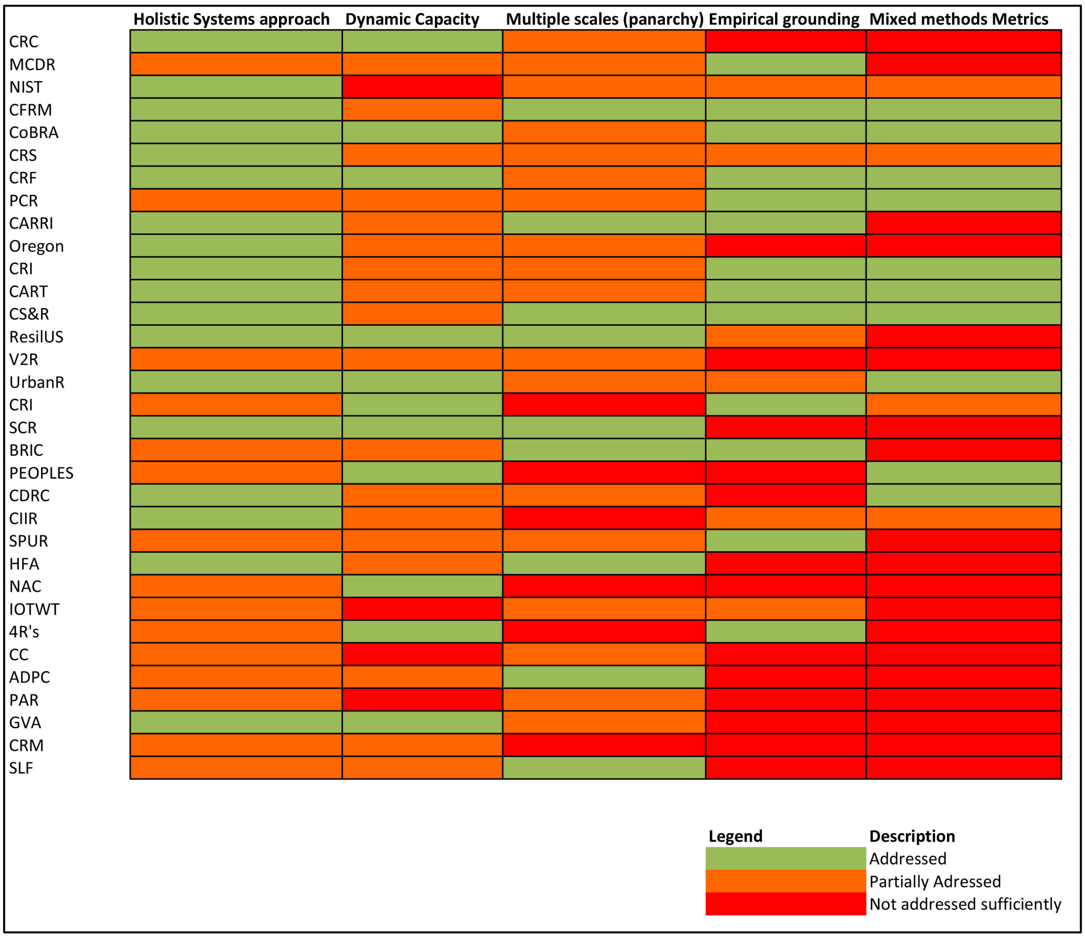
The analysis reveals that holistic 'systems thinking' is embedded within the majority of frameworks, either partially (35 of 77) or fully (42 of 77). However, despite this progress in resilience thinking, hesitancy to engage with the operationalisation of the concept is apparent in both the lack of empirical data and empirically tested frameworks (UNDP,2014; Bahadur, 2015). Overall, a minority of frameworks were found to have no empirical grounding, which raises questions about the practical validity of some extant frameworks. The analysis recognises advances in systems thinking within frameworks and further acknowledges the need to integrate the core tenet of systems thinking more rigorously in new frameworks. Furthermore, capturing and measuring the dynamic characteristics of resilient systems remains a key challenge for the operationalisation of the concept going forward.

Along the continuum of resilience (cope, adapt, transform), it was noted that the frameworks engaged least with the concept of transformational resilience. It was found that frameworks tended to focus on adaptation or absorption, rather than transformation. Furthermore, many focused on these capacities in isolation (short-term), rather than on the process of system adaptation along the continuum of resilience (long-term). Frameworks reflecting transformational resilience, regarded it as the ability to transform into a more sustainable trajectory when the existing situation became unstable (Action Aid, 2014). The absence of attempts to operationalise transformational resilience is arguably a reflection of its emergent nature and ambiguity (Bahadur, 2014). However, there is a clear argument within the literature, defending its potential and which calls for a more robust integration of the relationship between resilience and transformation (Pelling, 2011; Dodman, 2012; Bahadur et al, 2014).

The frameworks under review highlighted the prominence of community or local level resilience frameworks over those at a regional or national level. On the one hand, this is indicative of the practical ease of adopting frameworks and strategies at the more manageable community/local scale (Bahadur, 2013), but equally it reflects the proactive role undertaken by communities and organisations at the local level. While the frameworks acknowledge the importance of harnessing capacity at the community level, the review further recognised the need to complement these actions with cross-scalar governmental actions (Bourton, 2012; UNDP,2012). The urgency to promote cross-scalar actions is catalysed by the need to measure targets and indicators under new inter-governmental frameworks, such as the Sendai Framework for Action on Disaster Risk Reduction (UNDP, 2015). Despite the growing acknowledgement of the importance of cross-scalar dynamics at community and higher levels, 18% of frameworks did not address this issue at all and only 24% addressed the issue gap effectively (Bene, 2012).

Resilience metrics are fraught with difficulties and this has led to a common debate on qualitative versus quantitative assessments (Dodman et al, 2013). An emerging trend within more recent frameworks seeks to bridge this divide by employing both qualitative and quantitative assessments. The review found that 57% of frameworks adopted this mixed-methods approach. There is no prescribed path to balance the qualitative and quantitative objectives in frameworks, however a common theme is apparent, whereby resilience is understood as a sum of assets as well as the process of capacity building. Quantitative methods were predominantly used to assess the former and qualitative approaches to understand the latter. Acceptance and understanding of the merits of both approaches represents a viable precedent for measuring resilience in the future (DFID, 2013). An overview of the analysis discussed throughout this section is presented in Table 4.4.

Table 4.4 Overview of resilient system analysis



4.6 Framework development

Key insights from the previous section identified the need to capture both the assets (inherent) and dynamic processes (learned) of resilience through a mixed-methods approach. Critically, the literature is sceptical of frameworks which claim to assess resilience based on a set of characteristics which have not been empirically grounded (Gall, 2013; Levine, 2014). In light of this observation, this research seeks to further the current assessment of resilience by embedding the framework within an empirical context. In doing so, it is anticipated that emerging contextual and empirical data will enhance the credibility and robustness of its practical resilience assessments (emBRACE, 2015b). To advance this process, a theoretical framework first needs to be devised, that can act as a tool to guide the process of identifying ‘dynamic’ and ‘inherent’ resilience.

4.6.1 Identifying Framework Assets and Components

This section outlines the process of identifying the core components and assets/resources to be included within the proposed thesis framework. This process required further in-depth analysis and coding of the extant framework dataset in NVivo. The first step involved filtering the frameworks down to a more manageable number. As such, the fifteen frameworks which best met or fulfilled the five criteria listed in Table 4.4 only were selected for more detailed analysis. This distilled list of 15 frameworks then underwent multi-stage coding in NVivo.

First, an inductive approach to manual coding (axial-coding) was undertaken to create 'nodes' for the key themes/components which emerged. The process of manually coding in NVivo enabled codes to be assigned to the text and new nodes were created to act as 'storage containers' for the codes (Bazaley, 2007). Nodes were structured in a hierarchy, where a 'parent' node could hold several 'child' nodes within it. To enhance the robustness of the analysis, NVivo's 'query' function was used to conduct word frequency searches within particular nodes. As the analysis progressed, more components/characteristics emerged from the data. Cross-cutting (relevant to more than one node) and overlapping 'child' nodes were subsequently amalgamated to synthesise the number of nodes. The process of refinement distilled the 52 components of resilience into a final set of 28 main components as listed in Table 4.5.

The spread of resilience assets/components evident across the 15 frameworks highlighted a marked difference between frameworks that focused on the accumulation of existing community assets (human, economic, environment, social, physical), as opposed to those which sought to capture dynamic resilient capacities. For example, Table 4.8 below illustrates the core components of resilience identified within existing frameworks. The table highlights the differencing between frameworks based on community assets, such as the 'whole community' framework "Community and Regional Resilience Institute" (CARRI) (2013) or the "Measurement of Community Disaster Resilience" (MCDR), (2016). By contrast, frameworks accounting for wider resilience dynamics evidenced a greater diversity of components. Indeed, examples such as City Resilience Framework (CRF) by Arup (2014) and "A Framework for Community Safety and Resilience: In the Face of Disaster Risk" IFRC (2008) are notable examples, which tried to capture elements of 'inherent' and 'dynamic' resilience.

Table 4.5 NVivo screenshot of 25 main components and their frequency

Name	Sources	References
Environment	1	12
Economic	1	12
Physical infrastructure	1	9
Human	1	8
Critical Reflection	1	1
Learning_	4	4
Monitoring and review	2	2
Communication	2	2
Cohesiveness	1	1
Social Connectedness	13	13
Empowerment	2	2
Adaptive capacity	3	3
Decision-making	1	1
Coping capacity	3	3
Diversity and Flexibillity	2	2
Policy-Change	7	7
Information sharing	3	3
Innovation and resourcefulness	1	1
Leadership	1	1
Mobilise Resources	4	4
Recovery capacity	5	5
Responsibility	1	1
Well-being	4	4
Transformation capacity	1	1
Risk Awareness	8	8
Risk Acceptance	1	1
Mitigation	2	2
Peparedness	5	5

Table 4.6 Coding of resilient components across the 15 frameworks

	CRC (2015)	MCDR (2016)	(NIST) 2015	CFRM (2015)	CoBRA (2014)	CRF (2014)	CARRI (2013)	CRI (2013)
Mitigation	■							■
Preparedeness				■		■		■
Governance		■	■			■		
Learning				■		■		
Critical reflection								
Diversity				■		■		
Mobilisation of resources								
Recovery capacity	■					■		
Adaptive Capacity				■				
Coping/absorb Capacity				■				
Innovation and Transformation				■				
Risk Awareness	■							
Communication								
Responsibility	■							
Social connectedness	■	■	■	■	■	■	■	■
Information sharing	■			■				
Environment	■	■	■	■	■	■	■	
Economic	■	■	■	■	■	■	■	
Infrastrucutre		■	■	■	■	■		■
Human		■	■	■	■	■	■	
Social well being						■		
Data/ Infor Management								
Risk Transfer (insurance)								
Collective decision making								
Cultural			■					
Leadership						■		

Table 4.6 Coding of resilient components across the 15 frameworks

	ResilUS (2011)	BRIC (2010)	PEOPLES (2010)	SPUR (2009)	CDRC (2009)	NAC (2008)	IOTWS (2007)
Mitigation							
Preparedeness					■		■
Governance		■			■		■
Learning		■	■				
Critical reflection							
Diversity							■
Mobilisation of resources				■	■	■	■
Recovery capacity				■			■
Adaptive Capacity			■	■			
Coping/absorb Capacity			■	■	■		
Innovation and Transformation					■		
Risk Awareness		■	■	■	■		■
Communication					■	■	
Responsibility							
Social connectedness	■	■			■	■	■
Information sharing						■	
Environment	■	■	■		■		■
Economic	■	■	■			■	■
Infrastrucutre	■	■	■				
Human		■	■				
Social well being			■	■	■		
Data/ Infor Management							
Risk Transfer (insurance)		■					
Collective decision making						■	
Cultural							
Leadership							

4.6.2 Two phased approach to resilience assessment

The research acknowledges the value of assessing 'inherent' baseline resilience through a pre-disaster capital-based assessment. In addition, the research is cognisant that this research lies within the post-disaster recovery phase. As such, there is a focus on the 'dynamic' capacity of a community to transform and recover via a more sustainable trajectory. This called for the framework to be divided into two phases in order to properly capture the complexity of the resilience concept. To account for the distinction between 'inherent' resilience assets and 'dynamic' resilience capacities, a mixed-methods approach was required. The following sections will discuss the process of capturing both 'inherent' (Phase 1) and 'dynamic' resilience (Phase 2) resilience separately.

Phase 1 captures the 'inherent' or baseline resilience conditions existing within a community. Table 4.5 illustrates the coding framework generated within NVivo, highlighting the core community assets, namely: physical, environment, economic and human. These four assets are representative of existing conditions within the community and, as such, should be treated as background context to be assessed quantitatively. The approach taken draws upon capital-based frameworks, including those by Cutter (2008) and Mayunga (2007). However, the 'social' component, which is viewed as a dynamic attribute, is assessed (qualitatively) together with the other three dynamic components in Phase 2.

Phase 2 seeks to assess the 'dynamic' components of resilience, which a top-down quantitative assessment of resilience may overlook. This phase acknowledges that certain resilience characteristics only present themselves when a community is faced with an adverse event. As such, by focusing on the post-disaster phases, Phase 2 permits an assessment of 'dynamic' resilience capacity. The research considers the addition of a qualitative approach (Phase 2) to be more comprehensive, allowing the qualitative (Phase 2) and quantitative (Phase 1) research to be mutually reinforcing. Table 4.7 below illustrates the NVivo coding structure used to arrive at the four core 'dynamic' components, namely: risk; dynamic resources and capacities; connectedness; and learning. These four 'parent' nodes are presented together with their respective sub-components or 'child' nodes below (Table 4.7). The following sections will discuss the composition of these two phases in more detail.

Table 4.7 Systematic multi-stage analysis in NVivo, arriving at four main component 'themes' (risk; dynamic resources and capacities; connectedness and learning) and four community assets (environment, economic, human, physical).

Name	Sources	References
Environment	12	12
Economic	12	12
Physical infrastructure	9	9
Human	8	8
(1) Risk	0	0
Risk Awareness	8	8
Risk Acceptance	1	1
Mitigation	2	2
Peparedness	5	5
(2) Dynamic Resources and Capacities	0	0
Adaptive capacity	3	3
Decision-making	1	1
Coping capacity	3	3
Diversity and Flexibillity	2	2
Policy-Change	7	7
Information sharing	3	3
Innovation and resourcefulness	1	1
Leadership	1	1
Mobilise Resources	4	4
Recovery capacity	5	5
Responsibility	1	1
Well-being	4	4
Transformation capacity	2	2
(3) Connectedness	0	0
Communication	2	2
Cohesiveness	1	1
Social Connectedness	13	13
Empowerment	2	2
(4) Learning	0	0
Critical Reflection	1	1
Learning	4	4
Monitoring and review	2	2

4.6.3 Assessing 'inherent' resilience (phase 1)

The literature indicates broad consensus on the core community resources/assets, however how to accurately assess or measure these assets remains a contentious subject. The Phase 1 baseline assessment draws on capital-based frameworks such as those by Cutter et al (2008) and Mayunga, 2007. In doing so, Phase 1 is centred on the four 'inherent' resilient resources shown to emerge most prominently by the NVivo framework analysis. Figure 4.10 illustrates the coding weighting (hierarchy of codes identified) of extant frameworks, which found the core assets to be: environment; economics; human; and physical (Table 4.7). The coding weighting was found to be evenly distributed, with the exception of 'environment', which had a slightly higher weighting (Figure 4.10). Overall, there is consensus in the literature that a greater reserve of these assets will lead to improved resilience or, conversely, a deficit can reduce resilience (Mayunga, 2007; IFRC, 2012; Silva and Moreno, 2014). The process of identifying suitable variables to act as proxies for the four assets/resources is outlined in detail below.

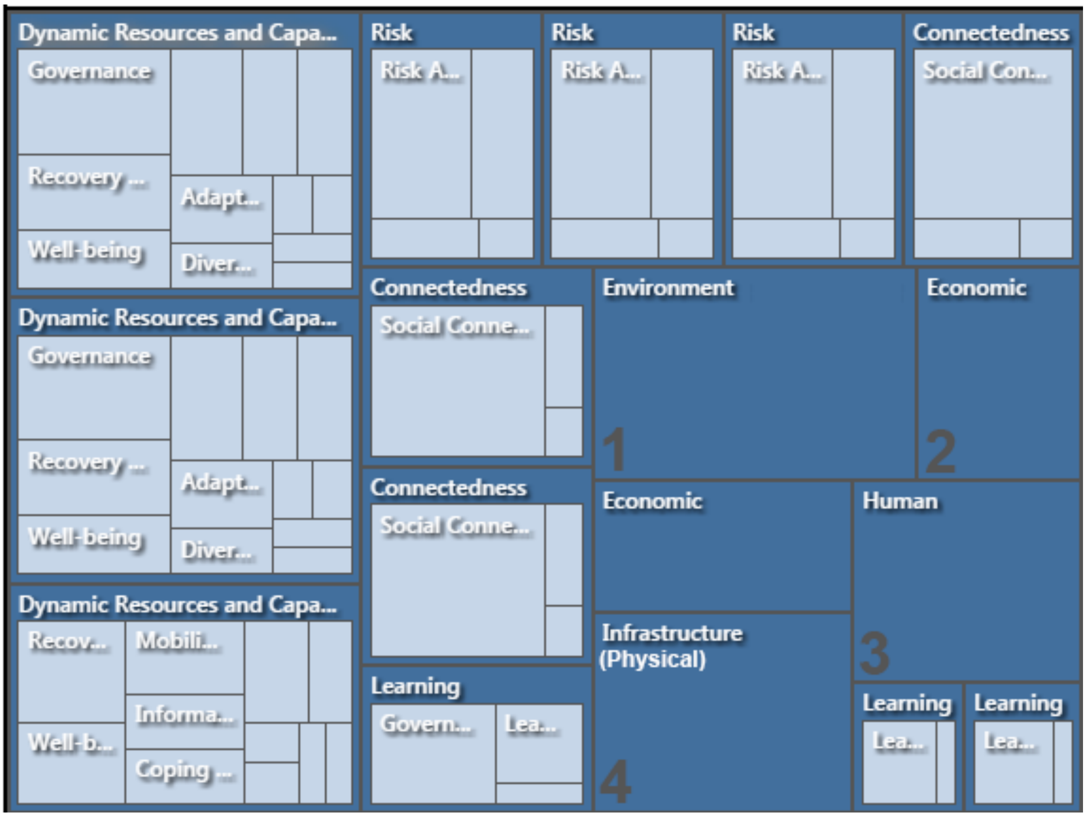


Figure 4.10 NVivo hierarchical coding matrix highlighting framework components and inherent resilience assets/resources, namely: (1) Environment; (2) Economic; (3) Human and (4) Physical.

As discussed in Section 4.4, the DROP model proposed by Cutter, focuses on the inherent resilience of place. This multifaceted interpretation of resilience considers five capitals or assets, namely: economic; infrastructure (Physical); social; community (Human); and institutional. The approach taken by Cutter is largely consistent with the four assets proposed in this Phase 1 assessment, using composite indicators. Composite indicators derived from open-source datasets are believed to be an effective means to capture ‘inherent’ resilience (pre-disaster) (Cutter et al, 2008). The omission of the ‘social’ and ‘institutional’ components for present purposes was deliberate, on the basis that the dynamics and connectedness of these two groups were more appropriately assessed qualitatively in the collective ‘connectedness’ component in Phase 2.

The Phase 1 assessment makes no claim to enhance resilience in itself, however combined with Phase 2 it makes an indirect contribution by identifying areas of low resilience to target intervention. Sole reliance on this form of top-down assessment is criticised within the literature (Bene et al, 2012; Bahadur, 2015), as national data sets can lack the granular detail required for community level studies. However, used in addition to qualitative methods, the quantitative capital-based approach can inform an assessment of baseline resilience. Acknowledging the limitations of a quantitatively biased approach, the proposed Phase 1 approach complements Phase 2, ensuring a more comprehensive assessment of the complex resilience concept.

4.6.4 Deductive variable selection (Phase 1)

The next step in framework development involved the identification of variables that are “relevant, robust, and representative” of the four community assets and components (Cutter et al, 2010:p51). A review of existing databases (Appendix 1) indicated that, there is no consensus within the literature on an accepted set of standardised disaster resilience indicators. Accordingly, in respect of the four ‘inherent’ resilience assets (Phase 1), a deductive method was adopted to identify variables. The process of variable selection relies predominantly on existing variables from extant frameworks. Cutter et al (2010) warn that limiting resilience to an absolute state would neglect the complexity of the resilience concept. As such, the framework identifies a number of variables which act as proxies for each of the four assets (Schneiderbauer and Ehrlich, 2006; Cutter et al, 2008). In line with the approach taken by Cutter et al’s (2008) process of variable selection, variables were selected in respect of two main considerations. First, they were underpinned by existing framework literature; and second, variable data could be sourced from publically available official datasets, thereby enhancing access and transferability. Context variances, together with policy differences and the availability of data sets, meant that a broader approach to variables was undertaken while still maintaining the philosophy of the assets/capital approach. Emphasis was placed on finding and evaluating existing national census or statistical surveys at the administrative community level, which could be used to conduct an inherent resilience assessment at the community level with a focus on flooding impacts.

The research is cognisant of the fact that, for the most part, disaster data are not held centrally and considerable effort was placed in collating publically available data for each variable. The readily available public data permitted a certain amount of flexibility and the research sought, where possible, to use the same variables for each case- study, however slight variations were inevitable. These differences in case-study variables are highlighted in bold in Appendix 2. The majority of selected variables were derived from the UK Census data, however others were obtained from County Council databases, flood maps, deprivation indexes and land cover maps (Appendix 2). Taking England as an example, a synthesised list of 21 variables and their literature underpinnings are listed in Table 4.8.

4.6.5 Phase 1 variables

'Physical' resilience refers to the influence of the built environment and critical infrastructure on a community's ability to recover. For example, proximity to services including: hospitals, fire station, police stations were found to provide an additional layer of resilience (Cutter et al, 2008). Finally, limiting exposure of housing, businesses and critical infrastructure in a disaster area can increase resilience (by reducing vulnerability) (Mileti, 1999; Ronan and Johnston, 2005; Lindley et al, 2011).

Table 4.8a Example of Northern Ireland indicators of 'Physical' resilience asset.

Community Asset:	**Variable Description**	**Variable assessment**	**Data source**	**Literature**
1.Physical resource				
Exposure	Increased exposure from river, surface water and tidal flooding reduces the resilience of the community	Flood risk from rivers AEP.	Rivers Agency historical flood zones (DfI)*1	IOTWS, 2007; Twigg, 2009; Lindley et al, 2011
		Flood risk from surface water AEP.	Rivers Agency historical flood zones (DfI) *1	IOTWS, 2007; Twigg, 2009; Lindley et al, 2011
		Tidal flood risk AEP.	Rivers Agency historical flood zones (DfI) *1	IOTWS, 2007; Twigg, 2009; Lindley et al, 2011
Access to services	Greater access to services/resources increases the ability of community to recover quickly.	**Proximity to services score**	Income: Multiple Deprivation Measure 2017 *2	Cutter et al, 2008; Cutter, 2010; Arup and Rockefeller, 2014
		% of people working further than 30k from home	UK Census, 2011 *3	Tierney 2009; Cutter, 2010; Lindley et al, 2011.

The thesis aligns itself with the socio-ecological approach to transformational resilience discussed in Chapter 3. Accordingly, the impact of disaster events on the environment can have a negative effect on resilience due to the instability caused and its knock-on effects on wider society. For example, development in flood plains and the amount of green open-space (absorbs flood water) can contribute to increased flood vulnerability and reduced community resilience (Lindley and O'Neill, 2013). Acknowledging the “all hazards” approach to this thesis, it was decided that this environmental component merited inclusion.

Table 4.8b Example of Northern Ireland indicators of ‘Environmental’ resilience asset.

Community Asset:	Variable description	Variable assessment	Data source	Literature
2. Environmental asset				
Environmental exposure	Permeable land reduces the impact of flooding.	**Shortfall of playing pitches*7**	Sport Northern Ireland’s (SNI) *4	Mayunga, 2007; Twigg, 2009; Arup, 2010; Bahadur, 2010
		No. of public parks in 1 mile radius	Belfast city council/ Fermanagh and Omagh District Council ***5**	Mayunga, 2007; Twigg, 2009; Arup, 2010; Bahadur, 2010
	Assessment of physical environment including vulnerability to flooding.	**Living Environment domain**	Environment: Model- Multiple Deprivation Measure 2017 ***2**	Twigg, 2009; Lindley et al, 2011

The ‘economic’ resource is illustrative of the economic stability of a community. Extant frameworks have shown that communities with high home ownership, low unemployment and economic diversity, are in a better position to recover quickly from a disaster event (Adger, 2000; Tierney et al, 2001; Cutter et al, 2008; Norris et al, 2008; Lindley et al, 2011).

Table 4.8c Example of Northern Ireland indicators of ‘Economic’ resilience asset.

Community Asset:	Variable Description	Variable Assessment	Data source	Literature
3. Economic resource				
Livelihood stability	Economic stability enhances a community’s ability to undertake resilience strategies.	% of working age that is employed	Census, 2011	Mileti, 1999; Cutter 2010; Sherrieb et al, 2010; Burton, 2015
		% unemployed	Census, 2011	Mileti, 1999; Cutter 2010; Sherrieb et al, 2010; Burton, 2015
Income	Income and employment levels are indicative of financial resilience.	**Income Deprivation domain**	Income Model- Multiple Deprivation Measure 2017 ***4**	Mileti, 1999; Berkes and Campanella, 2006; Cutter 2010; Sherrieb et al, 2010; Burton, 2015
		Employment Deprivation domain	Employment Model- Multiple Deprivation Measure 2017 ***4**	Mileti, 1999; Berkes and Campanella, 2006; Cutter 2010; Sherrieb et al, 2010; Burton, 2015

Tenure	Higher rates of homeownership is indicative of financial resilience.	% households owner occupier	Census, 2011	Norris et al, 2008; Burton, 2015

The ‘human’ asset refers to the social demographic existing within the community. For example, extant frameworks suggest that communities with high educational attainment, low crime and good health are likely to demonstrate a greater capacity to adapt and cope during a disruption.

Table 4.8d Example of Northern Ireland indicators of ‘Human’ resilience asset.

Community Asset:	**Variable description**	**Variable assessment**	**Data source**	**Literature**
4. Human Resource				
Community capacity	Young, active and healthy communities are characteristics associated with resilient communities. Access to a vehicle further enhances a community’s resilience capacity.	% of population over the age of 65	UK Census 2011	Morrow, 2008; Burton, 2015
		% of population <15	UK Census 2011	Morrow, 2008; Burton, 2015
		% of population stated general health was good	UK Census 2011	Heinz center, 2002; Burton, 2015
Education	Knowledge and skills enable a community to adapt to uncertainty.	% of college degree or higher % of college degree or higher (level 4 or above)	UK Census 2011	Norris et al, 2008; Morrow, 2008; Burton, 2015
		% of population with no or low qualifications (L1)	UK Census 2011	Norris et al, 2008; Morrow, 2008; Burton, 2015
		Education, skills and training rank	Multiple Deprivation Measure 2017 ***4**	Norris et al, 2008; Morrow, 2008; Burton, 2015
Social capital	Social capital is evidenced to produce synergistic resilience action. This is referred to in the literature as the ‘social infrastructure’ needed to effectively mobilise essential resources and capacities in a timely manner.	**Crime and disorder rank**	Multiple Deprivation Measure 2017 ***4**	Sherrieb et al, 2010
	High voting rate is indicative of a tight-knit community, willing to work collaboratively with community residents.	**% voter participation in last election**	Electoral Office for Northern Ireland (2013) *6	Cutter et al, 2008; Sherrieb et al, 2010.

Local knowledge	Local knowledge is higher in established communities.	% from outside the area	UK Census 2011	Cutter et al, 2008; Burton, 2015

4.7 Identifying 'dynamic' resilience (Phase 2)

In relation to the 'dynamic' capacity of resilience, analysis of the 28 components revealed the emergence of four core themes/components from the extant frameworks (Table 4.8 above). These four components comprise the 'dynamic' capacity of resilience, namely: risk; dynamic resources and capacities; connectedness and learning. Further sub-themes or 'child' nodes were subsequently grouped under these four core components (parents). Figure 4.11 below illustrates the weighting of the sub-components (child nodes) under the core components (parent nodes). The lower level coding in the 'learning' component reveals a gap in extant frameworks, which fail to capture the full transformational (betterment through learning) capacity of communities.

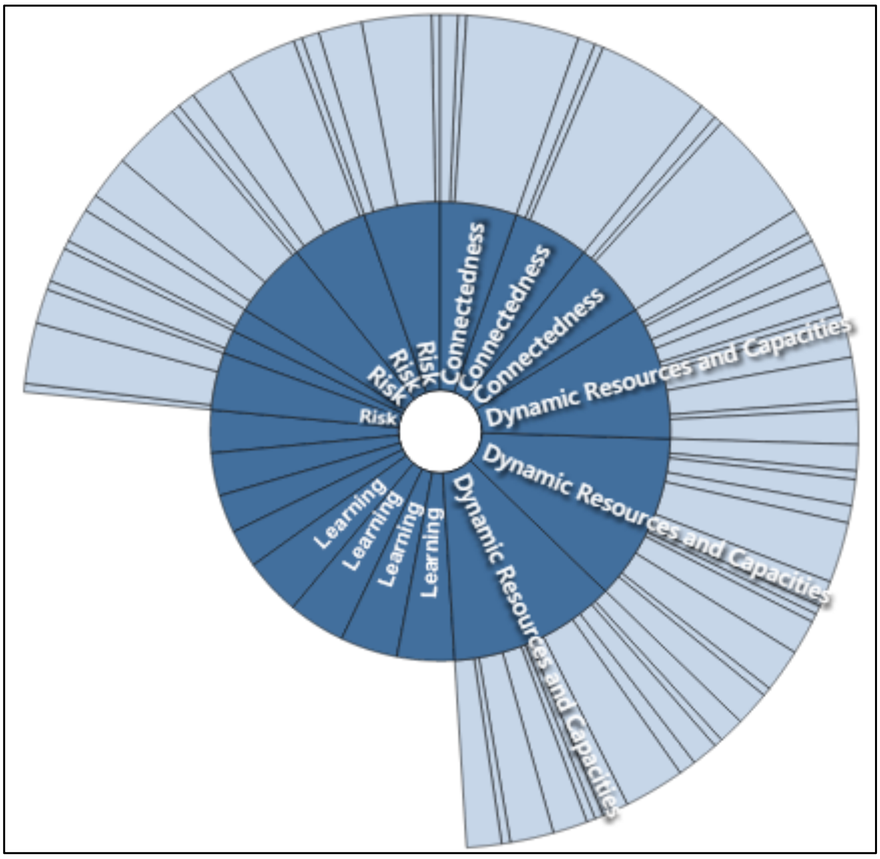


Figure 4.11 Weighted overview of the four resilience components: risk; dynamic resources and capacities; connectedness and learning.

Informed by the framework review (x of 33), the following section outlines a review of the four constituent components, which together were found to represent 'dynamic' resilience within extant frameworks, namely: risk; dynamic resources and capacities; connectedness and learning. Given the lack of useable data within existing European and UK disaster databases (Appendix 1), further analysis was undertaken on the four 'dynamic' nodes in NVivo, to identify sub-components and proxy indicators for these components. By way of example, Table 4.9 outlines the NVivo coding structure for the 'risk' component. It highlights how the risk 'parent' node comprises two potential sub-components, namely: risk awareness and risk acceptance. Further, the coding details how certain indicators were shown to have a positive influence on 'risk awareness', namely: education, risk knowledge; and risk understanding.

Table 4.9 NVivo coding structure for 'risk' component.

Nodes

Name	Sources
Risk	
Risk Awareness	8
Risk assessment	8
Early warning system	3
Access risk information	8
Knowledge of flood maps	2
Risk Acceptance	8
Peparedness	4
Risk Transfer	5
Flood Resileince Groups	6
Risk management plans	7

4.7.1 Component 1: Risk

The reviews of extant frameworks served to reaffirm the importance of the four core components of 'dynamic' resilience. Risk emerged as a theme across all frameworks, however the UN/ISDR "Disaster Resilience Scorecard for cities" (2014) present it from a community-centred perspective, analysing how a community understands, monitors and assesses risk. The framework highlights the importance of risk awareness and understanding as a critical first step in resilience development. Similarly, the International Federation of Red Cross (IFRC) (2008) developed a framework to assess and build community level resilience. Centred on four key resilience areas, the framework advocates the need to enhance 'knowledge' of risk (and health), arguing that misinterpretation of risk can impede a community's ability to mitigate against it. Once risk understanding and acceptance is established, attention then turns to actions designed to maintain the status quo in times of disaster. Further, risk acceptance is shown to lead to improved risk reduction strategies, such as the development of early warning systems and risk management plans (Paton et al, 2001; Mayunga, 2007). It was found that as risk understanding improved, risk responsibility developed in parallel (Paton et al, 2001). A key takeaway from this framework is that a community's perception of hazards and its associated relationship to risk is a fundamental foundation of community resilience (Alexander, 2012). While top-down assessments typically include risk assessments, few frameworks were found to address hazard risk from a community's perspective. As such, the thesis framework endeavors to address and develop risk awareness and understanding as an integral foundation to improving resilience.

4.7.2 Component 2: Dynamic resources and capacities

Building upon Norris's (2008) principles of adaptive capacity, Tierney and Bruneau (2007) developed the 4R's framework of resilience. The framework articulates four properties of resilient systems by incrementally building upon existing adaptive capacity. The framework proposes four components to strengthen adaptive capacity, namely: robustness; rapidity; redundancy; and resourcefulness. Robustness (absorb) refers to the inherent strength or ability of the system to resist uncertainty. In doing so, communities are able to cope and maintain essential functions through self-organisation (O'Rourke, 2008; Twigg, 2009). Redundancy (adapt) enables the system to adapt by using alternative resources when faced with uncertainty (Ostrom, 2009; Arup, 2010; Pasteur, 2011). Resourcefulness enhances the level of adaptation, enabling communities to mobilise resources and capacities when needed. These capacities can include flexibility, problem-solving, self-efficacy and innovation (Bahadur, 2010; 2011; Cutter, 2010 Pasteur, 2011). This has been referred to in the literature as the ability to transform. Other frameworks employ the principles of adaptive systems through their incorporation of 'absorb, adapt and transform' along the continuum of resilience (Frankenberger et al, 2013; Constas and Barret, 2013). However, the 4R's is pioneering in its inclusion of the time element of 'rapidity', referring to the speed at which normality can be regained by achieving recovery goals in a timely manner. The two framework examples discussed in this section highlight the importance of promoting dynamic adaptive capacity within resilient systems. Failure to embrace this change will limit a community's potential to adapt and transform into a more sustainable trajectory.

4.7.3 Component 3: Connectedness

The connectedness of a community is integral to the successful mobilisation of resources and capacities. This component seeks to exploit the social capital within a community through the development of bonding, bridging and linking network ties (Mayunga, 2007; Cutter, 2010). The "community resilience toolkit" (2015) from the Torrens Resilience Institute demonstrates the importance of a robust 'social infrastructure'. The framework develops an understanding of the role of dense social networks, enabling communities to mobilise resources and capacities more readily. The literature indicates that evidence of self-organisation and leadership is an indicator of community empowerment (Twigg, 2009; Bahadur et al, 2010). In addition, cohesive communities, which engage and collaborate during adversity, tend to exhibit higher levels of trust and sense of belonging (IOTWS, 2007; Paton, 2008; Bahadur, 2010; Pelling, 2011). As such, the framework acknowledges that unconnected communities are less likely to have access to the resources and capacities needed to recover in a timely manner.

4.7.4 Component 4: Learning

Frameworks which adopt a 'transformational' interpretation of resilience view resilience as an iterative 'process' of development, building resilience through experimentation and the implementation of lessons learned (Bene, 2012). In particular, ODI's "Characterisation of adaptive capacity" framework focused on the importance of 'learning' by sharing information and knowledge. Located at the community level, the framework has the ability to understand adaptive capacity at the local level, which can then be supported more widely at a regional/national level. The framework views resilience as a process, seeking to advance resilience actions incrementally. In particular, the framework develops an enabling environment to foster transformational resilience through its encouragement of resourceful and flexible adaptation. Critically, lessons learned are acted upon to inform long-term resilience actions. Central to this 'learning' aspect is knowledge and information dissemination in support of adaptation activities.

A more recent framework, acknowledging the importance of lessons learned, is the "City Resilience Framework" (2014) by the Rockefeller Foundation. The framework aims to articulate city resilience founded on past learning through an extensive literature review, case-studies and fieldwork. The systems approach includes both the physical and social attributes of a resilient city through its consideration of socially driven processes as ‘inherent’ components of the system. The approach adopts a learning element, which seeks to develop new skills and further highlights how ‘disaster learning’ can enhance a community’s ability to cope with new challenges (Rockefeller Foundation, 2014). Literature argues that the development of new practices, policy change and constant innovation are the cornerstones of transformational resilience (Bahadur, 2010; Pasteur, 2011; Zaida and Pelling, 2011).

The component analysis above outlined the selection of the four most pertinent components for capturing dynamic resilience. Further, it identified proxy indicators that are “relevant and representative” of the four ‘dynamic’ components (Cutter et al, 2010:p51). However, these identified indicators in NVivo are not set in stone, rather they will act as a form of hypothesis to be tested in the empirical work. Further, the research accepts that there is no ‘one size fits all approach’ to resilience and appropriate indicators will depend upon the context in which the framework is grounded. The intention of Table 4.10 is to act as a scaffold to assist empirical analysis, following data collection. Indeed, the research expects that application of the framework will reveal further indicators that can be added to those outlined in Table 4.10 below.

Table 4.10a Outline of ‘risk’ component indicators and their corresponding link to literature.

Component	Description	Sub-components and cross over indicators	Literature
Risk			
Risk Awareness	Awareness of potential risk and actions to mitigate against perceived residual risk	-Education, -Awareness -Knowledge -Risk understanding	Paton et al, (2001); IFRC, (2008); Mayunga, (2007)
Risk acceptance	Acknowledgement of risk and willingness to employ strategies against it	-Disaster experience -Risk reduction strategies -Responsibility -Early warning system -Risk management plans	Paton et al, (2001); Mayunga (2007)

Table 4.10b Outline of ‘resources and capacities’ component indicators and their corresponding link to literature.

Dynamic Resources and Capacities			
Absorb	Withstand external pressures and disturbances without loss of function.	-Bonding social-capital -Self-organisation -Preparedness -Robust -Risk transfer -Informal safety nets	IOTWS, 2007; O’Rourke, (2008); UNISDR, (2008); Twigg, (2009); Bahadur, (2010).
Adapt	Undergoing change in order to prepare for and negate the effects of risk	-Bridging social-capital -Innovative -Flexibility	Pasteur, (2011); Arup, (2010); Twigg, (2009);

		-Problem solve and act -Self-organisation -Self-efficacy -Financial capital mobilisation -Diversity of capacities -Learning and innovation -Risk transfer	Ostrom, (2009); Hofler, (2014); Bahadur, (2010); O'Rourke, (2008); Pasteur, (2010); Arup, (2010); Cutter, (2010).
Transform	The ability to adapt and change into a more sustainable trajectory	-Bridging and Linking social capital -Innovative -Resourceful Self-organisation -Self-efficacy -Establish priorities -Competent communication networks -Up-skilling -Flexible Governance -Use of infrastructure	O'Rourke, (2008); Twigg, (2009); Arup, (2010); Pasteur, (2010); Cutter, (2010); Hofler, (2014).

Table 4.10c Outline of 'connectedness' component indicators and their corresponding link to literature.

Connectedness			
Information and communication	The transfer of information assisting risk reduction objectives across social and policy domains/communities.	-Information sharing -Access to information	Mayunga, (2007);
Empowerment	Enabling communities to do more for themselves.	-Capacity to re-organise -Self-efficacy -Competence -Leadership -Shared decision making -Organisational capacities	Bahadur et al, (2010); Twigg, (2009); Cutter, (2010).
Cohesive community	The positive sense of community. This is closely linked with place attachment, belonging and densely networked communities.	-Bonding, bridging and linking social capital. -Sense of place -Cooperation -Participation -Belonging -Collaboration -Social cohesion -Trust	Walker et al (2004); Arup and Rockefeller Foundation (2014); Bahadur, (2010); Mayunga, (2007); Twigg, (2009). IOTWS, (2007); Schrieb, (2010); Paton et al, (2001); Zaida and Pelling (2011).

Table 4.10d Outline of 'connectedness' component indicators and their corresponding link to literature.

Learning			
Critical reflection	Questioning of actions by the community and Government to reduce risk and considering actions to improve.	-Education -Awareness -Knowledge -Diversity	Zaida and Pelling (2011); Paton et al, (2001) ODI, 2010 Bene,2012.

Innovation and experimentation	Innovative risk management strategies, utilising new knowledge and integrating new technologies. The willingness to try new approaches to reduce risk	-Adaptive capacity; -Coping capacity; -Education; -Awareness; -Knowledge, resources.	Twigg (2009); Zaida and Pelling (2011); Arup, 2014.
Monitoring and Review	Assess and review risks after a disaster. Build on past experiences and integrate with new knowledge, in a way that allows you to build back better.	-Assess, manage and monitor risks. - Build back better - Act on lessons learned	IFRC, (2008); Pasteur, (2011); Bahadur, (2010).
Policy change	The ability of policy to adapt and change in response to changing needs and environments.	Effective and flexible governance structures	Bahadur, (2010); Cutter, (2010); Pasteur, (2011); Twigg, (2009).

4.8 Framework outline

The review of frameworks throughout this chapter generated key insights informing the design of a framework appropriate to the context and objectives of this research. Further, it informed the selection of fundamental components of resilience and indicators of resilience appropriate to the research (Section 4.6-4.7). The objective of the proposed framework (Figure 4.12) is to act as a guide towards the holistic identification of indicators of community resilience (both inherent and dynamic). As outlined in Chapter 3, disaster communities in the context of this thesis are understood as a group of people who share a common interest or goal, but are not necessarily bounded by physical geography. The following section outlines the proposed theoretical framework and its key components, which inform and guide the empirical phase of this research.

The framework comprises a two-phased mixed methods approach. Phase 1 focuses on quantitative, inherent resilience (See Section 4.6.2) and Phase 2 on the dynamic capacity of communities. Phase 1 represents the contextual background or inherent resilience within the community and is assessed through four resources, namely: human; economic; environmental; and physical. As discussed in Section 4.6, these inherent assets are recognised as influencing the level of potential resilience in a community, and vary depending on conditions within each community. Hence, to facilitate transferability of the framework and to focus the research on community resilience, it was decided to position these issues outside the framework and employ a deductive and quantitative method to derive the contextual resilience of each community through these four assets (Table 4.10).

Phase 2 of the framework comprises the four ‘dynamic’ resilience components, namely: hazard risk; connectedness; dynamic resources and capacities and learning (Figure 4.12). In respect of its constituent components, Phase 2 begins by highlighting the importance of ‘risk’ (1) awareness and acceptance as the first step in any resilience building framework. The framework aims to capture the dynamic attributes of a resilient system and, as such, allows for the capturing of dynamic interactions of community resilience through the interplay of ‘resources and capacities’ (2) and the ‘connectedness’ of the community. In line with transformational thinking, this dynamic interplay between resources and capacities enables the community to absorb change (Nelson et al, 2007), adapt (Twigg, 2009), or reorganise and transform (including policy) (Folke, 2006); in the face of adversity. The application of these dynamic components is enhanced by the extent of connectedness of the system and also, critically, by the ‘learning’ component of the system. Further, the proposed framework acknowledges that capturing transformative capacity is not without its challenges and explains the lack of attempts to analyse and measure this parameter (Oxfam, 2016).

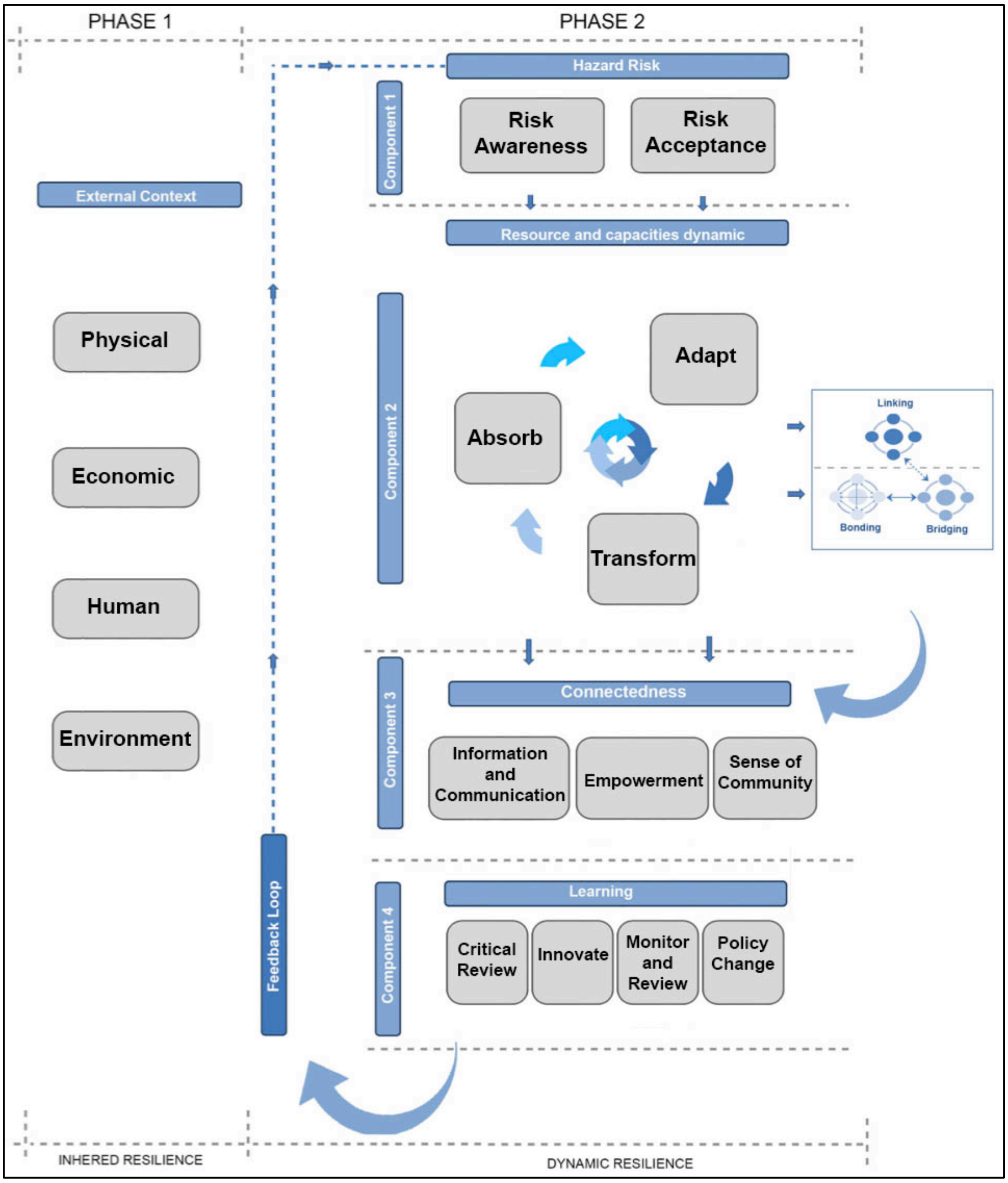


Figure 4.12 Proposed theoretical framework.

Ultimately, it is anticipated that this framework has the potential to capture the dynamic properties of resilient systems and represents a guiding tool for enabling and operationalising resilience at the community level. The broad range of contextualised indicators used in Phase 2 is reflective of the complex and diverse nature of the resilience concept. As such, it is expected that the framework will elicit a range of resilience indicators reflecting the diversity of the system or context in which they are situated. The following Chapter Five outlines the design methodology proposed to populate the framework, capturing both the inherent and dynamic resilient properties of a resilient community.

Chapter Five

Methodology

5.1 Introduction

Chapters 2 and 3 have identified gaps in the existing knowledge base and, together, they set the context for the empirical aspect of this study. Underpinned by an analysis of existing frameworks, Chapter 4 developed a theoretical resilience framework to both assess and assist in the operationalisation of community resilience (Figure 5.1), thus meeting objective 3 of this thesis. In this regard, the proposed theoretically anchored framework serves as a hypothesis to be tested and validated. This chapter centres on the process of populating this framework, by allowing for the extraction of contextualised resilience indicators that determine both the effectiveness and viability of the framework.

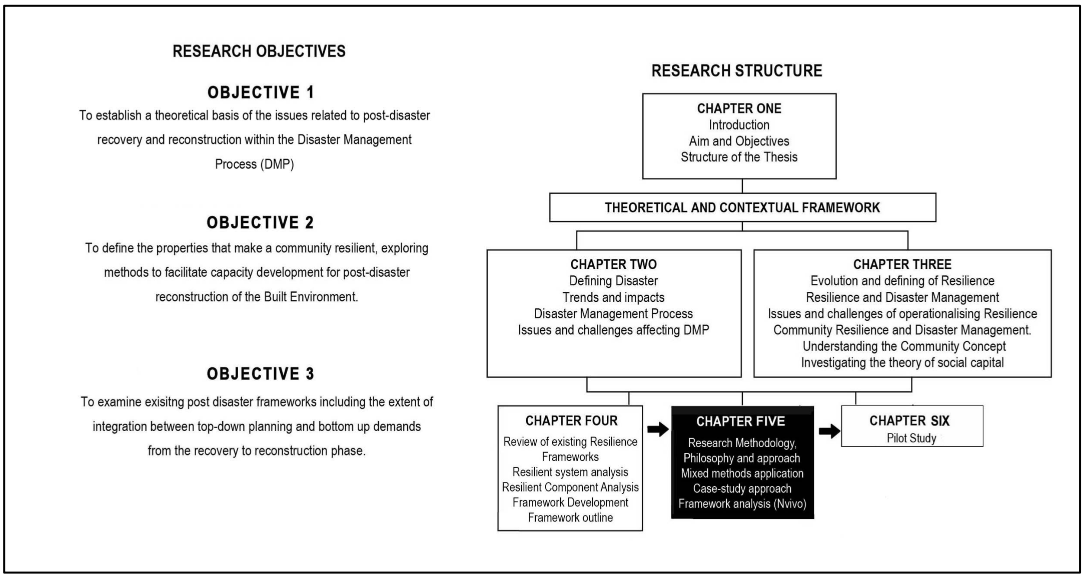


Figure 5.1 Position of Chapter 5 within the thesis structure.

In order to meet the objectives outlined at the outset of the thesis (Section 1.3), a methodological framework was adopted to guide progress through the operationalisation of the framework (Somekh and Lewin, 2005). The hierarchical model of research methodology proposed by Kagioglou et al (1998) was used to highlight the main arguments and justify the selection of an appropriate research approach, research methods and research philosophy (Figure 5.2). The ‘nested’ model illustrates the framework of methods which drove/dictated the wider research approach and research philosophy.

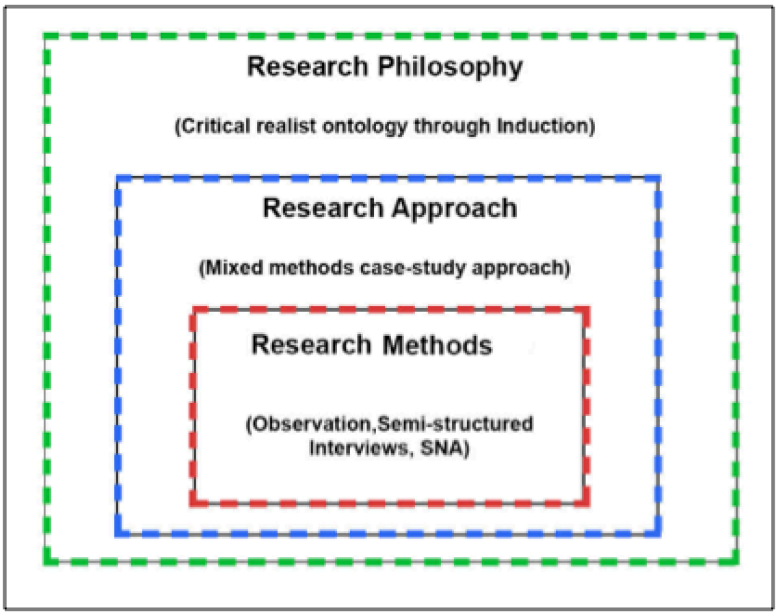


Figure 5.2 Hierarchical model of research methodology within this thesis, adapted from Kagioglou et al (1998).

Accordingly, the chapter first outlines the mixed methods approach used to guide the research approach and research philosophy (Section 5.2). Primary and secondary methods were selected to populate the quantitative (Phase 1) and qualitative (Phase 2) (Section 5.2.1) aspects of the thesis framework. Section 5.3 follows by presenting the case-study methodology employed to empirically address the fourth objective of this thesis, namely the development of a framework to bridge the gap between immediate recovery and long-term disaster reconstruction. Section 5.4 highlights the importance of social networks in disaster recovery through a Social Network Analysis (SNA) of both ‘physical’ and ‘virtual’ communities. Section 5.5 explains the “framework method” of data analysis using the Qualitative Data Analysis (QDA) software NVivo. This systematic approach to data analysis assisted the interpretation and synthesis of resilience indicators. Section 5.6 follows by outlining steps taken to ensure that research integrity and ethics were followed throughout the study. The chapter closes with a conclusion in Section 5.9.

5.2 Research approach and research philosophy

Chapter 1 outlined how a mixed methods approach was chosen to guide the direction of the research. Viewing the quantitative and qualitative elements as complementary, rather than conflicting, the mixed methods approach reflects the complexity of current disaster research. A mixed methods approach questions the meaning of ‘subjective’ and ‘objective’ in qualitative and quantitative disaster research. Contrary to extant research, this thesis does not assume that only positivist (quantitative) research can be objective, nor does it assume that qualitative and subjective research is less robust (Philip, 1998). On the contrary, the research dismisses the subjectivity-objectivity argument, arguing that value judgement plays a role in the research process (Holt-Jensen, 1988). Further, due to complexities inherent in data collection, no research is ‘entirely objective and error free’ (Philip, 1998). The research acknowledges that subjectivity plays a role in ‘purist’ qualitative or quantitative research and, as such, the two approaches are not mutually exclusive. Accordingly, any attempt at a purely objective (quantitative) approach is also not entirely achievable. In this regard the research seeks to move beyond the qualitative-quantitative divide, selecting research methods with due consideration for their weaknesses relative to the specific research goals.

Natural disasters by their nature are extreme events and often involve disruption and stress. Given the sensitive nature of the subject matter, it is of particular importance that the study remains objective. In this regard, the (impartial) viewpoint of professionals and experts alike will play a crucial role during the empirical aspects of this research. The mixed approach adopted offers a broader (subjective) understanding of community resilience that moves beyond a quantitative ‘snapshot’ assessment, to include the underlying mechanisms that operationalise the concept.

The philosophical stance of critical realism (CR) complements the data-driven, methodologically grounded approach to Framework development outlined above. Sympathetic to the nature of the research objectives, the data-driven approach underpins the methodological pragmatism of this research. In this regards, the CR approach complements the intention to understand the subjective (qualitative) nature of human resilience during a disaster, whilst also accounting for the objective (quantitative) resilience reality. Application of the theoretical Framework through a critical realist lens, enables the identification of causal mechanisms driving disaster resilience activities, but also maintains an objective reality. Further, this ‘objective subjectivity’ or ‘qualitative-quantitative dualism’ (Philips, 1997) helps to identify tangible and intangible resilience indicators.

This methodological pragmatism helps to reconcile some of the entrenched differences between qualitative and quantitative research. Hence, the two-pronged, mixed methods approach (Figure 5.3)[5] to assessing resilience through a qualitative (Phase 1) and quantitative (Phase 2) process is the most appropriate fit for this thesis.

5.2.1 Application of mixed methods approach to framework

The quantitative phase (Phase 1 in Figure 5.3), concerns an assessment of baseline resilience through resilience variables extracted from publically available data. Phase 1 was designed to acquire appropriate robust information surrounding the socio-demographic profile of the selected case-study communities. Based on publically available datasets, this approach was both time and resource efficient, and allowed for the assessment of existing baseline resilience of at-risk communities. The purpose of the Phase 1 is limited to serving as a baseline of existing community assets (human, economic, environmental, physical) against which the Phase 2 empirical indicators derived from the case-study data can be reflected.

Accordingly, Phase 2 enhances the robustness of indicators by grounding the selection of indicators (derived from the theoretical framework components in Chapter 4) within the empirical case-studies. Chapter 3 articulated that resilience is best realised after a disaster has occurred, highlighting the importance of this phase, which instead of measuring resilience in isolation, reflects the empirically grounded indicators against a priori indicators in the framework to reveal actual contributions to resilience.

[5] Highlighting the two-phased approach to framework development as first illustrated in Chapter4, Section 4.8

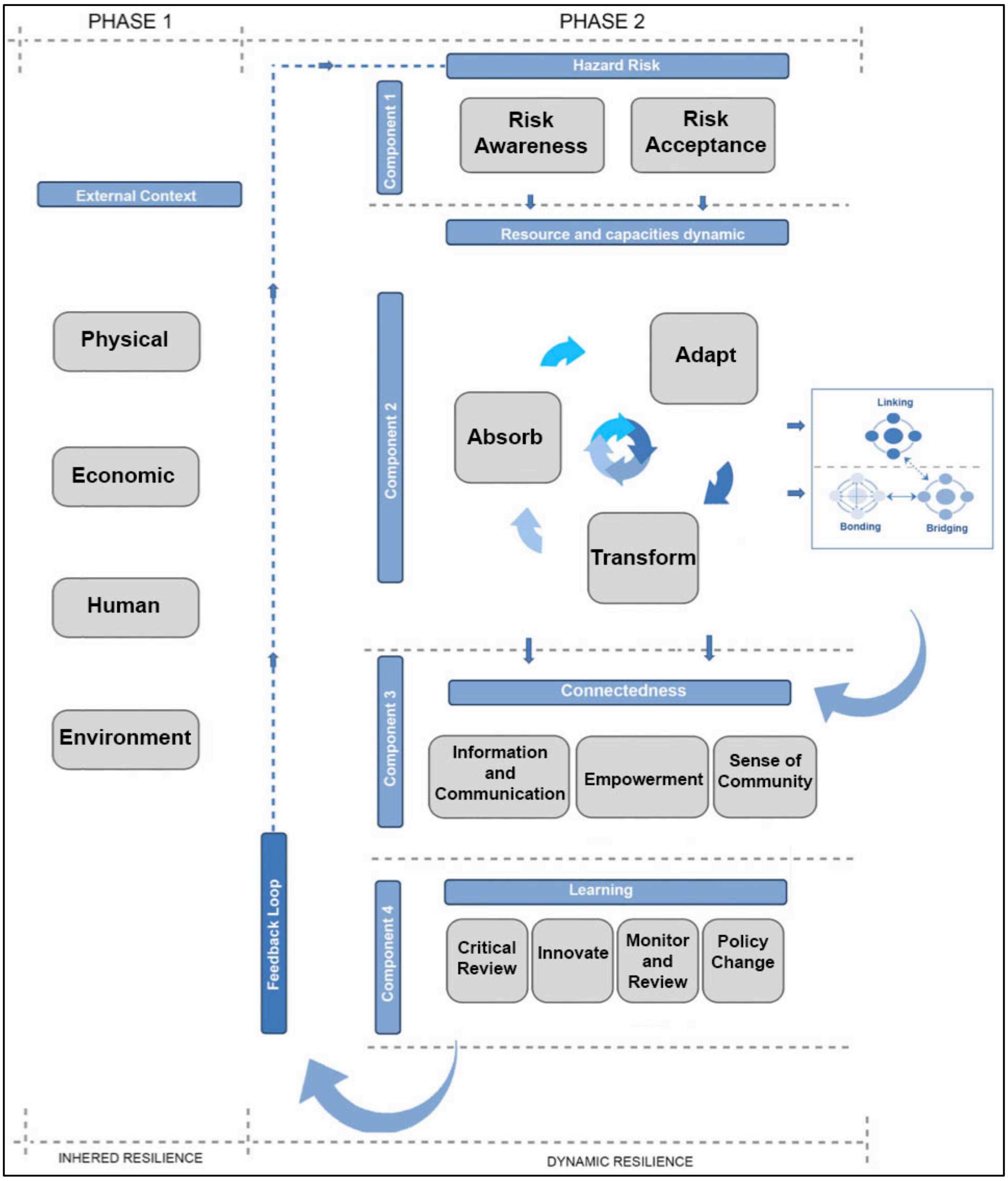


Figure 5.3 Highlighting mixed methods approach of Phase 1 (quantitative) and Phase 2 (qualitative) within the framework.

Phase 2 focuses on qualitatively capturing community resilience in respect of its constituent components and sub-components, highlighting the transformative and dynamic elements that quantitative assessments neglect. Guided by the theoretical framework developed in Chapter 4, this approach steers the focus of inquiry towards an investigation of framework components underpinning community resilience. In effect, whilst deductively guided by the framework, the approach is abductive in nature as it also permits axial coding[6]. Kothari (2004: p275) refers to this open process of analysis as a 'voyage of discovery', in that it accepts components and themes that stray from the framework. Collectively, the two phases (Figure 5.3) act as a bridge between a quantitative, top-down assessment (Phase 1) and a qualitative, bottom up investigation (Phase 2). Ultimately, this hybrid approach should ensure that the subtleties and nuances of resilience, which may be overlooked in solely quantitative datasets, are captured through the qualitative element of the framework.

5.3 Case-study approach

Chapter 1 established the justification for the selection of a case-study methodology lay in its flexibility towards behavioral actions and its degree of focus on contemporary (as opposed to historical) events. The flexibility offered by studying a phenomenon within its surroundings allows for a contextualised and in depth analysis of resilience behaviour within a disaster context without losing the meaning or significance of the issue had it been studied out of context (De Vaus, 2001).

5.3.1 Unit of analysis: Case type

The aim of this thesis outlined in Chapter 1 (to enhance an awareness of resilience in post-disaster affected communities) guides the research to explore evidence of indicators representing operationalised resilience. In this context, a "case" is both the "unit of analysis" and the "object" under investigation (De Vaus, 2001:p8). The research phenomenon is a disaster event that impacts upon the resilience levels of a community. In particular, it seeks to address the dearth of empirically verified resilience indicator frameworks, building upon past framework research, by validating and grounding the findings within the empirical case-studies (Schipper and Langston, 2015: p19).

Accordingly, the 'case' required the selection of a disaster type to anchor the in-depth analysis on. As articulated in Chapter 2, the 'case' should constitute a disaster by fulfilling the criteria established by EM-DAT. Further, in order to capture performed dynamic resilience, the case-study requires a disaster that has recently occurred and has memory of the recovery process or is still active in that phase. As

[6] Axial coding is a form of open coding which combines both inductive and deductive (abductive) methods of analysis (Phase 2) to deduce themes.

such, the selection of the ‘phenomena’ or disaster type under investigation required the fulfillment of the following criteria:

Table 5.1 Criteria for case-study selection as outlined by the thesis.

Criteria	Case-study selection
Criterion 1	Costliest disaster within Europe in terms of monetary costs
Criterion 2	Most frequent disaster within Europe as identified by the EM-DAT, thus providing opportunities for the implementation of lessons learned.
Criterion 3	Substantial enough in scale to require outside assistance thus providing development scale and yielding a sufficient level of detailed data.
Criterion 4	Include both an urban and rural settlement for comparison purposes.
Criterion 5	Disaster event has occurred in the recent past < two years since the event.

Chapter 2 reported that research commissioned by the Swiss Re (Sigma Re) research institute (2014) demonstrated 90% of the global disaster bill is attributed to three forms of natural disasters, namely: floods; tropical cyclones and earthquakes. Hydrological disasters such as storms and flooding accounted for the most frequently reported disaster in Europe in 2016 (EM-DAT). Further, as outlined in Chapter 2, flooding in the UK equated to the highest disaster bill, standing at £2.9 billion for the year 2015 (EM-DAT, 2016). Beyond these figures, the wider economic impact is estimated at £5.8 billion per year when under-insurance, infrastructure, business loss and flood defence repairs are taken into consideration (House of Commons, 2016). Considering the above, the empirical element of this thesis focuses upon flooding within a UK context, as discussed in more detail below.

The UK has a long history of recurrent flooding, with the increasing risk and impact of flooding being described as the peril of our nation (Lamond, 2014; National Flood Forum, 2015). Thus, in line with criteria 2 (Table 5.1), the UK ranks highest for flood frequency within Europe, standing at 14 floods over the last decade 2005-2015 (EM-DAT, 2016). During this same period, repeat flood events per annum were recorded in six of the ten years. In addition, reduced recovery time between recurrent floods incurs economic losses beyond direct damages, having a knock on effect on the wider economic climate. Further, recurrent flood events offer opportunities for lessons learned (Cosgrave, 2014), thus offering a suitable context within which to gain a more in-depth understanding of the ‘learning’ component within the theoretical framework.

The backdrop of the ‘Making space for water’ (DEFRA, 2005) flood strategy and the subsequent Pitt review report (2008) after the devastation of the 2007 summer floods across the UK, marked the beginning of a paradigm shift towards no longer viewing recurrent flooding as a preventable structural issue and instead adopting an approach to management of probabilities and consequences of flood risk. The continuum of change towards viewing the social aspect of flood management, led the Department for Environment Food and Rural Affairs (DEFRA) (the Westminster department with overall national responsibility for policy on flooding in England[7]) to formally acknowledge the value of communities in flood resilience through the flood strategy report entitled 'Understanding the risks, empowering communities, building resilience' (2011). This saw the emergence of a new flood risk landscape across the UK, leading to similar publications in Wales[8], Northern Ireland[9] and Scotland[10]. It prompted a change in the division of responsibility from a top-down approach to an appreciation of a bottom up approach, making this an opportune time to study the paradigm shift in flood resilience practice.

Within Europe, the UK represents the country with the highest amount of affected people as a consequence of flooding, to the extent that outside assistance is required during the response and recovery phase (criterion 3, Table 5.1). This level of risk is largely attributed to the high percentage of development within flood plains in expanding urban areas (RICS, 2015). Such development in flood plains has resulted in a situation whereby one in six properties in the UK are at risk of flooding, accounting for 5 million homes and 300,000 businesses across the UK (RICS, 2015). Indeed, there has been a long history of floods affecting populated areas within the UK (Fagan, 2000; SEPA, 2011a; Rivers Agency, 2013). It is reported that over 80% of the UK population live in urban areas and are reported as having a low ability to adapt (Lindley et al, 2011). Whilst the figures of affected population in rural areas is lower, the impact felt per head of population is significant (EA, 2016). Unable to meet the cost benefit for investment, these areas tend to exhibit higher levels of resilience at the community level. For consistency, the research followed the Government (England and Wales) Urban-Rural classification 2011, where settlements with a population above the threshold of 10,000 are designated 'urban' cities. Settlements with a population below this 10,000 threshold are designated as

[7] As of April 2013, the Environment Agency (EA) (sponsored by the United Kingdom government's Department for Environment, Food and Rural Affairs (DEFRA)) no longer has responsibility for flood protection in Wales. It has been replaced by Natural Resources Wales, a body sponsored by the Welsh Government.
[8] Public Accounts Committee. Coastal flood and erosion management in Wales.
[9] Doe (2006) Towards an integrated Coastal Zone Management Strategy for Northern Ireland; PEDU report (2012) Review of responses to flooding on the 27th and 28th June 2012.
[10] Flood Risk Management (Scotland) Act (2009) and Mapping Flood Disadvantage (Kazmierczak et al, 2015)

‘rural’ villages. The ‘town’ category straddled both the urban and rural divide, in that, depending on which side of the urban/rural threshold (10,000 population) it sat, a town might be categorised as either a ‘sparse’ urban area or a ‘town and fringe’ rural area. As such, the settlement hierarchy is comprised (in the first instance) of urban or rural, including (1) cities (urban), (2) villages (rural) and (3) towns (urban/rural depending on density). Accordingly, in fulfillment of criterion 4 (Table 5.1), case-studies include a range of settlement hierarchies from the ‘urban’ city to the ‘rural’ town and/or village, thus providing a means to explore the nuances between urban and rural resilience on a comparative basis.

To best reflect dynamic resilience indicators (Phase 2) against inherent (baseline) resilience (Phase 1), a recent past flood event was required to capture this post-disaster context. The winter flood events of 2015 were the wettest on record in the UK since 1910, significantly affecting northern parts of England, Southern Scotland and Northern Ireland as illustrated in Figure 5.4 (NERC, 2016). Noting the unprecedented rainfall (that exceeded the capacity of the local community), the extent of damage and its wider economic implication on society, it was decided to base the case-studies on the winter floods 2015 disaster across the UK.

5.3.2 Case-study regions

Northern Ireland was selected as the case-study area within which to test the framework prior to its application on the larger scale main studies. The area is representative of the flood risk issue within the UK having witnessed significant long-term recurrent risk associated with sustained rainfall events (Figure 5.4), (5 inches in 24 hours in winter 2015) resulting in almost annual flooding (NIAO, 2016) (criterion 2, Table 5.1). It is estimated that 46,000 (5%) properties across Northern Ireland are at high risk from flooding due to their location on river or coastal flood plains (Northern Ireland Assembly, 2015). In addition, Northern Ireland surface water flood maps illustrate that approximately 20,000 (over 2%) of properties are situated within a flood risk area. The extent of this risk has exceeded the capacity of the local community and created the impetus for the establishment for the Regional Community Resilience Group (RCRG) to assist communities with the recovery process after a flood event (criterion 3, Table 5.1).

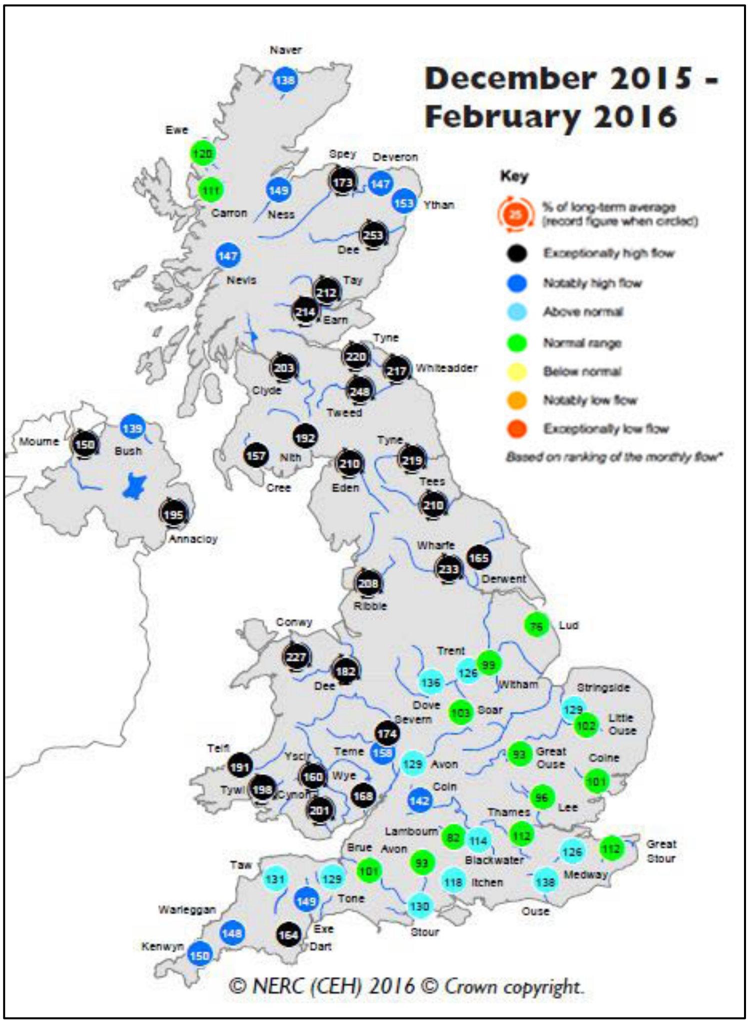


Figure 5.4 The accumulated rainfall amounts for the UK for the period December 2015-February 2016, highlighting rainfall peaks over the Lake District in Cumbria and significant levels in Scotland and Northern Ireland. Source: NERC (CEH), 2016.

The two selected case-studies represent an area within Belfast to illustrate an urban area and a rural settlement, Fintona in the west of NI (criterion 4, Table 5.1). Both case-studies have a flood protection standard with a high annual exceedance probability (AEP)[11] of between 0.5% (1 in 200 year) and 1% (1 in 100 year). However, East Belfast has recently had structural flood defences put in place whilst Fintona relies on community resilience actions, thus highlighting the disparity in needs between at-risk remote[12] rural and urban communities (criterion 5, Table 5.1). The above discussion serves to highlight the increasing impact and severity of flood risk within Northern Ireland, thus making the case for its selection as a pilot case-study to assess the resilience levels demonstrated during the recent winter floods 2015 (criterion 6, Table 5.1) and evaluate the viability of the research instrument.

[11] Annual Exceedance Probability (AEP) is the likelihood of a flood occurrence (expressed as a percentage) in any one year (EA, 2015).
[12] Rural refers to a settlement of less than 10,000 people and open countryside (ODPM, 2004).

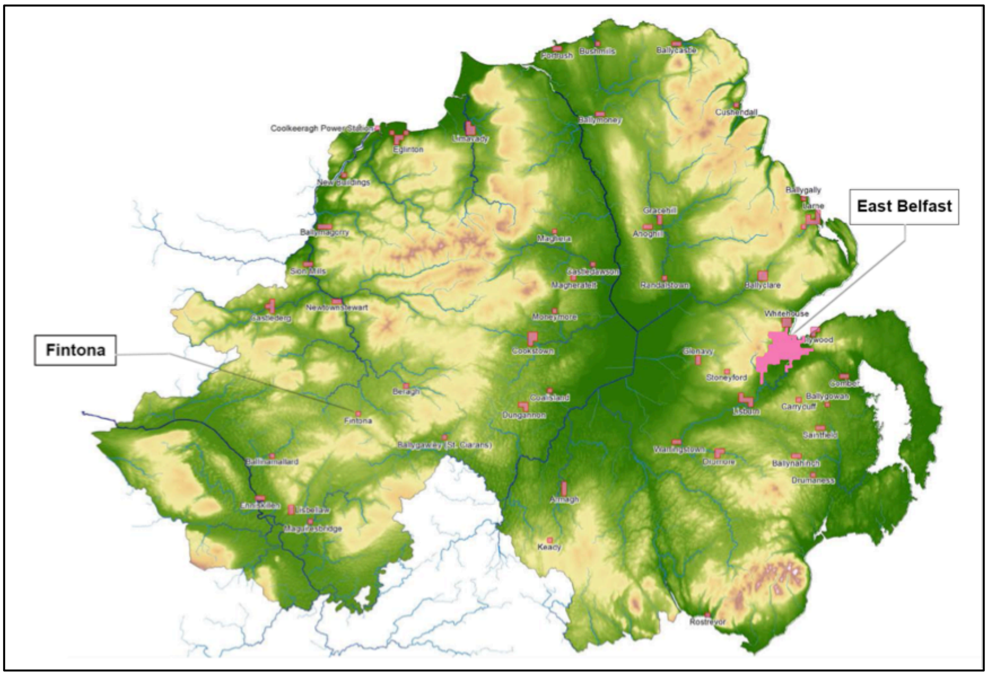


Figure 5.5 Map indicating location of Northern Ireland case-study areas. Source: annotated from DARD, 2015a.

The damage bill of flooding in England stands to breach the £5 billion (criterion 1, Table 5.1) barrier for the year 2015 (EA, 2010; KPMG, 2015; EA, 2018). The worst hit area, Cumbria in the North West of England, has a longstanding and devastating flood history, recording significant levels of damage and disruption as a result of both recurrent (criterion 2, Table 5.1) and first time flooding events (Pitt, 2008; Tapsell and Tunstall, 2008; EA, 2009d; CCC, 2016). Furthermore, the level of flooding has exceeded the capacity of the local community in the past and required outside assistance with danger to life a critical issue (EA, 2011). During the recent winter 2015 floods, one loss of life was recorded and an Emergency Officer noted “It’s a wonder more people didn’t die” (The Guardian, 2015). Cumbria was the most severely impacted county in England during that period (criterion 5, Table 5.1), experiencing more than a month’s rain in one day on Saturday 5th December 2015, causing main rivers all across Cumbria to exceed the highest levels ever recorded (Figure 5.6). It was the region most severely affected in terms of flood levels, the number of affected properties and disruption to critical infrastructure and services (JBA, 2015; Cumbria County Council, 2016; House of Commons, 2016).

Social connectedness and the dynamics between settlements of various contexts and densities is an important factor in the evaluation of community resilience (EA, 2011). As such, the unprecedented flooding events are investigated in detail through the lens of 8 micro case-study settlements, both urban and rural, within Cumbria (criterion 4, Table 5.1). Whilst each of these 8 settlements possesses unique characteristics, they are broadly representative of other populated settlements in England (House of Commons, 2006). From a flood-risk perspective, the settlements are representative of a variance of protection standard from 0.5 - 1.35% Annual Exceedance Probability (AEP). This informed the decision to include settlements which were structurally and non-structurally defended. The settlements chosen comprised the city of Carlisle, the market towns of Appleby, Kirkby Stephen, Keswick, Kendal and the villages of Shap, Eamont Bridge and Glenridding (Figure 5.6). The presence of existing Flood Action Groups (FAGs) is also a significant indicator of resilience and a mix of communities with and without the presence of FAGs was deliberately chosen.

Figure 5.6 Map indicating the location of the Cumbrian case-study and the 8 case-study settlements. Annotated from BBC, 2016a.

Scotland similarly witnessed extreme rainfall and subsequent flooding in the winter of 2015 (criterion 6, Table 5.1) as illustrated in Figure 5.4 (Aberdeenshire Council, 2017a; CEH, 2016). The rising annual flood damage bill in Scotland is estimated to average £31.5 million from inland flooding (river and surface water flooding) and £19.1 million from coastal flooding. Together with wider business disruption costs, this places a significant financial burden upon wider society (Werritty et al, 2007) (criterion 1, Table 5.1).

The transposing of water policy into Scots law (2009) in the form of the Flood Risk Management (Scotland) Act, was a consequence of the increased extent of recurrent flooding suffered in the country (Scottish Government, 2009a). The UK Climate Projections data reiterates the increased and recurrent frequency of flooding, describing it as an issue that shows no sign of waning and warn that increased rainfall and rising sea levels, is a trend that is set to continue (Spray et al, 2014).

Acknowledging this growing issue, the Scottish Parliament passed the Community Empowerment (Scotland) Bill (SCDC, 2015), promoting a community centric 'working with' approach, as distinct from the former 'working against' (defense) approach, to flooding. It was argued that strengthening community voices and enabling management of their own risks serves as an enriching context within which to uncover community resilience indicators in practice. However, unprecedented events such as the 'winter floods' 2015, exceed the capacity of many local communities. Such events increase the risk to life and well-being (DEFRA, 2011) and require outside assistance to bounce back (criterion 3, Table 5.1).

SEPA (2015) reports that an estimated 170,000 residential and commercial properties are estimated to be at risk of flooding in Scotland. This equates to 1 in 22 homes or over 4% of the built environment (SEPA, 2015). The majority of these properties are in the larger cities where most funding is concentrated (Lindley et al, 2013). Consequently, isolated villages are more at risk as a result of being cut off from emergency services and limited investment in flood defences (Lindley et al, 2013). As a consequence of the aforementioned, case-studies were selected to represent a hierarchy of settlements ranging from village to market town and city (criterion 4, Table 5.1).

Rainfall levels across Scotland during the winter 2015/2016 were the wettest ever recorded since records began in 1910 (Met Office, 2016). Met Office statistics further reveal that an of 760mm of rainfall was recorded across Scotland during the months December 2015- February 2016. In particular, the effects of this 'remarkable winter' were most felt in North East Scotland, where "exceptionally high rainfall" led to widespread flooding across Aberdeenshire (Met Office, 2016; NERC, 2016;). (See Figure 5.4). In terms of risk, Aberdeenshire Council (2016c) estimate that 13,000 residential and 3,600 non-residential properties are at risk of flooding across the North East Local Plan district. All four case-study settlements (Figure 5.7) hold risk classifications which stand at the most severe rank of 'very high risk' and are identified as Potentially Vulnerable Areas (PVA) within the Government Flood Risk Assessment Maps, under the Flood Act (SEPA, 2011b). Consistent with the approach taken in Northern Ireland and Cumbria, case-studies, settlements were chosen to represent various settlement hierarchies. Aberdeen city (including the suburb of Peterculter[13]) represented the urban city scale, Inverurie represented the town scale and Ballater was representative of the village scale (Figure 5.7). Further, the selection of case-studies is representative of both structurally defended and non-defended communities through a range of AEP percentages from 0.1- 0.5%. As such, each settlement was acknowledged to retain an element of residual risk directly related to exposure to low probability / high consequence flood hazards (Faber, 2006; SEPA, 2011b). Prior to the 2015/2016 flooding, only the suburb of Peterculter had an established and operational resilience group.

The selection of the three case-studies across three jurisdictions in the UK, is representative of recurrent flooding issues within the UK. Wales was not included in the selection for two reasons. Firstly, the Flood Risk Management structure in Wales is similar to England, as it operated under the auspices of the EA until 2013, thus potentially offering less new material in comparison to a different Flood Management Body such as SEPA in Scotland. Secondly, whilst Wales suffered greatly from the effects of the Winter Floods 2015, the impact was not as severe as that felt in England and, in particular, the worst hit area of England, Cumbria. For these reasons it was felt that Cumbria was a better fit for the thesis and through the inclusion of the Scottish jurisdiction greater transferability of lessons learned could be offered. The selection of case-studies at different settlement scales is illustrative of the differences of impact at the varying levels highlighting the nuances between urban and rural resilience needs. All case-studies lie within flood management plans developed by statutory bodies as part of the current flood management policy in

[13] Peterculter is a large village within Aberdeen city and a former village in its own right prior to incorporation into the city's Lower Deeside ward in 1996. Peterculter (qua village) comprises a separate case-study to offer comparative analysis of nuances between resilience at urban and rural villages.

accordance with the EU Directive (2007/60/EC). Thus, they permit an examination of flood management strategies and practices from central government, through to implementation at the local authority and at community level.

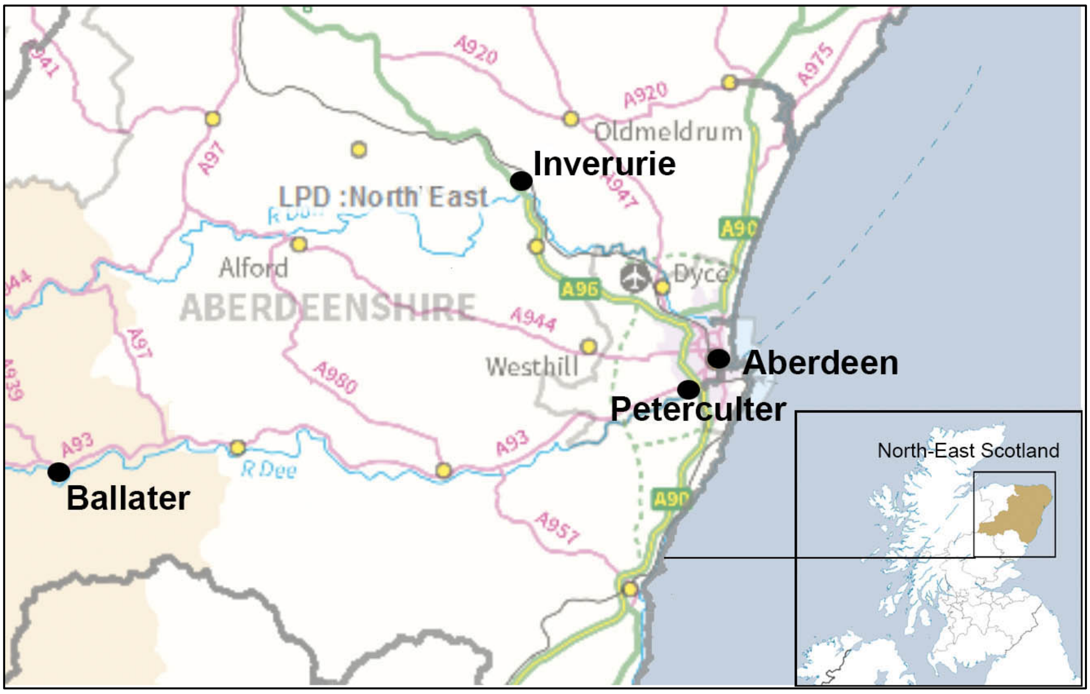


Figure 5.7 Map indicating the North-East Scotland Case-study settlements. Annotated from SEPA, 2017b.

5.3.3 Multiple case-study approach

In order to capture the wider perspective of flood-risk context and experiences across the UK, a multiple case-study approach as proposed by Yin (2014). As outlined in the previous section following initial pilot testing in Northern Ireland, this thesis adopts two main case-study regions (Cumbria and North-East Scotland), embedding micro case- studies (Figure 5.8). These are differentiated by three hierarchical scales comprising village, town and city.

The decision to adopt a multiple case-study approach was based on three key reasons. First, the comparative dimension enables a more comprehensive in-depth analysis, identifying data patterns and relationships cross case-studies (Yin, 2014). Second, broadening the contextual background across two case-study regions, allows for more generalisable conclusions to be drawn. Third, the introduction of a hierarchy of scales (city, town, village) enhances the transferability of the framework (Campbell, 1975). The settlement scale (city, town, village) was guided by the 'England and Wales Urban-Rural Population Thresholds'. Their settlement hierarchy differentiates between urban and rural settlements, describing ‘urban’ (city) as settlements with a population above 10,000. Populations below 10,000 are categorised into three standard profiles, namely: ‘Rural town and fringe’ representing the ‘town’ scale and ‘rural village’ representing the village scale. The categorisation also includes ‘dispersed’ dwellings, which are not representative of the community focus of the research and therefore are not considered.

Similar (if not identical) hierarchies are currently implemented in Scotland through the ‘Scottish Government Urban Rural Classification 2013-2014’ and in Northern Ireland through the ‘Statistical Classification and Delineation of Settlements’ 2015. As such, this settlement hierarchy was considered transferable across the UK context of this research.

In addition, pattern matching across the multiple scales enhances the level of confidence and validity of the research. For example, the inclusion of both urban and rural scales enabled the research to reveal the nuances and subtleties of how resilience manifests itself across scales (Cloke, 2006). In particular, Wheater and Evans, (2007) highlight how variances of physical, environmental (including policy), human and economic contexts at the urban and rural scale, can significantly influence community resilience levels. For example, higher density and lack of green spaces associated with urban areas, can reduce flood resilience due to reduced capacity to store excess water in green ‘sponges’ potential (Wheater and Evans, 2007). As such, individual data-collection with each case-study allows provides the opportunity for rich data-comparison across the two case-study regions. The comparative capacity of the multi-case design is discussed in more detail in Section 5.7.

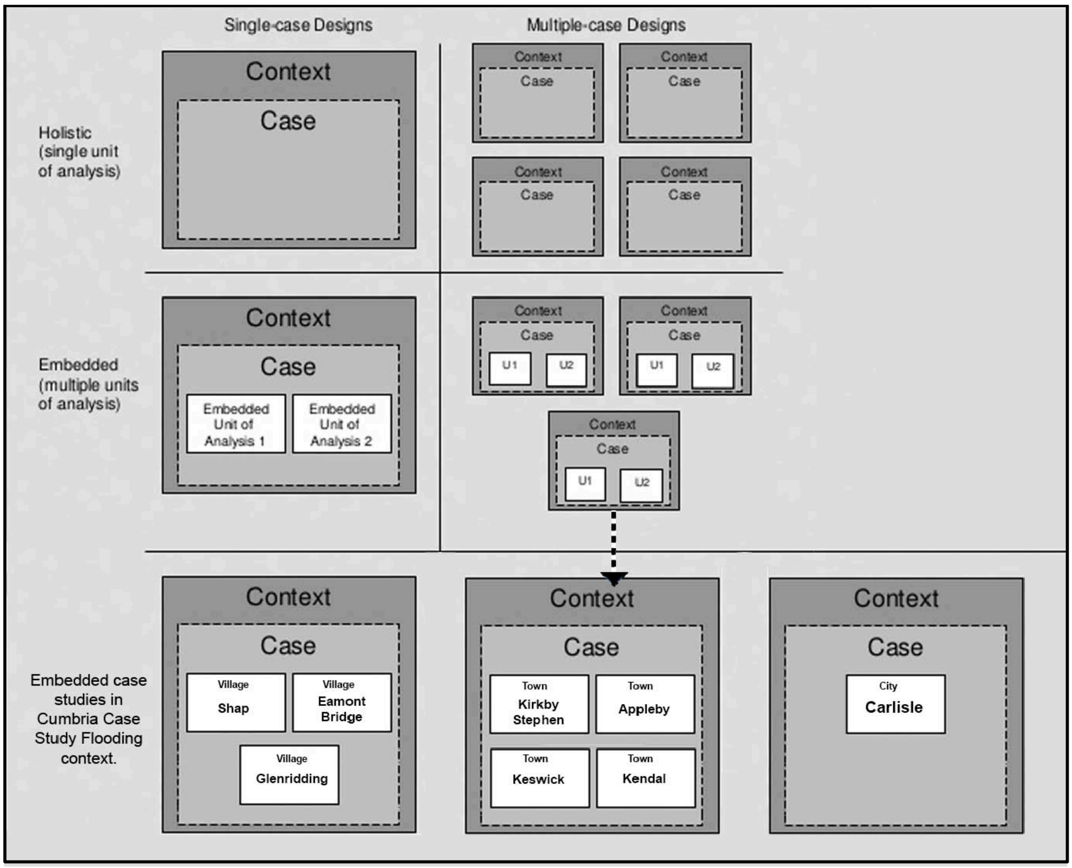


Figure 5.8 Example of proposed comparative multiple-case design, Cumbria. Adapted from Yin, 2014.

5.4 Research methods

Successfully carrying out the case-studies required a variety of research methods to capture the complexity of resilience within a bounded context (case-study locations). As outlined in Chapter 4 (Section 4.6.2), it is necessary not only to identify empirical indicators of community resilience after a disaster (Phase 2) but further test those measures against pre-disaster baseline data (Phase 1). It is anticipated that this multi-faceted approach of reflecting Phase 2 data against Phase 1 data, may inform as to why some communities recover quicker than others in the same disaster, despite similar resilience baselines (human, physical, economic, environmental).

Accordingly, to fulfill the aim of this thesis a mix of both qualitative and quantitative methods are employed. Secondary data collection was achieved through document analysis and by identifying publically available official data sets, while primary data collection was collectively achieved through a mix of observation, semi-structured interviews at the community and practitioner level and social network data. These methods are described in more detail in the following sections.

5.4.1 Secondary data methods

Document analysis was utilised in this research to corroborate and segment evidence from other sources, allowing for inferences and insights for further research (Yin, 2014). The process began by analysing policy reports, planning documents and academic reports (listed in Appendix 3), to develop an understanding of the current flood risk policy landscape. These documents set out the political and legislative context for the investigation and assisted in forming a background resilience profile for the pilot and two main regional case-studies.

5.4.2 Background resilience assessment (Empirical Phase 1)

Beyond archival and policy documents, secondary data sources were employed to assess the contextual baseline resilience of both case-study regions. As discussed in Section 5.3.1, an assessment of the four community assets (physical, human, economic, environment) constituting Phase 1 of the theoretical framework (Section 4.6.2), was made to form a baseline resilience level for the communities. By way of an example, Figure 5.9 illustrates where Phase 1 sits within the overall theoretical framework and presents the Cumbrian case-study variables. It is anticipated that a baseline assessment of resilience founded on their existing community assets will serve to highlight areas of resilience weakness. Building community resilience requires a process of progressively addressing areas of low resilience, in line with the interpretation of resilience as a process (as articulated in Chapter 3). Mapping resilience weaknesses identified in Phase 1 against indicators of performed resilience in Phase 2, provide the opportunity to implement resilience strategies and resources directly where the greatest resilience deficit lies.

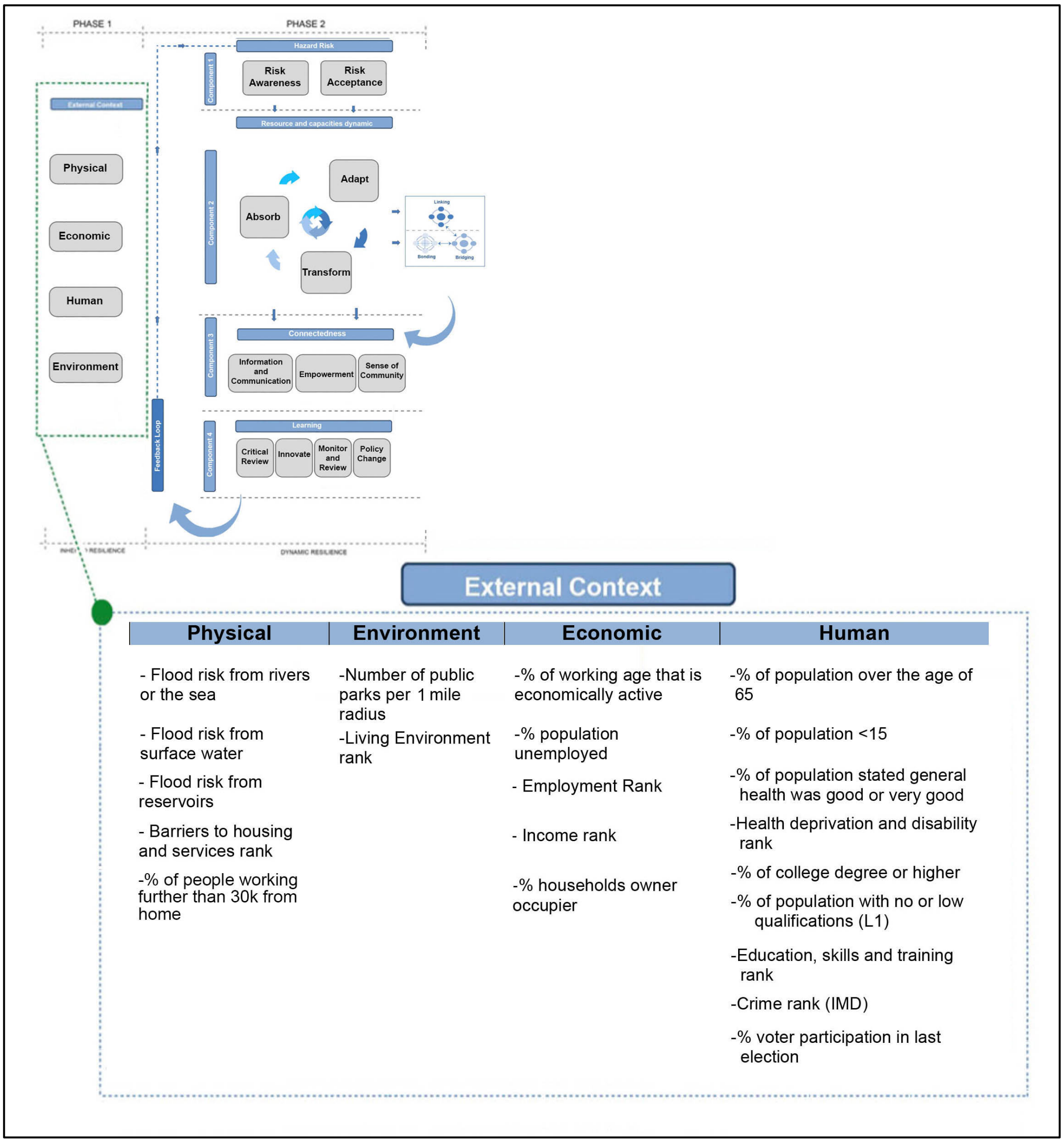


Figure 5.9 Theoretical framework proposed by this thesis highlighting the Phase 1 baseline resilience assessment.

Phase 1 can be interpreted as a top down assessment of the resilience within the community based on their existing assets (physical, environmental, economic, human). The synthesised list of 21 variables (Figure 5.9) arrived at were based on their prominence in the literature base, use in past research and availability of data (Section 4.6.3). In terms of the four community assets, comprising the contextual resilience background, the variables group into physical asset (5), environmental (2), economic (5) and human (9). The variables are guided by the four community assets, which collectively comprise the contextual resilience background to each community as identified by the proposed resilience framework in Chapter 4.

The research is cognisant of the fact that for the most part disaster data are not held centrally and considerable emphasis was placed on collating publically available official data for each variable. The readily available official data permitted a certain amount of flexibility, and the research sought, where possible, to use the same variables for each case-study, however slight variations were inevitable. These differences in case-study variables are highlighted in bold in Appendix 2. The majority of selected variables were derived from the underpinning data set of the UK Census, however others were from environmental land cover maps, flood maps and risk assessments. The number of variables in each of the four assets/resources (Physical, Economics, Environmental, Human), is outlined in Figure 5.9.

The choice of data scales (geographies) used was dependent upon the availability of suitable data at a useable/practical scale (Lindley et al, 2013). Northern Ireland used Super Output Areas (SOAs), Lower Super Output Areas (LSOAs) were used for England and Scotland used Data Zones (DZs). SOAs have a minimum of 1,300 residents and a mean of 1,900, LSOAs a minimum of 1,000 and a mean of 1,500 and DZs between 500 and 1,000 residents. Despite the difference in terms, the geographical units are of comparable size, facilitating transferability and comparability as required.

5.4.3 Data aggregation and normalization

With the variables defined and data sources established, the next step was to select a way of normalising the data for each variable. The publically available official data sets used to assess the 21 variables were derived from multiple sources that included various raw counts, percentages, ratios, differences and averages. Accordingly, it was necessary to adjust the values of the different scales to a notionally common scale by normalisation[14] using the min-max scaling technique common to indicator research (Cutter, 2008). Min-max normalisation provides linear transformation of raw source data whilst maintaining a link to the original data. It is a relatively simple technique that can specifically fit data in a pre-defined boundary. A process of rescaling was undertaken in instance where a high variable value equates to low resilience (Cutter et al, 2010). For example, high unemployment equates to low resilience and as such the variable score was inverted. This process involved inverting the value such that low resilience equated to zero (worst score/low resilience) and high resilience equated to one (best score/ highest level of

[14] Normalisation refers to rescaling all the indicators using one method (Min-Max) so that all the data obtain comparable reference points. Min-Max rescaling is a method in which variables are standardised within a range of 0 to 1. In the context of this research zero equates to low resilience and 1 equates to high resilience.

resilience). This is referred to in the literature as min-max scaling (Cutter et al, 2010; Miller et al, 2016). The variables were then summed within each of the four resources and the average produced for each resource set (physical, human, economic, environment). These scores were then mapped on a radar diagram within Excel to highlight the variations in resilience levels between the components. An example of this process is illustrated in Table 5.2 highlighting the 'Economic' asset aggregation within a Northern Ireland context. A worked example for the 'economic' resource is included in Appendix 2.

Table 5.2 Example of individual variable and aggregated scores for the 'Economic' asset, Fintona (village), Northern Ireland.

Community Asset:	**Variable**	**Fintona**	**Data source**
3. Economic resource			
Livelihood stability	% of working age that is employed	0.6	Census 2011
	% unemployed	0.2	Census 2011 /Labour market report 2017. (NISRA - Economic and Labour Market Statistics)
Income	**Income Deprivation domain**	0.1	Multiple Deprivation Measure 2017 ***2**
	Employment Deprivation domain	0.1	Multiple Deprivation Measure 2017 ***2**
Tenure	% households owner occupier	0.6	Census 2011
Aggregated score per resource		**2.3**	**Total asset score (scale 1-5)= 1.9**

Each of the (Phase 1) four Community assets (human, environmental, physical and economic) was equally weighted and there was no weighting of their corresponding variables. The approach was taken as certain communities may have a greater number of relevant variables than others, however that does not necessarily equate to higher resilience. Furthermore as outlined by Cutter et al (2010:p10), the chosen method of data aggregation without weighting, is "transparent and easy to understand", a criterion that was considered important for its intended users, for example policy makers, community champions and third sector community organisations. Further, there is currently no empirical evidence (theoretical or practical) to substantiate the prioritisation or greater weighting of one variable over another (Keating et al, 2015).

5.5 Primary data collection (Empirical Phase 2)

Once case-study sites had been selected and baseline resilience assessments undertaken (Phase 1), the research then focused on the substantive aspect of the methodology, namely the collection of primary evidence (Phase 2). This information comprises two elements: first, field notes from observation exercises and, second, interview transcripts from community level and practitioner/key informant interviews, including Social Network analysis. The intention of this data is to capture post-disaster indicators of operationalised 'dynamic' resilience. It is anticipated that, when analysed by reference to the baseline findings from Phase 1, resilience weaknesses will be identified.

5.5.1 Observation

The observation method added to the research, capturing information that transcends people's perceptions and attitudes towards flooding, by analysing community resilience in a natural setting (Gray, 2009). Observational techniques employed throughout the case-studies included: direct observation; field visits and transect walks. Direct observation was used as a stand-alone technique and informs the contextual background information for the case-study evaluation. In line with Yin's (2014) interpretation of direct observation, descriptive reporting was undertaken to convey important contextual and background information about the case-study sites. For example, in Cumbria, guided field visits to flooded catchments by private water company 'United Utilities' provided a more comprehensive overview of the complex flooding situation. These field visits afforded critical insight into the profiling and understanding of the wider environmental issues affecting the communities.

The transect walk is a research approach that observes and evaluates an environment by walking through it with a facilitator (Taplin, 2002; USAID 2009). The facilitator or 'community champion' facilitating this research was an active member of the community who had either been directly affected by the floods or voluntarily assisted the flood recovery process. The facilitator in each community was identified through a variety of community groups, such as church organisations, voluntary recovery organisations or flood recovery groups and had no professional involvement in FRM. Transect walks serve to create a narrative in respect of the case-study, highlighting specific resources, community perspectives and landscape features (World Bank, 2013). The walks provided the opportunity to clarify issues pertinent to the study that could not be accessed via desk research prior to the fieldwork. The walks further permitted the observation of general conditions within each respective case-study, such as: the layout and orientation of the village; geographical location; socio-demographics; community activities and services of particular significance. The walks allowed the facilitator and affected community to express their knowledge of flooding issues and the measures in place to plan and mitigate against them. In addition, observational data was also collected in a passive manner at flood conferences, community flood meetings held by the lead local flood authority and the Environment Agency, workshops and other events across the disciplines (Appendix 3.2).

5.5.2 Collecting and recording observational material

A systematic data collection process was used to ensure data integrity, which also helped the follow up analysis. In this respect, data was initially filed chronologically before undergoing critical analysis through coding in NVivo (Gray, 2009). Key themes and insights could be drawn from the data and coded into ‘nodes’ in NVivo. Gathering data in this way allowed access to intangible resilience characteristics that otherwise would have been difficult to capture (Neutons and Rubinson, 2010). Indeed, in their community resilience study on disasters across Europe, emBRACE (2012a; 2012b), note that capturing the dynamic contextual background within disaster contexts is challenging and is often missed by rigid techniques such as survey methods. In this regard and for the purposes of this study, observation complements the other data collection methods employed by informing the contextual backdrop that frames communities’ interactions and relationships.

5.5.3 Semi-structured interviews

The interview method was undertaken as a means to further investigate the opinions and perceptions of resilience that emerge in a post-disaster context. The semi-structured interviews moved away from the rigidity of structured interviews by including prompt questions. As such, the interview process benefitted from “the free-wheeling quality” of unstructured interviewing, ensuring unexpected data could be captured (Bernard, 1994:p138). The following sections outline the content of the questions set for the semi-structured interviews, designed to elicit information on indicators relating to the four key themes of the theoretical framework (Phase 2); risk, resource and capacity dynamics, connectedness and learning (Figure 5.3).

5.5.4 Interview question set

Set in a post-flooding context, the community level question set centred on addressing the four main components of the framework, articulated in Chapter 4. The framework provides the structure upon which the Phase 2 qualitative analysis is based through the identification of indicators emerging from the data representing each of the four components. As discussed in Chapter 3, it is important to stress that a resilient community, within the context of this thesis, is one which has the ability to absorb, adapt or transform as necessary in order to withstand and recover from adverse flood events. The questions are designed in a manner to elicit how communities perceive risk and their level of understanding and acceptance of risk. In particular the interviews question the capacity of the community to harness resources and expertise to help themselves recover from flooding events and assess how their actions complement or impede the work of other disaster stakeholders. Existence of social capital and network ties at multiple levels are questioned in order to discern the existing mechanisms to assist communities. Evidence of lessons learned and application of local knowledge is also examined. A full list of the questions is presented in Appendix 5.

The practitioner level question set was similarly designed around the four main components of the theoretical framework and tailored to suit their job description and responsibility in flood risk management. Insights from key informants within these agencies can serve to complement the broader information gleaned through a review of the literature, by offering a more site specific perspective. Initially, all individuals were asked to describe their role and their experience. Interviewees were then asked a series of questions about their knowledge and experience of flooding and the role of their agency or institution in the recovery process after a flood event. Interviewees were also asked about their understanding of concepts such as resilience and how they personally applied, promoted and resourced these concepts within their respective community. As with the community level interviews, the questions focused on eliciting the practitioners' perspective on the four constituent components of the framework, namely: risk awareness, dynamic resources and capacities, connectedness and learning. Key-informant interviews proved to be a valuable method of inquiry as, whilst the interviewees represented the perspective of their formal agency or organisational role, they also provided particular insights of local challenges from the perspective of formal operational parameters.

5.5.5 The sampling frame

As outlined in Chapter 1, this thesis is located at the community level however it acknowledges influence from systems at both lower and higher levels (Constas et al, 2014). As such, the interviews took place at both the community and practitioner level, ensuring that the sample closely reflects the full range of opinions and perceptions of the community. In this way, the research takes into consideration actions outside the community level domain and includes the resilience enabling environment by encompassing the statutory level perspective through key-informant interviews.

Participants involved in community level interviews were chosen based on the fulfillment of certain criteria (Table 5.3). Participant were selected who were directly affected by a flooding event and reside within a flood risk area as formally indicated on a flood map. Adults above the age of 18 were interviewed as they are more likely to hold responsibility for the contents and structure of the affected property. In line with this thinking, adults are arguably the household members with the greatest capacity to initiate resilience measures, thus enabling the identification of resilience actions through the mobilisation of resources and capacities. Both affected household members and businesses are included in the sample cohorts drawn from the pilot and main case-studies. In doing so, nuances between how resident communities and businesses participate and contribute to social networks during the recovery phase could be identified. Further, affected business community members may not reside in the community and it may prove interesting to understand the influence of this on their risk, attitude towards risk and their potentially reduced capacity to adapt as a consequence of fewer community ties.

Table 5.3 Criteria for sampling selection at the community level.

	Participant selection criteria
1.	Reside in a flood risk area on a flood map
2.	Adults over 18 years
3.	Members of the community (Businesses or residents)

Recruitment at the community level was purposive and initiated through contact with a ‘facilitator’ or community champion. Facilitators in smaller settlement hierarchies were easier to identify through the community council, local church or flood recovery groups. The bigger urban areas required multiple strategies including notices on the local radio, posts on Flood Action Group (FAG) web/facebook pages and assistance from resilience team members within the local council.

The recruitment process took place during a period when the majority of the affected community members were still displaced. For example, during the recruitment process for the Cumbria region case-study less than 15% of the population had returned to their property. In this instance, the facilitator was invaluable to the research by assisting with the identification and location of affected members in each community as well as delivering an expression of interest form by hand. Having read an outline of the research, individuals who wanted to take part in the study were requested to return an expression of interest form. As the case-studies progressed, trust and rapport was built-up with certain key figures involved in the case-study communities, generating greater access to affected members of the community and yielding increased participant numbers. The snowball sampling technique was also used to recruit new participants as recommended by existing participants. In total 233 interviews were undertaken at the community level across the three case-studies. Details of the participant interviews are outlined in sections 6.4.1, 7.5.2 and 8.5.2 respectively.

Running in parallel to the community level interviews, a range of sampling techniques were employed to select the practitioner level interviewees. The sample was selected based on their role in flood risk management within the UK. Initially an analysis of policy documents, reports and web based research formed the basis for selection. To synthesise the results, additional criteria for selecting participants were that they had a direct role or were in some way influential in decision making and communication with the affected community in relation to flood recovery activities.

The first step in practitioner level/key informant interviewing involved a stakeholder mapping exercise in order to identify the most influential stakeholders in risk reduction activities. Hence, practitioner stakeholders were organised into categories (policy-prevention; recovery and reconstruction; emergency management; independent and industry) across institutional and geographical scales (Figure 5.10) and a list of key stakeholders at the statutory level was developed. The selection process of the stakeholders was iterative, beginning with the identification of participants that were representative of these groups but was re-evaluated as the research progressed and suggestions from interviewees were taken into consideration.

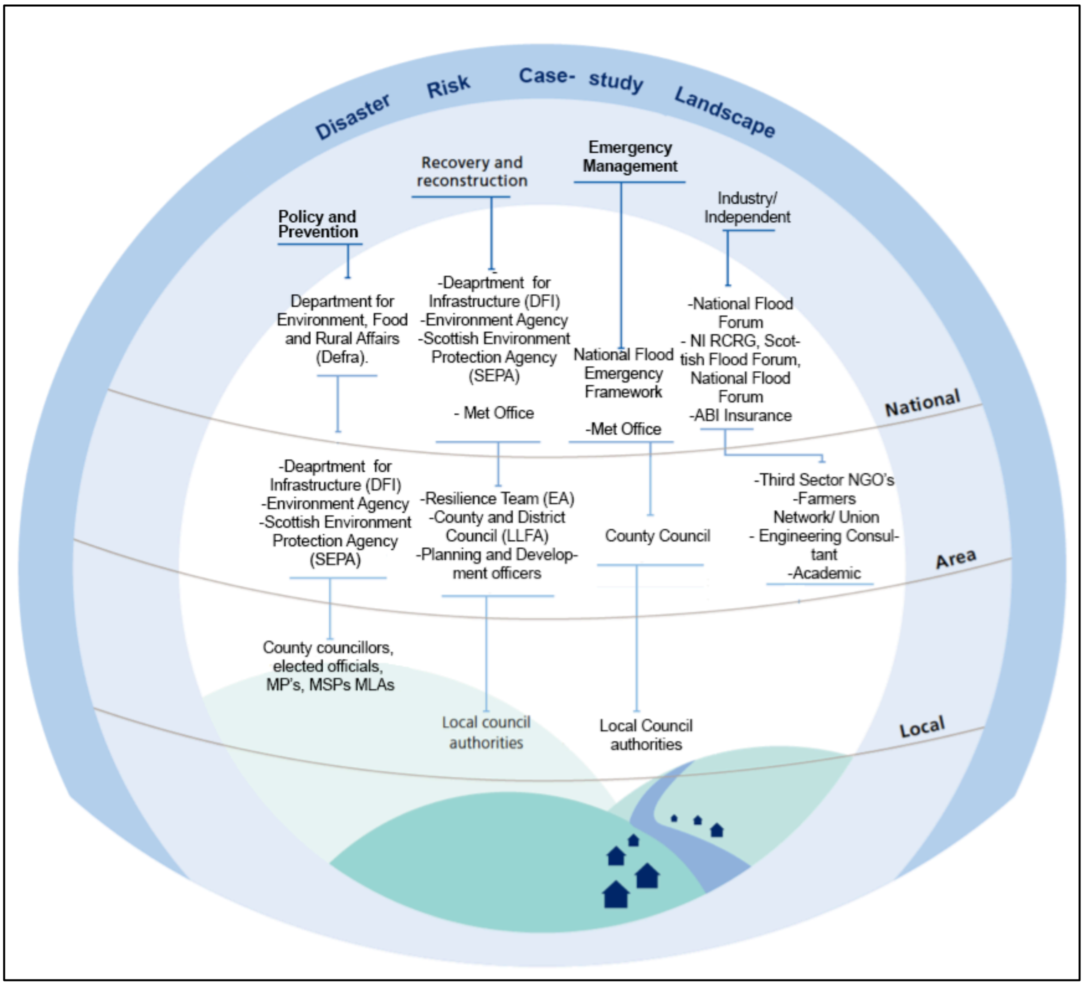


Figure 5.10 Overview map of stakeholders within the disaster risk management landscape in the UK. Adapted from JBA, 2015.

The starting point for practitioner level purposive sampling was a review of recent policy publications from the relevant statutory authorities in each jurisdiction. Government reports and consultation documents from the Environment Agency (EA), Scottish Environment Protection Agency (SEPA), Department for Environment, Food and Rural affairs (DEFRA), Rivers Agency and the former Office of the Deputy Prime Minister (ODPM), now Department for Communities, were consulted. Government strategies and policy outlines for flood management together with select committee reports were further consulted for potential interview candidates. Staying within the policy domain, planning guidance such as Public Policy Guidance 25 (Equivalent to PPS 15 in Northern Ireland and SPP 7 in Scotland) highlighted the relevant parties in respect of land use and development planning. A web search of the official websites of industry and independent organisations provided contact details for applicable interviewees. A full list of the reviewed documents is listed in Appendix 3. Collectively the documents highlighted over 170 key figures within flood management institutions. The decision was taken to select key organisations that had a direct role in regards to flood recovery and reconstruction.

Individuals were selected with the intention of exploring their understanding of their institution's strategies and policies on flood resilience building and their impressions of risk awareness, mobilisation of resources and capacities, connectedness and lessons learned within the case-study populations. Once potential participants were identified through a search of relevant websites, contact was made primarily through email or by telephone. Purposive sampling targeted key informants from the following four key functions:

1. Policy and Governance: Devolved Government has a primary role in flood management activities and is responsible for implementing a strategic approach to floods.
2. Recovery and reconstruction: Public investment in flood risk management through the auspices of the Environment Agency (EA) in England, SEPA in Scotland and Rivers Agency in Northern Ireland, where resilience officers and flood incident managers are responsible for flood forecasting (with assistance from the Met Office) and communication of potential flood risk to the community. The recovery phase also involves the county or district council, depending on the jurisdiction, acting as lead local flood authority including roles such as planning and development officers, resilience team members and managers and organisations such as the National Farmers Union and community foundations. The EA, SEPA and Rivers Agency have powers in relation to planning, however they are limited to providing guidance and placing objections. Local Councils or districts (planning departments) approve or deny the planning applications.
3. Emergency Management: Local and district authorities and councils have emergency managers responsible for coordinating emergency plans by organising the chain of responses undertaken by the relevant authority departments and officers during emergencies.
4. Independent/Industry: Independent charities such as the National Flood Forum (NFF), the Scottish Flood Forum and the Regional Community Resilience Group (RCRG) (Northern Ireland) represent communities at risk. The Association of British Insurers (ABI) are a trade body representing the

majority of the insurance industry that offer risk transfer of flooding in the form of insurance. Engineering consultancy firms offer informed advice on the design, construction and implementation of flood management schemes for the authorities, developers and individuals investing in flood management. This category also included representation from local councilors, elected officials, MP's, MSPs and MLAs acting in the best interests of affected community members within their constituency. They did so by engaging and lobbying on flood resilience issues within their respective settlements.

Following a purposive sampling process, snowball sampling was utilised to broaden the sample frame. In total 63 interviews were undertaken across the three case-studies at practitioner level. Further detail in respect of participant interviews is outlined in sections 6.4.1, 7.5.2 and 8.5.2 respectively. Participants were asked to recommend or suggest further potential participants they considered as influential in relation to flood management and recovery (Berg, 2007). Once interviewees had been identified, discussions with statutory authorities were framed within a semi-structured interview process. This approach facilitated specific themes and ideas to be targeted whilst maintaining a degree of flexibility to draw unexpected ideas and experiences (Garson and Horowitz, 2002). Each interview was guided by an 'interview guide', which was adapted and tailored in accordance with the framework component output from Chapter 4. Interviews were recorded with permission and lasted approximately 30-45 minutes. A sample interview guide, participant information sheet and consent form is included in Appendix 4.

5.6 Social Network Analysis (SNA)

A key learning outcome emanating from the pilot (Chapter 6) findings was the extent to which social networks contribute to community resilience. The literature base articulates that the social infrastructure of a community is integral to community resilience (Aldrich, 2012; emBRACE, 2015a; Semaan et al, 2015). The premise of Social Network Analysis (SNA) is that a diverse and dense social network enhances community resilience. Consequently, it was decided to include Social Network Analysis (SNA) as part of the main case-study analysis. Social networks in the context of this research refers to both the physical networks 'of place' within a community and also 'virtual' networks created through social media platforms such as Facebook.

The use of SNA benefits the research in three main ways. Firstly, it investigates network structure (physical or virtual), as depicted through a pattern of connections and actors (nodes). Second, it identifies the ability of the network to interact and mobilise resources and assistance when required over space and time. In doing so the analysis identified key actors or 'ego's' who maintain the greatest influence within the social structure. Third, SNA identifies structural holes in the multi-scalar communication structure, which may act as barriers to the distribution of resources and reduce resilience. It is anticipated that greater knowledge of the interdependencies in behavior and relationships between network configurations can inform strategies to promote greater social connections. The process of SNA is outlined in greater detail in Appendix 4.1.

5.6.1 Mixed methods approach

A recent growth in social media offering real time dissemination of information during a disaster, together with access to wider social connections post-disaster, informed the decision to include 'virtual' communities. A mixed method approach was used to undertake structural analysis of both physical and 'virtual' networks networks. First, quantitative data was 'mined' from the social media platform 'Facebook', in order to determine the structure of different 'virtual' networks. The data collection and extraction application 'Netvizz', allowed data to be 'mined' in standard file formats from the relevant Facebook pages for analysis in the open-source Social Network Analysis (SNA) software 'Gephi'. The mining of data was limited to the three month period directly after the winter floods of 2015/2016. Selection of the relevant Facebook pages was also carried out using the Netvizz application 'search' function.

In addition, qualitative data was derived from interview discourse informing 'ego-centric' analysis of key community actors. Ego-centric analysis focuses on the individual rather than the community, by analysing the structure, function and composition of the networks within which it operates and influences. Ego's were selected through a process of purposive sampling. The recall method was used to allow interviewees to elicit key sources of assistance during the recovery process (Wasserman and Faust, 1994). The emerging data (nodes and edges) were subsequently formatted in excel columns and exported as a .CSV file for interpretation in 'Gephi' network analysis software. The resulting data was mapped into social network visualisations for interpretation and interrogation in the Gephi platform.

5.6.2 Analysis framework

Crowe's (2007) characterisation of networks framework (Figure 5.11) guided the structural analysis of social networks. The framework illustrates how interpretation of network structures can shed light on functional relationship ties between nodes. For example, it can be seen that bonding social capital is reflected in complete or clustered (factional)[15] structures, whereas weaker bridging ties are typically found in separated cluster (coalitional)[16] and bridging structures. Crowe's framework suggests that network structures that appear as a 'continuum' rather than discrete groups are considered more cohesive.

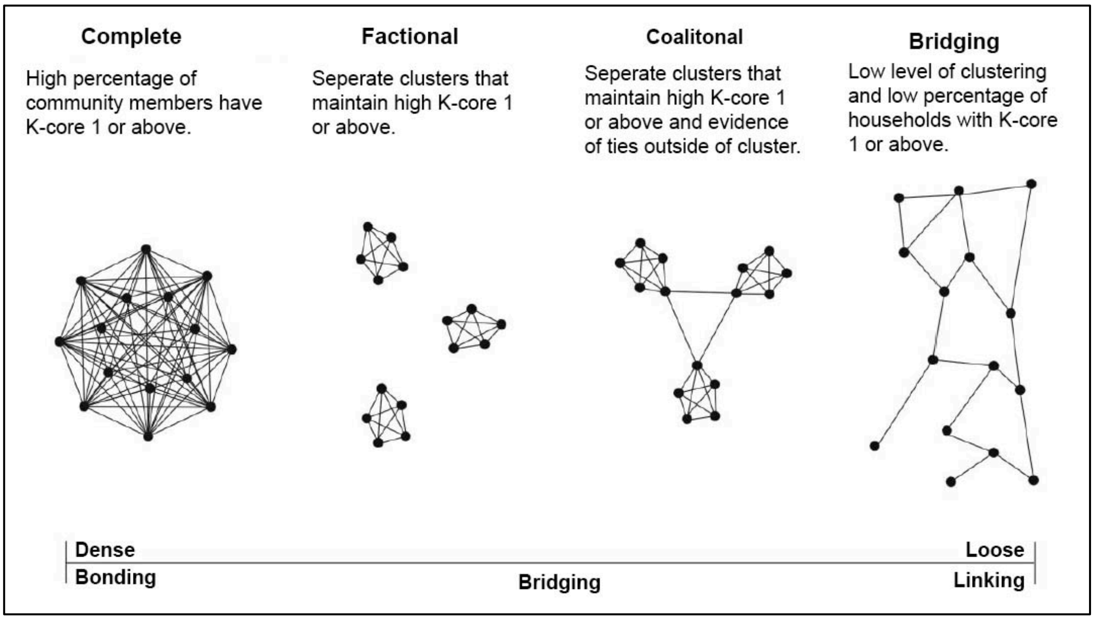


Figure 5.11 Network structure properties analysis framework. Source: Berman, 2014; adapted from Crowe, 2007.

It is argued that increased activity and denseness within networks stands as a foundation for community empowerment (Hoppe and Reinelt, 2010). As such, it was important for the research to understand how network density or 'modularity' impacts upon the mobilisation of resources and capacities within a network. Further, the research analyses the potential of 'key actors', to act as catalysts within the community, by facilitating the mobilisation of resources. Gephi software assisted

[15] Factional structures exhibit separate clusters that maintain high k-core 1 or above.
[16] Separate clusters that maintain high K-core and evidence ties outside of the cluster.

this process of analysis by providing tools to calculate and measure key network statistics such as network density and centrality (Wasserman and Faust, 1994). These descriptive values and measures are discussed in more detail in Appendix 4.1.

5.7 Indicator development and analysis

As discussed in Chapter 3 (Section 3.3.2), resilience is a process of iterative change and development in pursuit of an improved state. Due to its intangible nature, the concept of resilience is not directly observable (Keesssen, 2013). As such, the thesis seeks to identify proxies representative of the resilience process, i.e. characteristics of capacity building and resilience actions (emBRACE, 2015; Schipper and Langston, 2015). Further, the subtleties of resilience change are arguably best identified at the community level by discreet indicators (specific proxies), as opposed to by more generic, composite indicators (Spearman and McGray, 2011).

The first step in defining an indicator type is to ensure that it aligns with the framing of resilience as outlined by this thesis. As postulated in Chapter 3, resilience in describes a system's capacity to absorb disturbance whilst still maintaining or improving function of the system. Such a system is characterised by its ability to not only re-organise into a fully functioning state that existed before the disturbance, but also to transform as a consequence of learning and adaptation.

Proxy indicators can be classified into various categories, namely: process, output and outcomes (Bours et al, 2014). Outcome indicators assess resilience as the end goal by assessing the broader results achieved through the provision of resources and capacities. Similarly output indicators assess the extent to which a project has delivered certain resilience activities and their quality. Outputs and outcome indicators are highly specific thus reducing their transferability.

The definition of resilience describes the ongoing iterative process of resilience and as such is viewed as a process not an outcome (Section 4.4.2). Process indicators never intend to represent a state of completeness or an end result. Instead, they represent a position along the continuum of resilience (Cutter et al, 2008). In doing so they capture the incremental process of development and its contribution (both positive and negative) towards long-term resilience goals. Embedding the resilience indicators within post-disaster empirical case-studies, enables the research to capture the processes and drivers of post-disaster resilience action (embrace, 2012b; Keating et al, 2015). This approach captures pro-active action taken to prepare, mitigate, adapt and recover from an adverse event. Focusing on the process rather than the outcome enables the identification of incremental adaptive change over time which may ultimately lead to transformational change within the system.

Three approaches are available for the development and analysis of these discreet indicators, namely: deductive, inductive and normative through expert judgement (Hinkel, 2011). As outlined previously in Chapter 4 (Section 4.6.2), the theoretical framework acts as a scaffold to guide deductive analysis of resilience indicators aligned to the four core components. However, the analysis also permits axial coding (inductive) to ensure that new and case-specific indicators are not overlooked. As such a flexible abductive approach is undertaken, accommodating the context-specific nature of indicator development by including unique indicators outside of the pre-defined components (Figure 5.13). The approach described above highlights the flexibility and transferability of the framework to operate at a higher level across different scales and contexts, while still producing local level community specific indicators. As such, the framework serves two functions. First it operates as a higher-level heuristic device that can be transposed across various case-studies, to guide resilience building. Second, situated at the local level, the framework provides an approach to extract a list of indicators that are appropriate and meaningful at the community level. The following section explains further how this abductive process was carried out in practice.

5.7.1 Framework analysis in NVivo

This research adopts a systematic process to deriving qualitative resilience indicators from the Phase 2 qualitative information namely observation, semi-structured interviews (at the community and practitioner level) and SNA. To assist with this process, the structured ‘framework method’ as expounded by Pope et al (2000) was adopted in this research. This method was selected as a means to order the vast amount of textual qualitative data in the form of transcripts and observational field-notes. Framework analysis was chosen within this study due to its highly structured approach to synthesis and analysis of high amounts of data through techniques such as framework codes and matrices, as will be discussed later in this section.

The systematic approach guided by the framework method allows for the process of indicator extraction to be carried out in a structured manner. The key characteristics of this method are its hierarchical approach to components, subcomponents and indicators, with each key component forming one 'matrix' in the analytical framework. In this manner, the subcomponents and indicators emerging from the four components of the framework analysis in Chapter 4 are synthesised.

5.7.2 Extracting indicators from qualitative data

Stage 1: Transcription and familiarisation

Prior to carrying out the analytical steps, a significant task was to transcribe verbatim the community and practitioner level semi-structured interviews. The goal of these 'decontextualised conversations' (Bazaley, 2007:p47) is to be as true to the conversation as possible, yet pragmatic in dealing with the data. Once transcribed, the data were anonymised such that the participants' identity could not be revealed from the transcripts.

The coding process of interviews was assisted through the use of the Qualitative Data Analysis (QDA) package NVivo 11 (QSR, 2011). The software was chosen over other analysis software such as Atlas.ti and Ethnograph as the coding methods adopted by this thesis translate naturally into the NVivo analysis structure. Each audio-recording and transcript was reviewed iteratively through immersion within the text. This process allowed the researcher to become fully emersed with the interview discourse and forms an important step in data interpretation

Stage 2: Categorisation of codes

This stage involved the creation of 'cases' for the participants. Firstly, a socio-demographic profile of all participants was created, imported into the NVivo casebook and an attribute table developed. The codebook comprised age, gender, employment status and length of time living in the community. Essentially, this process created storage containers for each participant to hold the codes derived from the data during the coding stage 3. The cases enable data interrogation and the identification of patterns between specific demographics, such as age, gender, employment status and emerging codes.

Stage 3: Developing an analytical framework

Once the cases have been created, the coding process could begin. The transcripts, together with field notes, were read line by line, applying a 'code' or label to the text in NVivo. Codes highlight important elements of the interview discourse, acting as a shorthand interpretation of the data. The deductive approach adopted in this research means that these coded nodes can be assigned to the components derived from the framework, namely: risk, dynamic resources and capacities, connectedness and learning. A misconception associated with qualitative data analysis software is that the researcher relies on the software to interpret the data. On the contrary, the computer is used solely for its efficiency in organising data, not as a means to analyse or interpret the data (Krueger and Casey, 2000).

To increase the rigour of the analysis, some 'open coding'[17] was undertaken to ensure important passages of the data were not overlooked. By approaching coding in this manner, line-by-line coding can often highlight additional sub-components or indicators to consider which may remain unidentified as they do not directly 'fit' within the pre-defined framework. This approach to coding challenges the nuances revealed in the data, serving to make the analysis stronger. Figure 5.12 shows a sample NVivo 'coding matrix' hierarchy chart undertaken as part of the pilot study. The figure illustrates the distribution of coding across the four components, highlighting a relative lack in learning components.

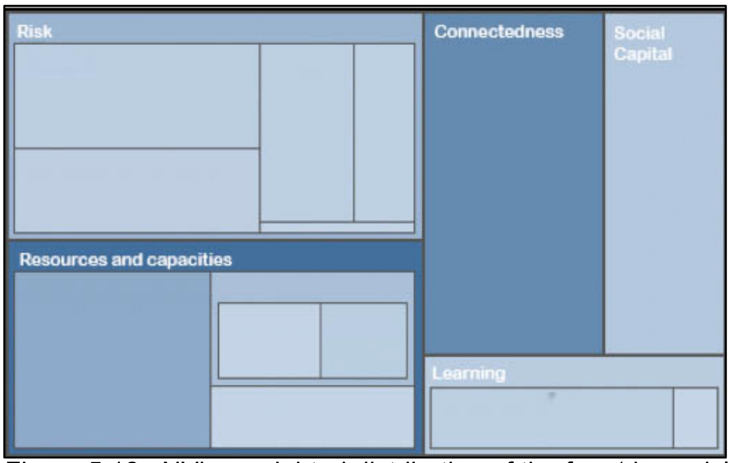


Figure 5.12a NVivo weighted distribution of the four 'dynamic' components.

[17] Open Coding involves inductively assigning labels or codes to observed data and themes (Strauss and Corbin, 1990).

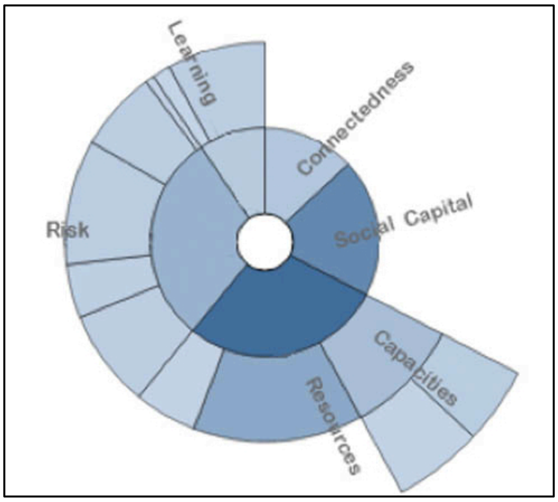


Figure 5.12b A sample NVivo 'coding matrix' hierarchy chart, highlighting the weighted distribution of the four 'dynamic' components.

Stage 4: Charting

This stage involves the organisation of the indicator data into charts (themes) by reference to a set of criteria (Table 5.4). Past literature criticises the quality and limited standardisation of data collection in disaster research (Redman, 2004; emBRACE, 2012b; UNDP, 2014). The system of indicator identification proposed in this research seeks to address this issue and ensure appropriate rigour is attached to the development of indicators.

Table 5.4 Structured data collection of empirically grounded resilience indicators.

Criteria for indicator selection	
1.	Indicator title and the component of the framework it is acting as a proxy for.
2.	Description of indicator
3.	Method of assessment: highlighting identified sub-indicators.
4.	Empirical evidence- Semi-structured interview, observation.
5.	Indicator influence on resilience: positive or negative effect
6.	Scale of application: Individual, community, regional

Table 5.5 Sample 'charted' indicator.

Sub-components	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
20. Integrated development planning	Catchment wide approach to planning and development	_Consultation on planning process _Appropriate land-use planning _Stricter planning approval and enforcement	Semi-structured interview	Positive or negative	Individual, community

This set of attributes was then applied to all subsequent transcripts. Attributes were grouped together within their theme codes using a tree diagram function within NVivo. This clearly indicates the defined codes and establishes and analytical framework to guide further analysis. Essentially the process maps the illustrated components of the theoretical framework into NVivo (Figure 5.13). It is likely that the analytical framework will undergo a process of iterative coding until no new codes emerge and a refined analytical framework is achieved.

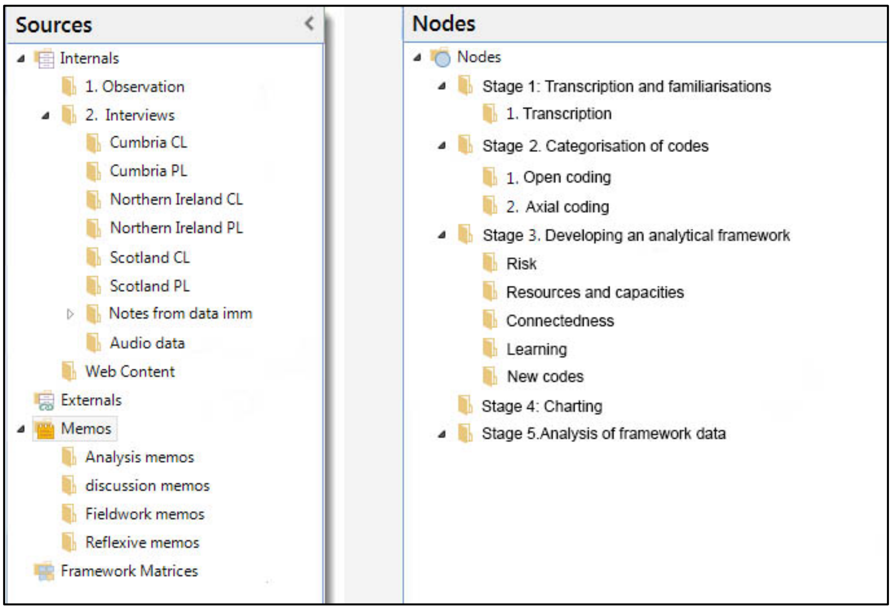


Figure 5.13 Overview of desktop in NVivo highlighting the mapping of the four components via the 'Framework method' within NVivo.

Stage 5: Analysis of framework data

The analytical framework was applied across the remaining transcripts. To ensure anonymity of the data, the 'codes' were assigned a number, which also helped the identification and management of data (Richie and Spencer, 1994). The main benefit of NVivo here was its ability to expedite the analysis process, and leave a 'paper-trail' so that data can be efficiently accessed later in more in-depth comparative analysis.

The Matrix output at stage 5 is the defining feature of framework analysis (Gale et al, 2013). The example matrix shown in Figure 5.16 provides a structure to assist data analysis by organising the data in: codes (cases); columns (codes); and 'cells' of synthesised data (Gale et al, 2013). Comparing and contrasting 'cases' and codes is an essential element of the data interrogation. The matrix assists data comparison “across cases as well as within cases”, producing highly structured and robust data outputs. The synthesised matrix data was subsequently displayed in a ‘charted’ spreadsheet (known as ‘indexing’), summarising the matrix data by category (1.1,1.2) from each transcript (Pope et al, 2000). This ‘indexing’ process served to reduce the dataset without sacrificing meaning or ‘feel’ of the interviewees’ words. Figure 5.16 is an example of illustrative quotations that help to explain why certain indicators were identified.

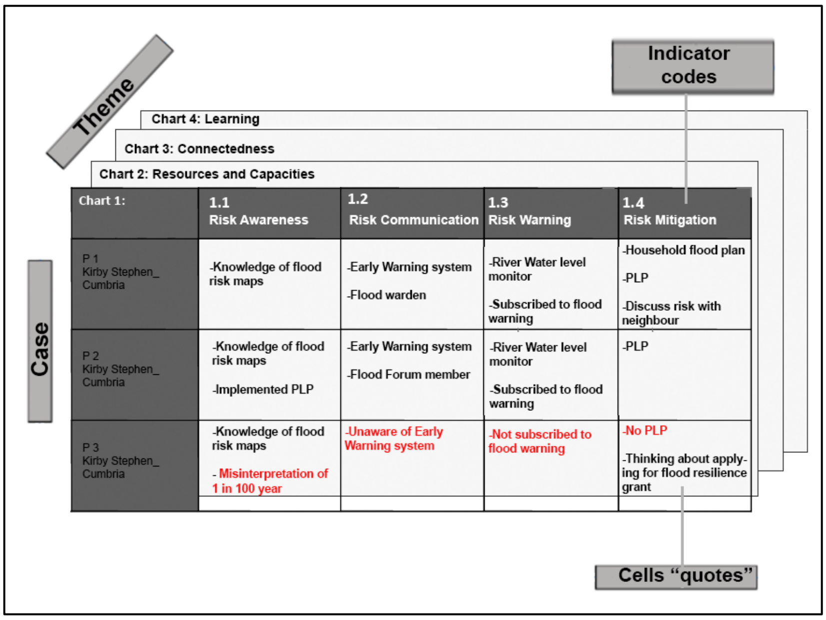


Figure 5.14 NVivo Matrix example from Cumbria case-study.

5.7.3 Final analysis

Located at the community level, a key objective of the framework is to derive indicators from ‘the bottom up’. Grounding the indicators based on the empirical evidence driven by the framework permits a meaningful understanding of resilience at the community level. The components within the theoretically anchored framework guided the extraction of indicators (deductive), however it did not determine them. Rather a flexible abductive approach permitted the identification of unique indicators through an additional layer of axial coding (inductive). Thus, the analysis provides a method by which locally contextualised indicators were related to a broader conceptual framework that can be transposed and applied within any community.

As the emerging data was collected and analysed, the mixed-methods approach began to show context-specific results of the different analyses. The quantitative methods assessed the contextual inherent (baseline) resilience of the community, based on its four assets/resources (human; environment; physical and economic). The role of the qualitative techniques was not to confirm these phenomena, instead it sought to uncover the respondents' subjective (and often contradictory) perceptions of resilience. This contextualised approach should not however limit transferability; rather, the higher-level framework guides the emergence of contextualised indicators at a lower scale, generating indicators which are both relevant and practically applicable at the community level. The issue with a context specific approach, is its potential to lead to less comprehensive and less transferable indicators (Yoo et al, 2011). However, the approach taken in this research mitigates against this risk by identifying empirically driven, context-specific resilience indicators from within the affected communities themselves. As such, the framework design can be considered cross-scalar, connecting community resilience (local level) and higher-level resilience within the one framework. The higher-level framework moves beyond the creation of isolated, community-level indicators, to actually understanding the causal mechanisms and operation of these indicators as part of a resilient system.

5.8 Data reliability

Validity refers to the extent to which research assesses what it purports to measure and how credibly the findings reflect what is being observed or analysed (Finlay, 2006). In order to ensure validity, reliability and credibility, certain precautionary steps were taken as discussed below.

5.8.1 Pilot study

A pilot study was undertaken to test the feasibility of the research by trialing a small-scale version of the study within Northern Ireland. It was considered important to test the adequacy of the research instrument before rolling it out across within the main case-study regions of Cumbria and North-East Scotland. In effect, the pilot enhanced the robustness of the study by adhering the researcher to practice and assess the effectiveness of the case-study methodology and allow for refinement of procedures where necessary before the large-scale study is undertaken. This pilot experience and the lessons learned from it are discussed in further detail in the following Chapter 6.

5.8.2 Triangulation

To gain a more accurate and balanced set of indicators, triangulation was incorporated into the study, as a means to assess and ensure the validity of the findings (Cozby, 2001). This was achieved by adopting a mixed-methods approach through which data were generated from a combination of semi-structured interviews at the community level and key informant interviews and secondary data sources. Interviews were conducted at both the community and practitioner (key informant) level and in doing so the research presents a balanced perspective of resilience within the case-studies. The representation of data from multiple sources enables the verification of findings and alternative perspectives thereby achieving a truer representation of the data.

5.8.3 Research ethics

Involving affected community participants in a resilience analysis prompts ethical issues such as respect for privacy, vulnerability and dignity (Geale, 2012). Cognisant of the importance of research ethics, all stages of the research were in compliance with the University of Ulster's research governance and ethics. Protecting the identity of social media users was a key ethical consideration in the SNA. Only social media that was 'open' was accessed (Boyd and Crawfoed, 2012) and the anonymity of participants was maintained throughout the study (Narayanan and Shmatikov, 2009). These steps ensured no harm or distress would be caused to the participants as a consequence of the study (British Psychological Association, 2013).

In addition, the research complied with a checklist of ethical issues based on appropriate moral and legal principles (Sanjari et al, 2014). To ensure validity of research findings a number of further considerations summarised in Appendix 6 were taken into account, in adherence with the University guidelines.

5.9 Conclusion

This chapter has outlined and justified the methods adopted throughout the empirical phase of this research. It began with an explanation of the framework that guided the methods employed to fulfill the objectives set out by this thesis. Adopting a critical realist stance within a case-study methodology, the chapter describes the selection of primary and secondary data sources and explains the sampling strategy used to recruit interviewees that possess attributes representative of a flood-affected community.

The chapter explains how the two aspects of the research were undertaken through a quantitative analysis of publically available official secondary data, while qualitative methods used observation, semi-structured interviews and SNA methods. Guided by the theoretical framework developed in Chapter 4, the analysis was structured on its four main components: risk; dynamic resources and capacities; connectedness and learning. Collecting data on corresponding indicators in a systematic manner assisted the extraction of contextualised resilience indicators.

Data validity concerns were addressed to ensure that data collection and findings accurately reflect reality. Acknowledging the importance of data validity and robustness, steps were taken to enhance data rigour by embedding the framework within empirical case-studies. Deriving empirical indicators in this manner mitigates against robustness criticisms often associated with other theoretical frameworks (Luthar,2000). As such, the framework bridges the gap between theoretical and practical frameworks, by deriving contextualised indicators to enhance resilience, whilst simultaneously validating the theoretical framework in practice.

From the outset of this chapter, the methodological process was guided by the research model proposed by Kagioglou et al (1998). Figure 5.17 provides an overview of the overall methodological design, illustrating how the chosen critical realist approach to a case-study methodology, sits within Kagioglou's nested model and is delivered through a mixed methods approach.

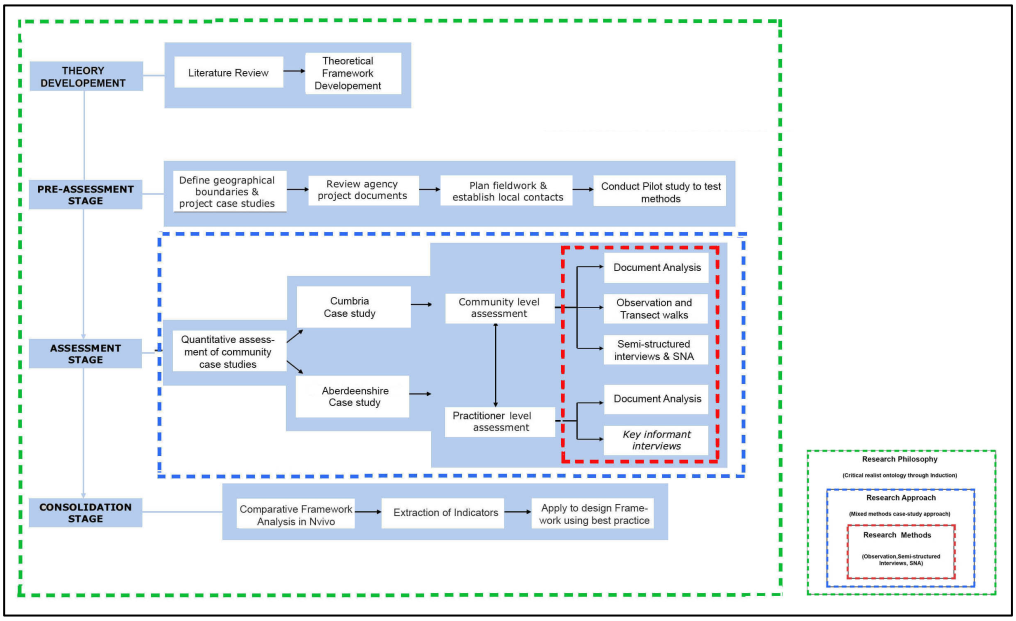


Figure 5.15 Overview of the final methodological process embedded within Kagioglou et al's (1998) research model.

Having outlined in detail the methodological approach of this thesis the next step was to pilot the various aspects of the research before utilising it a larger scale. The next chapter outlines the pilot studies undertaken in Northern Ireland and describes the lessons learned that shaped the final research instrument going forward to the main case-studies.

Chapter Six

Northern Ireland Case-study

6.1 Introduction

Chapter 4 described the development of a theoretically anchored framework to guide the research and allow for the extraction of empirically grounded resilience indicators (the 'Framework'). Chapter 5 outlined and justified the selection and application of specific techniques used to identify, collect and analyse data to populate this Framework. This chapter, detailing evidence from pilot case-studies, concerns the usability and effectiveness of the proposed Framework within a post flooding Northern Ireland context, before scaling across two further regional studies. It does so by testing the framework on a small-scale version of the main study, including participants from both a rural and urban context, similar to those to be recruited in the main case-study.

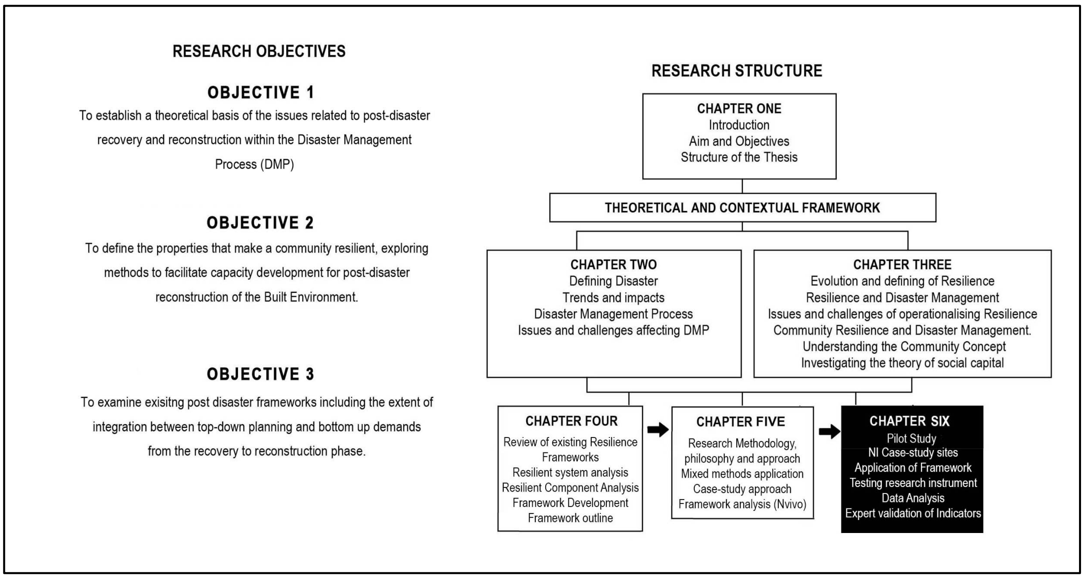


Figure 6.1 Position of Chapter 6 within the thesis structure.

The pilot chapter is structured to meet four main goals. Firstly, the pilot developed and tested the research instruments and identified logistical issues associated with the application of the chosen research methods in populating the Framework. To achieve this goal it first outlined the twin case-studies, representative of a Northern Ireland flood context (Section 6.2). The case-studies serve as the testing ground for the application and validation of the Framework.

Section 6.3 followed by outlining the application of the quantitative (Phase 1) of the framework, designed to evaluate the baseline resilience levels within both case-studies. Section 6.4 tests the qualitative research instruments through the application of the research methods adopted in the qualitative phase (Phase 2) of the Framework. In fulfillment of the second goal of the chapter, the research instrument was piloted in order to assess the appropriateness and practicality of the sampling frame and its corresponding recruitment approach (Section 6.4.1). In doing so, potential issues such as community access and 'buy in' from community members were highlighted as key factors. Section 6.5 allowed the researcher to practice and assess the effectiveness of the case-study methods. This process permitted refinement of procedures where necessary before rolling out the large-scale study (Kim, 2011).

Fulfilling the third goal, Section 6.6 served to evaluate the 'framework method' data analysis procedure by clarifying the effectiveness of the analytical methods and the richness of the emerging data. Finally the fourth chapter goal was achieved by determining the feasibility of the project in terms of the viability of extending it to a full-scale project. The chapter closes with Section 6.7 outlining reflections on the process and the refinement of procedures (where necessary) before application in the main case- studies.

6.2 Case-study sites in Northern Ireland

Chapter 5 outlined how a study of community resilience within recurrently flood-affected communities in Northern Ireland met the five criterion of case-study selection, proposed by this thesis (Table 6.1). Fulfilling criteria 1 and 2, both case-studies are located within significant high-risk flood areas, as identified through Northern Ireland Rivers Agency flood maps. Further, floods were found to be the costliest natural hazard in Northern Ireland (EM-DAT, 2016). Specifically, recurrent flooding exceeded the resources of flooded communities and required outside assistance from statutory agencies through the auspices of the Department for Infrastructure (DfI) (criteria 3, Table 6.1). The following sections introduce the twin case-studies of rural Fintona and urban East Belfast, which serve to provide an understanding of the varied fabric of both rural and urban settlements. Their location within Northern Ireland is illustrated on the map in Figure 6.2.

Table 6.1 Criteria for case-study selection as outlined by the thesis.

Criteria	Case-study selection
Criterion 1	Costliest disaster within Europe in terms of monetary costs
Criterion 2	Most frequent disaster within Europe as identified by the EM-DAT, thus providing opportunities for the implementation of lessons learned.
Criterion 3	Substantial enough in scale to require outside assistance thus providing development scale and yielding a sufficient level of detailed data.
Criterion 4	Include both an urban and rural settlement for comparison purposes.
Criterion 5	Disaster event has occurred in the recent past (< two years since the event).

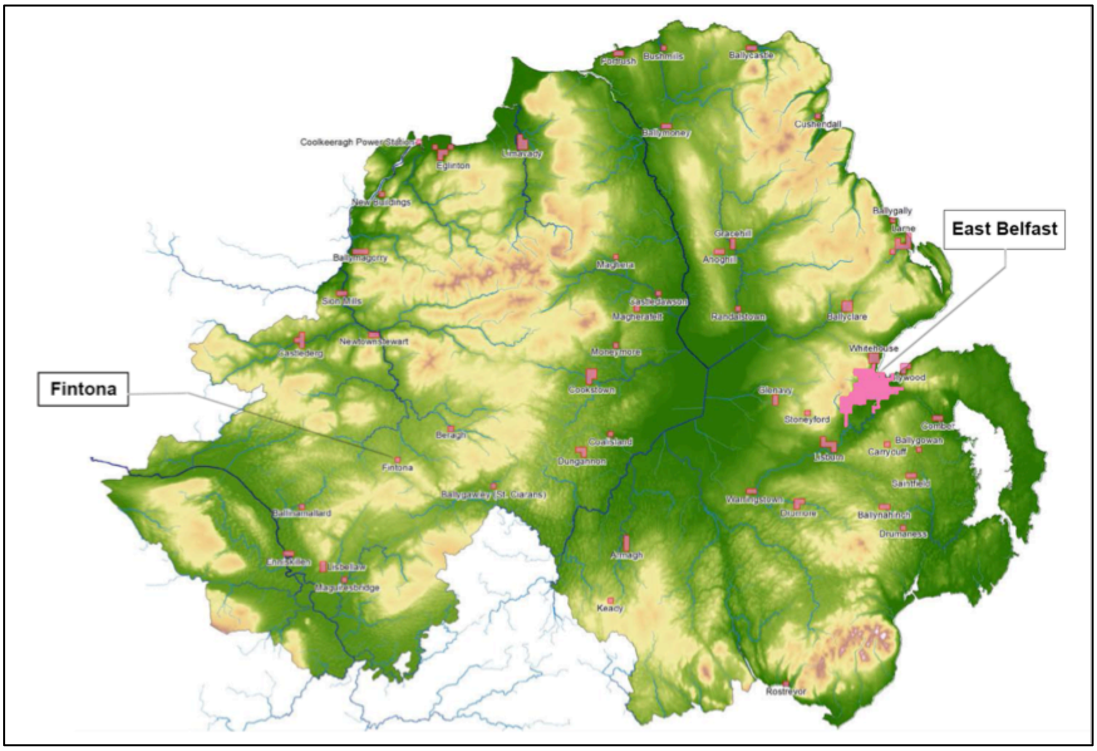


Figure 6.2 Location map of two pilot case-studies of Fintona and East Belfast in Northern Ireland[18]. Source: annotated from DARD, 2015a.

6.2.1 Rural case-study profile

The selected rural case-study (Criterion 4, Table 6.1) is the village of Fintona, a townland in County Tyrone, Northern Ireland. Fintona lies within the North Western River Flood Risk Management Plan area (DARD, 2015b). The mountainous topography contributes to the low average population density in the district, with the village comprising a population of just over 1,300 residents. It has a long history of

[18] Figure previously presented for explanatory purposes in Chapter 5, Figure 5.5.

recurrent flooding (criterion 2, Table 6.1), including highly irregular and unpredicted flash flooding in 2011 and 2014, exceeding the capacity of the community and requiring outside assistance (Criterion 3, Table 6.1) Since 2011, Fintona has experienced an increasing level of recurrent annual fluvial and pluvial flooding (Criterion 5, Table 6.1), during which homes and businesses have suffered (Figure 6.3), the village has become isolated as roads have become impassable and on at least one occasion elderly residents have been evacuated from their flooded properties. Further details on Fintona's flood profile are available in Appendix 7.1.

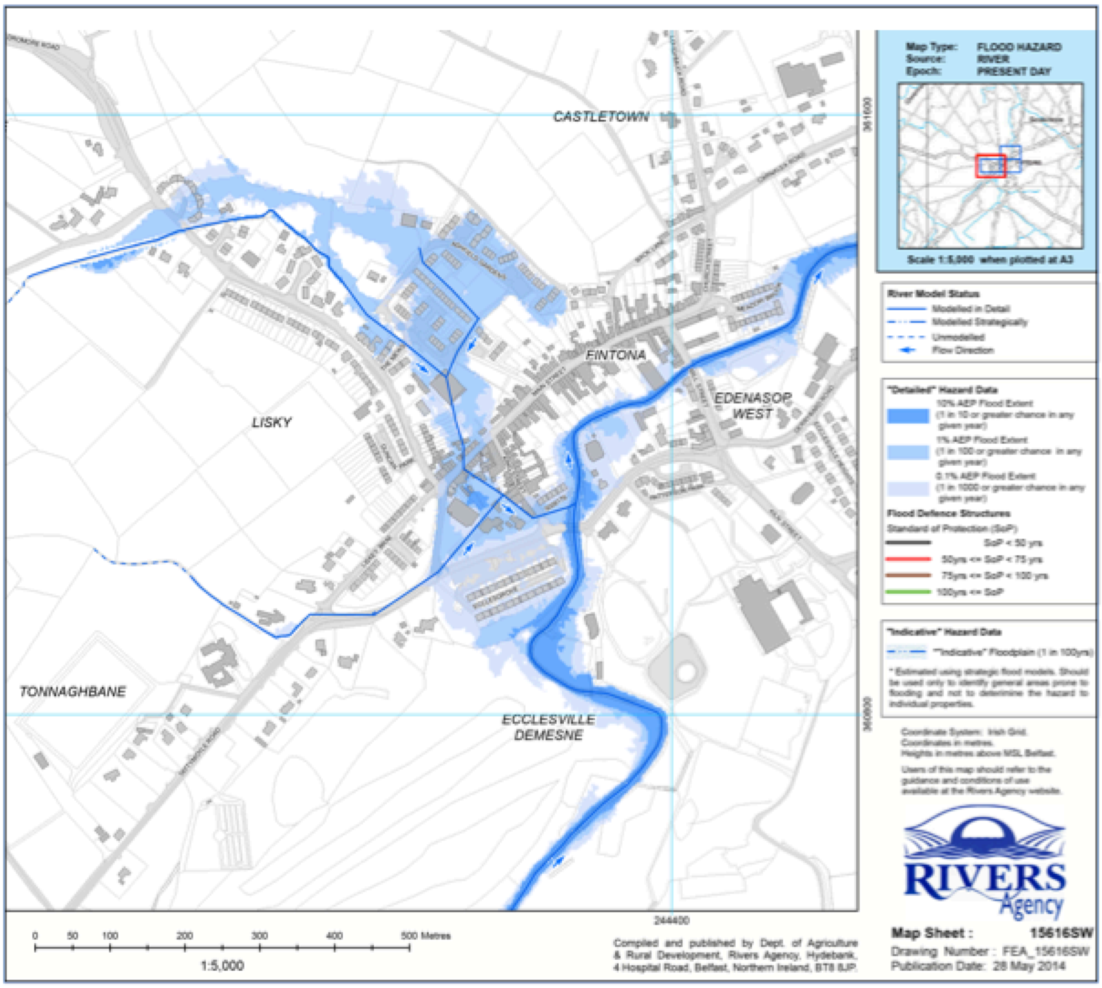


Figure 6.3 Flood Risk Map, Fintona Town. Source: Rivers Agency, 2017.

6.2.2 Urban case-study: Belfast

Situated at the western end of Belfast Lough and at the mouth of the River Lagan, Belfast is the capital of and largest city in Northern Ireland. At the 2011 NI census, Belfast city had a population of 286,000 making it an appropriate urban context within which to situate the Northern Ireland pilot (criterion 4, Table 6.1). In particular, the area of East Belfast was identified as a hot spot for recurrent flooding by the

Rivers Agency (criterion 2, Table 6.1), further evidenced by the high number of multiple flood relief payments received in the city (DOE, 2016; Appendix 13).

The Connswater Greenway is a project ongoing since 2014 that seeks to alleviate the extent of flood impact in East Belfast. Prior to this development, the area benefitted from little structural defence and the extent of flooding required outside assistance (criteria 3, Table 6.1). Through a £40 million investment, the project has created a 5.5 mile linear park through East Belfast, following the course of the Connswater, Knock and Loop Rivers, connecting certain open and green spaces. The communities of Sydenham, Clara Wood Park and Orangefield (Figure 6.4-6.5) are those most affected by recurrent flooding in recent years (criterion 4, Table 6.1) and as such the three communities comprise the East Belfast pilot case-study area. The areas collectively suffer from various flooding types including fluvial, pluvial, surface water and, in the case of Sydenham, tidal and sewage water flooding from the adjacent Waste Water Pumping Station. Despite the geographical proximity of the three selected communities in East Belfast, the socio-economic profile of each community varies from the top to the bottom quartile of the most deprived areas in Northern Ireland (NIMD, 2017). Further details on their socio-economic profile of the area is available in Appendix 7.

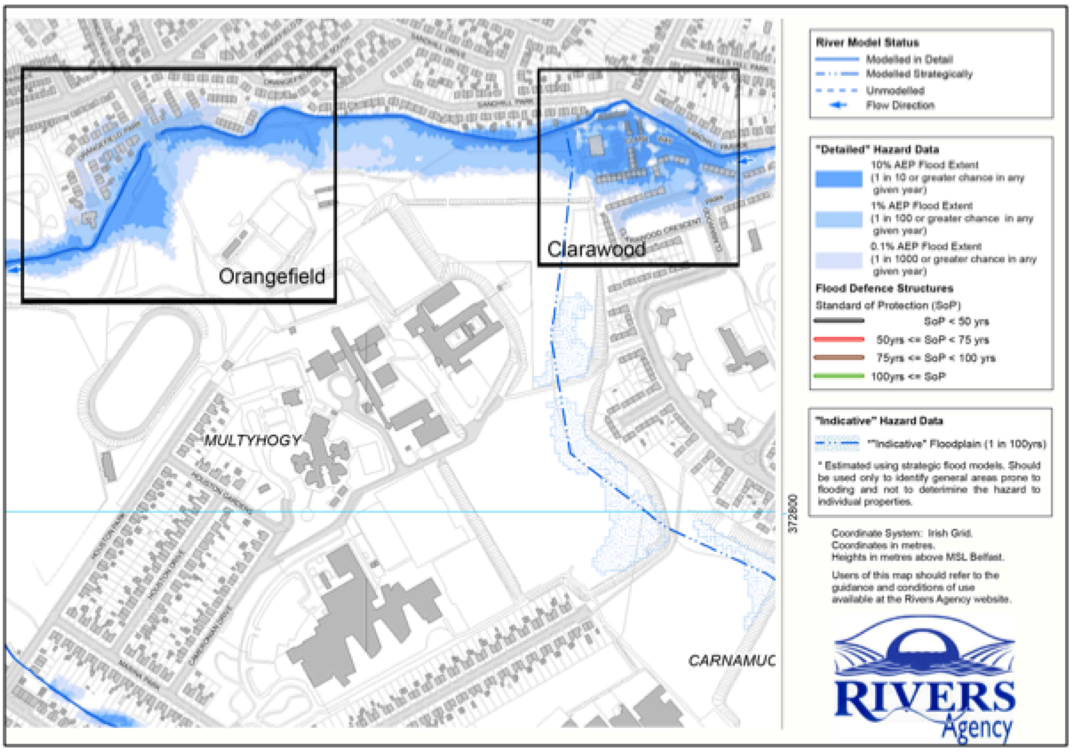


Figure 6.4 Clarawood and Orangefield flood risk map. Source: Rivers Agency, 2017.

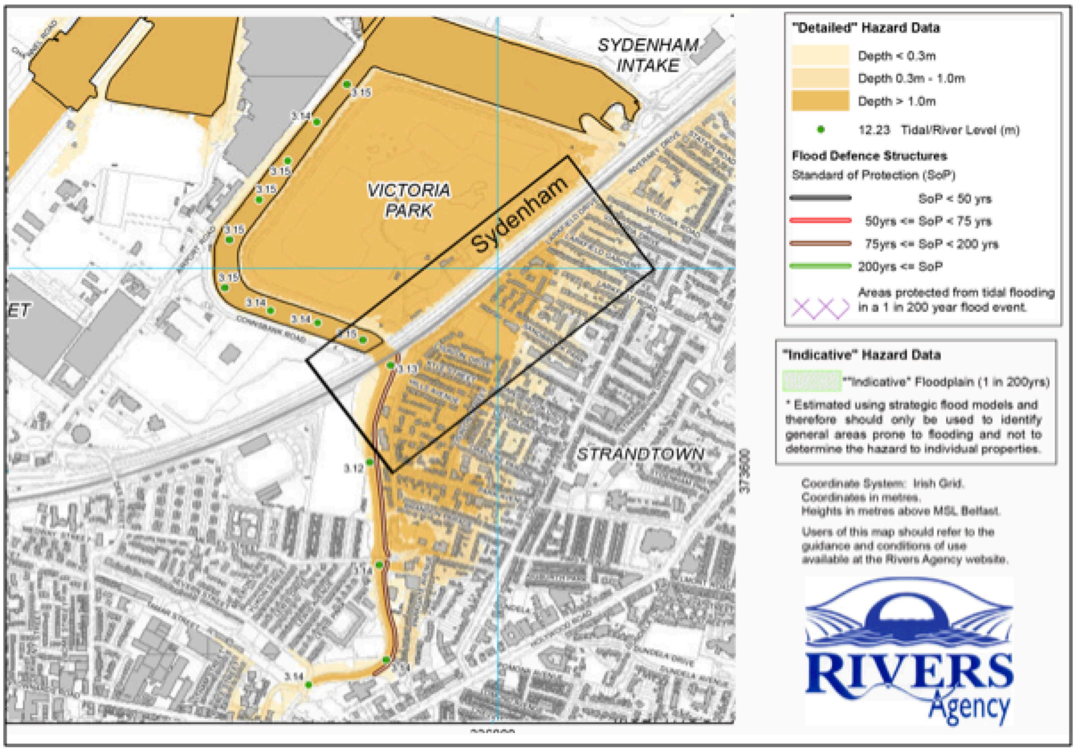


Figure 6.5 Sydenham tidal flood risk map. Source: Rivers Agency, 2017.

6.3 Application of the Framework phases and their methods

The primary intention of the proposed Framework (Chapter 5) was to produce a structure that could operationalise community resilience and, as such, it is imperative that the Framework can be delivered on a practical level. This section, therefore, concerns the testing of the Framework instrument and its associated methods, through a two-phase process as outlined in Chapter 5. This approach began with a top down quantitative assessment (Phase 1), relying on secondary data to assess the existing baseline resilience levels within both communities. The subsequent qualitative element (Phase 2) took into account perceived changes in resilience performance, through a qualitative assessment grounded in the present, thus revealing moments of resilience change and dynamics. The value of this two-phased approach reveals itself when indicators of community resilience identified from Phase 2 can be targeted to areas of low resilience identified from Phase 1.

6.3.1 Application of Phase 1 Secondary data

Application of research methods was sequenced in line with the critical realist approach identified in Chapter 5, thus assisting the researcher's familiarisation within the case-study sites prior to undertaking the qualitative fieldwork interviews. In this regard, Phase 1 began with a documentary analysis of secondary data including policy reports, planning documents and academic reports (as discussed in Chapter 5, Section 5.4.1, Appendix 3), gaining an overview of the flood risk landscape within Northern Ireland and an understanding of the availability of publically available data sets. Having established the socio-demographic profile through document analysis, the research moved towards the identification of suitable variables. As discussed in Chapter 5 (Section 5.4), the starting point for this identification of variables had its origins in Cutter et al's (2008) DROP model but was adapted to comprise the four community resources (physical, human, economic, environment), constituting Phase 1 of the theoretical framework (Chapter 5, Figure 5.9). The intention was to maintain the underpinnings of a capital based approach and adopt alternative variables within the literature. Accordingly, 36 variables were selected to represent the four community assets (Chapter 4, Section 4.7) but were adapted to a Northern Ireland flood context, to meet variances in policy and data set availability. The majority of variables selected were obtained from UK Census data however others were derived from statistical or environmental services data as listed in Table 6.1. The readily available publically available data permitted a certain amount of flexibility in terms of transferability across jurisdictions and sought where possible, to use the same variables for each case-study. However inevitably slight variations were inevitable, for instance, the use of different data scales (geographies) between the Northern Irish, English and Scottish variables. However, as explained in Chapter 5 (Section 5.4.2) differentiation was in name only and does not compromise case-study data comparison. Accordingly, Super Output Areas (SOAs) with a minimum of 1,300 residents and a mean of 1,900 were used. Further data variations stem from the fact that certain data is centrally held and remains with statutory organisations within the respective jurisdictions. For instance, historical flood map data are held by the Rivers Agency in Northern Ireland, the Environment Agency in England and Scottish Environment Protection Agency (SEPA) in Scotland. Multiple deprivation indexes and variables also comprise jurisdiction variances.

Further details on the variables are shown in Table (6.2) together with their corresponding data sources. Those highlighted in bold are indicative of the use of an alternative variable data source.

Table 6.2a Northern Ireland sample of individual variable and aggregated scores for the 'Physical' resource.

Community Asset:	Variable	Fintona	East Belfast	Data source
1. Physical resource				
Exposure	Flood risk from rivers (AEP)	0.6	0.01	Rivers Agency historical flood zones (DfI)***2**
	Flood risk from surface water (AEP)	0.2	0.2	Rivers Agency historical flood zones (DfI) ***2**
	Tidal flood risk (AEP)	N/A	0.8	Rivers Agency historical flood zones (DfI) ***2**
Access to services	**Proximity to services score**	0.2	0.8	Income: Multiple Deprivation Measure 2017 ***4**
	% of people working further than 30k from home	0.9	0.9	Belfast city Council/ Fermanagh and Omagh District Council.
Aggregate score per resource[19]		**2.8**	**3.5**	

Table 6.2b Northern Ireland sample of individual variables and aggregated scores for the 'Environmental' resource.

Community Asset:	Variable	Fintona	East Belfast	Data source
2. Environmental resource				
Environmental exposure	**Shortfall of playing pitches*7**	0.7	0.6	Sport Northern Ireland's (SNI) ***5**
	No. of public parks in 3 mile radius	0.7	0.8	Belfast city council/ Fermanagh and Omagh District Council
	Living Environment domain	0.4	0.4	Environment: Model- Multiple Deprivation Measure 2017 ***4**
Aggregated score		**3.0**	**3.0**	

Table 6.2c Northern Ireland sample of individual variables and aggregated scores for the 'Environmental' asset.

Community Asset:	Variable	Fintona	East Belfast	Data source
3. Economic resource				
Livelihood stability	% of working age that is employed	0.6	0.8	UK Census 2011
	% unemployed	0.3	0.7	UK Census 2011

[19] Score (0 least resilient, -1 most resilient)

Income	**Income Deprivation domain *4**	0.1	0.6	Multiple Deprivation Measure 2017 ***4**
	Employment Deprivation domain *4	0.1	0.5	Multiple Deprivation Measure 2017 ***4**
	% households owner occupier	0.6	0.8	UK Census 2011
Aggregated score		**1.6**	**3.4**	

Table 6.2d Northern Ireland sample of individual variables and aggregated scores for the 'Human' asset.

Community Asset:	**Variable**	**Fintona**	**East Belfast**	**Data source**
4. Human resource				
Community capacity	% of population over the age of 65	0.6	0.4	UK Census 2011
	% of population <15	0.5	0.6	UK Census 2011
	% of population stated general health was good or very good	0.7	0.7	UK Census 2011
Equity	% of college degree or higher (Level 4 or above)	0.4	0.5	UK Census 2011
	% of population with no or low qualifications (L1)	0.2	0.3	UK Census 2011
	Education, skills and training rank	0.5	0.3	Multiple Deprivation Measure 2017 ***4**
Social capital	**Crime and disorder rank**	0.3	0.3	Multiple Deprivation Measure 2017 ***4**
	% voter participation in last election	0.8	0.8	Electoral Office for Northern Ireland (2013) *6
Local knowledge	% from outside the area	0.6	0.6	UK Census 2011
Aggregated score		**2.5**	**1.9**	

6.3.2 Normalisation of variables

Once suitable variables were identified and altered to suit Northern Ireland data availability, the process of normalising the data for each variable began. As discussed in Chapter 5 (Section 5.4.3), due to the various raw counts and percentages, ratios and differences within the raw data, the values were adjusted from the different scales and a notionally common scale was established through normalisation. The process of normalisation was achieved through the min-max scaling technique, thereby providing a linear transformation of raw data whilst maintaining a link to the original data. It is a relatively simple technique that can specifically fit data in a pre-defined boundary. A process of rescaling was undertaken in instance where a high variable value equates to low resilience (Cutter et al, 2010).

As such, in instances where high scores equated to low resilience the dataset was inverted. For instance, taking the example of equity as a variable of the “Human’ resource, a measure of the ‘% of population with no or low qualifications’ was used. A high % in this case would mean low resilience and as such the raw counts needed to be inverted to be consistent with the other interpretations with zero equals low resilience and one represents high resilience. As outlined in Chapter 5, the choice was made to apply an equal weighting approach and there was no weighting of the corresponding variables (Section 5.4.3). The variables were summed within each of the four community assets and the average produced for each resource set (physical, human, economic, environment). Mapping the scores on a radar diagram served to highlight that a community’s resilience actions do not operate in isolation. Interlinking with Phase 2, the results serve to highlight resource areas where intervention would be of most benefit to the enhancement of overall resilience levels (Figure 6.6).

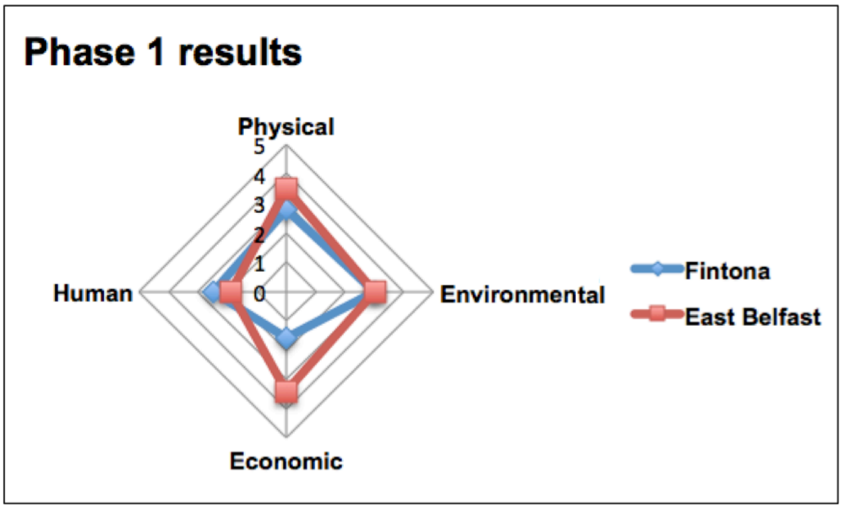


Figure 6.6 Phase 1 (baseline assessment) results, Fintona and East Belfast.

The marginal difference in ‘Physical’ resource scores between both communities was attributed to their comparable proximity of properties to a watercourse and susceptibility to surface water flooding. It was noted that urban Belfast benefited form close proximity to services.

Despite its rural nature, Fintona was found to have a similar ‘Environmental’ resource score to Belfast. This may be attributable to increased investment in recreational parks in Belfast (for example the Connswater Greenway project), and the fulfillment of recommendations from the ‘Active Places Report’ (Sports NI, 2009). The ‘Economic’ scores indicate that Belfast held higher economic resilience, as a consequence of its greater employment and homeownership rate, coupled with a lower deprivation ranking. By contrast, the lower economic capacity of Fintona would benefit from resilience action, as their already depleted economic resources do not have the excess capacity and resources needed to bounce back after a flood event (Kapucu et al, 2013).

An older population was found across both communities, thus explaining the low ‘Human’ resource in each location. Further, low educational achievement and high crime rates reduced the resource scores.

This statistical ‘snapshot’ assessment characterises baseline resilience ‘of place’ within both communities, and importantly served to highlight areas where resilience intervention is most needed. Phase 2 sought to capture indicators of performed resilience, identified through empirical case-studies where the dynamic and actionable attributes of resilience are played out in practice. The Phase 2 findings of performed resilience were subsequently reflected against the Phase 1 baseline data in order to determine which resilience interventions are needed and where these would be most effective. The following section details the application of this qualitative approach.

6.4 Phase 2 research methods

Maintaining the critical realist approach, the qualitative research methods in Phase 2 were arranged to assist the researcher’s grounding within the contextual reality of the fieldwork sites. In this regard, observation techniques (including direct observation and transect walks) were initially undertaken to provide a contextual overview of the case-study areas prior to undertaking further fieldwork methods. A guided transect walk accompanied by a facilitator was undertaken in Fintona, with examples of resilience recorded in a fieldwork journal. The walk served to provide critical insight into the contextual flood risk situation in the village and an understanding of the wider environmental issues affecting the communities. Association with a facilitator built trust and legitimacy with community members, assisting both the recruitment and interview process. By contrast, an accompanied transect walk was unfeasible in Belfast, as the recruitment of a willing facilitator via an identifiable community group proved unachievable. Nonetheless, information attributing to the wider profiling of the East Belfast flood risk area was highlighted on a map, by a community representative prior to undertaking the transect walk. This approach proved beneficial towards gaining an understanding of the area, however a critical insight into the issues affecting the communities was not forthcoming at this early stage in the pilot study due the absence of a facilitator.

6.4.1 Process of recruiting interview participants

The successful application of a research instrument lies in its capacity to recruit interviewees using an appropriate sampling frame. In fulfillment of the second goal of the chapter, the pilot served to test and develop the adequacy of the proposed research sampling frame, thus fulfilling the second goal of this chapter. A crucial early stage of the research and one that impacts on the selected methodology is the ability to create contacts and relationships with community members and statutory organisations acting on behalf of affected community members. As discussed in Chapter 5, a combination of snowball and purposive sampling was employed, thus allowing for the sample respondents to be chosen in accordance to the criteria outlined by the thesis (Chapter 5, section 5.6.5)

In the first instance, attention was given to establishing contact with a 'community champion' to assist recruitment at the community level. Acting as a facilitator the 'community champion' served to gain 'buy in' from the community (Pasick et al, 2010). With initial contact established, a meeting with the willing facilitator was organised to explain the purpose and procedure of the project and ascertain their willingness to assist with the recruitment and distribution of expression-of-interest forms amongst interviewees. As a gesture of goodwill in appreciation of research participation, it was agreed that the results of the research would be compiled into a summary and made available to the community.

The existence of an established Flood Resilience Group (FRG)[20] in Fintona eased the recruitment process considerably through its network of key stakeholders involved in flood risk management. The organisational structure and contacts attached to this group provided the means by which to engage and recruit potential respondents. Participants fulfilling the selection criteria (Chapter 5, Section 5.6.5.) were identified with the assistance of the facilitator and expression-of-interest letters were distributed among them. In contrast, in the absence of a facilitator in East Belfast, gaining buy-in at the community level proved challenging. The lack of a Flood Resilience Group (FRG) was attributable to the dispersed nature of the affected properties, traversing different sub-markets and different communities. Consequently, recruiting a facilitator active in all three East Belfast communities was not achievable, thus necessitating a strategy of engagement with multiple stakeholders from within all three communities. Despite the existence of a residents' association, no representative could be found in the Clarawood community. A facilitator was recruited in Orangefield and Sydenham, however the absence of an attachment to a FRG limited the extent of their connectedness within the flood risk community and is reflective of the comparably lower number of recruited participants (Table 6.3). A key learning outcome from this phase of the pilot highlighted that without gaining 'buy in' through a willing facilitator, engagement and participation at the community level would prove an unviable task.

Table 6.3 Interview logbook of community-level participants in East Belfast and Fintona.

Case-Study Area	**Location**	**Interviews conducted**	**Interview codes**
East Belfast		**16**	
	Sydenham: Park avenue and Lisavon Street	4	B 1-4
	Orangefield: Orangefield Drive and Orangefield Lane.	4	B 5-8
	Clarawood: Clarawood Park and Clarawood way.	4	B 8-12
Fintona		**12**	
	Fintona Town	12	F 12-28
	Total	**28**	

[20] A Flood Resilience Group is a community based group or 'community of practice', who join together in pursuit of a common goal to reduce flood risk. They often work in partnership with higher-level authorities.

Identifying practitioner interview participants adopted a similar purposive recruitment strategy, based on respective roles and responsibilities within organisations. A mapping exercise was conducted to identify individual stakeholders representative from three key areas namely; policy-prevention arena, emergency management; recovery and reconstruction; and industry or independent professionals involved in flooding (Figure 6.7).

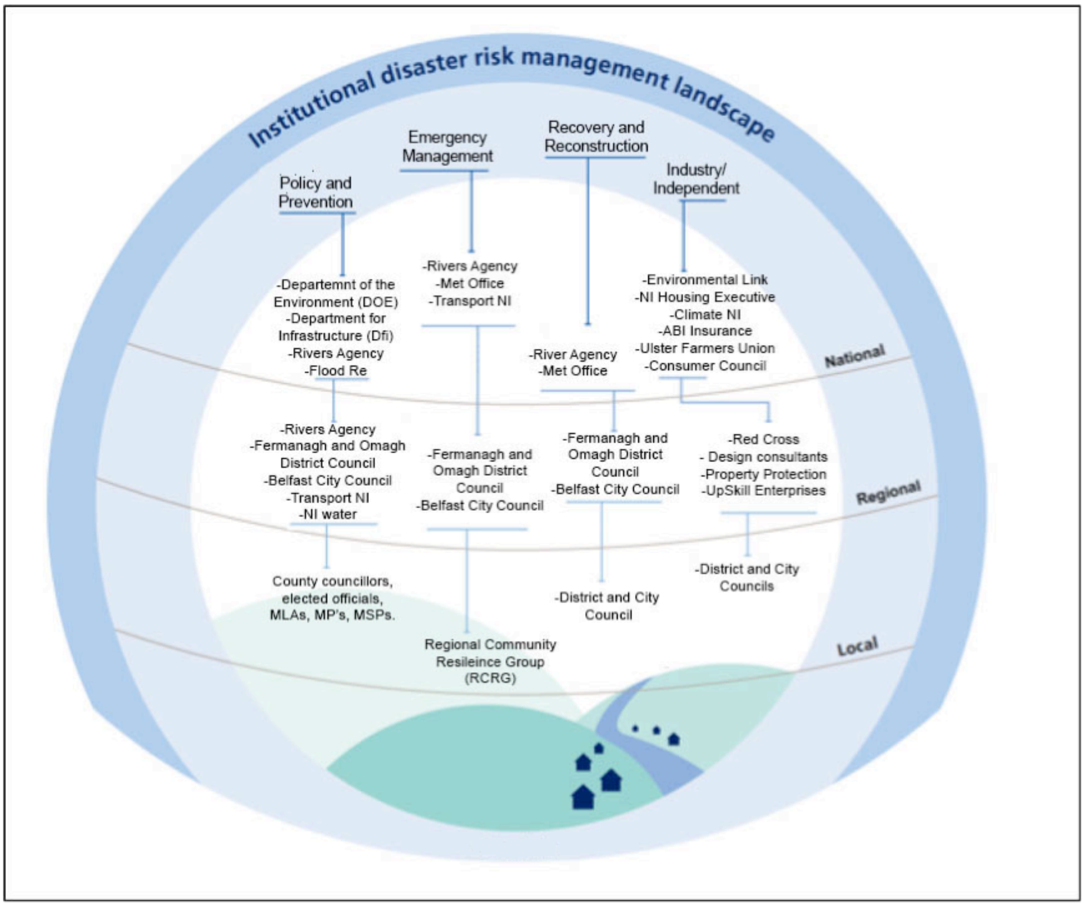


Figure 6.7 Targeted practitioners and organisations for Key informant interviews. Adapted from JBA, 2015.

Those stakeholders with responsibility for flood risk management were identified from within the policy-prevention arena. The body with primary responsibility for flood risk in NI is The Department for Infrastructure (DfI), however no single Executive Department is responsible for all types of flooding (i.e. fluvial, pluvial). Instead a long-standing ‘Bateman Formula’ determines that central government has a responsibility to construct, maintain and repair defenses in their possession (Rivers Agency, 2013). As such, interviewees were sought from the Department for Infrastructure (DfI) Rivers Agency (RA) who are responsible for the maintenance of 16 miles of sea defenses and tidal barriers. Transport NI (part of DfI) are responsible for the protection of the public road and rail network. Further, in the rural context of Fintona, the Department of Agriculture, Environment and Rural Affairs (DAERA) is charged with protecting the aquatic environment, including river basin management.

These organisations also play a critical role in 'emergency management' as well as in the 'recovery and reconstruction' arenas. In particular, at the national level, the Rivers Agency, Met Office and Transport NI contribute heavily to flood risk management activities. At the regional and local level, representation from the district and city councils was sought. In addition, the voluntary 'Regional Community Resilience Group' (RCRG), chaired by local government and the Rivers Agency, works collaboratively with the affected communities across Northern Ireland to enhance their resilience.

Independent bodies and industry professionals involved in flood risk management and active in relevant research were also identified. Participants were sought from 'Environmental Link', a forum and networking body for organisations interested in environmental issues such as flooding in Northern Ireland. Also participation was sought from The Regional Community Resilience Group (RCRG), acting as a multiagency partnership framework for Northern Ireland, which was established as the community voice towards flood resilience. The Northern Ireland Housing Executive (NIHE) is the strategic housing authority for NI. A percentage of their tenanted properties are located within flood risk areas and, as such, the NIHE is responsible for the provision of Property Level Protection (PLP)[21] to its tenants within those areas. The Association of British Insurers (ABI) is the voice of the insurance industry across the UK, covering over 94% of the insurance business in the UK (ABI, 2016). A NI ABI member was sampled to provide more specific insight into insurance company procedures with regard to flood risk. In addition, the opinion of the farming community was sought through the Ulster Farmers Union. Finally, academics involved in both the policy sphere and flood risk modeling were identified for their roles in adaptation to climate change and flood risk impacts. All potential

[21] Property Level Protection describes measures taken to protect individual properties from the impacts of flooding. Such interventions extend beyond relying on sandbags, to include tools such as Homeowner Emergency Plans, flood doors and air vent covers to enable homeowners to take more effective action to manage their flood risk.

participants were emailed an expression of interest form outlining the nature of the study and subsequently followed up with a phone call. Table 6.4 presents the number of practitioner level interviews conducted; a further codebook of all organisations interviewed is presented in Appendix 8.

Table 6.4 Number of practitioner level interviews.

Practitioner level interviews	Policy-prevention	Recovery and Reconstruction	Emergency management	Industry and independent
Number of interviews	2	8	6	9

6.5 Testing the research methods

Returned expression-of-interest forms, including the contact details of the potential interviewees, served as the starting point for making contact with and confirming interviewee numbers. Contact was made via telephone to outline the purpose of the proposed interview, its procedure and offered the opportunity for the participant to ask any clarification questions or raise any concerns. Once confirmation of participation was agreed, arrangements were subsequently made to hold the interview at a public venue, at a time convenient to the interviewee and (where relevant) in the presence of the community facilitator.

Prior to commencing the interview, the participants were read the procedure of the interview and were asked permission to audio record the interview in accordance with Ulster University's research governance procedures. The questions were tested on a sample to ensure they were clear, unambiguous and designed in a way that allowed for the uncovering of explanatory and causal mechanics of resilience actions (Agee, 2009). Questions posed were designed to elicit their understanding and perception of the flooding event and their level of risk awareness, capability and self-efficacy to recover and reconstruct their lives after a flood disaster event. The questions sought to assess the variables that influence such capacity or lack thereof, and their perceived needs for different kinds of support to enable them to recover.

Throughout the interview process, the questions were evaluated in relation to a number of key criteria namely:

- Is the language appropriate, direct and familiar to the interviewees?

- Do the questions try to cover more than one point or are they ambiguous in nature?
- Could any questions be deemed as leading questions? Is emotive language used?
- Are the questions designed appropriately for the intended audience?
- Do the questions give an adequate range of responses?
- Do the questions encourage personal viewpoints as opposed to giving socially acceptable answers?
- Can questions be shortened without losing the intended meaning?

On average the community level interviews lasted 20 minutes[22] with the longest lasting over an hour. By contrast, practitioner level interviews ranged from 45 minutes to 2 hours. The process of interviewing was an iterative progression whereby reflective notes made after each interview were incorporated into the amended interview question set. As the interview process progressed, insight was gained on the phenomena under study, resulting in case-specific adjustments to prompt questions. In doing so, the contextual richness of data output was improved. It was difficult to ascertain the knowledge and expertise levels of practitioner level participants prior to interviews. As such, further prompt questions were included, so as to maintain the appropriateness of the questions to the particular audience. In doing so it avoided asking questions which were beyond the expertise of the respondent, thus mitigating the feeling that the respondent was not suitably qualified for the interview.

The process of listening and reading through transcript recordings improved the structuring and the ease of movement between themes in the question set (Gale, et al, 2013). Further reflection on the questions, together with the process of verbatim transcription, led to amendments such as the exclusion of overlapping questions or those that did not elicit expected responses leading to re-wording or re-scaling as appropriate. Overall the process refined the interview technique prior to the main case-studies and advanced knowledge of the phenomena under study. A full list of the amended questions following the pilot is included in Appendix 9.

[22] Interviews were conducted during the recovery period, when emotions were still high, and on two occasions the interview had to be stopped as it was deemed unethical by the researcher and did not comply with good practice guidelines surrounding vulnerable participants. Those that found the interview emotional commented that it was the first time someone had asked them how they experienced the event, as their main priority had been on coping not reflecting.

6.6 Data analysis (Framework method in NVivo)

The intention of Phase 1 was not to enhance resilience in itself, however highlighting areas of low resilience in combination with instances of performed resilience from Phase 2, served to inform what change was needed most. As such, the baseline assessment of resilience founded on existing community assets served to highlight areas of resilience weakness as illustrated in the radar diagrams (Figure 6.6). To this end, mapping resilience weaknesses identified in Phase 1 against indicators of performed resilience in Phase 2, provides the opportunity to implement resilience strategies and resources directly where the greatest resilience deficit lies.

This section extends beyond an analysis of data collection to include analysis processes, thus fulfilling the third goal of this chapter. The primary objective of the data analysis was to extract resilience indicators and determine their location within the theoretical resilience framework (Figure 4.13). In doing so, it permits the drawing of inferences about the operationalisation and practicality of the framework itself.

In accordance with the structured 'Framework Method' of data analysis described in Chapter 5, the process began with Stage 1 'Transcription and Familiarisation' of the interview recordings and field-notes. Initiated through a process of verbatim transcription of the recorded interviews, it allowed for familiarisation of the data. Due to the background noise associated with interviews in public spaces, the transcription was only possible with the assistance of notes taken during the interview. Consequently, transcription proved particularly time consuming and highlighted an underestimation of the time required to transcribe all the interviews.

Stage 2 comprised the 'Categorisation of the Codes' and involved the creation of 'cases' for the participants. A codebook was created in NVivo for both case-studies in which the demographic data of participants was inputted so as to allow for interrogation and identification of patterns later in coding Stage 3. Essentially this stage set up 'storage containers' (known as cases in NVivo), in which information derived from the coding stage could be stored for interrogation. This process enabled NVivo to compare codes across the different cases, namely: gender; age; time in community; number of people in the household; location and flood experience (Table 6.5).

Table 6.5 NVivo case classifications.

A : Gender	B : Age profile	C : Time in community	D : People in household	E : community location	F : Flood experience
Male	18-45	6-10 years	Business	Fintona	3 times and above
Female	65 and above	6-10 years	2 adults	Fintona	1st time
Male	18-45	11-20	Business	Fintona	3 times and above
Male	18-45	11-20	Business	Fintona	1st time
Male	18-45	11-20	2 adults	Fintona	3 times and above
Female	46-64	6-10 years	1 adult	Fintona	1st time

Stage 3 describes the process of developing a working "Analytical Framework". After familiarisation with the transcripts and field-notes, the interview texts were considered on a line by line basis in order to apply 'codes' to data deemed as important and relevant to the components of the theoretical Framework namely; risk; resources and capacities; connectedness and learning (Figure 6.8). Aside from this deductive process, a process of open coding was undertaken to understand the causal mechanics of resilience actions. This abductive approach did not reveal new components within the two case-studies, however it did identify new sub-components outside the original framework as highlighted in Table 6.6. A learning outcome from this process generated an awareness of the time demands of data coding and the need for sufficient time to be allocated for the main case-studies. A list of the synthesised 21 indicators are presented in Table 6.7 below.

Table 6.6 Working analytical framework of allocation indicators identified within the Fintona and Belfast case-studies.

Nodes

Name

- Connectedness
  - 13. Social capital
    - Collaboration
    - Self-organisation
    - Member of a resileince group
  - 14. Integration of Social networks
    - Bonding ties
    - Bridging ties
    - Linking ties
  - 15. Sense of belonging
    - Unwilling to relocate
    - Participation inn resilience action
    - Time spent in community
  - 16. Trust in Authorities
    - Higher level collaboration

Table 6.7 Working analytical framework of allocation indicators identified within the Fintona and Belfast case-studies.

Component	Sub-components
Risk awareness	
1.	Risk awareness
2.	**Risk communication**
3.	Risk acceptance and mitigation
4.	**Risk experience**
5.	**Risk knowledge**
Dynamic Resources and Capacities	
6.	Self organisation
7.	**Capacity building/up-skilling**
8.	**Insurance**
9.	Collaboration
10.	Innovation
11.	Self-efficacy
12.	**Flood responsibility**
Connectedness	
13.	Social capital
14.	Integration of Social networks
15.	Sense of belonging
16.	Higher-level trust
Learning	
17.	**Problem Definition**
18.	Critical Reflection
19.	Experimentation
20.	Transfer of (local) knowledge
21.	Monitor and review

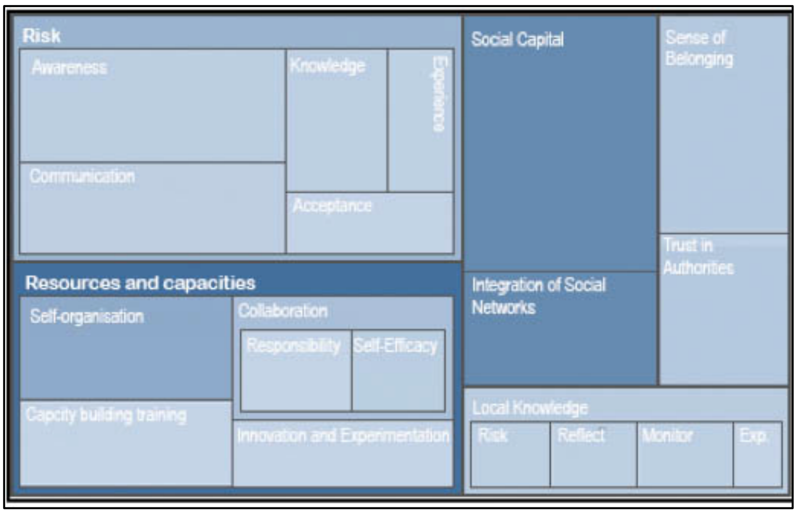


Figure 6.8 Illustration of working analytical framework and allocation indicators within Nvivo.

The organisational focus of Stage 4 'Charting' allowed for the indicator data to be compiled in a structured manner under component themes. An example of a charted indicator is presented in Table 6.8 below. Identified indicators were categorised in accordance with a set of attributes within their component theme (Chapter 5, Section 5.7) and applied to all subsequent transcripts from both case-studies. Attribute categories were set within the spreadsheets (Tables 6.9-6.12), stipulating the indicator title, method used to obtain the indicator, the relationship to the resilience (positive or negative), the scale of application as well as context and hazard specificity. Systematically collecting the indicator data in Stage 3 allows for the pragmatic but informed identification of the indicators within the Framework. The diversity of indicator outputs (Table 6.7) reflects the ability of indicators to vary across scales (urban-rural) and contexts depending on the impact sustained.

Table 6.8 Stage 3 identification of indicators.

Sub-components	Indicator description	Assessment/criteria	Empirical evidence	Effect on resilience	Scale
17. Problem Definition	Considering options to mitigate risk as a consequence of past flood experience	Include risk mitigation measures in community resilience plan	Semi-structured interview	Positive	Individual, community

Stage 5 comprised the application of the above mentioned analytical framework, involving the indexing of subsequent transcripts. Each code was assigned a number or abbreviation for easy identification (ensuring anonymity and saving time). Expedited through the capabilities of NVivo, the process provided an effective means to store and collate the indicator data making it accessible for analysis. To this end, the following section presents the synthesised indicator results representing the four main components (Tables 6.9-6.12).

Table 6.9 Risk component indicators.

Components	Indicator	Indicator description	Assessment/criteria	Empirical evidence	Effect on resilience	Scale
Risk	1. Risk Awareness	Awareness of risk and vulnerabilities in the area	Knowledge of whether property lies within a risk risk zone as indicated on a map	Semi-structured interview	Positive and Negative	Individual, community
	2. Risk Communication	Existence of Early warning system	Existing and utilised	Semi-structured interview	Positive	Individual, community
	3.Risk acceptance/ Mitigation	Existence of community emergency plan/Signed up for receiving flood warning.	Existing and practiced/Receive texts, email or phone warning	Semi-structured interview/ Observation	Positive	Individual, community
	4.Risk experience	Active flood memory- previous hazard experience	Knowledge about past flood events	Semi-structured interview	Positive	Individual, community
	5.Risk Knowledge	Knowledge and understanding of the cause of flooding	Monitor and review flood risk/ local knowledge	Semi-structured interview	Positive	Individual, community

Emerging ‘risk’ indicators support the argument that risk awareness is a key driver of resilience building (Conrad et al, 2006). Both pilot case-studies revealed indicators representative of the complex link between risk awareness (Indicator 1) and subsequent resilience action. Interview discourse indicated those most vulnerable to risk were not in receipt of a flood alert warning, thus highlighting the importance of risk communication (Indicator 2) as an indicator of resilience building. Poor communication was attributed to a corresponding low social connectedness and reluctance to engage with risk communication technology, thus eroding resilience further.

Knowledge of flood maps and the location of their property within such maps is a known indicator of risk awareness (Cutter et al, 2012). This proxy indicator evidenced that 86% of residents reported that they were unaware they resided in a flood risk area until they were flooded for the first time. Hence the apparent correlation between flood awareness (Indicator 1) and risk knowledge (Indicator 5) is related to previous flood experience.

Chandra et al’s (2011) assumption that risk experience leads to improved resilience action proved positive in the flood prone areas of both Fintona and East Belfast, whereby mitigation efforts (Indicator 4) such as early warning systems and community flood plans were available. In the case of Fintona, mitigation efforts were further identified through the introduction of an active FRG. By contrast, risk awareness and knowledge (Indicator 1) was also seen to reduce resilience, whereby those aged 65 and above felt the need to bury their head in the sand for fear it “*would get in on them*” (F12). Consequently, this had a negative knock on effect on risk mitigation (Indicator 4) uptake.

The second framework component ‘Resources and Capacities’ is dynamic in nature as illustrated in Table 6.10.

Table 6.10 Resources and capacities component indicators

Components	Indicator	Indicator description	Assessment/criteria	Empirical evidence	Effect on resilience	Scale
Resources and capacities	6. Self-organisation	Ability of thecommunity to come together to achieve a common goal	Evidence of a resilience/flood group or an active residents association	Semi-structured interview	Positive	Individual, community
	7. Capacity building/ up-skilling	Resilience training offered to Authorities and community leaders	Resilience training offered to Authorities and community leaders	Semi-structured interview	Positive	Individual, community
	8. Insurance	Uptake of Insurance resource	Percentage of Insurance uptake	Semi-structured interview	Positive	Individual, community
	9.Collaboration	Ability to collaborate horizontally with Agencies	Frequency of interaction with Agencies	Semi-structured interview/ observation	Positive	community
	10.Innovation	Innovative and experimental actions as a response to risk	Evidence of calibration of risk to proactive resilience actions	Observation	Positive	Individual, community
	11.Self-efficacy	Individual self belief	Membership of Resilience Group	Semi-structured interview	Positive	Individual, community
	12. Flood responsibility	Personal flood mitigation actions	Installing property level protection, insurance, signed up to early warning.	Semi-structured interview	Positive	Individual

Evidence of the mobilisation of 'resources and capacities' was most prominent among those with past flood experience, particularly those afflicted by annual recurrent flood events. Self-organisation (Indicator 6) led to proactive responses by the affected community in order to expedite the recovery process, thus demonstrating an understanding of the demands this phase placed on both the community and statutory agencies. Further, it indicated an acknowledgment of the desire to transform out of the recovery phase in an expedited fashion through mitigative resilience action in advance of the next potential disaster.

Community resilience actions presented themselves through both technical (internal changes to property) and behavioural (moving furniture upstairs) measures at the individual level. Recurrent flood victims were notably more likely to take responsibility (Indicator 12) for their own recovery in comparison to first time flood victims, through resilience and resistance measures and in doing so enhanced the feeling of preparedness ahead of potential future flood events. Insurance (Indicator 8) uptake was highest among repeat flood victims, highlighting how insurance as a resource is a critical part of flood recovery. Cited in the literature as having the potential to act as a resilience tool (Surminski and Eldridge, 2015), the case-studies found that (financially) insurance helped the recovery process however technically its inflexibility to accommodate Property Level Protection (PLP) and replacement of like for like, rendered it a barrier to long-term resilience building. NVivo codes of the behavioural and technical resilience actions mentioned above, are illustrated in Figure 6.9.

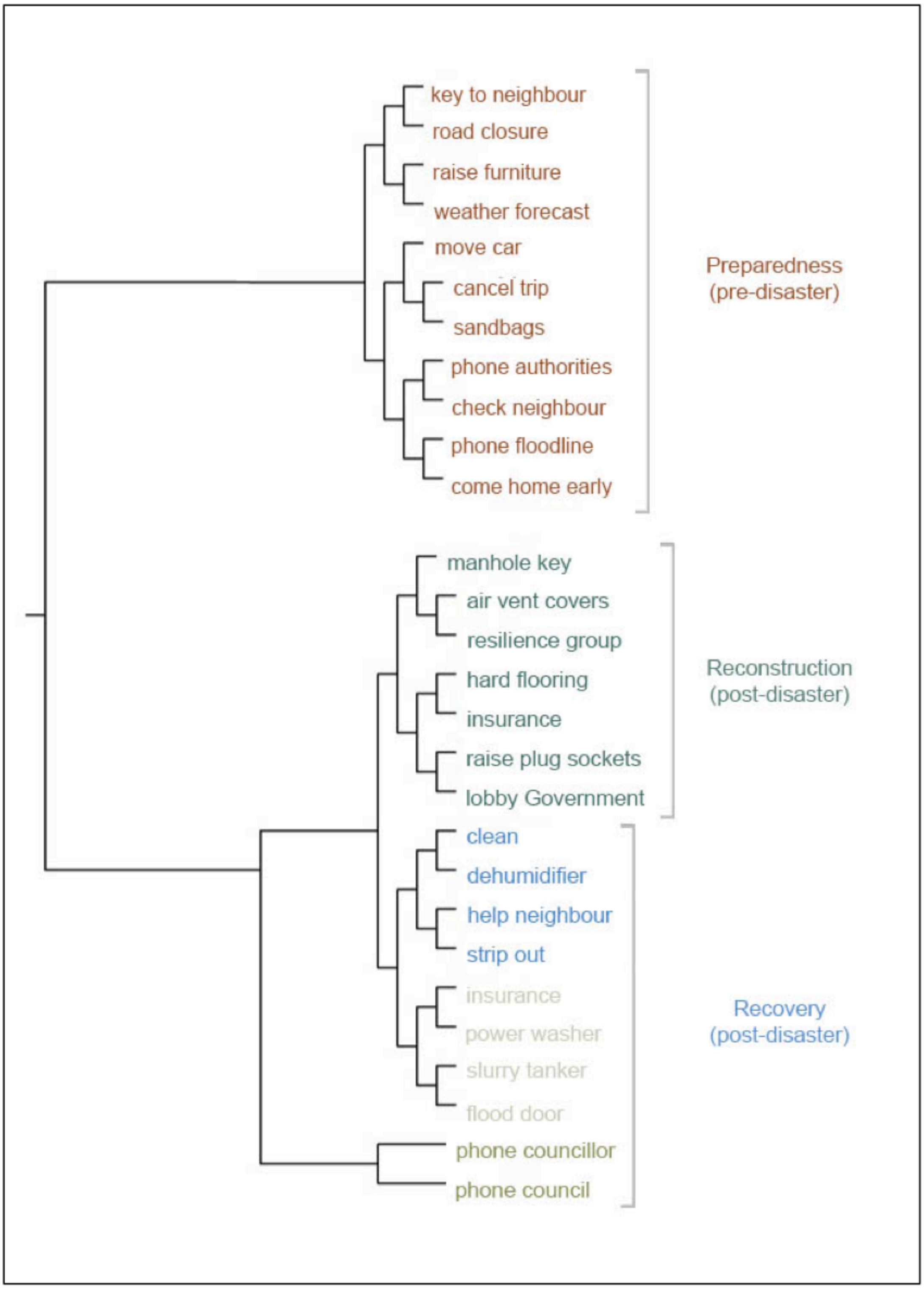


Figure 6.9 Resilience actions undertaken by both communities during the recovery and reconstruction phase.

Forward thinking approaches to resilience were also present at the statutory level, through employee resilience training (Indicator 7). This is indicative of the commitment by agencies and serves to strengthen the collaborative (Indicator 9) links within the community through the incorporation of both vertical and horizontal social ties. Collaborative action in practice was demonstrated through the establishment of an active FRG in Fintona indicating the self-efficacy levels within the community by way of growing membership numbers.

The third component ‘Connectedness’ identifies how social network typologies interact, both horizontally between communities and vertically between statutory agencies (Table 6.11). In doing so, this component evidences the extent to which diverse relationships and social capital (Indicator 13) play a key role in community resilience building. A key finding from both pilot studies revealed that ‘bonding’ social capital is advantageous during the recovery phase, particularly in the 65 and above age profile. The literature suggests that residents possessing a low level of social connectedness are unlikely to receive the necessary information or support during a flood (Tunstall et al, 2007). This assumption proved true in the case of the Fintona pilot, where 66% of the elderly population were unaware of the existing FRG in the village. This reinforces the concern attached to singular forms of social capital. Not unique in this finding, gaps in communication were similarly found within the East Belfast case- study. In particular, the lack of bridging and linking relationships within the community, translated to 76% of the residents stating in the event of a subsequent flood event they were unaware of who to contact for assistance. In Fintona, the high level of bonding social capital, in contrast to lower bridging and linking social capital, was largely attributed to the ‘sense of community’ (Indicator 15) felt by its inhabitants. This was apparent within the interview discourse by way of the community’s reluctance to move property in the face of close to annual disturbance due to flooding. However, despite the benefits attached to bonding social capital at the individual level, it can also act as a barrier to community resilience through over reliance on a single relationship form. As such, cross-scalar engagement through relationships with the statutory agencies (bridging and linking) was shown to have the potential to enhance community resilience. In particular, the interview discourse noted a relationship between higher-level trust (Indicator 16) and bridging and linking social capital. Positive relationships through horizontal ties were visible throughout the process of forming a FRG.

The social capital indicators uncovered gaps in patterns of linking and bridging connections between communities and higher level connections, highlighting communication barriers and difficulties that can lead to power imbalances and a lack of a joined up approach inhibiting community resilience.

Table 6.11 ‘Connectedness’ component indicators.

Components	Indicator	Indicator description	Assessment/criteria	Empirical evidence	Effect on resilience	Scale
Connectedness	13.Social capital	Diversity of social capital	Evidence of all social capitals: bonding, bridging and linking	Semi-structured interview/ observation	Positive and Negative	community
	14.Integration in social networks/ organisation	Extent of social networks within the community	Number of social groups a community resident is a member of	Semi-structured interview	Positive	Individual, community
	15.Sense of belonging in community	Affected community feel part of the community	Unwillingness to relocate after a flood	Semi-structured interview	Positive	Individual, community
	16. Higher-level trust	Positive relationship with horizontal ties	Inclusion and liaise within Flood action Group activities	Semi-structured interview	Positive	Individual, community

The ‘Learning’ component of the framework offered examples of flexibility to experiment, innovate and to provide novel solutions (Indicator 20) to ever -changing resilience challenges. In this vein, the local FRG in Fintona provided a medium within which the community could analytically discuss (Indicator 17) the extent of their future risk after the flood. Further evidence of ‘learning’ was apparent through the process of critical reflection (Indicator 18), leading the community to conclude that any actions undertaken by the community themselves would stand to improve resilience, particularly in situations where statutory agency resources are overextended and prioritised in densely populated areas.

Moreover, critical reflection prompted communities to experiment and innovate (Indicator 19), by operationalising resilience action strategies as outlined in their Community Resilience plan. Demonstration of collaboration and self-organisation, assisted through the organisational structure of the FRG, led to increased mitigation action. In the absence of a FRG in East Belfast, indicators of critical reflection and analytical thinking were limited. Consequently, identified examples of innovation occurred largely in isolation on an individual basis.

The interviews acknowledged the value of untapped pre-existing community capacities and local knowledge (Indicator 21) suggesting effective distribution of such resources was attributed to a feeling of empowerment by the community. The value of this indicator lies in its ability to take account of local human and physical vulnerabilities, for instance, an awareness of those most exposed within the community. This was acutely demonstrated in Fintona whereby those most vulnerable and at risk were assisted first by the community. In the case of Fintona, collaboration between agencies and the community was greatly assisted through the medium of FRG demonstrated by its broadening ‘sphere of influence’, allowing for enhanced information flows between the various levels.

Moreover, the interview discourse highlighted that local knowledge was channelled into risk monitoring (Indicator 21) roles within the community and subsequently became embedded into their everyday routine. For instance, checking river levels while walking the dog provides one simple example. In contrast, this indicator was not as pronounced in the East Belfast case-study, arising from the transient nature of the community as demonstrated by the above average rental occupancy of 46%. Indicators of the fourth component, ‘learning’, are synthesised in Table 6.10.

Table 6.12 Component: ‘Learning’ indicators.

Components	Indicator	Indicator description	Assessment/criteria	Empirical evidence	Effect on resilience	Scale
Learning	17. Problem Definition	Considering options to mitigate risk as a consequence of past flood experience	Include risk mitigation measures in community resilience plan	Semi-structured interview	Positive	Individual, community
	18.Critical reflection	Have considered relocating house/ Existence of a Flood Group to allow for reflection	Existence of active flood group/considered selling or relocating	Semi-structured interview	Positive or negative	Individual, community
	19.Experimentation	Resilience actions that are experimental or innovative informed by lessons learned	Performed actions that challenge the status quo and suggest alternative strategies	Semi-structured interview/ observation	Positive	community
	20.Transfer of knowledge/sharing	Knowledge sharing	Dissemination of results actions across stakeholders	Semi-structured interview	Positive	community
	21.Monitor and review	Feedback into risk awareness related actions	Capacity/structure for feedback to be linked to risk awareness related actions	Semi-structured interview	Positive	community

The process of completing the above 4 stages led to the production of the defining feature of the Framework analysis in terms of a matrix output (Gale et al, 2013). Comprising Stage 5, the matrix consisted of rows (cases), columns (codes) and 'cells' of synthesised data, guiding the analysis by case and code (Section 5.7, Figure 5.16). This process served to reduce the data without sacrificing meaning or 'feel' of the interviewees' words. The information within the matrix comprised summarised data and quotes from each transcript by category. Ultimately the Framework serves as a means of extracting key higher-level indicators, whilst simultaneously recognising a longer list of more context specific indicators for each case-study. Additionally, it assists potential transferability between other case-study areas. Further, approaching the organisation of data in this structured manner mitigates against the criticism attached to qualitative data collection surrounding a lack of standardisation of data (Ranger and Suminski, 2013). To this end, Table 6.13 below presents as an example, the charted data for the 'Learning' component. An extended list of component charts is presented in Appendix 10, illustrating how indicator data can easily be compared and contrasted for further interrogation.

6.6.1 Expert validation of data indicator results

The Framework approach articulated in Chapters 4 and 5 resulted in a list of 21 higher-level indicators (Tables 6.7 - 6.10). The research acknowledges that qualitative research inevitably runs the risk of encapsulating some form of research bias through its subjective coding process (Norris, 1997). In order to mitigate against this, the results were disseminated through a presentation to a group of statutory level participants in Belfast, in September 2016. Details of the response and feedback from experts are presented in Appendix 9.2.

Table 6.13 ‘Learning’ component chart representing the Belfast case-study at the community and practitioner level.

Chart 4 Learning	17. Problem definition	18. Critical Reflection	19. Experimentation and innovation	20. Transfer of Konwledge	21. Monitor and Review
Belfast Community level case-study	“The drainage isn’t up to standard and they need to monitor that pumping station. They failed us time and again” (B1).	*“Move your car quick is the lesson I learned” (B4).*	*“I blocked the road with my van to stop the cars sending waves of water in the house” (B8)*	*"I knew to watch out for the lady a few houses up who lives by herself". (B11)*	
		“It became dangerous at one point so at a certain point next time I’ll stop trying to get sandbags” (B8).	*"I've concreted the floors now" (B12)*	*"I know the lady on the corner has 3 children that are sick so I go and offer her help and ask if there is anything I can do”. (B2).*	
		We were trapsing around in sewage and oil looking for sandbags which made no difference and in the end we all got hand foot and mouth and were quite sick. So in future I’d just leave it and let it do its damage and then worry about it (B2).			
		“*We don’t need to worry about sandbags anymore, there would need to be a Noah’s arch flood for us to flood again after that scheme is finished”* (B9).			
		“There is just so much development, all drives and gardens are paved now too. That can’t help” (B12).			
Chart 4 Learning	**17. Problem definition**	**18. Critical Reflection**	**19. Experimentation and innovation**	**20. Transfer of local Knowledge**	**21. Monitor and Review**
Belfast Practitioner Level	*“New developments and urban creep the volume in sewers is going to increase by 51% by 2040…we need to be proactive in this regard” (P 29).*	*“If you don’t have the architecture there for things to happen then it wont happen…its that simple” (P 41).*	*“The mind shift in government took a while (Community resilience) but it’s a model that works and we are becoming more confident with it” (P 52).*	*“Local knowledge has a role in assisting more vulnerable neighbours, acting out a flood plan and lobbying government to meet their need” (P 40).*	“We would like to see a review done by the statutory levels” (P 30).
	“It’s really a very real danger in terms of health and safety (for farmers)” (P 49).	*“We’ve learned the need for a better joined up approach under one minister and will hopefully lead to better policy making” (P 30).*	*“Engineers in NI have their blinkers on, they need to start thinking holisitically about drainage and developments, and their knock on effects on the community”(P 34).*	*“A lot of knowledge has left due to the VES (redundancys) and I fear we are not as effective as we were before” (P 39).*	*“Tackling flooding is a long term issue and that is the response that we need to now put in place for the future” (P 36).*
	“Flooding will happen again and again unless there is a serious commitment from the agencies” (P 37).	*“Community resource is not being utilised, we don’t have the resources to encourage this and this needs to change” (P 36).*	*“The community really comes together and helps each other out…they have a lot of personal resources they use” (P 41).*	“The community know their community best.…they are the people best placed to highlight where we could implement a good SUDs scheme (P 36)	*“PPS15 should enforce SUDs and change its terminology from ‘should’ to ‘must’ “ (P 36).*
		“As development arises more houses will be added to the same risk register as they know the pipes are now outdated. How does planning not consult with NI water about this!” (P 29).			*“When you look at the hard facts of how many properties are actually being flooded it s clear we need to stand up and take action” (P 40).*

6.6.2 Interlinking two phases of the Framework

The results from Phase 1 revealed that across both case-studies the 'Human' resource was the weakest of all four resources. This is largely attributed to: the above average age of case-study area populations and low education levels. Moreover, Fintona ranks in the top 15% for crime in Northern Ireland and has an above average unemployment rate. In contrast to the aforementioned statistics, the Phase 2 analysis identified that Fintona demonstrated greater resilience through self-organisation (Indicator 6) and collaboration (Indicator 9) in comparison to East Belfast. The overarching reason for this finding is attributable to Fintona's more extensive use of social capital (Indicator 13) and the strong sense of belonging (Indicator 15) within the community. Housing tenure was a variable of the 'Economic' resource, however it is noteworthy that high rental tenure in East Belfast (attributable to the transient nature of urban areas), significantly reduced the sense of belonging (Indicator 15) within the community.

Overall however, Belfast scored higher than Fintona in respect of its 'Economic' resource. This finding is typical of rural communities (Cutter et al, 2016) and provision should be made within Fintona to ensure business continuity. For instance, flood damage has a knock-on effect on the provision of employment and services and as such, a long-term approach towards business investment should be a priority for the village (Sahebjamnia et al, 2015).

Phase 2 demonstrated that through working together as a community, the FRG assisted in reducing community vulnerability and in doing so further reduced the social isolation of their elderly residents. In turn, these actions eventually fed-back by increasing the overall capacity (Indicator 7), empowerment and self-efficacy (Indicator 11) levels of the community. This finding highlights that resources should be targeted to improve the 'Human' resource but equally attention should be concentrated on building and integrating social networks (Indicator 14) through the establishment of a FRG.

The 'Physical' resource scores in Phase 1 did not reflect the investment in flood alleviation in East Belfast, as a consequence of the lagging-effect associated with official statistics. Moreover, it is important to note that this investment was counter intuitive, while enhancing flood protection it simultaneously erodes community resilience as residents become complacent and misinformed about flood risk (Indicator 5) as they feel protected. The 'Physical' resource further identified the important role of risk awareness (Indicator 1) and communication of this risk (Indicator 2) play in communicating the percentage of properties at risk through their location on a flood map. Phase 2 reveals that it is this awareness that creates the impetus for communities to take resilience action. However, contrary to the literature, proximity to services was not found to enhance resilience. The findings reveal that an awareness of this vulnerability led rural Fintona to *'Take resilience by the scruff of the neck"* (F27) and establish a FRG.

The overlapping of the above resources (Phase 1) with resilience indicators (Phase 2) demonstrate the inter-connectedness of community resilience. Phase 1 served to provide a range of important insights about the origins of a community's baseline resilience and Phase 2 followed by identifying indicators that can be targeted to have the greatest impact on enhancing resilience to flood events. Importantly, holistic approaches that can work with the highly interconnected issues facing communities will be needed to address the challenge of climate change.

6.7 Conclusion

The pilot was undertaken to test four key areas of this research. First, it served to test the application of the theoretical framework within case-studies in Northern Ireland. The application of the research framework proved more time consuming than anticipated as a consequence of the lengthy transcription process. Audio recording was of poor quality due to location of interviews in public places with considerable background noise. As such, it was only possible to transcribe interview recordings with the assistance of detailed notes taken throughout the interviews to avoid omitting important data. Second, it aimed to establish the suitability and practicality of the sampling frame. The decision to engage a facilitator to assist with the recruitment of interviewees via purposive sampling proved very effective. The researcher is aware that without this assistance the case-study would not have been possible. Should a facilitator be unidentifiable in the main case-study, it will be necessary to resort to an alternative case-study option. Testing the research method allowed for the development of interview skills, in particular in relation to executing the critical realist perspective, whereby the researcher seeks to take meaning from participants' experiences in order to understand their perceptions, viewpoints and understanding of the recovery process after a flood event. The semi-structured interview question set was found to be effective, however some refinements were made to improve clarity and yield more concise answers (Appendix 9). In particular, prompt questions were added to the practitioner level questions so as to ensure the appropriateness of the questions when the exact knowledge/expertise of the participant is unknown prior to undertaking the interview.

Third, the pilot allowed for the evaluation of the 'framework method' of analysis, assessing the richness and usefulness of the data in populating the framework. This procedure entailed the time consuming task of coding interviews and the experience informed what was deemed a feasible sampling size going forward into the main case-studies. The data analysis, assisted by NVivo, uncovered 21 resilience indicators common to both case-studies. The multifaceted approach of comparing empirical indicators of performed resilience (Phase 2) against baseline data (Phase 1), provided understanding of resilience gaps and weaknesses currently limiting community resilience. The findings revealed that whether a risk perception is high or low is not the most important factor, rather it is an individual's awareness and understanding of disaster risk that encourages long-term and anticipatory strategies that require significant investments in the home. Furthermore, it is important to uncover the nuances which shed light onto how risk perceptions shape incremental adaptation and transformational resilience actions. Conversely, flood awareness was seen to have a negative effect on elderly victims of recurrent flooding. As such, an investigation into the links between flood experience (on the one hand) and resilience actions or resilience erosion (on the other), calls for further investigation in the main study. The data revealed variances between how urban and rural communities cope, adapt, and transform through mobilisation of resources and capacities after a disaster. Contrary to the literature, it was found that close proximity to services did not necessarily enhance community resilience. By contrast, awareness of the community's vulnerability due to their isolated location in rural Fintona, prompted the community to develop a FRG as they were aware that in practice the services were unable to arrive immediately.

Of note, it was found that the variable 'proximity to services' within the Phase 1 'Economic' resource, does not necessarily increase resilience. Conversely it was found in the case of Fintona that acknowledgment of their vulnerability, due to remoteness, prompted the community to take responsibility for their own flood risk and action their Community Flood Resilience plan ahead of the statutory services. Urban areas tend to display higher resilience due to proximity to services. However, this was not found to be the case in the Belfast case-study, where a transient population and subsequent lack of community participation and engagement was found to limit resilience actions. Critically, the absence of a FRG proved to significantly impede their resilience actions due to the absence of any organisational mechanism to mobilise their resources.

The ‘Connectedness’ component proved to be the lynchpin for how successfully communities engaged in adaptive and transformational resilience actions. Fintona held both vertical and horizontal networks and consequently evidenced greater incremental change and transformational actions. Particularly, given the absence of a FRG, East Belfast evidenced individual resilience however overall community resilience levels were low due to the absence of an organisational mechanism in place to facilitate resilience action. Over-reliance on bonding social capital led to coping and adaptive resilience but due to the lack of a developed ‘social infrastructure’ beyond horizontal ties, transformational resilience was restricted.

As a consequence of this finding, it was decided to further explore the critical role social networks play in building resilience by including Social Network Analysis within the main case-studies. Finally in fulfilment of the fourth goal, it is anticipated that addressing the above outcomes will enable the development of a more cohesive, robust study with better potential to contribute to disaster resilience knowledge. As such, it was determined that extending this pilot to a full-scale case-study (studies) project is a feasible option that will deliver the richness of data required to populate the proposed Framework and aid the fulfillment of the objectives of this thesis

Chapter Seven

Cumbria Case-study

7.1 Introduction

Chapter 5 outlined the two-phased application of the Framework developed in the methodology (Chapter 4). Chapter 6 followed by detailing the pilot study undertaken in Northern Ireland to test the research instrument and described the considerations and refinement applied to the main case-study going forward. Figure 7.1 illustrates the positioning of this empirical chapter within the empirical knowledge element of the thesis. The chapter does so by presenting evidence in respect of the first main case-study conducted in this research, namely Cumbria. Section 7.2 sets the context of flood-affected communities by framing the flood risk landscape in England, through an evaluation of its historical context. It does so by describing significant policy changes in recent years, revealing the paradigm shift from flood defence to an integrated catchment wide approach. Section 7.3 maps the key flood risk management stakeholders involved in this shift and outlines their roles, responsibilities and the rationale for their selection as part of the case-study interviews.

Section 7.4 introduces the Cumbrian case-study through a description of its spatial geography and socio-economic profile. This articulates the varied flood challenges faced by the region depicting the three river catchment areas as well as the eight settlements which constitute the overall case-study area. The core analysis underpinning this case-study follows in Section 7.5 to 7.8. Section 7.5 outlines the application of the quantitative Phase 1 resilience baseline assessment and is followed by Phase 2 analysis of the affected communities' perception of resilience after the 2015 winter floods. It does so by highlighting resilience indicators that enhance and impede a community's ability to recover. Social Network Analysis was carried out in Section 7.6, illustrating the important role social networks play in creating these indicators through enhanced mobilisation of resources and capacities. Section 7.7 follows with a comparative analysis of the distribution of revealed indicators at different settlement scales. Section 7.8 articulates further analysis on how these indicators can be fed back into weaknesses identifies in Phase 1 to enhance overall community resilience levels. The chapter closes with conclusions drawn from the Cumbrian case-study (Section 7.9), highlighting the need for a bespoke approach towards resilience planning.

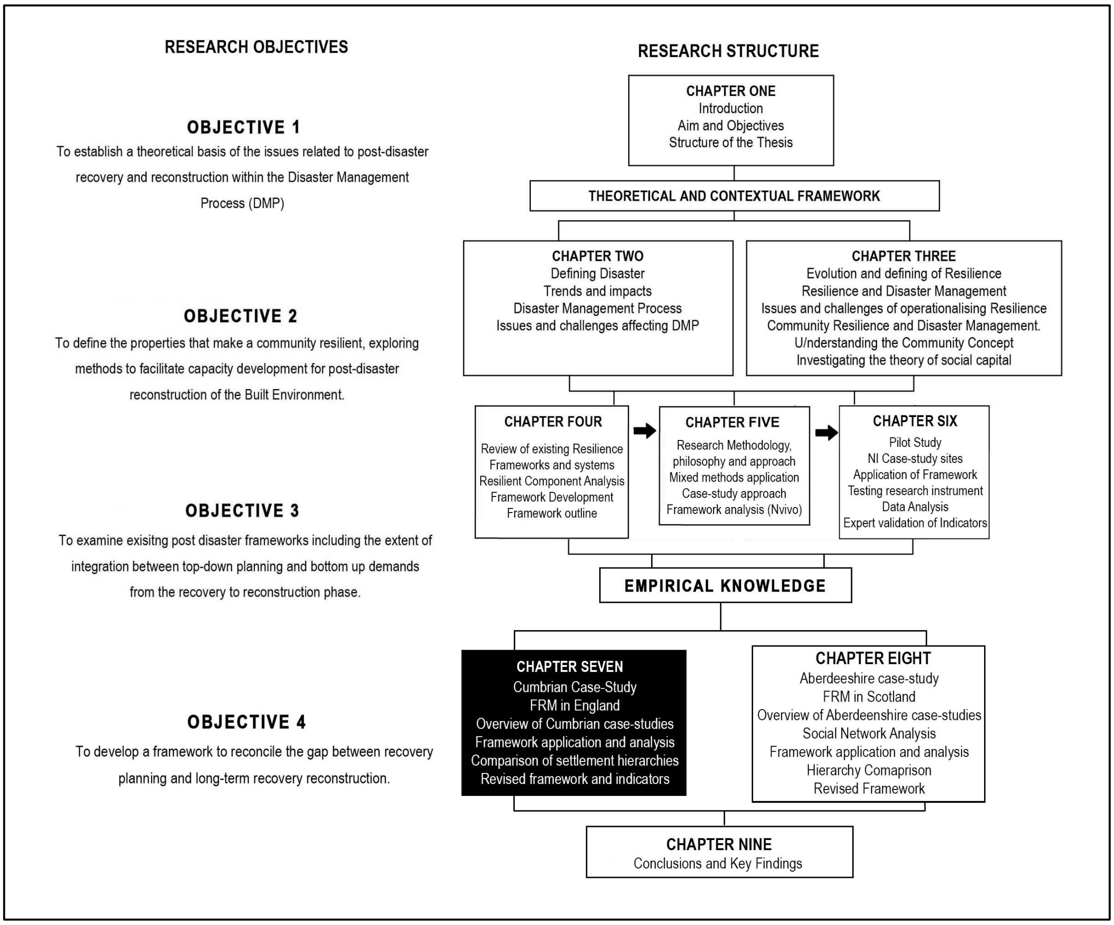


Figure 7.1 Position of Chapter 7 within the thesis structure.

7.2 History of flood risk management in England

The following section expands on the evolving Flood Risk Management (FRM) policy landscape in England, as it is incrementally shaped by (1) high incident events and (2) a shift away from hard engineering towards catchment flood management. Historically, a period of intensified farming after World War 1 led to increased flooding. In response to this, the Government introduced a hard engineered approach to flood management (Scarse and Sheate, 2005). Despite this hard engineering intervention, increases in industries and homes on floodplains (SCA, 1998; Butler, 2007), together with the growing effects of climate change, inevitably led to the realisation that a hard engineering approach was not a panacea for the flood issue. This prompted a re-think on a defence approach and subsequently led to the introduction of the 'Making Space For Water' (2005) strategic approach to flooding. The strategy marks a shift towards empowering those at risk of flooding to "manage their own flood risk" (Johnson and Priest, 2008:p520).

Further, findings from an independent, Government-commissioned flood review, the Pitt Review (Pitt, 2008), reaffirmed this transition towards local empowerment. Recommendations following the 2007 floods across England were drawn from existing Flood Action groups (FAGs) and findings supported collaboration between local groups and local organisations. The Pitt Review further acted as a driver towards the passing of the Flood and Water Management Act (2010). In line with Pitt Review findings, this Act was premised on the idea that hard-engineering schemes have their limitations. It advocated the concept that flood risk can be managed through a portfolio of strategies, of which community resilience was strongly supported (Schelfault, 2011; Sayers, 2016).

The 2015 floods both in England and across the rest of the UK further galvanised the need for a change in thinking towards an integrated, decentralised and collaborative approach to FRM. More specifically, the Cumbria Floods Partnership was established and tasked with "improving flood defences" however it also included broader catchment wide themes. Indeed, the partnerships policy paper: *"Cumbria Flood Action Plan - reducing flood risk from source to sea"* included 'resilience' as one of its five themes for action as well as highlighting the complexity of the systemic issue of flood resilience (Deeming, 2011; EA, 2016; Sanders et al, 2016) where flooding is no longer viewed as an 'engineering pursuit' but as a 'social endeavour' (Sayers, 2016).

Set against a backdrop of austerity communities are realising their potential to contribute to flood recovery (Wright, 2016). In this vein community groups began to emerge with the focus of lessening the impact of flooding rather than trying to prevent flooding. This pattern of localism is not to be mistakenly viewed as the government withdrawing from their duty to protect society from hazards. Conversely, it is about empowering communities to utilise their resources and capacity through community participation and collaboration with the local authorities.

Thus a new paradigm reflecting a move away from the classic, engineering approach to a community centred portfolio of solutions is being proposed collaboratively with statutory agencies. At the heart of this decentralised approach is the promotion of FAGs, which serve as a vehicle for communities to harness their resources and capacities, in a way that complements the work of the flood authorities.

7.2.1 Flood history in Cumbria and England

Flooding has a long history affecting populated areas in England (Fagan, 2000; EA,2009f; EA, 2017). It is estimated that more than five million properties are located within flood risk areas (EA, 2009a). Increased developments within floodplains has created a situation whereby one in six properties are at risk of flooding, accounting for 2.4 million homes and 185,000 businesses in England and Wales (ICE, 2016). The number is expected to increase as a consequence of climate change and increased urbanisation (Joseph Rowntree Foundation, 2011). Research by the Environment Agency projects that by 2080, river flows may increase as much 30% to 70% above the 1961-90 baseline. The UK Climate Change Risk Assessment (2015) forecast a similarly negative outlook, reporting that future flood risk is set to increase the vulnerability of communities as a direct result of extreme weather conditions and wetter winters.

Cumbria, in the North west of England, has witnessed a devastating flood history, recording significant levels of damage and disruption as a result of both recurrent and first time flooding (Bye and Horner, 1998; Pitt, 2008; Tapsell and Tunstall, 2008;EA, 2009d; EA, 2009f; EA, 2010d; EA, 2017). However, the research presented in this thesis focuses specifically on the 'flood event' of the winter floods 2015 brought by the high winds and heavy rainfall of storm 'Desmond' and 'Frank'. Cumbria was the worst-hit UK county experiencing more than a month's rain in one day on Saturday (5^{th} December) with all main rivers across Cumbria exceeding the highest levels ever previously recorded (CEH, 2015) (Figure 7.2)

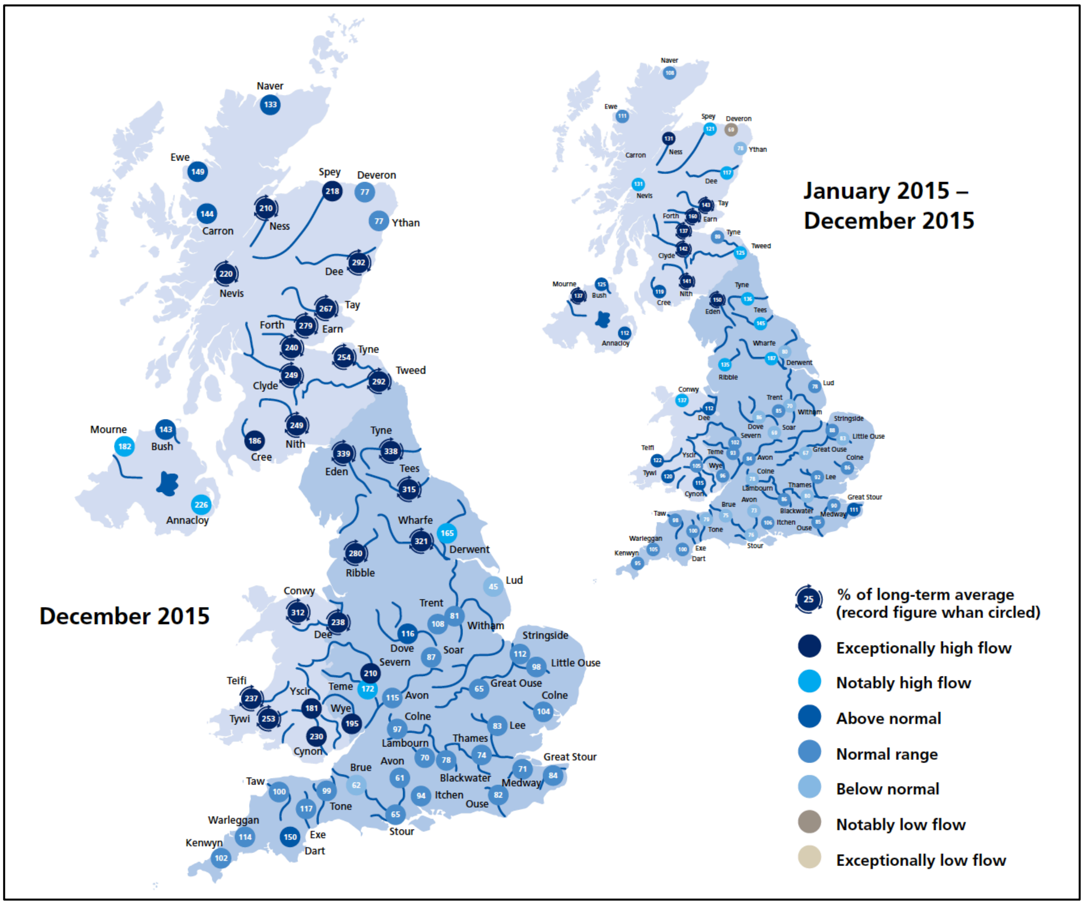


Figure 7.2 River flows across the UK in December 2015 (relative to annual rainfall averages). Source: CEH, 2015.

As the 2015 floods occurred during the formative stage of research, the scale of flooding offered a timely opportunity to assess the recovery strategies and decision-making processes at a time of heightened engagement from all stakeholders. Across Cumbria 6,300 properties and business owners were affected (Figure 7.3), with 63 per cent of affected groups being from older social groups (65 and above) (Cumbria Intelligence Observatory (CIA), 2010).

The intense rainfall in a short period of time onto an already saturated ground led to rapid surface run-off causing record river levels (JBA, 2015). For example, the towns of Appleby, Keswick and Kendal recorded a height of 0.28m, 0.75m and 0.62m respectively above the previous highest recorded river level (Cumbria County Council, 2016).

Figure 7.3 Estimated number of flooded properties across the Cumbrian region (Environment Agency, 2016).

Despite previous floods with significant impacts during 2003, 2005 and 2009, the geographic scale and impact of the 2015 winter floods was unprecedented (JBA, 2015; House of Commons, 2016), exceeding the capacity of the community and requiring outside assistance. The following section articulates the key stakeholders involved in providing this assistance at a multi-scalar level.

7.3 Flood Risk Management stakeholders

The following section outlines the role of Flood Risk Management stakeholders involved in Flood Risk Management (FRM) within Cumbria. Through policy document analysis (Appendix 3), key stakeholders and institutes are identified. In order to gain a clearer understanding of the role and responsibilities of the stakeholders, flood risk organisations are broken down into three categories in accordance of their hierarchical level namely; national, regional and local but all are evaluated in the context of Cumbria, as illustrated in Figure 7.4.

7.3.1 National level

The Department for Environment, Food and Rural Affairs (DEFRA) is tasked with protection against flood risk, through flood warnings and the development of flood risk management strategies. National policies (England) developed by DEFRA set the mandate for responsible authorities (Environment Agency's (EA) and the Lead Local Flood Authority's) to follow to mitigate flood risk. Through funding from DEFRA the EA is responsible for river and coastal defense, whilst maintaining a strategic overview of flood risk management (JBA, 2015). As such, the building, maintenance and performance of flood defences is the sole responsibility of the EA. The EA also works closely with the Met Office, providing flood forecasts as part of the Agency's Floodline and early warning flood service. The Department for Communities and Local Government (DC) holds responsibility for planning policy in England and the prevention of flooding through management and enforcement of spatial planning policy. Beyond their responsibilities in planning the Department also acts as the lead government department in recovery from flooding events.

7.3.2 Regional level

A government-commissioned review into the 2007 flooding across England called for greater flood risk management at the local level, recommending local authorities take responsibility for local flooding (Pitt Review, 2008). This prompted the introduction of the Flood and Water Management Act (2010), devolving power to the county council level through their new leadership duties as the appointed Lead Local Flood Authority (LLFA). Under the Act, the Council was charged with the development, management and implementation of local flood risk strategy. In this regard, clearly defined roles and responsibilities for all stakeholders enabled effective collaboration between the LLFA and the other relevant authorities, namely: local councils, EA, Highways England and private water companies (United Utilities), to manage flood risk.

7.3.3 Local level

The prominent stakeholders at the local level include those involved in Local Resilience Forums (LRFs) and third sector charitable organisations. The umbrella role of the Cumbria Local Resilience Forum (CLRF) allows all stakeholders involved in FRM in Cumbria to collaborate together and deal with local problems at the most immediate local level. The forum comprises both category 1 and category 2 responders, operating under the Civil Contingencies Act 2004[23]. Category 1 members are predominantly made up of emergency services, local authorities, health bodies and Environment agency (Cumbria County Council (CCC), 2017). Category 2 members comprise “co-operating bodies” involved directly in flood incidents including: United Utilities (water company), Highways England (transport) and communication operators. The forum holds decisive power, however the importance of local decision-making is advocated and supported where necessary at a higher level.

The local level also witnessed considerable support from charities (such as the National Flood Forum) and third sector organisations (for example Cumbria Foundation) throughout the recovery phase both in 2015 and during previous flood events. The National Flood Forum[24] works on behalf of the affected residents and businesses to find ways of minimise the effects of flooding, through the medium of FAGs the Forum engages with local authorities and other organisations to reduce the risk of flooding. A further example of this engagement is the Cumbria Floods Partnership. Created with the best interests of the community at its core the group seeks to create a long-term (25 year) ‘flood action plan’ for those areas most affected by the winter 2015 flooding.

[23] The Civil Contingencies Act (2004) is an Act of Parliament which sets out a framework under which category 1 and category 2 responders can deal with a disaster event.

[24] The NFF assist flood-affected communities to prepare, mitigate and build the capacity needed to reduce flood risk within their communities. Acting as the voice of the community they lobby the government on their behalf. Further, they work collaboratively with agencies and government to ensure that flood policy and strategies place the community at its core.

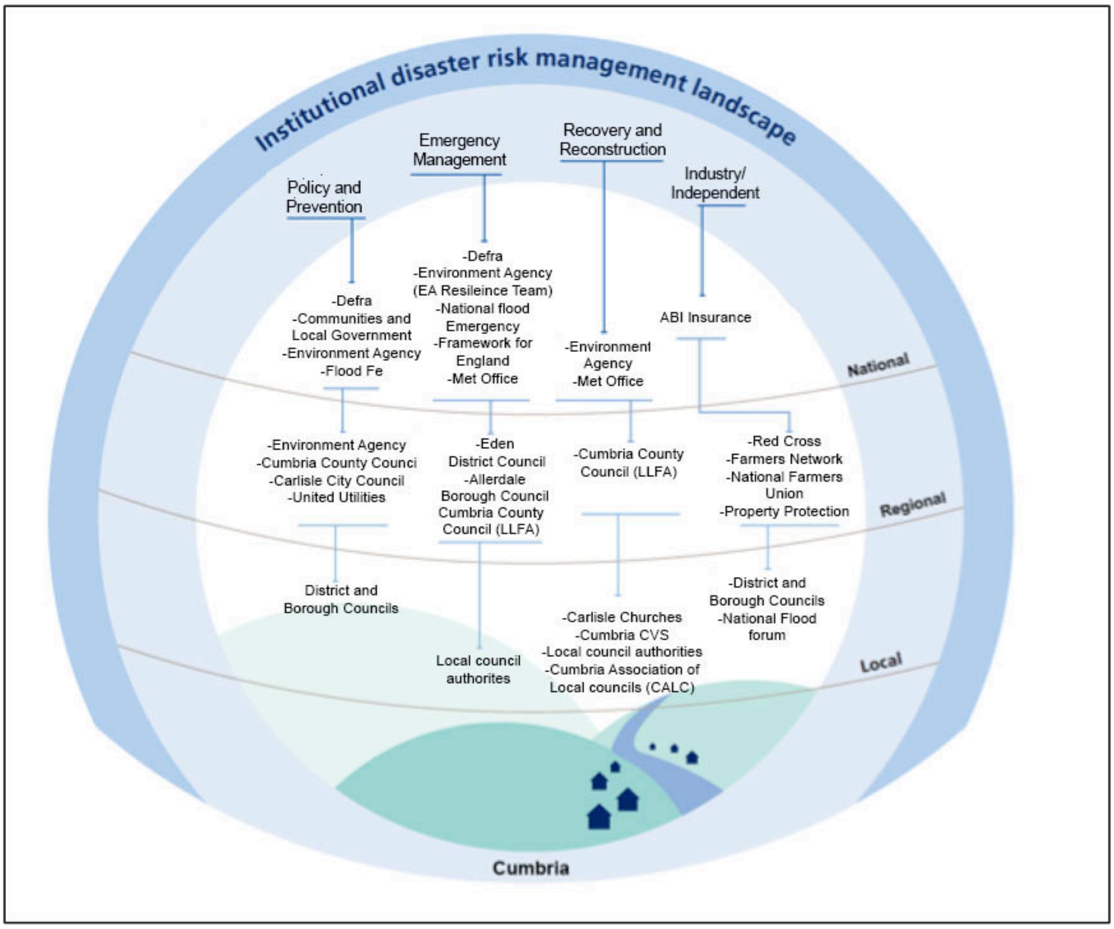


Figure 7.4 Institutional Disaster management landscape, Cumbria[25]. Adapted from JBA, 2015.

The above section has outlined the policy backdrop against which the multi-scalar stakeholders operate in FRM. The following section presents the contextual setting of the Cumbrian case-studies in which these complex organisational structures operate. It does so by describing the impact of the 2015 winter flooding event on Cumbria and presents and an overview of the socio demographic background of the region (Appendix 7.3). Further, it introduces the eight case-study areas by presenting each settlement profile in their respective catchments: Eden; Derwent and the Leven and Kent (Appendix 7.4).

7.4 Introduction to Cumbrian case-study context

The following section presents an overview of the Cumbria region in which the eight case-studies are situated. The sparsely populated county of Cumbria is situated

[25] Figure previously presented for explanatory purposes in Chapter 5, Figure 5.10.

within rural North West England. Cumbria is the most mountainous county in England, contributing to its long flood history as excess run off comes down from the fells. The county is a designated "area of outstanding natural beauty" (AONB), as it is home to the Lake District National Park. The county of Cumbria comprises six districts (Allerdale, Barrow-in-Furness, Carlisle, Copeland, Eden and South Lakeland) as illustrated in Appendix 7.3. The Cumbria Intelligence Observatory state that the county population is 499,100, with the city of Carlisle comprising the largest urban settlement (CIO, 2012). The ethnic homogeneity of the county is evident through its high percentage of White British residents, comprising 95.1% of the population (Census, 2011). However, this percentage was more in line with the English national average in the larger towns.

The socio-economic profile of the area is affected by factors including: population demographics; deprivation level; education; access to services; health and housing. These factors are discussed in detail in Appendix 7.3.

7.4.1 Overview of selected case-study areas

The unprecedented flooding events of storm Desmond in December 2015 acted as a lens through which resilience of the eight case-studies could be explored. The Cumbria region in particular was chosen, as it was the region most severely affected by Storm Desmond in terms of flood levels, number of affected properties and disruption to critical infrastructure/services (House of Commons, 2016). The event was significant enough to exceed the capacity of the local community and require outside assistance. Furthermore, danger to life was a critical issue causing one loss of life and leading an Emergency Officer to comment *"It's a wonder more people didn't die"* (BBC, 2016b).

As outlined in Chapter 5, case-studies were selected in order to include a balance of urban and rural settlements with a varied flood history and defence investment. Furthermore, in order to access levels of social connectedness it was deemed important to include a mix of settlements that had either established, new or no FAGs.

Cumbria has a unique and varied flood history (Deeming, 2016). As such, both first time and recurrent flood communities were selected, to allow for analysis between the multiple case-studies and to offer an opportunity to investigate evidence of lessons learned. Flood defence proximity to properties is frequently understood to reduce risk of flooding (UCEM, 2006). This irrational interpretation equates to communities being more willing to purchase a property in a location with an Annual Exceedance Probability (AEP) of 1% with defences in place rather than in a low risk area AEP 0.5% but is undefended. Furthermore, over reliance upon flood defences causes complacency and decreases motivation for local flood resilience activities (Committee on Climate Change, 2014).

Considering the above, settlements were chosen that offered a variance of protection standard from 0.5 -1.35% AEP. This decision allowed for the inclusion of settlements which were structurally and non-structurally defended. At the same time, however, each settlement was also formally acknowledged to retain an element of residual risk, which was directly related to their exposure to low probability / high consequence flood hazards (Faber, 2006). All these factors, which informed the decision to select these eight communities, are discussed in more detail in the following section.

Social connectedness and the dynamics between settlements of various densities/population size are important factors in the evaluation of community resilience. In particular, the presence of FAGs was found to be a fruitful medium through which multi-scalar ties could be analysed and understood. As such a hierarchy of settlements, with and without FAGs, were chosen to reflect the variance of social capital across Cumbria. The eight settlements selected are the city of Carlisle[26], representing the top level of the urban hierarchy in Cumbria, the market towns of Appleby, Kirkby Stephen, Keswick, Kendal and at the lower end of the hierarchy the villages of Shap, Eamont Bridge and Glenridding (Figure 7.5).

A broad range of literature has been drawn upon to provide information about the 8 case-study profiles and their respective flood histories. Future plans for the protection of the towns from flood hazards have also been outlined, through reference to contemporary flood-risk management documents. An overview of the catchment areas and an evaluation of the cultural history of each case-study within it, is presented in Appendix 7.4.

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[26] The Carlisle case-study focused on the areas most affected by flooding, namely: Warrick Road (St.Aidans and Botchery LSOA); Viaduct Estate and Willow Holmes (Denton Holme and Castle LSOA).

Figure 7.5 Map indicating the location of the 8 case-study settlements[27]. Annotated from BBC, 2016a.

The above sections introduced and presented the socio-economic profile of the 8 micro case-studies (Appendix 7.3-7.4) and set the Cumbrian region within the backdrop of current Flood Risk Management practice. The section discussed the incremental policy changes that led to the shift from flood defence toward a holistic catchment approach have been outlined. It is clear that communities and agencies are now realising that a portfolio of solutions, both hard and soft are required to address the complex flooding situation. Instrumental to the functioning of this is a collaborative approach between agencies and communities. Breached flood defences have expedited this thought-process, making communities accept residual risk and work with agencies to address the issue. The dearth of FAGs highlights that this process is in its infancy. Further, the socio-economic profiles have revealed

[27] Figure previously presented for explanatory purposes in Chapter 5, Figure 5.6.

a disparity in inhered resilience across the community. This galvanises the need for communities to acknowledge these weaknesses and direct attention towards a process of 'learned' resilience through capacity building. The following section is a practical response to this issue. It outlines the application of proposed framework to build resilience within communities facing complex flood issues. It begins by outlining Phase 1 of this process.

7.5 Framework application

As outlined in chapter 5 (Section 5.5.1), the Framework application comprises two phases. It begins with a top-down quantitative assessment, drawing on secondary data to assess the existing inhered resilience levels within the 8 case-study communities (Phase 1). Chapter 4 further outlined how the foundational resilience tool developed by Cutter et al (2008) was drawn upon and adapted to fit a flooding context. Illustrated in Figure 7.6, the refined community assets identified in Section 4.6.2 comprise: economic, infrastructure (Physical), social community (Human) and institutional, together with their associated variables. The 21 variables (corresponding to the four assets) (Figure 7.6) were predominantly drawn from publically available data such as the census (2011) and environmental data from the EA. An exhaustive list of these variables and their data sources are set out in Table 7.1 a-d. Framework variables contained within these community assets were adjusted slightly to meet English data availability and flood policy variations. Those variables highlighted in bold indicate the use of an alternative variable data source. For example, the English Indices of Deprivation, compiled by the Ministry of Housing, Communities and Local Government and published by the Office of National Statistics were accessed on the 'Cumbria Observatory' website. The baseline assessments are presented at the three hierarchical scales, beginning with the urban scale and proceeding to the village scale.

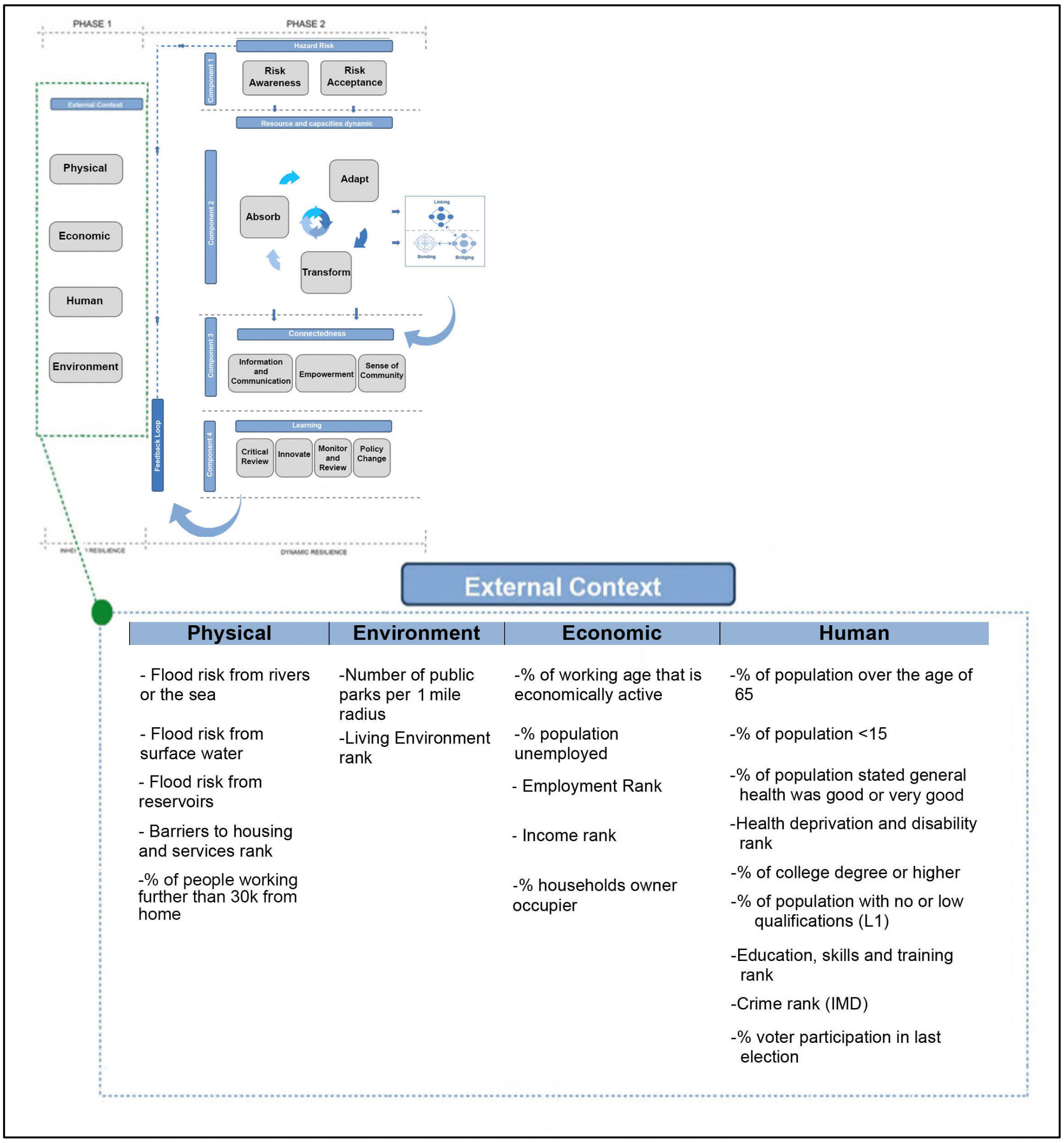


Figure 7.6 Theoretical Framework proposed by this thesis, highlighting the Phase 1 baseline resilience assessment[28].

7.5.1 Data aggregation and normalisation.

Having established the variables, a process of normalising the data began and data sources were adjusted to meet Cumbrian data availability (Chapter 5, Section 5.4.3 detailed how raw counts from differing data sources were normalised using the min-max scaling technique). After conversion, each score was decomposed into a range from 0 to 1, with scores of zero equated to low resilience and one equating to high resilience. The variable scores were subsequently aggregated within each asset

[28] Figure previously presented for explanatory purposes in Chapter 5, Figure 5.9.

(physical, human, economic, environment) and visually represented through a radar diagram.

In the discussion of methodology (Chapter 5), the decision to apply equal weight across the variables was argued. This approach was taken as certain communities may have a greater number of relevant variables than others, however that does not necessarily equate to higher resilience. The variable scores were summed for each of the four community assets and the average produced for each resource set (physical, human, economic, environment). In doing so, a separate radar diagram was produced for each community (Figures 7.7) which allowed for comparative analysis of baseline resilience levels. Table 7.1 outline this process using Carlisle[29], Kendal and Glenridding case-studies as examples. A fully worked example is presented in Appendix 2.

Table 7.1a Examples of individual variable and aggregated scores for the 'Physical' resource in the context of Carlisle, Kendal and Glenridding.

Community Asset:	**Variable**	**Carlisle**	**Kendal**	**Glenridding**	**Data source**
1. Physical resource					
	Flood risk from rivers or the sea	0.1	0.1	0.5	Environment Agency, Long-term flood risk maps***1**
	Flood risk from surface water	0.5	0.5	0.5	Environment Agency, Long-term flood risk maps***1**
	Flood risk from reservoirs	0.5	0.5	N/A	Environment Agency, Long-term flood risk maps***1**
Access to services	**Barriers to housing and services rank**	0.8	0.4	0.0	Income: Multiple Deprivation Measure 2011***2**
Access to 'Recovery" shelter	% of people working further than 30k from home	0.8	0.8	0.5	UK Census, 2011 ***3**
Aggregate score per resource		**2.7**	**2.3**	**1.8**	

[29] Carlisle data refers to those areas directly affected by flooding. For example, St. Aidans (006D/E), Botchery (004A), Castle (008A/B) and Denton Holme (008C) wards.

Table 7.1b Examples of individual variable and aggregated scores for the 'Environmental' resource in the context of Carlisle, Kendal and Glenridding.

Community Asset:	**Variable**	**Carlisle**	**Kendal**	**Glenridding**	**Data source**
2.Environmental resource					
Environmental exposure	**Number of public parks per 3 mile radius**	0.8	0.8	0.6	Cumbria County Council ***4**
	Living Environment rank	0.8	0.4	0.0	English Indices of Deprivation 2015 ***2**
Aggregated score per resource		**4.0**	**3.0**	**1.5**	

Table 7.1c Examples of individual variable and aggregated scores for the 'Economic' resource in the context of Carlisle, Kendal and Glenridding.

Community Asset:	**Variable**	**Carlisle**	**Kendal**	**Glenridding**	**Data source**
3.Economic resource					
Livelihood stability	% of working age that is economically active	0.1	0.8	0.8	UK Census 2011
	% population unemployed	0.3	0.8	0.8	UK Census 2011
	Employment Rank	0.5	0.8	1.0	English Indices of Deprivation 2015 ***2**
	Income rank	0.5	0.7	1.0	English Indices of Deprivation 2015 ***2**
Tenure	% households owner occupier	0.7	0.7	0.7	UK Census 2011
Aggregated score per resource		**3.1**	**3.8**	**4.3**	

Table 7.1d Examples of individual variable and aggregated scores for the ‘Human’ resource in the context of Carlisle, Kendal and Glenridding.

Community Asset:	**Variable**	**Carlisle**	**Kendal**	**Glenridding**	**Data source**
4.Human resource					
Community capacity	% of population over the age of 65	0.2	0.3	0.2	UK Census 2011
	% of population <15	1.0	0.9	0.7	UK Census 2011
	% of population stated general health was ‘good’ or ‘very good’	0.8	0.8	0.9	UK Census 2011
	Health deprivation and disability rank	0.2	0.8	0.8	English Indices of Deprivation 2015 ***2**
Equity	% of college degree or above (Level 4 or higher)	0.5	0.7	0.9	UK Census 2011
	% of population with no or low qualifications (L1)	0.3	0.6	0.6	UK Census 2011
	Education, skills and training rank	0.4	0.7	0.6	English Indices of Deprivation 2015 ***2**
Social capital	**Crime rank**	0.4	0.6	1.0	English Indices of Deprivation 2015 ***2**
	% voter participation in last election *	0.9	0.4	0.4	UK Electoral Commission ***5**
Local knowledge	% from outside the area	0.6	0.9	0.7	UK Census 2011
Aggregated score per resource		**2.7**	**3.4**	**3.4**	

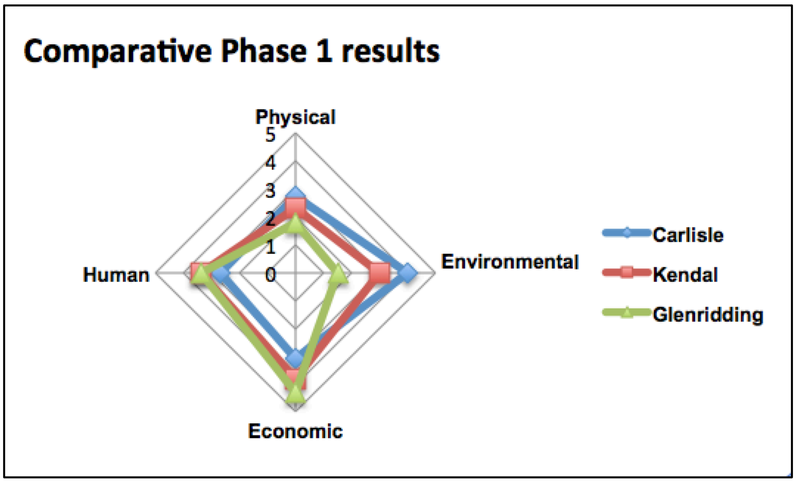


Figure 7.7a Comparative baseline assessment (Phase 1) results: city; town; and village scale.

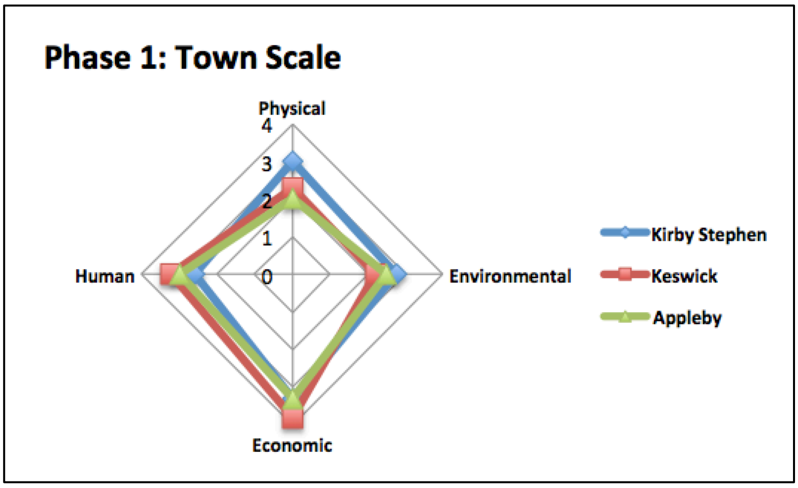


Figure 7.7b Baseline assessments (Phase 1) results, town scale.

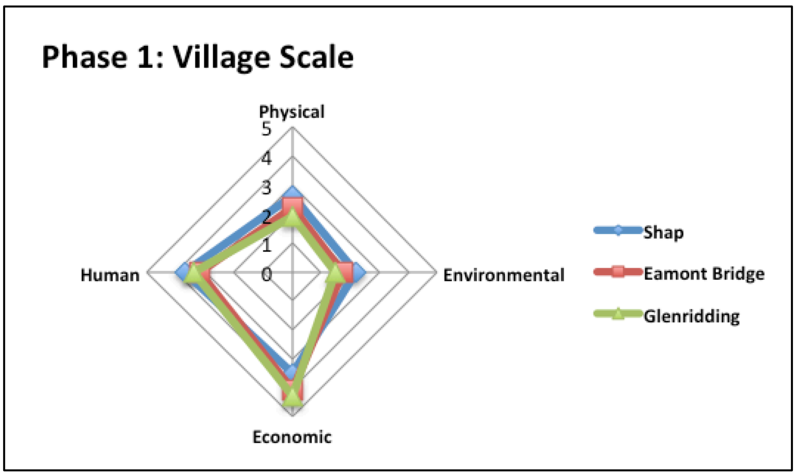


Figure 7.7c Baseline assessment (Phase 1) results, village scale.

The baseline assessment results (Figure 7.7) indicate that low physical resource scores are attributed to the settlement's location in high flood risk zones (level 3). The village scale (in particular Shap) ranked higher in terms of its environmental resource score as a consequence of the quality of the outdoor environment and proximity to parks. The village scale ranked highly in terms of economic resources, due to employment from its farming and tourism sectors. However, the percentage of economically active residents was comparatively low at the city scale, which may be attributed to the low level of education and skills. Reaffirming this assumption, Carlisle (city scale) ranked lowest of the three scales in respect of 'human' capacity, with lower educational attainment a significant contributor to this. A high crime rate at was also found to reduce social capital at the city scale. In addition an aging population whose average age was well above the English average (low percentage in 0-15 years) reduced the 'human' resource at the all there scales. This statistical 'snapshot' characterises baseline resilience 'of place' within each of the communities and has highlighted areas where resilience intervention is most needed. The following section captures indicators of realised resilience, identified through the Phase 2 empirical analysis.

7.5.2 Phase 2 recruitment and sampling

As discussed in Chapter 5, purposive sampling was employed to allow respondents to be chosen in accordance with the criteria outlined by the thesis (Chapter 5, Section 5.6.5). The pilot study highlighted the importance of engaging a facilitator to gain a contextual grounding of the site context whilst further assisting access to potential affected community members. Further, this process gained trust and legitimacy among the affected community and eased the recruitment process considerably. To begin this process key figures were contacted through residents' associations, parish councils, churches and in particular flood action groups. In the case of Cumbria, the organisational structure attached to FAGs proved an invaluable method of engaging interviewees.

However, Shap, Kirby Stephen and parts of Carlisle, proved to be the exception as recruitment of a facilitator was not feasible. Low incident level coupled with sparse populations in Shap and Kirby Stephen, contributed to low community engagement and subsequent difficulty recruiting a facilitator. Despite widespread flooding in Carlisle city, engaging a facilitator across all affected areas across the city proved difficult. On these occasions contact with a local councilor, parish council and

Environment Agency resilience officer was established to create links into the community.

A further difficulty arose from the timing of the interviews. This research concerns the recovery and reconstruction phase of the Disaster Management Process. As such, entering the field seven months after the event meant a large proportion of affected residents had not completed the renovation works to their properties and were residing in temporary accommodation. This presented an issue when trying to contact interviewees as home telephone numbers were not in use, temporary accommodation had limited access to the internet and contact details for their rental property was not known by the FAG facilitator.

In a bid to overcome recruitment issues, attendance at post-flooding community meetings proved to be vital. These events, organised by the council and EA as part of their remit as LLFA under Section 19 of the Flood and Water Management Act (2010), brought together affected individuals. During this period of heightened engagement, large numbers of flood affected community members were in attendance, with numbers exceeding 250 at the city scale. Leaflets explaining the nature and purpose of the research together with contact details, were made available at these events. This recruitment method yielded 23% of the overall interview count.

Attendance at the North West Regional Flood and Coastal Committee Floods Conference proved a valuable means of populating the Framework and further presented an opportunity to engage and recruit additional practitioner participants. Contextual understanding of the flood devastation was afforded through a guided tour of the damaged United Utilities infrastructure on privately owned lands, otherwise inaccessible without their kind collaboration.

In addition to the above purposive recruitment methods, snowball sampling was used to ensure a balanced sample of gender and age profiles (Figure 7.14), flood experience levels (Figure 7.15) and time lived in the area (Figure 7.16) was achieved. Table 7.2 presents the community level sample across the eight case-study settlements.

Table 7.2 Interview logbook of community level sample.

Case-Study Area	Properties affected	Number of Interviews	Interview Codes (NVivo)
City Hierarchy			
Carlisle	2500	46	C 22-68
Town hierarchy			
Appleby	176	21	A 1-21
Kendal	2150	42	K 92-133
Keswick	515	13	K 134-147
Village hierarchy			
Eamont Bridge	72	12	E 69-81
Glenridding	15	9	G 82-91
Kirby Stephen	20	8	K 148-156
Shap	20	3	S 157-159
Total		**159**	

The sample was evenly distributed across the three age categories, namely: 65 and above; 46-64; and 18-45 (Appendix 11). Further, the sample included a spread of flood experience levels ranging from first time victims to those flooded three times or more (Table 7.3). This allowed for analysis as to the influence of flood experience on resilience levels. In addition, a range of 'time spent in the community' was evident across the sample (Table 7.4), permitting comparative analysis on the influence of place attachment, belonging and social cohesion on resilience levels.

Table 7.3 Distribution of interviewee flood experience levels (NVivo).

Flood experience	Number of scoped items which have that particular attribute value combination
1st time	66
2nd time	65
3 times and above	23

Table 7.4 Distibution of 'time spent in the community' case category (NVivo)

Time in community	Number of scoped items which have that particular attribute value combination
11-20	59
20 plus	34
6-10 years	33
1-5 years	22
1 year or less	5

Lessons learned from the pilot study interview process (Chapter 6) informed refinements to the interview design, structure and location. For example, every effort was made to ensure that interviews took place in a quiet location, allowing for clear audio recording for ease the transcription. This was unfortunately not always feasible and the need to consult handwritten notes did lengthen the transcription process. The practitioner level interviews ranged from 45 minutes to an hour and half long. In respect of community level interviews, it became apparent that the timing of the interviews so close after the flood event meant that emotions were still high. Interviewees tended to focus on the day of the flood event itself, rather than reflecting on the recovery process. Consequently, prompt questions were used to steer the interview discourse away from the response phase towards the thesis focus, i.e. on mechanisms relating to the recovery and reconstruction process.

7.5.3 Practitioner level interviews

As outlined in Chapter 6, practitioner level interviewees were purposively recruited based on respective roles and responsibilities within their organisations. Consistent with the approach outlined in Chapter 5 (Section 5.5.5), a mapping exercise was conducted to identify individual stakeholders representative of four key areas, namely: (1) policy and prevention; (2) emergency management; (3) recovery and reconstruction; and (4) independent industry arena. Section 5.5.5 further outlined the sampling and recruitment strategy used to identify suitable participants based on their area of expertise. A full list of ppractitioner level interviewees together with their NVivo codes are listed in Table 7.5.

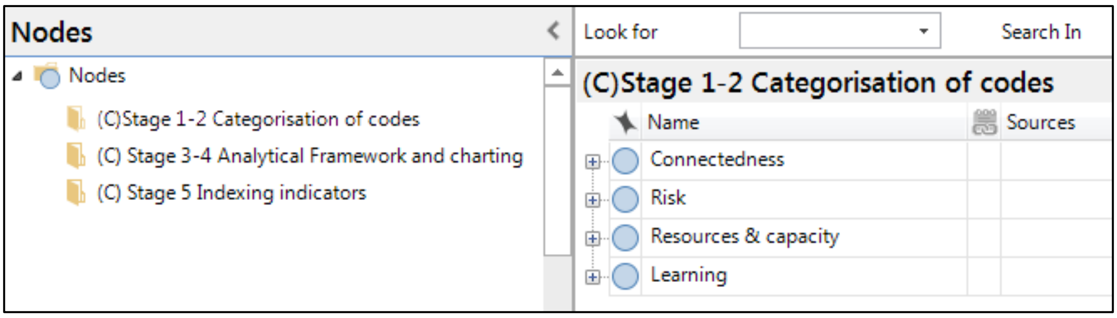
Table 7.5 Codebook of Practitioner level interviewees.

Organisation	**Responsibility**	**Interview codes (NVivo)**
Policy and prevention		
Environment Agency	Asset Engineer	P165
United Utilities	Head of water programme	P167
Carlisle City Council	Principal planning officer	P171
Eden District Council	Principal Development and Management Officer	P173
Emergency Management		
Met Office	Flood forecasting and communicating.	P174
Environment Agency	Resilience officer	P163
Allerdale Borough Council	Flood Risk Team	P175
Cumbria County Council	Flood Risk Management Team	P168
Recovery and Reconstruction		

Environment Agency	Asset manager	P176
Cumbria County Council	Development and infrastructure planning	P177
Cumbria County Council	Community planning and development	P178
Cumbria County Council	Councillor	P179
Carlisle City Council	Community and economic development	P162
Carlisle Churches	Flood Recovery Team	P164
Cumbria CVS	Flood Recovery Manager	P166
Industry and Independent		
Red Cross	Community adviser	P180
Farmers Network	Managing director	P161
Cumbria action for sustainability	Property resilience manager	P170
National Farmers Union	Vice president	P169
Property level Protection	Business manager	P181
ABI representative	Risk adviser	P182

In accordance with the structured 'Framework Method' data analysis outlined in Chapter 5 (Section 5.7.1), the five systematic phases of analysis was transposed and applied in NVivo (Table 7.6).

Table 7.6 Transposing the 5 stage 'Framework method' of analysis into NVivo



The process began with Stage 1 'Transcription and Familiarisation' of the interview recordings and field-notes. Once familiar with the data, Stage 2 followed with 'Categorisation of the Codes' involving the creation of 'cases' for the participants (Table 7.7). This was an important step as it permitted interrogation and identification of patterns later in coding (Stage 3) of the framework analysis. The cases were categorised into different case profiles, namely: gender; age; time in community; number of people in household; community location and flood experience.

Table 7.7 Stage 2: Screenshot example of 'case profiles' in NVivo to ease comparison between cases.

A : Gender	B : Age profile	C : Time in community	D : People in household	E : community location	F : Flood experience
Male	46-64	20 plus	adults and up to 2 children	appleby	3 times and above
Male	18-45	11-20	adults and up to 2 children	appleby	2nd time
Female	65 and above	20 plus	2 adults	appleby	2nd time
Male	65 and above	11-20	2 adults	appleby	1st time
Female	65 and above	20 plus	2 adults	appleby	1st time
Female	65 and above	20 plus	adults and up to 2 children	appleby	3 times and above
Male	18-45	20 plus	2 adults	appleby	2nd time
Female	18-45	11-20	2 adults	appleby	2nd time

Stage 3 followed by describing the application of the "Analytical Framework" proposed in Chapter 6. Transcripts were 'coded' line by line, with relevant data being placed within the applicable pre-defined thesis Framework, namely; risk; resources and capacities; connectedness and learning (Table 7.8).

Table 7.8 Stage 3: Coding framework of component 'nodes'.

(C)Stage 1-2 Categorisation of codes		
Name	Sources	References
Connectedness	91	499
Resources & capacity	94	443
Risk	96	318
Learning	84	264

A process of 'open coding' allowed for new or unique sub-components (child nodes) to emerge outside of those found within the Chapter 6 pilot study. For example, Figure 7.8 highlights how the "awareness" sub-component can have many 'child nodes' or indicators (e.g. knowledge or possession of a disaster plan) which stand as proxies of the "risk awareness" indicator.

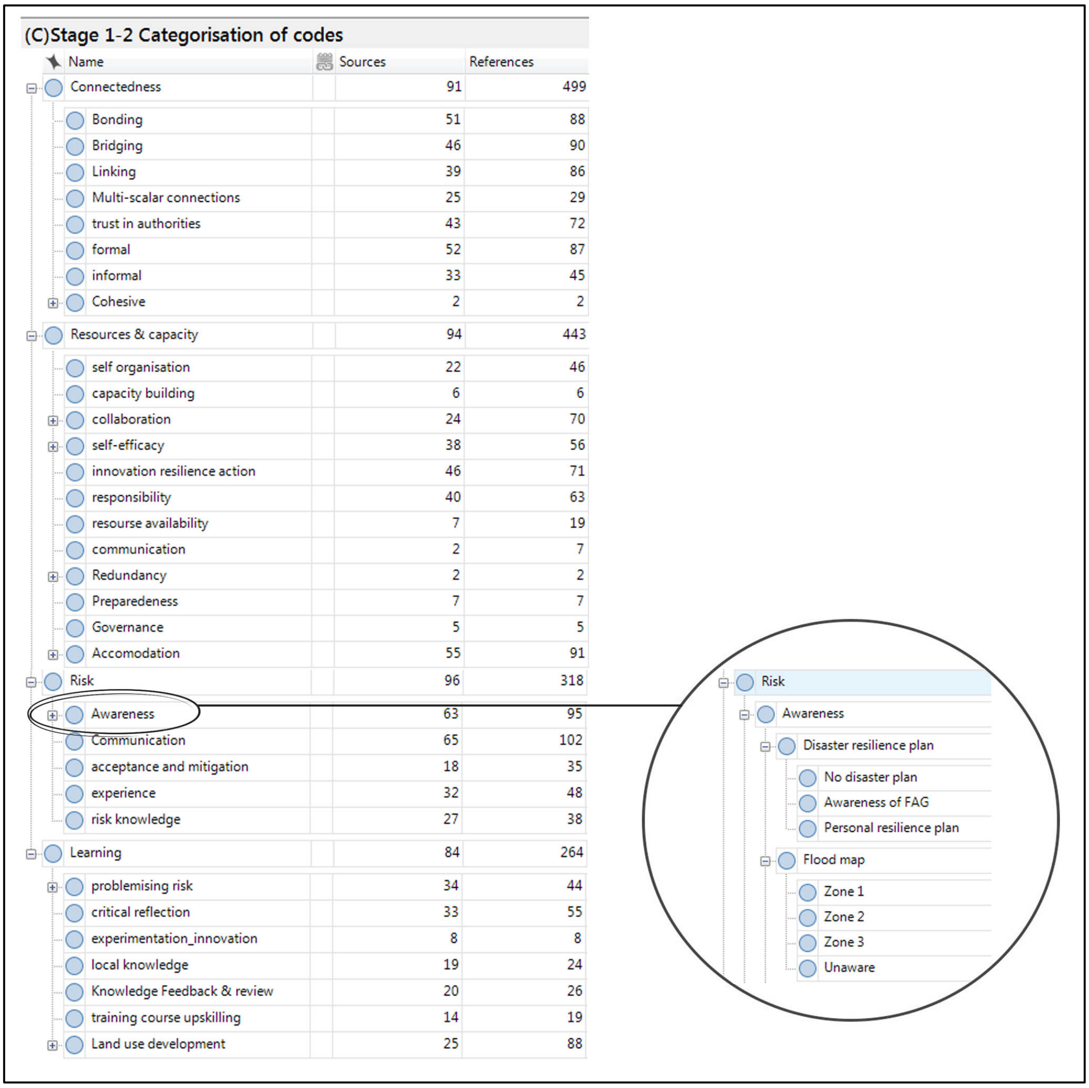


Figure 7.8 Stage 3: Coding framework of 'parent nodes' (components) and 'child nodes' (sub-components).

Stage 4 comprised the method of 'Charting' the indicator data in a structured manner within the pre-defined spreadsheet template outlined in Chapter 6. Firstly, a word frequency query was run for each of the four components within NVivo to ensure no new emerging themes were overlooked. The resulting 'clustering (tree) diagrams' (Figure 7.9) assisted with the synthesis of vast amounts of indicators into a more workable scale.

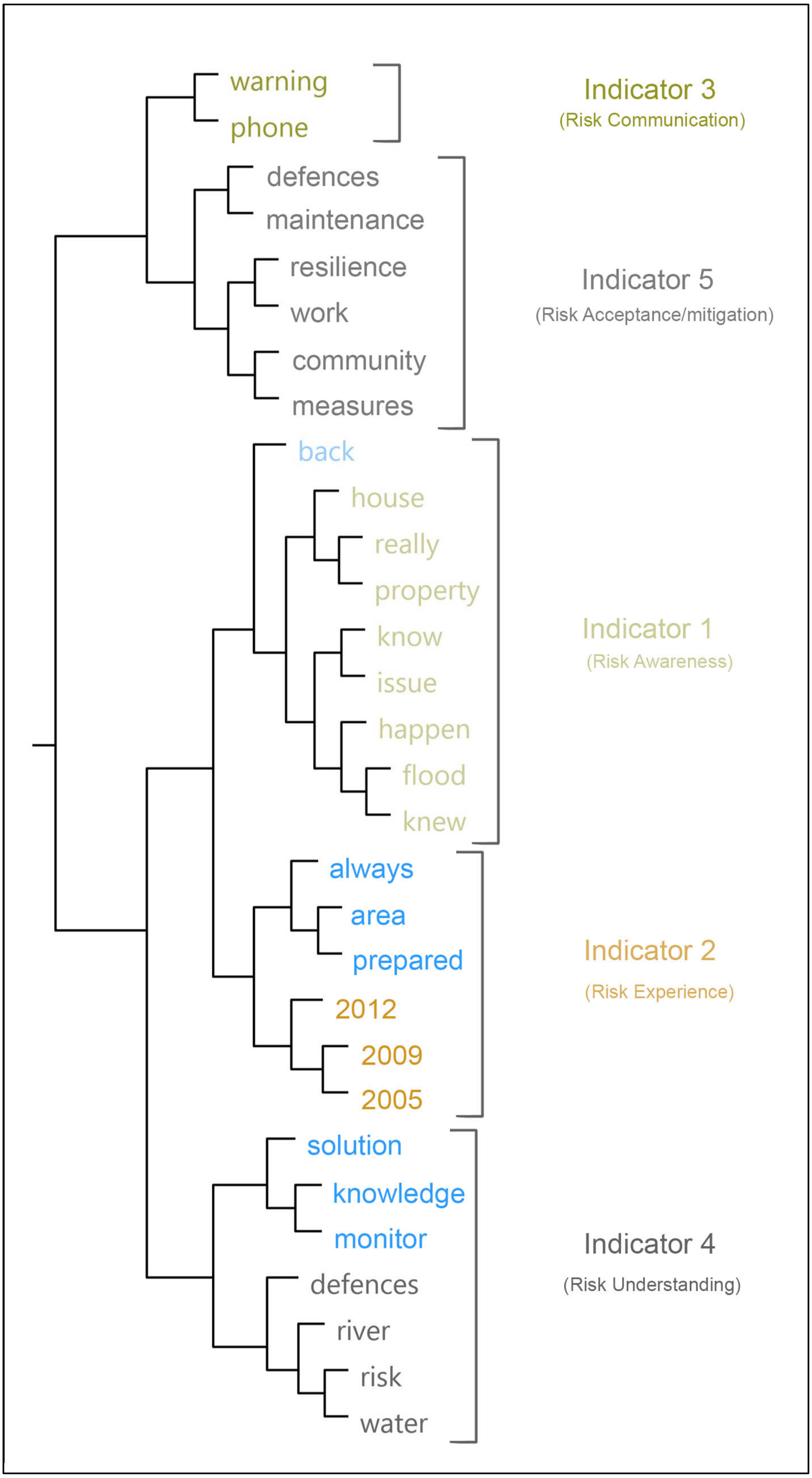


Figure 7.9a Stage 4: Process of charting 'Risk' component indicators

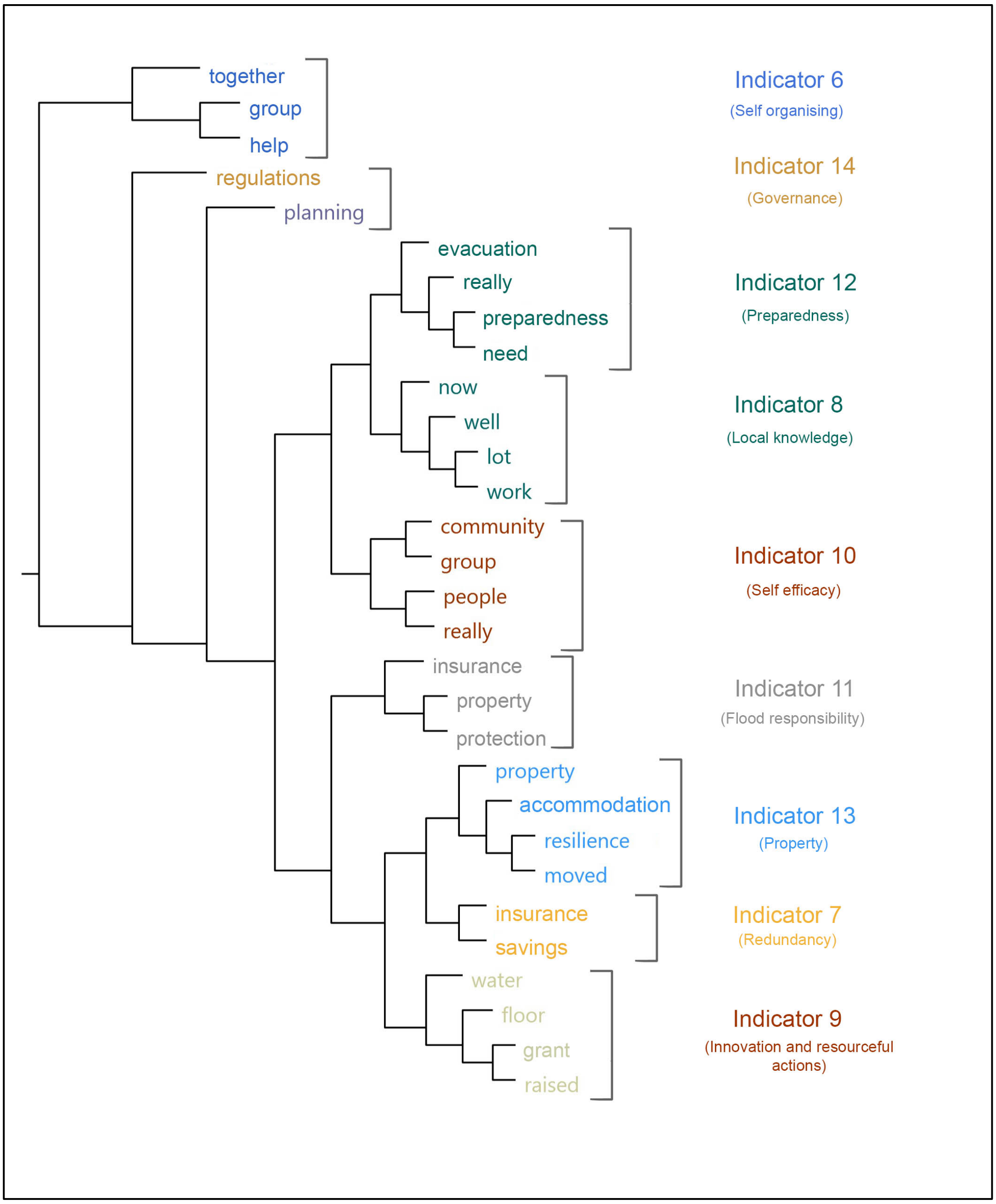


Figure 7.9b Stage 4: Process of charting the 'Resources and capacity' component indicators.

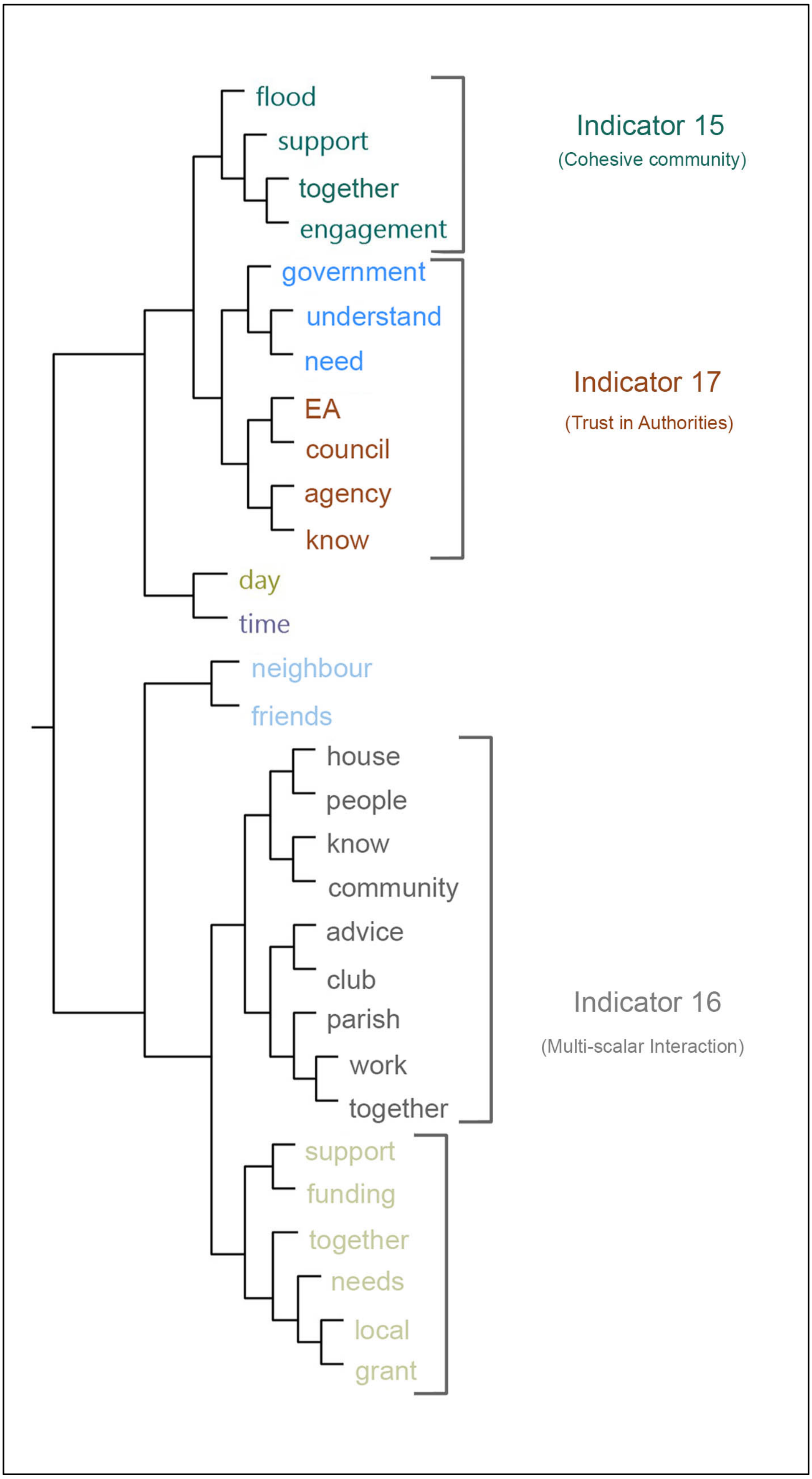


Figure 7.9c Stage 4: Process of charting the 'Connectedness' component indicators.

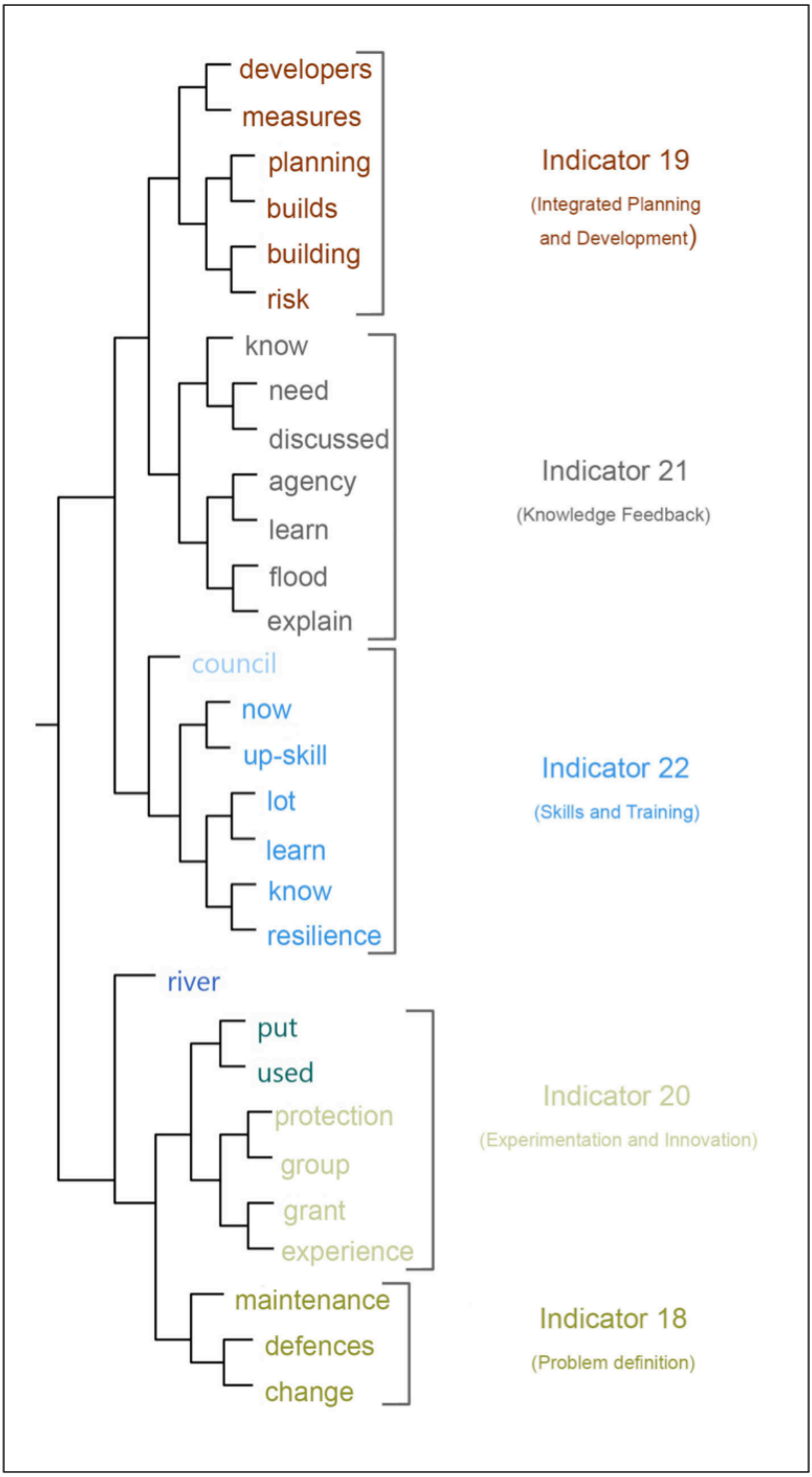


Figure 7.9d Stage 4: Process of charting the ‘Learning’ component indicators.

By way of example, the resulting “Risk” indicators are set out in Table 7.9 (a full list of all indicators is presented in Appendix 12).

Table 7.9 Stage 5: Indexed “Risk” component indicator list.

Framework Component	Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
Risk (community level)	**1. Risk Awareness**	Awareness of hazard risk information and exposure	_Awareness of whether property lies within a risk risk zone as indicated on a flood map _Existence of disaster management plan	Semi-structured interview	Positive	Individual, community
	2.Risk Experience	Active flood memory-previous hazard experience leading to mitigative action.	_Knowledge and experience of past flood events	Semi-structured interview	Positive and Negative	Individual, community
	3. Risk Communication	Existence of Early warning system	_Signed up to EA flood alert _River guage	Semi-structured interview	Positive	Individual, community
	4. Risk Understanding	Knowledge and understanding of the extent of risk and cause of flooding	_Monitor and review flood risk _Utilising local knowledge _Critical thinking toward proposing risk solutions	Semi-structured interview	Positive	Individual, community
	5.Risk Acceptance/ Mitigation	Acceptance of risk and adjusting mitigative action appropriately	_Existing and practiced resileince plan _Member of FAG _Implementation of PLP _Current flood risk mapping _Community resileince initiatives _Flood risk maintenance	Semi-structured interview/ Observation	Positive	Individual, community
	<u>(Practitioner level)</u>		_Commitment of long-term proactive funding for Flood Risk Reduction _Acknowledging increasing risk with updated codes,standards and enforcement.	Semi-structured interview	Positive	Community

Stage 5 concludes the structured “Framework method” by indexing indicators within their respective components. Results from this stage led to the creation of twenty-two ‘community resilience’ indicators as listed in Table 7.10. Those highlighted in bold reflect new indicators that did not emerge in the Northern Ireland pilot data.

Table 7.10 Comparison of indicator allocation for Northern Ireland pilot and Cumbrian case-studies. Those highlighted in bold are unique to that region.

Framework Components	Pilot Study	Cumbria
Risk awareness		
	1.Risk awareness	1. Risk awareness
	2. Risk communication	2.Risk experience
	3. Risk acceptance and mitigation	3.Risk communication
	4. Risk experience	**4. Risk understanding**
	5. Risk Knowledge	5. Risk acceptance and mitigation
Resources and Capacities		
	6. Self organising	6. Self organising
	7. Capacity building/upskilling	**7. Redundancy**
	8. Insurance	**8. Local knowledge**
	9. Collaboration	**9. Resourcefulness**
	10.Innovation	10. Self-efficacy
	11. Self-efficacy	11. Flood responsibility
	12. Flood responsibility	**12. Preparedness**
		13. Property
		14. Governance
Connectedness		
	13. Social capital	**15. Cohesive community**
	14. Integration of Social networks	**16. Multi-scalar interaction**
	15. Sense of belonging	17. **Higher-level Trust**
	16. Trust in authorities	
Learning		
	17. Problem definition	**18. Analytical thinking**
	18. Critical Reflection	**19. Integrated development planning**
	19. Experimentation	20. Experimentation and innovation
	20. Transfer of (local) knowledge	**21. Knowledge feedback and review**
	21. Monitor and review	**22.Skills and training**

Figures 7.10 and 7.11, give an overview of the weighted breakdown of coded indicators (number of codes per indicator theme), together with their respective components. The findings reveal 'Risk' as the most prominent component, followed by "Resources and Capacities" and "Connectedness" in almost equal measure. "Learning" was referenced the least, despite its critical role in transformational resilience. The outer ring of coding in Figure 7.25 illustrates the number of

indicators representative of the sub-components or 'child nodes' (middle ring), which in turn represent the key component indicators (innermost ring). Taking the four components in turn, an analysis of the "risk" component and its respective sub-component indicators is presented in more detail below

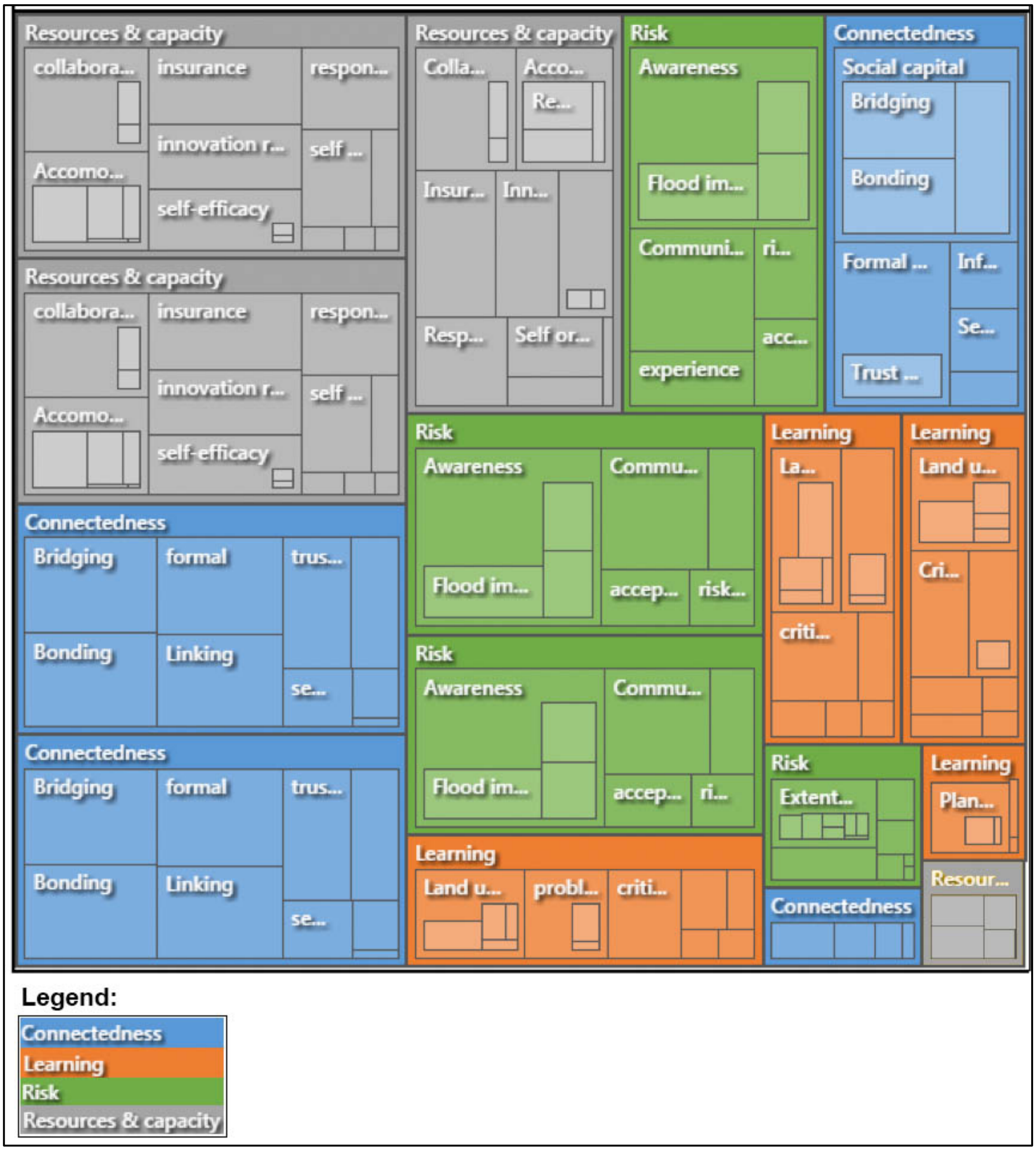


Figure 7.10 NVivo hierarchy visualisation of coded component 'nodes'.

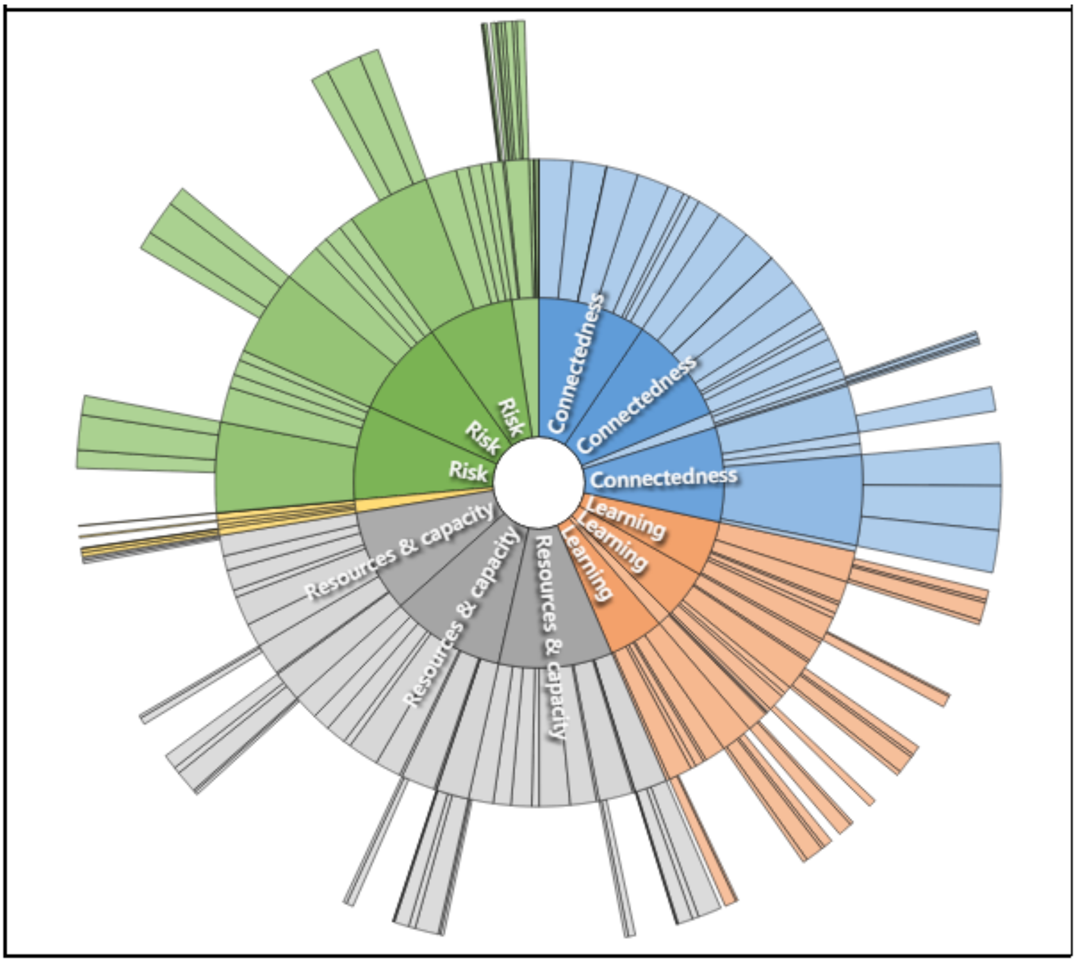


Figure 7.11 NVivo hierarchy visualisation of coded component ‘nodes’.

7.5.4 Risk indicators

Chapter 6 highlighted the complex relationship between risk awareness as a driver towards resilience mitigation action. Using knowledge of flood maps as an indicator of ‘risk awareness’ (Indicator 1), it was found that 96% of first time flood victims were unaware of their proximity to or in a flood zone and as such were apparently unaware of their risk. A matrix query was run in NVivo isolating ‘flood experience’ case profiles: three times and above, second time and first time flood victims. In doing so, it allowed comparison between these case categories and the indicator node ‘risk awareness’ (Indicator 1). The comparative results highlight a lack of flood risk awareness amongst those flooded for the first time as illustrated in Figure 7.12.

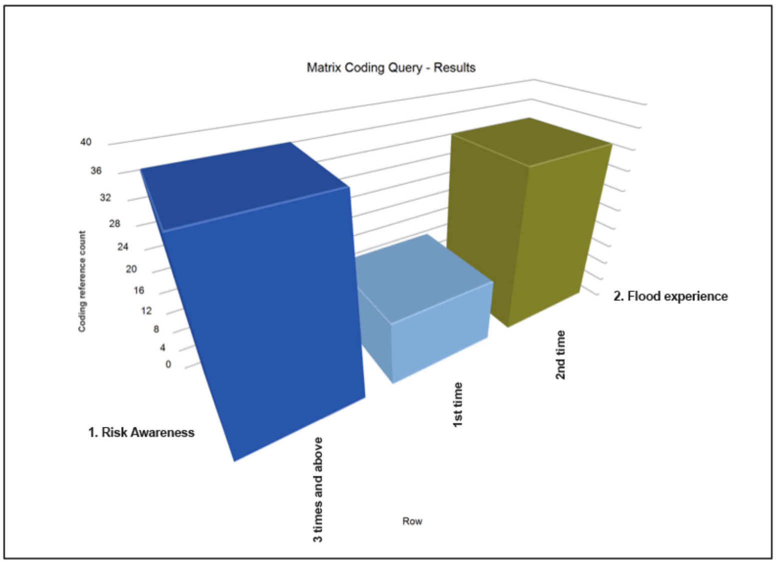


Figure 7.12 NVivo matrix coding query highlighting low risk awareness among first time flood affected residents.

Corroborating Cutter et al's (2010) assumption that risk awareness levels lead to preparedness action, it was found that communities with higher awareness had community disaster plans in place (Section 6.6). With the exception of Keswick, none of the case-study communities had a resilience plan in place prior to the winter flood 2015. In addition, communities affected by a high first time flood percentage were prompted to establish a FAG post event. As part of this positive resilience action, many are in the process of developing flood action plans to *"Get everyone around the table and shape a plan for a safer city"* (C55).

Table 7.11 Indicator 1, Risk Awareness.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
1. Risk Awareness	Awareness of hazard risk information and exposure	_Awareness of whether property lies within a risk risk zone as indicated on a flood map _Existence of disaster management plan	Semi-structured interview	Positive	Individual, community

'Risk experience' (Indicator 2) emerged strongly from the NVivo coding (word search query) by reference to previous flood events in 2005, 2009 and 2012 (Figure 7.9). However, whether this experience leads to positive mitigative action (Chandra et al, 2012) relies on two factors: a correlation between high frequency of event (3 times or more) and a corresponding higher uptake of property level protection. For example, an elderly couple flooded for the third time in Keswick 'flipped' their house by relocating the kitchen upstairs during post flood renovations: they can live in the property during potential future renovations:

"The hardest part is constantly moving from temporary accommodation to temporary accommodation during the renovations. With the kitchen now upstairs we can close the door at the bottom of the stairs and carry on with life as the renovations get underway" (K 112)

Risk experience did not, however, always result in positive resilience action. In this regard, a relationship was found between a lower than average time of years spent living in the community (<10 years case category) and an unwillingness to invest in resilience measures. When asked the question "Would you be willing to invest in flood resilience measures for your property?", Carlisle was found to have the lowest 'Yes' response at 67% in comparison to an average of 86% over the other case-studies.

This could be attributed to the transient nature of the Carlisle population, typical of many urban settlements[30]. An above average rental tenure in the city (25.6 %), coupled with lower than average time spent living in the community (54 % in the <10 years case category), potentially led to a reduced sense of belonging as proposed by Cutter et al (2012). Highlighting this assumption, a tenant renting in Carlisle commented: *"I'm not going through this again. Once I get sorted with a new house to rent I'm out of here"* (C 51). Equally, reduced time living in the area led to one property owner of six years to comment: *"I'm selling the house at auction, cutting my losses and getting out. Life is too short to be living in a house that is a construction site"* (C 51).

Table 7.12 Indicator 2, Risk Experience.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
2.Risk Experience	Active flood memory-previous hazard experience leading to mitigative action.	_Knowledge and experience of past flood events	Semi-structured interview	Positive and Negative	Individual, community

[30] Carlisle holds a comparatively higher rental tenure (29%) to that of the Cumbrian average. This is partly attributable to the student population attending the University of Cumbria campus (9,500 students enrolled).

Risk communication' (Indicator 3) was measured by the percentage of members signed up to the EA flood alert system. The low percentage in Kendal was attributed to the high number of flooded properties that were not in an EA flood risk area. As such, they did not receive a warning and it *"Wasn't until the water was running down the street that we had any idea we were going to flood"* (K 129). This highlights the need for a portfolio of communication options. In addition to formal communication channels such as the EA flood alert, the Met Office website and television/radio news, it was found that informal methods were also effective. The interview discourse revealed that Keswick informed at-risk-residents through their flood warden scheme by knocking on residents' doors. Word of mouth and social media (albeit to a lesser extent in rural villages) served as informing channels in all communities. The apparent relationship between flood experience and flood communication was visible through the manner in which some Carlisle residents became aware of the threat of flooding: *"When I heard that Appleby was flooded then I knew we were next" (C 42).*

In particular, local knowledge played a role in more localised flooding: *"It's the drains in the street behind that flooded us. Myself and the neighbour have a look at them every so often, particularly when it rains" (K142).* Additional evidence was noted in Eamont Bridge where properties overlooking the river use visual monitoring, together with a river level gauge, as additional means of informing. An early warning system using the Appleby fire station siren was used to communicate flood threat in that location. However, evidence cited in the interview discourse regarding operational failure of the river gauge and human error over the siren in Appleby, highlight the need for multiple forms of informing.

Further, it was found that the type of communication needs to be tailored to the community demographic. Social media, texts and email alerts may not be suitable for all community demographics, particularly in respect to the elderly who often rely on more informal methods of risk communication:

"You know yourself by looking out the window at the river levels. My neighbour was good to me too. He warned me to get ready to leave… he helped me put some valuables like the TV upstairs" (E 77).

Table 7.13 Indicator 3, Risk Communication.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
3. Risk Communication	Existence of Early warning system	_Signed up to EA flood alert _River guage	Semi-structured interview	Positive	Individual, community

An apparent link between ‘risk understanding’ (Indicator 4) and subsequent ‘risk acceptance’ (Indicator 5), leading to mitigation action was noted in the Cumbria case- studies. It was apparent that risk understanding was evident through the community’s deep understanding of how river behaviour impacts upon their community: *“When the river gets up to the height of the fence there, that’s when I know to knock on the neighbour’s door and drive up the hill to park the car”* (E79). The interview discourse further revealed how understanding informed potential monitoring and solution approaches:

“That river needs to be cleared out. It hasn’t been cleared for years. The water then can’t get through the bridge quick enough, gets backed up and then we flood in a matter of hours” (C 47).

It was also found that the misinterpretation of technical language by the community can erode resilience. Technical terms such as Annual Exceedance Probability (AEP) and ‘1 in a 100 year flood’ were found to be understood by many communities to mean that they should expect a flood every one hundred years. *“I bought this house after the 2009 floods, I had thought that it wouldn’t flood for another 100 years”* (C53). This reinforces the viewpoint of Catto (2010), who argues that the use of technical jargon at the local level exacerbates the flooding issue by limiting a community’s ability to articulate or appreciate their own risk.

Table 7.14 Indicator 4, Risk Understanding.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
4. Risk Understanding	Knowledge and understanding of the extent of risk and cause of flooding	_Monitor and review flood risk _Utilising local knowledge _Critical thinking toward proposing risk solutions	Semi-structured interview	Positive	Individual, community

Acceptance of risk as a by-product of awareness (Indicator 1), experience (Indicator 2) and indeed understanding (Indicator 4) is argued to prompt communities to mitigate their risk with appropriate resilience action (Chandra et al, 2012).

Both the community and practitioner levels agreed establishing FAGs was an immediate resilience "win" that could stand to benefit the community in the long term. The community interview discourse (particularly with those flooded more than once) demonstrated adaptation measures, including property level protection and maintenance of gulleys, drains and rivers.

However, both practitioners and the communities argued the need for proactive change and updating in relation to flood risk maps, building codes, standards and enforcement. These data point to an acceptance from both practitioners and the community that existing strategies are not calibrated to the increasing level of risk and proactive change is required. In response to the need to account for this residual risk, the development manager at Carlisle City Council stated *"It's clear flood defences designed to withstand past floods will not withstand the increasing pressure that climate change presents"* (P162). In addition, practitioner discourse pointed to a concern over a *"lack of long term funding"* (P169), suggesting present risk acceptance levels are not tailored to appropriate Government long-term funding strategies.

Table 7.15 Indicator 5, Risk Acceptance.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
5.Risk Acceptance/ Mitigation	Acceptance of risk and adjusting mitigative action appropriately	_Existing and practiced resileince plan _Member of FAG _Implementation of PLP _Current flood risk mapping _Community resileince initiatives _Flood risk maintenance	Semi-structured interview/ Observation	Positive	Individual, community
(Practitioner level)		_Commitment of long-term proactive funding for Flood Risk Reduction _Acknowledging increasing risk with updated codes,standards and enforcement.	Semi-structured interview	Positive	Community

7.5.5 Resources and capacities indicators

Once adequately informed of their risk, it is important to understand the factors and processes that drive the mobilisation of resources (Magis, 2010). As such, this component focuses on a community's ability to develop and engage with resources in a way that allows them to thrive during the uncertainty that characterises the post-flood recovery phase.

The process of 'self-organisation' (Indicator 6) was found to increase the capacity of a community to come together as a collective to sustain, change or develop action. An indicator of this collective capacity was evident in the interview discourse through the introduction of FAGs or other, more informal resilience groups using existing networks such as the parish council. The findings show that self organisation enhanced resilience during the temporal preparedness, recovery and reconstruction phases: *"Resilience plans made us (as a community) more prepared should we get hit once again"* (K146): *"We help each other out throughout the rebuilding"* (K142), with the overall aim of improving the situation to ensure *"Our city is safe for its residents"* (K142) in the future.

Table 7.16 Indicator 6, Self organising.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
6. Self organising	Capacity of community to self organise	Establishing of Community Resilience Group/organisational reform	Semi-structured interview	Positive	Individual, community

'Redundancy' in terms of the ability of a community to rely on extra resources when faced with adversity, was highlighted in Chapter 4 as a key aspect of resilience theory (Norris et al, 2008; Biggs et al, 2012). The findings from Cumbria reinforce this argument by highlighting the relationship between redundancy and a community's corresponding ability to share resources. Use of redundancy (Indicator 7) was identified through (1) access to specialist equipment, (2) stable and diverse economy, (3) risk transfer (insurance) and (4) access to public buildings. Taking each resource in turn, access to resources such as tractors, diggers, chain saws and shovels were drawn upon in rural areas, such as the following example from Glenridding:

"*First thing we got a chain saw and pulley to the tree trunk blocking the passage of* *water through the bridge, it was acting like a dam….We got diggers from a local contractor loaned to us to get the rubble out of the river…we removed tonnes*" (G 90).

Whilst this resource was evident in a rural context, it should be noted (by contrast) that no evidence of access to machinery was available in an urban context. However, despite the immediate benefit brought about by this type of intervention, it does raise questions about consent and safety when operating heavy machinery in a river.

Economic diversity was a concern across all communities. In particular, reliance on the 'McVities' factory in Carlisle (a major employer within Carlisle which flooded) led to situation where many locals (many of whom flooded themselves) were out of a job during a period of mounting renovation costs: *"In the space of a day I lost my job and my house. It was such a disruption to my life I still haven't recovered"* (C52). The associated financial stress illuminated the need for communities to build in some personal financial redundancy:

"I learned the true meaning of saving for a rainy day. I had to pay for a deposit for a new house to rent, new clothes for the baby, hotel meals as we were out of the house...and all within the space of a few days. The insurance company is slow to pay out " (C45).

The practitioner level discourse acknowledged the need for a public building to act as a rest centre during evacuation procedures in the preparedness phase: *"We are working with communities, particularly those with FAGs to set up rest centres…central points for people to go and register as flooded after being evacuated. Somewhere to dry off, get a cup of tea, clothes and be safe. Many end up sleeping there until alternative accommodation is found"* (P163).

The evidence above highlights how the provision or absence of these four redundancies is a critical aspect of resilience theory. Redundancy provides communities with the capability to switch between numerous available resources in order to maintain performance during uncertainty.

Table 7.17 Indicator 7, Redundancy.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
7. Redundancy	Insurance as a risk transfer resource_ _Extra capacity to allow for flexible and adaptable resources _ Availability and access to specialist recovery equipment_ Balanced spread of economic industries	_Access to tractors, 4x4 vehicles,diggers, machinery. _Savings _Local Emergency shelter, centre _Diverse employment opportunites _Business resilience Continutity plan	Semi-structured interview/ observation	Positive	community

Local knowledge (Indicator 8) was found to be a critical resource during the Northern Ireland pilot (Chapter 6), particularly in relation to warning and informing. Evidence from the Cumbrian community level discourse reaffirmed this initial finding, with an affected resident noting: *"You know we can tell when it's going to happen (flood)…you can tell by looking at the river there. When it rises to the level of that fence I know we are done for"* (K141). The practitioner level further reinforced this finding, with a Flood Risk Manager from CCC commenting: *"No one knows a community better than someone who has lived in it all their life...it's invaluable"* (P163).

The value of local knowledge further presented itself through alerting local authorities to potentially inappropriate planning developments: *"I knew that site would flood, I objected to it when the planning application was going through. That very site was a lake in December"* (E76).

Table 7.18 Indicator 8, Local Knowledge.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
8.Local knowledge	Understading of the importance of local knowledge	_Object to inappropriate planning applications _Awareness of river behaviour and levels	Semi-structured interview/ observation	Positive	community

Proactive responses to risk were consolidated in the indicator "resourcefulness" (Indicator 9). At an individual scale, PLP glavanised household resilience ahead of the next potential flood. After being flooded for the second time, an Appleby resident explained the extent of their PLP efforts:

"We tanked up the wall to about a foot higher than it was after the last flood. We dug up the floors and put damp proof membrane and then put concrete on top of that. We dug down one or two feet. Concrete then epoxy resin matrix and then on top of that a flooring sandwich of insulation and a floor surface on top of that. It worked" (A13).

In addition, evidence of innovatively calibrating resilience actions to increasing risk was demonstrated through preparedness actions: *"As soon as I got the alert I knew to take my car to higher ground. I knocked on a few neighbours' doors to let them know. A lot of people still lost their cars though"* (K113).

Recovery efforts were also aided by small, impromptu resourceful actions such as offering to charge affected residents' phones: *"I took all their phones and brought them to my house to charge. The town was completely cut off with no electricity"* (A4). Other members of the Appleby community utilised social media and notified the local school (which served as a rest centre) that they could offer some accommodation to those displaced. *"We offered up spare bedrooms in our house on Facebook. We also rang the grammar school and let them know that we had spare beds available if they knew someone who may need them" (A4).*

An apparent correlation was noted between flood experience and an acknowledgement that innovative measures, beyond the current provision of hard defenses, are required if a pathway to transformational resilience is to be realised:

"We need to start thinking beyond flood walls…we can see they didn't work. In the FAG we are looking at a range of possible solutions from leaky dams further upstream, dredging the river, holding back the water…." (C61).

The above evidence corroborates Fazey et al's (2017) assumption that a dialogue about transformational change and potential opportunities is a fundamental step towards re-shaping more sustainable future trajectories.

Table 7.19 Indicator 9, Resourcefulness.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
9.Resourcefulness	Proactive actions in response to risk	_Implementaiton of PLP _Evidence of calibration of risk to proactive resilience actions	Semi-structured interviews/ Observation	Positive	Individual, Community

The presence of ‘self-efficacy’ (Indicator 10) was found to play a critical role in realising resilience actions. It was found that a belief in what they could achieve (*“We know what to do now”* (K135)) left communities feeling empowered: *“The FAG is well set up now. We all have our roles, we have done dry runs. We are in as good a position as we can be should it happen again"* (K137). This quote from a resident in Keswick highlights the fundamental role FAGs play towards empowering communities to galvanise their potential.

Table 7.20 Indicator 10, Self efficacy.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
10.Self efficacy	Empowerment and self belief in resileince capabilities	_Membership of Resilience Group/FAG	Semi-structured interview	Positive	Individual, community

The pilot chapter findings uncovered an apparent relationship between ‘flood responsibility’ (Indicator 11) and ‘flood experience’ (Indicator 2). A matrix query was run in NVivo, across all Cumbrian case-studies, isolating the former node for comparison against the case profile ‘Flood experience’. The results indicate that flood responsibility increases in line with flood experience (Figure 7.13).

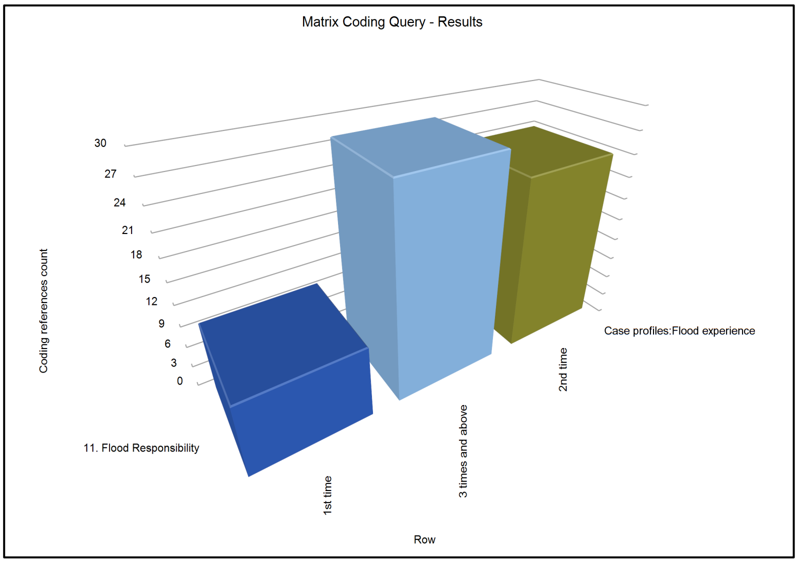


Figure 7.13 Matrix coding highlighting the influence of time living in an area on the resilience indicator ‘Flood responsibility’.

A further query was run to explore the relationship between ‘time spent in the community’ (Case profile) and increased flood responsibility (Figure 7.14). It was learned that residents in more established communities, who have resided in the area for a longer period, are more likely to undertake resilience measures.

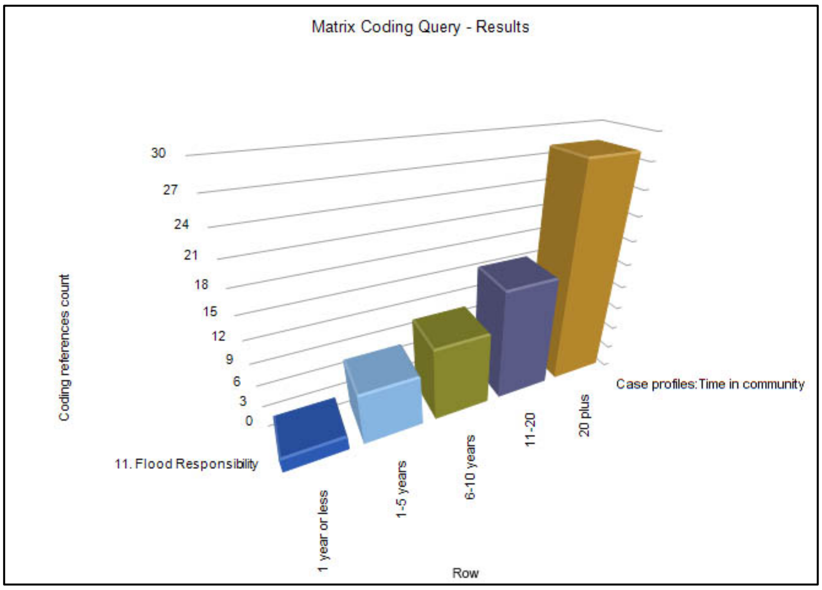


Figure 7.14 Matrix coding highlighting the influence of time living in an area on the resilience indicator ‘Flood responsibility’.

Evidence from interview discourse uncovered three potential factors, signifying acceptance of a community’s own responsibility towards mitigating flood risk. The first recognised a pattern between installing PLP and insurance uptake as having a potential influence on a community’s propensity to accept responsibility for their own risk. *“It’s our house and obviously we want to protect it. We have taken up the resilience grant and made our home as flood proof as possible"* (S158).

However, reluctance on the part of insurance companies to facilitate resilience measures was found to impede resilience: *“I put in some resilience measures with the money from the grant. I'd like to get a bit more done, concrete in the floor and raise plug socket levels but the insurance won’t pay for that and I don't have the money"* (C38).

A further commitment to flood responsibility was demonstrated through the EA flood alert registration figures. Flood experience played a role in increasing these numbers, however, many previously flooded still felt it was a once off and did not calibrate this risk with a need to receive a formal flood warning. By contrast, those who accept flood responsibility were found to be signed up to multiple flood alert channels:

“You are constantly checking the river when there is heavy rain. You’d be listening to the radio and watching the news as well….when you hear Pooley (further up-river) is flooded then we need to be alert. We have a river gauge too that we can monitor from the laptop. As a community the neighbours would be talking about it, letting people know if they thought they needed to put their flood gates up” (E79).

Table 7.21 Indicator 11, Flood Responsibility.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
11. Flood responsibility	Personal flood mitigation actions	_Installing property level protection, insurance, signed up to early warning.	Semi-structured interview	Positive	Individual

Evidence of evacuation plans and multi-scalar co-ordination were found to enhance the preparedness of at-risk communities. ‘Preparedness’ (Indicator 12) did not emerge as an indicator in its own right but instead it formed part of the ‘flood responsibility’ indicator. The lack of ‘preparedness’ evidence cited within interview discourse by contrast to the Cumbrian context, is largely attributed to higher level of impact sustained in Cumbria. The evidence from the Northern Ireland pilot did not present flooding as a risk to life. However, floodwater reached a height of over 1.4 metres in some Cumbrian properties. A household in Carlisle which had flooded twice previously explained their preparedness routine:

“As a family we have a household resilience plan. My husband is very organised like that and insisted we make one. Last week we got a flood alert and I was out shopping. My son rang me and said we moved the TV and valuables upstairs and that I should get home" (C49).

Other flood-affected members highlighted their preparedness by keeping a *‘grab bag’ (K142)* ready for evacuation, whilst residents in Carlisle reaffirmed the importance of PLP: *"I've taken all the resilience measures I can to make the house flood-proof. We spent a lot more than the grant they gave out"* (C48).

Table 7.22 Indicator 12, Preparedness.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
12.Preparedness	Evacuation protocol	_Recognised public buildings as energency centre and shelter _Evacuation protocol _Evacuation 'Grab bag'	Semi-structure	Positive	Individual, community

'Property' (Indicator 13) is a new indicator that did not present itself as strongly in the Northern Ireland pilot. The indicator focused on the standard (flood resilience) and availability of accommodation needed to relocate as a consequence of post-flood renovations. Relocation was frequently cited as the hardest part of the recovery process: *"I could watch the flood water come and go but living out of a suitcase for months was very tough on the family"* (K 126). The extent of widespread flooding resulted in an accommodation shortage across Cumbria, requiring displaced families to change alternative accommodation several times: *"We've had to move 6 times over the 7 months. I used to be able to walk to work, now I have to drive an hour each way. On top of that I have the added stress of needing to check how the builders are getting on with the renovations"* (C65). NVivo coding related to 'Property' further reinforced the importance of PLP (Indicator 9) as a means for communities to increase their individual resilience. Frustration over restrictions to the implementation of property level protection within conservation areas was expressed in the discourse:

"How can they tell me to be resilient and then turn around and say you're not allowed put in a flood gate without getting planning permission. There really is a lack of common sense there on the behalf of the Council" (A21).

Table 7.23 Indicator 13, Property.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
13. Property	Standard and availabilty of property	_Uptake of property level protection _Provision of alternative accommodation	Semi-structured interview	Positive	Process

Modes of 'Governance' (Indicator 14) and flexible-decision making have been put forward in the literature as critical aspects of transformational change (Biermann et al, 2012). The case-study communities expressed a desire for a more long-term Government approach to FRM: *"I would prefer if the Government kept their £5000 (resilience grant) and instead pooled it together to solve the problem"* (K121). Further, the need for the Government to take stock of increasing risk was expressed by many: *"I don't think the Government are aware how bad the situation is. We feel like we have been forgotten about. We need to see some changes"* (E72). Contrary to the community's perception, the practitioner level expressed an understanding of increasing flood risk and a need to calibrate responses accordingly: *"We have moved away from an approach of building defences to looking at a portfolio of solutions. This ties in with our joined up approach" (P162).*

In light of the above evidence, it has become apparent that a 'politics as usual' approach may stand as a roadblock to positive transformation (Dryzek and Stevenson, 2011). The evidence from Cumbria suggests that a more adaptive approach to policy may help meet the changing demands imposed by an uncertain environment.

Table 7.24 Indicator 14, Governance.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
14. Governance	Flexible Governance	_Governance and policy adapting to changes in risk environment _Communitis lobby Government for change	Semi-structured interview	Positive	Process

7.5.6 Connectedness indicators

As outlined in Chapter 6, the 'Connectedness' component, presents evidence of how horizontal and vertical interactions are integral to the effective functioning of community network typologies. The section below discusses how the presence of (1) cohesiveness, (2) multi-scalar interaction and (3) trust in authorities are integral to a community's ability to mobilise resources and capacities in the face of adversity.

Evidence of 'cohesiveness' (Indicator 15) was apparent in the relationship between place-based social cohesion and resilience. This was shown through membership of clubs and organisations and engagement levels in FAGs and other resilience groups: *"We came together as a group to see what we can do as a community to be* *more prepared but even beyond that ….I know you can't stop the rain but we want to see what can be done better so that we aren't in this mess again"* (G90).

The findings revealed an apparent relationship between settlement scale (urban/rural) and cohesiveness. Referring to the cohesiveness of rural areas, an Appleby resident commented: *"Appleby is one of those nodding hello type of places"* (A19). By contrast, evidence from urban Carlisle presented the opposite: *"You just get on with it (recovery) don't you. Everyone around here has enough to be worrying about without worrying about how you are getting on"* (C62).

The presence of a 'cohesive community' (Indicator 15) also extended to a desire to remain in the area, referred to in the literature as 'sense of belonging' (Nowicki, 2008). Despite the adversity faced, a resident in Appleby commented: *"I didn't want to leave the house, it was my house, it was my home, I wanted to stay here despite the flooding" (A19).* Another resident also expressed reluctance to move out of Appleby during the reconstruction process*: "I didn't want to see my belongings leave Appleby"* (A1). The literature suggests that 'sense of belonging' may be more prominent in established communities (Cutter et al, 2012). Further, low levels of renting, (typical in rural villages) could also be attributed to increased sense of belonging and community cohesiveness.

The practitioner level further vindicated this initial finding that rural communities exhibit higher cohesiveness over their urban counterparts: *"What we tend to find is that the rural villages come together more easily. It's the practicalities of their size more than anything else"* (P163).

However, certain communities within Carlisle highlighted inconsistencies regarding the assumption that urban areas are isolating and non-cohesive. In Carlisle, it was also found that distinct neighbourhoods/communities acted as 'urban villages' within the city fabric. For example, the community of Caldewgate in Carlisle had strong ties to the local biscuit factory, employing 800 staff, many of whom lived in the Caldewgate area. This localised pattern of employment created a stable population within the community. One retired lady commented:

" I grew up smelling the biscuits in the playground at school…. I've been working there since I failed my 11+ exams…. We (neighbours) helped each other out (after the floods) with cleaning and so on. A few in the street mucked in."

Evidence of local connection, kinship and cohesion, stemming from shared employment as well as living together in the same neighbourhood, cuts across the preconcieved view of Carlisle as a 'cold' city and instead recognises certain communities (such as Caldewgate) as an 'urban village' within Carlisle city.

Table 7.25 Indicator 15, Cohesive Community.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
15.Cohesive community	Sense of belong within a community leading to participative action	_Number of social groups a community resident is a member of _Unwillingness to relocate after a flood __Place attachment (housing tenure) _Volunteer to clean up after a flood (Actively engaged)	Semi-structured interview	Positive	Individual, community

The evidence from Cumbria acknowledges the need for 'multi-scalar interactions' (Indicator 16) and, as such, this section presents evidence of relationship ties. In particular, it reveals attempts by communities to extend beyond internal ties (bonding, bridging) to engage and interact with outside resources such as statutory agencies (linking). Taking each relationship tie in turn, the following section presents evidence of these ties in practice.

7.5.6.1 Bonding ties

Bonding ties were found to facilitate communities in receiving flood warnings, taking mitigative action, arranging alternative accommodation and accessing resources and capacities needed to plan for long-term recovery (Table 7.28). Conversely, it was found that while businesses are integral to the functioning of a community, evidence of businesses drawing on bonding capital was limited: *"We just get on with it ourselves. Between the staff and the insurance company we got it done"* (C68). This may, however, be attributed to the temporal nature of less established small businesses whose owners/managers may not live in the area affected by flooding.

Table 7.26 Coded quotes indicating use of bonding social capital.

1.	*"I gave a key to my neighbour and she saved what she could"* (A18)
2.	*"A lot of my husband's friends are burly so they helped me with the clear out"* (C22)
3.	*"We know who to call here in the village...it's that kind of place"* (G90)
4.	*"We helped each other on the street…we went from door to door helping out"* (A18)

The findings corroborate Tunstall et al's (2007) assumption that the elderly have an over reliance on bonding social capital. Further compounding this vulnerability was the fact that these ties were not geographically located in the community. For example, an elderly lady speaking of the assistance she received from her son in a town over fifteen miles away, commented:

"My son is very good to me. He's a good lad and helps me with everything since my husband died. I moved into his house (in another town) with his wife for five months while the builders were in. I'd be lost without him" (K127).

A number of residents commented that they were unaware FAGs existed in their areas. Of this number, 73% were in the >65 age group. This evidence draws an apparent correlation between elderly residents and low bridging and linking social connectivity. Affirming this belief, an elderly resident in Carlisle commented: *"I don't get out much, I wouldn't know much of what goes on in the town. I rely very much on my son"* (C43).

7.5.6.2 Bridging ties

The previous section presented evidence of how bonding ties can potentially restrict network innovation by resisting outside assistance. By contrast, bridging ties are evidenced to expedite recovery through the connecting of two loosely related ties (Levin and Walter, 2011). Most commonly found in heterogeneous groups, evidence of a community's ability to access new information and resources was seen through a variety of institutions and organisations, including: charities, churches, nongovernmental organisations, clubs, societies and local businesses. These more fragile ties were cited as enhancing the community's ability to recover by providing wider access to resources and capacities. In particular, many residents in Kendal referred to receiving vital support from the church:

"I relied on the church a lot for support. I'm not sure I'd be sitting here today if it wasn't for them…and that's the truth of it. I'm not talking financial support now but advice…form filling and that kind of thing. It was a place to go when you were down, have a cup of tea and pull yourself together again. There were other volunteers that came around too, again religious groups, the muslims came and a friend who I play bridge with helped me too with clearing out the house" (K133).

Displacement to temporary accommodation was found to negatively impact upon community relations. Exacerbating the already stressful situation, one resident commented:

"You don't see your neighbours once you move out unless you bump into them when you come to check up on the builders. People are coming and going from one temporary accommodation to the next... you can't keep track" (E79).

7.5.6.3 Linking multi-scalar interactions

Linking social capital was the least evident dynamic within the Cumbrian networks. However, it could be argued that it is the most important for resilience as it is the tie that connects community members with those in power.

Evidence of multi-scalar dynamics (Indicator 16), including linking ties, were demonstrated through FAGs - the primary means of engagement between the statutory level and the community level. Formally established in Carlisle, Keswick and Kendal and informally through parish councils in Glenridding, FAGs displayed characteristics of vertical and horizontal ties and form the main data source for this analysis.

The findings indicate that the extent of integration between the community and statutory agencies is largely dependent on the degree of flood responsibility (Indicator 11) accepted by the community. This is reflected in the reasoning behind establishing a Flood Action Group. Irrespective of the group title (FAGs, Resilience Groups, Flood Groups), these groups were found to comprise two main forms: pressure groups and action groups.

Evidence from pressure groups found that flooding was viewed as the responsibility of the government. As such, they form after a flood in response to a perceived contractual breach by the agencies who, from the community's perspective, *"allowed us to be flooded"* (C59). Their intention is to "*hold government agencies to account"* (C59) for this breach through consultation with the agencies or in extreme cases they pursue direct action by taking over responsibility for the breach themselves (for example river maintenance). A member of the Carlisle pressure groups commented: *"The Government need to stand up and take this issue seriously. It's not my fault I'm flooded is it?"* (K 155).

Action Groups view engagement and collaboration with statutory agencies as a collaborative exchange of skills and resources. Linking (vertical) ties were found as a source of empowerment, facilitating the community to develop skills and knowledge to reduce their flood risk. Corroborating this viewpoint, a Keswick resident commented:

"We know what to do now. We all have roles and they know where we fit in the overall plan. I think people feel comforted by this, you know that can be useful and help it" (K146).

The effectiveness of this re-delegation of responsibility to the community level (linking ties) is dependent on the existence of trust with authorities.

Table 7.27 Indicator 16, Multi-scalar interaction.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
16. Multi-scalar interaction	Effective communicatin through multi-scalar channels (bonding, bridging, linking)	_Support from a mix of bonding, bridging and linking sources. _Access to technical Advice (linking) _Colaborative support at local level (bonding) _ Emotional support (bonding) _Number of organisations and clubs in settlement _Membership of FAG	Semi-structured interview	Positive and Negative	Individual, community

The last of the connectedness indicators 'higher-level trust' (Indicator 17), concerns building relationships of trust between communities and authorities. Overall, a sentiment of distrust between the two actors was evident: *"You don't see them from one flood to the next"* (C35). The main concern from the community's perspective was the disrupted nature of engagement which appears to intensify only when an event occurs: *"You only see them when we're flooded"* (G82). The communities expressed the view that local knowledge was not adequately taken into account by authorities*: "They came from all over the country descended on us with all sorts of ideas, come up with suggestions and then we never see them again"* (G82). In addition, their dissatisfaction extended to the process of engagement: *"No one is listening" (A15)*.

Conversely, those who engaged with authorities through FAGs spoke positively of the relationships built: *"It's nice to know there is someone in an office somewhere working on our behalf" (*K142). Equally, the practitioner discourse commended community engagement via FAG channels: *“We work with communities through the channel of the Parish council or FAGs. This is an effective route for us. Over time this relationship builds and strengthens"* (P168).

Despite this progress, practitioners did acknowledge that communication channels with communities could be improved: *"I think there is a lack of understanding of public sector protocol that we must follow. It can be frustrating for both sides"* (162). The above narratives are suggestive of a breakdown in communication between both sides, despite sharing a common goal. These gaps in linking and bridging connections highlight structural communication holes within community networks. The importance of this key component justifies further research as to the causal mechanisms of these structural holes. As such, Social Network Analysis (SNA) is carried out in Section 7.6 to further reveal the barriers and drivers to a joined up approach to recovery.

In reference back to ‘bonding social capital’ in the previous component, a relationship was found between communities exhibiting dense bonding networks (in particular the >65 demographic) and a lack of trust of outside agencies. Dense networks (unfamiliar with working with actors outside their network), were found have a tendency to resist external support until a relationship of trust is established: *“They come in here in with their shiny shoes and clipboards, having never stepped foot in the village before. They don’t even introduce themselves or tell us what they intend to do. How can you trust them when they carry on like that” (K120).*

This suggests that density of bonding ties alone can potentially act as a barrier to accessing outside formal assistance that could potentially lead to transformational resilience.

Table 7.28 Indicator 17, Higher-level trust.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
17. Higher-level Trust	Positive relationship with horizontal ties	Inclusion and liaise within Flood action Group activities (linking)	Semi-structured interview	Positive	Individual, community

7.5.7 Learning indicators

This component illuminates opportunities to facilitate and navigate positive transformational change through learning. It reveals potential factors that have been highlighted in the Cumbrian interview discourse as a means to shape new trajectories towards transformational change.

The first of the learning indicators 'analytical thinking' (Indicator 18) considers reflective framing of the flood issue based on past experience. Critical reflection (through the medium of FAGs) in the aftermath of a disaster provides the space for communities and practitioners to critique current societal recovery patterns and to suggest new thinking and pathways going forward.

The FAGs presented an effective platform from which communities could discuss and reflect on past flood issues. In doing so, communities were able to iteratively calibrate mitigative action: *"The purpose of the group (FAG) is more than just support. Yes we chat with others who have flooded and are in the same boat, but, we also look at ways of coming together to be more prepared next time"* (K142).

Table 7.29 Indicator 18, Analytical thinking.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
18.Analytical thinking	Reflective consideration of mitigative options based on past flood experience	_ Existence of a Flood Group to allow for reflection _Calibration of risk to community resilience plan	Semi-structured interview	Positive	Individual, community

'Integrated development' (Indicator 19) emerged as an indicator in response to the extent of interview discourse surrounding inappropriate planning and development. Respondents presented the argument that inappropriate development contributed to the flooding: *"Those houses shouldn't have been built. They are what has us in this mess"* (A5).

Further, there was concern that local knowledge on development issues was not adequately accounted for by the authorities: *"I objected to the planning application. I remember the site used to be a marsh field and I'd play in it with the frogs as a child. Is it any surprise it flooded. It shouldn't have been granted permission"* (K153).

Residents expressed concern over developments knowingly built in flood plains but granted planning permission on account that resilient measures were taken: *"These houses are built right beside the river but designed with the garage below and the living space above. They were designed to withstand a 1 in 100 year flood…so they knew the area was a flood risk. Now here we are sitting on garden furniture inside a gutted house"* (A19).

Practitioners also expressed the need to account for future climate change risk when granting planning permission: "*What's fit for purpose today might not be fit for purpose in 20 years time…you need to bear climate change in mind"* (P168). More positively, the council commented that *"steps forward"* (P 168) taking account of climate change are being made within planning. In particular, practitioner discourse did make suggestions as to the cause of the underlying planning issue: *"They are planners not hydrologists…that is the issue"* (P162).

This highlights an apparent understanding of the limitations of the current planning system in relation to FRM. The above discourse suggests that future development decisions need to be set against a backdrop of future climate risk.

Table 7.30 Indicator 19, Integrated development planning.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
19. Integrated development planning	Catchment wide approach to planning and development	_Consultation on planning process _Appropriate land-use planning _Stricter planning approval and enforcement	Semi-structured interview	Positive or negative	Individual, community

Examples of 'experimentation and innovation" (Indicator 20) were shown through advances in individual PLP measures: "*We put a lot more resilience measures in … tiled floors, raised plug sockets and raised flood defence wall outside…hardwood doors and flood barriers. We got the advice from builders"* (E81). Further examples included resilient furniture: *"We've had new furniture installed to be flood resilient"* (K135) and the use of the resilience grant to part fund concrete floors: "*We used the grant to concrete in the floor so when it floods again it will dry out much quicker"* (C33).

By contrast, Shap and Kirby Stephen demonstrated a relationship between communities who displayed low cohesion and in turn limited evidence of experimentation and innovation:

"My son is a builder so he re-done my house and then did the same with his own house. What else can you do, you just have to accept it's just one of those things isn't it" (S158)

In part, this can be attributed to the fact that flooding was isolated and not widely felt across the Shap and Kirby Stephen settlements. As such no FAG was established leaving little opportunity for the affected community to discuss potential strategies to reduce flood risk.

Further measures, challenging the status quo in other case-studies, included the creation of a community register to prioritise assistance to those who need it the most: *"We are trying to create a register of who on the street is elderly, lives alone or is disabled…they should be getting help first"* (C22).

Table 7.31 Indicator 20, Integrated development planning.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
20.Experimentation	Experimental Resileince actions that question the status quo and infomred by lessons learned	_Policy change _Resileince strategies and plans _Soft approaches to flood risk reduction NFM _Build back better	Semi-structured interview/ observation	Positive	Community

'Knowledge feedback" (Indicator 21) describes the process of taking lessons learned and reinterpreting them as positive resilience actions. The most prominent proxy for this indicator was recognition of local knowledge being accounted for by tailoring mitigative actions accordingly. For example, flood affected residents commented that poor river maintenance exacerbated the extent of flooding: *"We've put it to the council that they need to manage the river better. We used to be able to dive off the river bank into it. You'd need a crash helmet to do that now"* (E76).

Improvements in communication as a consequence of the Flood and Water Management Act (2010) have provided opportunities for communities to present their account of events at LLFA organised meetings:

“Dealing with communities is not something this agency would typically have done in the past. We are learning, we are getting better at it. It's a different language. We need to communicate flooding in an understandable manner, to allow us to move forward together" (P168).

Highlighting this positive development, a council representative commented: *“Community meetings as part of the section 19 report were a great way to learn more about what happened on the day” (P168).* This evidence reaffirms the need for higher-level acknowledgment of the local knowledge resource, a council representative commented: *“Particularly in relation to planning objections we need to take local knowledge seriously"* (P171).

A notable finding, at both the practitioner and community level, was a call for updated standards in line with the increasing risk. *"I think there needs to be some form of resilience standards. Why did they suck the insulation out of that house and not mine? Too many cowboy builders out there"* (K132). The practitioner level corroborated the need to adapt policy and regulations in line with increasing risk: *“We need to keep our policy in line with climate change and this needs constant monitoring and adaptation to ensure we are making the right decisions!” (P171).* However, this sentiment was not shared by all practitioners with some feeling the recovery process as it stands is still reactive: *"I have battered my head trying to get them to take on the recovery process and they haven't"* (P164).

Table 7.32 Indicator 21, Knowledge feedback.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
21.Knowledge feedback	Knowledge and information feedback and sharing _Feedback into risk awareness related actions	_Dissemination of results actions across stakeholders _Utilisation of local knowledge _Capacity/structure for feedback to be linked to risk awareness related actions	Semi-structured interview	Positive	community

The above findings highlight an apparent relationship between knowledge feedback (as a consequence of flood experience) and lessons learned has the potential to lead to informed future risk strategies. The Cumbrian findings suggest that actions emerging from lessons learned can positively equate to communities reflecting on past flood experience and integrating new knowledge. For example, a business owner in Carlisle commented: “*As a business we were completely unprepared. Now we are investing some time in business contingency plans....it's a resilience plan really. We could have had the shop back open a lot quicker had we been prepared"* (C37).

The above discourse reaffirms the argument in literature that “skills and training' (Indicator 22) have the propensity to enhance a community's recovery (UNDP, 2012).

FAGs represent another arena in which resilience skills can be practised and developed: *“We had the idea of getting a resilience group together before the floods. Now we really are working on it, fine tuning it. It's come a long way and we are much better prepared. For starters everyone knows each other"* (C43). Individually, community members have also sought advice from council flood teams regarding PLP: *“We got advice from the council and made use of the resilience grant"* (K114). In addition, training was offered to ensure PLP was installed correctly: *"We got some training on how to put in the flood gates. We hadn't a clue before. The firemen had to put them in but it was too late anyway"* (A19).

In addition, positive developments in relation to increased surveys to investigate long-term strategies were proposed in the practitioner level discourse: *“We need to be looking at long term strategies for flooding but actually a lot of the funding available is time restricted so it's actually quite reactive*” (P165). Further, sustainable urban drainage SUDs and alternative catchment wide soft approaches were proposed as potentially reducing flood risk:

“There needs to be more education on the benefit of soft engineered approaches such as SUDs. Not just at council level but communicating the benefits to developers as well. They are actually cost effective but that message hasn't been reinforced very well I don't think' “ (P170).

Overall, a long-term focus on betterment through education is apparent throughout the practitioner discourse. Acceptance of increased risk: “*The figures this year are higher than the last flood”* (P165), prompting *“changes in policy”* (P162) has created a roadmap for improvement. Ensuring staff have updated knowledge, skills and *“the appropriate training”* (P164) is integral to this process of betterment.

Table 7.33 Indicator 22, Skills and training.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
22. Skills and training	Build capacity informed by past experience and integrate new knowledge	_Development of Business Resileince plans _First Aid training _Resileince plan dry run/tabletop exercises __Resilience training offered to Authorities and community leaders	Semi-structured interview and observation	Positive	community

7.6 Social Network Analysis

The ‘connectedness’ indicators (19-21) identified in the previous section demonstrate that community social structures ‘of place’ have the potential to enable communities to recover more quickly after a flood event. In that light, this section explores wider, non-geographic connections obtained from social media networks. As such, data from the social media platform ‘Facebook” was ‘mined’[31] to uncover wider, multi-scalar connections otherwise difficult to detect through interview discourse. The resulting network visualisation maps present an opportunity to assess social structure and patterns of relations that reflect social capital (Aldrich et al, 2015).

Accordingly, Social Network Analysis (SNA) was applied to (1) determine the structure of different support networks; (2) provide Ego-centric analysis of key brokers facilitating multi-scalar interactions; and (3) identify the barriers to development of multi-scalar social networks. Further knowledge of the structure and gaps, that characterise social networks will inform how networks can positively influence the nature and level of resilience in a community.

7.6.1 Methods and application of SNA

This analysis focuses on understanding the network structure at village, town and city scale, as represented by Glenridding, Kendal and Carlisle respectively. A mixed-method approach was applied to achieve the three aims of the section. Firstly, in order to determine the structures of different support networks, quantitative data ‘mined’ from social media was analysed. Secondly, the quantitative data provided an opportunity to identify evidence of multi-scalar relationship ties through analysis of their visualised networks. Thirdly, barriers and

[31] Data mining refers to the practice of analysing large pre-existing databases with the intention of revealing novel information.

drivers of multi-scalar networks were qualitatively analysed from interview discourse. Taking each point in turn the following section outlines the approach to social structure analysis.

7.6.2 Analysis of Social Network Structure

'Data mining' of the social media platform 'Facebook' was conducted to draw quantitative information on network structures beyond their immediate 'of place' geographical community. The process of identifying wider multi-scalar links began by using the open source Social Network Analysis software 'Gephi'. The data collection and extraction application, 'Netvizz', allowed data to be 'mined' in standard file formats from the relevant Facebook pages for analysis in Gephi. Selection of the relevant Facebook pages was also carried out using the Netvizz application. Selecting pages representative of the three scales was conducted by the application of "mining" search words in Netvizz including; 'Cumbria', 'flood', 'Flood action group', 'FAG' and/or 'Kendal', 'Carlisle', 'Glenridding', 'Shap', 'Kirby Stephen' and 'Eden'. Of the thirteen Facebook pages identified, those with the highest number of members representative of the city, town, and village scale were selected and analysed (Table 7.34). However, pages were restricted to those that were publicly 'open' with no privacy restrictions, meaning access to personal accounts was not necessary. As no dedicated page existed at the village scale, a district level page encompassing three Eden villages was used as a proxy.

Following the data extraction process, the four pages selected were analysed to identify both physical and virtual ties within communities. In doing so, comparative interpretation of properties and structure such as degree, distribution, modularity, cohesion (k-core) and community detection was possible.

Table 7.34 Data sources representative of community groups within Cumbria. Data was 'mined' from Facebook using the data collection and extraction application 'Netvizz'.

Page ID	Name	Category	Members	Group/Page
1731271137092519	Carlisle Flood Action Group	Community	783	Page
1607232116235659	North East Kendal Flood Action Group	Community	-	Group
525779977593445	Support Eden Cumbria Flood Volunteers	Cause	340	Page

7.6.3 Framework for Social Network Analysis

This section outlines the structural analysis of mined data against Crowe's (2007) characterisation framework of networks (Section 5.6.2, Figure 5.11). The framework illustrates how interpretation network structures can shed light on the mechanisms of relationship ties within them. For example, it can be seen that bonding social capital is reflected in complete or clustered (factional)[32] structures, whereas weaker bridging ties are typically found in separated cluster (coalitional)[33] and bridging structures. Crowe's framework suggests that network structures that appear as a 'continuum' rather than discrete groups are considered more cohesive.

In order to analyse cohesiveness and overall network structure, k-core and modularity measures were carried out. K-core referred to the number of connections a member has within a community. The higher the k-core (cohesiveness), the less structural holes a network holds and the less likely a system will collapse. In addition, modularity analysis and partitioning in Gephi assisted structural analysis by dividing the structure into sub-networks.

7.6.4 Structural analysis findings

Having extracted the connection data via Netvizz, the analysis of connection structure commenced in Gephi. The overall findings for all four communities are presented in Table 7.35. The 'Nodes' in the table represent the people or 'actors' in the relevant network. The 'edges' represent the connections between the nodes, while 'active communities' refers to the clusters or groupings found within the network.

Taking each community network in turn, the city results for "Carlisle Flood Action group" revealed a relatively low or 'sparse' network density of 0.007. A network's density is the ratio of the number of edges in the network over the total number of possible edges between all pairs of nodes. This measure is used to determine the connectedness or how 'closely knit' a social community is. A perfectly connected network is called a 'clique' and has density =1. The low-density score in this example can be attributed to the high number of actors outside the network core (grey, blue, orange and green nodes illustrated in Figure 7.15). However, while the

[32] Factional structures exhibit separate clusters that maintain high k-core 1 or above.
[33] Separate clusters that maintain high K-core and evidence ties outside of the cluster.

overall density score may be low, the K-core[34] results supports the view that the network has a cohesive core. Running K-core analysis at >1 eliminated only one category of nodes (10) (Figure 7.16).

Table 7.35 Structural findings on community networks in Kendal, Carlisle and Eden villages. 'Cumbria Flood recovery 2009' page was included to illustrate the rise in social media use during the recovery process since 2009.

Community group/page	**Nodes**	**Edges**	**Active Communities**	**Modularity centrality**	**Degree Distribution**	**Network Density**
Carlisle Flood Action Group	360	565	783	0.427	2.588	0.007
"North East Kendal" Flood Action Group	192	144	70	0.470	1.709	0.012
Support Eden flood Volunteers	26	16	10	0.443	0.944	(N/A to pages)
Cumbria Flood Recovery 2009	75	52	10	.682	0.693	(N/A to pages)

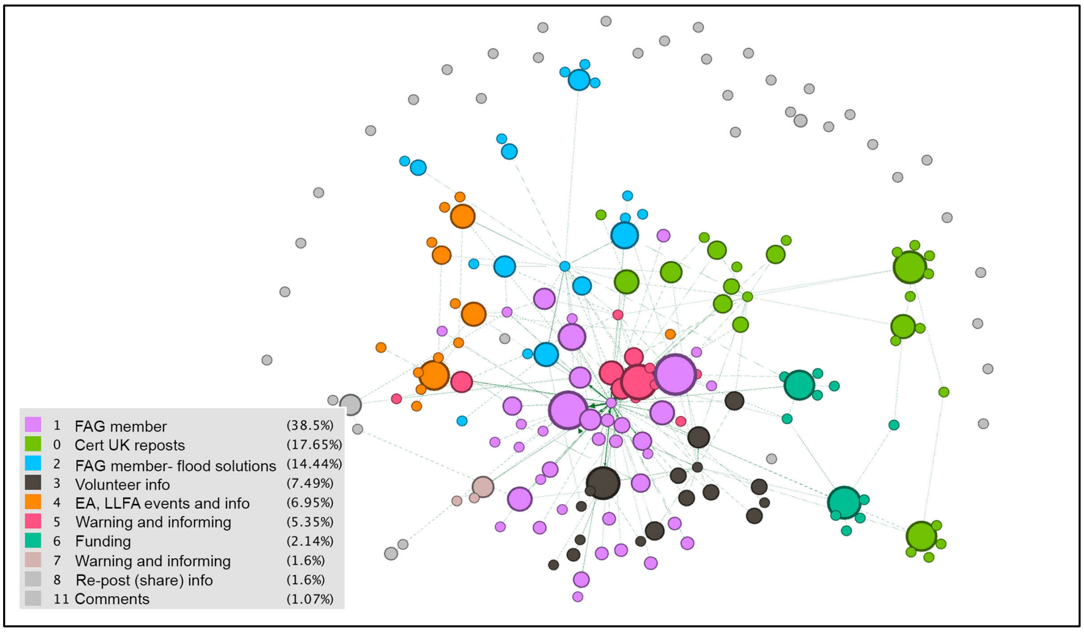


Figure 7.15 Gephi social network visualisation of "Carlisle Flood Action Group". Visual representation using Force Atlas algorithm.

[34] K-core is a visualisation of structural cohesion. It prunes all vertices and their respective edges that hold a degree less than k <1 leaving only cohesive nodes remaining (Seidman, 1983).

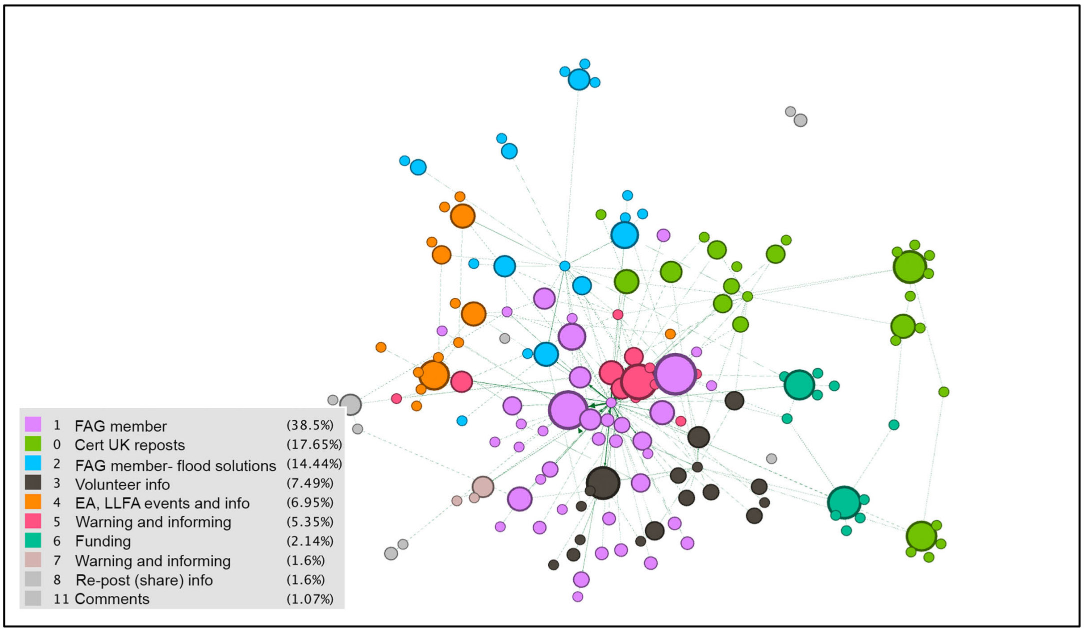


Figure 7.16 Gephi social network visualisation of K-core >1 for "Carlisle Flood Action Group". Visual representation using Force Atlas algorithm.

Degree distribution[35] is representative of the number of connections between nodes. Standing at 2.588 (Figure 7.16), this figure is higher than the Kendal and Eden examples. It demonstrates greater engagement between nodes with less reliance on key brokers to mobilise resources. While enhanced distribution is overall a positive for network resilience, weakness in the network was revealed through an over-reliance on one actor in Carlisle holding 38.5% of connection distribution (Figure 7.15).

This imbalance in degree (number of connections) across the network, is illustrated through the tapering off of nodes on the x-axis of the Degree Distribution results (Figure 7.17). Application of Crowe's (2007) theory reaffirms this apparent imbalance of network ties, revealing a fractional network with signs of separate clusters (coalitonal) causing structural holes. Reference back to Crowe's Framework (Figure 5.11), illustrates this apparent clustering through isolated grouping (factional) of bridging and linking capital outside the network core. While evidence of bridging and linking connections are positive for a network, the isolated nature of the clustering potentially attributes to the overall low network density distribution. Further, its dense connected core is further represented in its modularity results of 0.427 as illustrated on the x-axis (0-14) in Figure 7.18.

[35] The 'degree' of a node refers to the number of connections between nodes within its network. Degree distribution is the probability distribution of these degrees over the whole network.

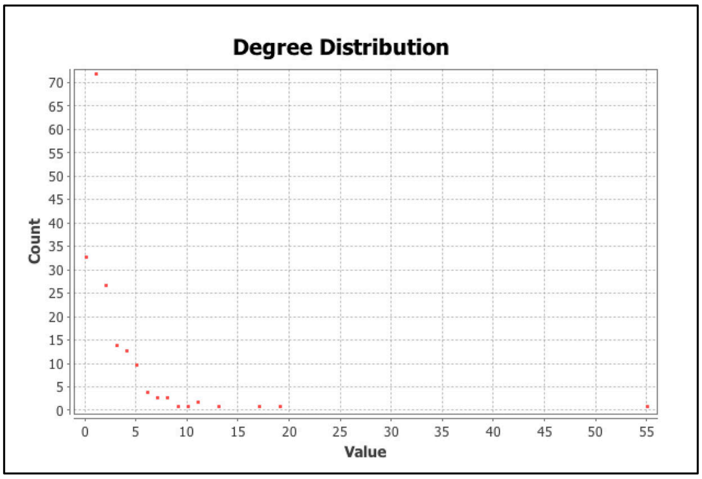


Figure 7.17 Average distribution measure of 1.294. Carlisle Flood Action Group.

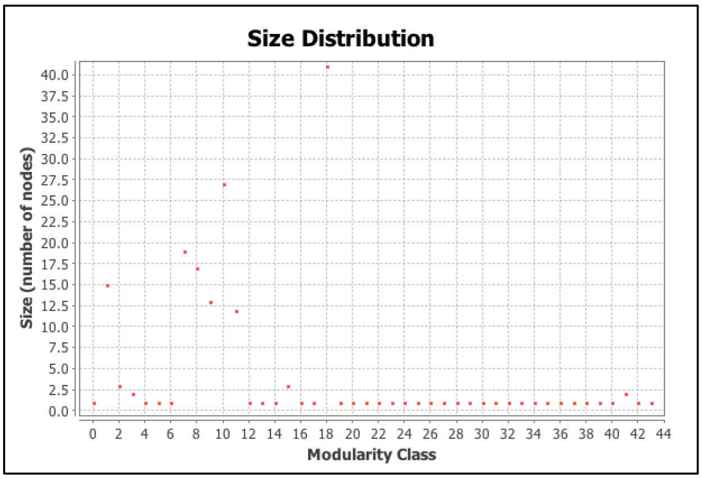


Figure 7.18 Modularity distribution measure of 0.47, Carlisle Flood Action Group.

Similar to the previous example, the town results derived from the "North East Kendal" group revealed a relatively 'sparse' network density of 0.012. Further, a relatively low degree distribution of 1.709 (Appendix 4.2) reveals that communication is loosely distributed and reliant on four main 'brokers' holding 69.5% of interaction (Figure 7.19). Corroborating this evidence, Figure 7.19 depicts a colour coded spatial visualisation of the network using the 'degree centrality' metric to highlight reliance on key brokers. The illustrative map shows larger nodes with a higher centrality measures (degree of connectivity), representative of the influence of 'brokerage' within the group.

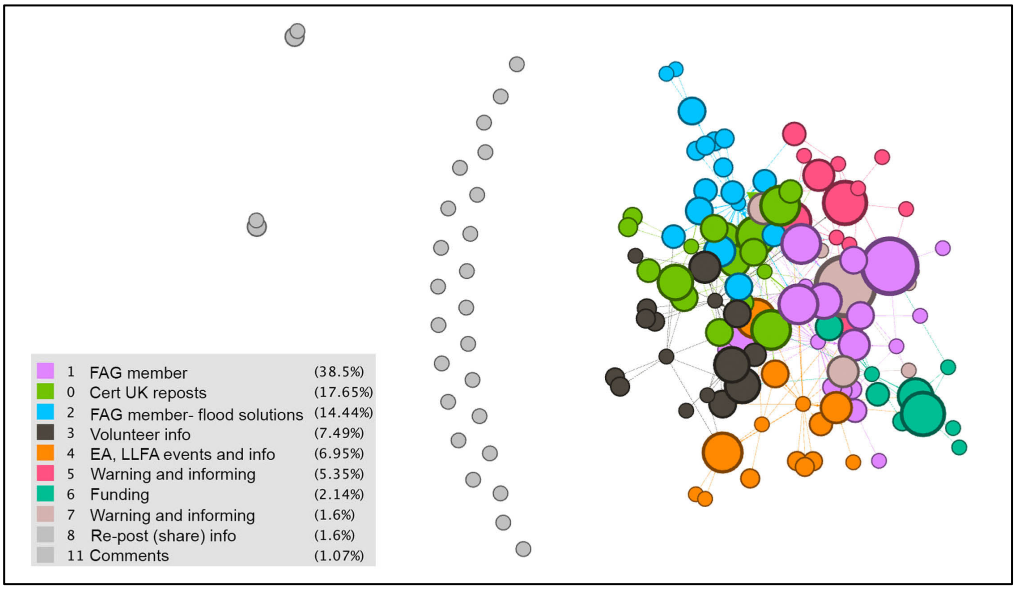


Figure 7.19 Gephi social network visualisation, "North East Kendal" FAG. Presented using Force Atlas algorithm.

Dense 'Degree centrality' was found as only 1.3% of the network does not have a K-Core >1. In this instance, the 1.3% removed were found to be from the 'Donations and support' (10) category, who rather than weakening the network are considered to strengthen it (Appendix 4.2). However, the low degree of distribution (1.709) is indicative of structural holes across the network, through its uneven 'distribution' of connections. Further, modularity results of 0.470 reaffirm this finding, by highlighting a dearth in connections beyond its dense core.

Applying Crowe's (2007) theory once more (Figure 5.11), the social network visualisation map (Figure 7.19) correlates with the earlier findings of a dense fractional network, also referred to as clustering (Crowe, 2007). The network visualisation shows how these broker connections act as a valuable bridging channel for loose connections as regards warning and informing (4) and donations (10). The network visualisation also presents evidence of linking social capital as seen through re-posts and sharing of high level information concerning upcoming EA and LLFA authority events.

The final SNA analysis relates to the "Support Eden Flood Volunteers" page, which served as a proxy for the village scale. Due to the relatively small scale of the settlements, no dedicated page existed to examine a specific village network. The lack of social media engagement is potentially attributable to poor internet access and an aging population unfamiliar with technology, typical of rural areas (Cutter et al, 2016). As such, the analysis is based on ten active communities within the network. Degree distribution (0.443) and modularity (0.944) scores are typical of the other groups analysed, however the network is highly vulnerable to collapse due to a 57.6% and 30.7% reliance on two actors (Figure 7.20).

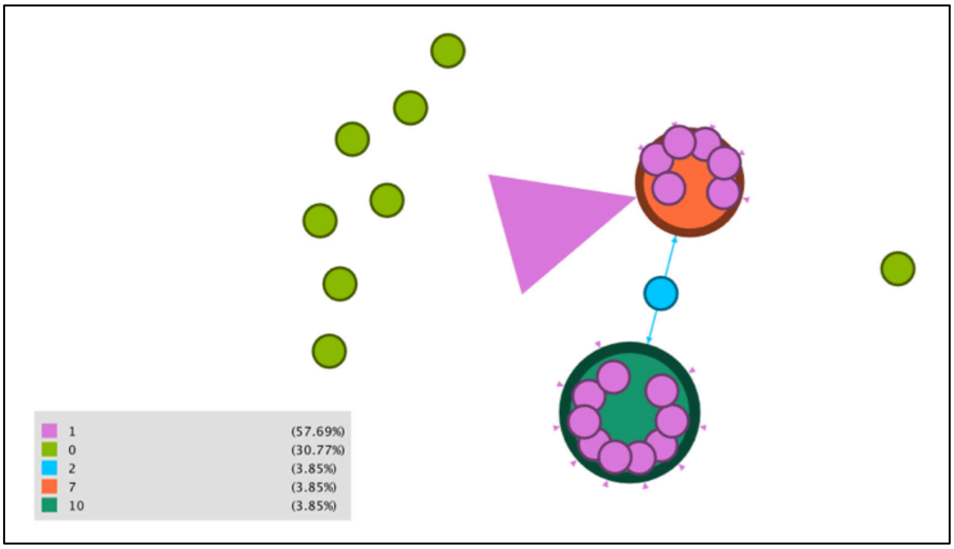


Figure 7.20 Gephi social network visualisation for "Support Eden Flood Volunteers". Visual representation using Force Atlas algorithm.

The imbalance in connections is evident through the high degree distribution of nodes (Average distribution measure 0.944). Critically, while the modularity score is typical of the other two communities (0.443), it is dependent on only two nodes. The over-reliance on two key actors reinforces the fragility of the network and emphasises the need for investment in other forms of social capital at the village scale. Further detail on average distribution measure and modularity are presented in Appendix 4.2.

The presentation of the three case-studies above highlighted a variance in network structure across the scales. The city scale presented more linking social capital, demonstrated through engagement with authorities and non-geographic links. The nature of bridging and linking connections varied from support for authorities, to funding and donations from 'virtual' community members. Further, the social network provided an organisation structure for volunteers from outside the geographic community to offer their skills and services. Kendal also displayed evidence of bridging and linking social capital, however overall the structure was less 'clustered' (fractional) than Carlisle. Carlisle exhibited more clustering which may in part be attributed to the spread of flooding affecting different sections of the city. For example, a large percentage of support in Carlisle was directed at a particular street (Warrick Road), as it was reported as being the worst affected area. By contrast, Kendal suffered widespread flooding in separate areas across the town, however, its smaller scale allowed support/assistance to be offered to the town as a whole. The sparse 'Eden' network stands in stark contrast to the two previous examples. The analysis clearly highlights an imbalanced network, with little evidence of bridging and linking ties.

The analysis of network structures above highlighted an imbalance in network ties across all three settlement scales. Such 'Structural holes' limit the potential of networks to mobilise resources and capacities, thus reducing resilience capacity. Similarly, an overdependence on bonding capital known as a 'closed' network, resist outside assistance and underutilise the resilience potential of the network. As such, the development of a balanced network of bonding, bridging and linking ties are critical to the functioning of resilient networks. 'Brokers' are integral to the development of bridging and linking ties, serving to connect loosely related ties. As such, 'Key Brokers' or Egos are explored in more detail below.

7.6.5 Ego-centric analysis

The section above focused on the potential contribution of multi-scalar interactions towards robust and complete network structures. Integral to this are brokers or 'egos'[36], who are influential members of a network. They have the potential to act as an agent by connecting members, horizontally and vertically, to other members outside their immediate ties (Fernandez and Gould, 1989).

A mixed method approach to ego-centric analysis is outlined, which relies on quantitative mined data in addition to qualitative interview data. The methodological process began prior to the empirical fieldwork by purposively and quantitatively identifying brokers. This was achieved by running an Ego Network query in Gephi. In doing so, nodes with high in-degree[37] and betweenness centrality[38] (Chapter 5, Section 5.6.6) measures were isolated and their 'Node ID' examined to reveal their identity. The results revealed that founding members of FAGs/Flood groups were those most influential in the network.

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[36] An Ego is a key player in a social network. Ego-centric analysis is a methodological tool used to understand the structure, function and composition of network ties around a key actor or ego.
[37] In-degree centrality is a measure of the centrality of a particular individual in a network relative to all other individuals within that network.
[38] Betweenness centrality concerns the centrality of a node within a network. The measure is calculated by the number of shortest paths from all vertices to all others that pass through that node (Freeman, 1977).

Qualitative data was drawn upon through subsequent fieldwork interviews to understand the sources of assistance, information or resource. The recall method (as proposed by Wasserman and Faust, 1994) was used, allowing interviewees to list assistance sources without being prompted. The qualitative data elicited was subsequently formatted in excel in preparation for interpretation and visualisation in Gephi. Character interaction data (i.e. actors in the network) were inserted into excel columns and exported as a .CSV file to be read by the Gephi software. The ego-network maps (Figure 7.21–7.23) represent 'key brokers' in Carlisle, Kendal and Glenridding respectively.

The centrality of the actors were differentiated by size (those with more 'edges' or influence are represented with bigger node sizes). Beginning at the urban scale, it is apparent that the Carlisle 'Ego' drew upon all 3 multi-scalar levels (Figure 7.21). Active engagement between the FAG and statutory agencies is clearly demonstrated through the larger nodes on the map: LLFA, Environment Agency and to a lesser extent United Utilities and Carlisle City Council. Bridging social capital was apparent through third sector organisations and volunteers such as Cumbria Foundation, National flood Forum, Church and various volunteers. The final capital was illustrated through the large bonding 'friends' and, to a lesser extent, neighbours.

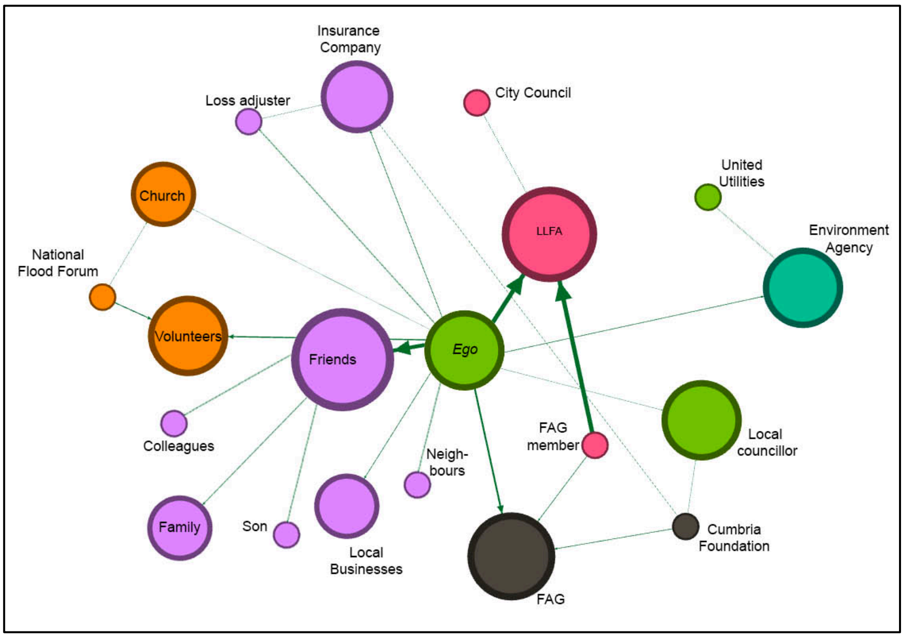

Figure 7.21 Ego centric map for key actor in Carlisle FAG.

By contrast, the Kendal example is indicative of a close-knit community reliant on friends and family (Figure 7.22). Linking capital was limited to a reference to the council. Rather than a form of collaborative interaction, the connection was in relation to waste collection and the provision of skips. Bridging capital was evident through assistance and services offered by third sector organisations including the Cumbria Community Foundation and the Red Cross. The contribution of the third sector emerged in interview discourse through the church's capacity to expedite the recovery process in Kendal. One Kendal resident commented *"I wouldn't have been able to cope without them"* (K94), whilst others acknowledged their presence but felt she could manage by herself and *"Left that service for those who needed it more"* (K131).

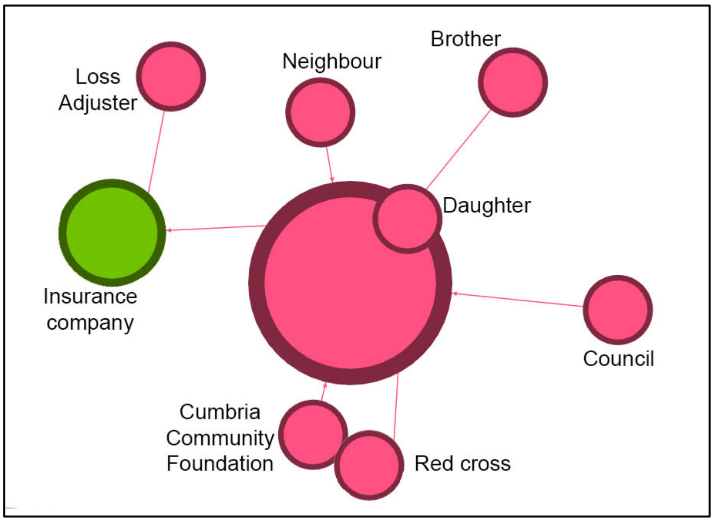

Figure 7.22 Ego centric map for low resilience actor in Kendal FAG.

Conversely, the 'Eden' example exhibited tight-knit bonding ties through friends and family and had limited reliance on external linking capital (Figure 7.23). The stark social capital imbalance in 'Eden' is highlighted through large bonding and bridging nodes, by contrast to a solitary linking node. Bridging capital was evidenced through the Parish Council and local contractors whose support expedited the recovery process. Examples included local businesses donating free lunches to volunteers and contractors loaning (at no cost) heavy machinery such as diggers to allow the river (beck) to be cleared.

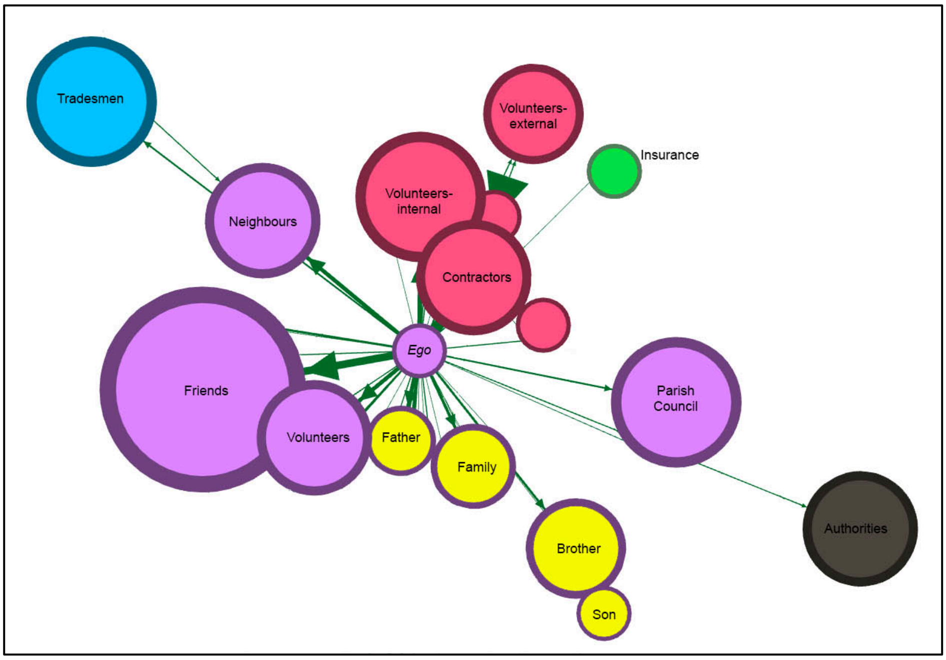

Figure 7.23 Ego centric map for low resilience actor for Glenridding (Eden) resident.

To conclude this section, the Ego-centric maps reaffirm earlier findings of structural holes and communication weaknesses with respect to linking capital in particular. Although linking capital was evident through the Carlisle FAG, the *nature* and intention of this engagement influences the resilience capacity of the community. For example, the interview discourse revealed that many Carlisle FAG members viewed the FAG as a pressure group to hold the statutory agencies to account, as opposed to a vehicle to work collaboratively with authorities. Whilst this is not the viewpoint of all members, it was commented by an agency representative that this approach was *"unhelpful"* (P168). The following section seeks to understand the barriers to multi-scalar engagement and concludes the SNA by providing drivers to promote these relationships. The barriers and drivers to multi-scalar engagement are discussed in further detail in Appendix 4.3.

7.6.6 Enhancing social networks for improved resilience

An important learning point from the above findings, it that it is not necessarily the level of participation that is most important, rather the form of engagement. Engagement with linking social capital through FAGs can take two forms, either as (1) a pressure/lobby group or as (2) a collective FAG. The "blame game" evident in the former group can be attributed to a lack of understanding from the communities as to what agencies are responsible for in FRM. Consistent and regular engagement from the agencies would help improve the level of trust between the two groups and potentially lead to less of a blame culture and a more harmonious approach to FRM, as exhibited by some FAGs. By contrast, Keswick FAG emerged on the understanding that their role was both equal and complementary to the efforts of the authorities. Their respective roles were well defined and local knowledge led to empowerment through the acknowledgment of the full capabilities of the community resource.

In concluding this section on SNA, the evidence presented of indicators influencing multi-scalar interaction makes the case for FRM to broaden strategies beyond physical infrastructure to include social infrastructure. The evidence has shown that social capital is not a constant asset (flood memory), it needs maintenance to avoid degradation. As such, investment in strategies to improve trust between the community and the statutory/institutional level has the potential to facilitate linking social capital.

7.7 Comparative settlement hierarchy

This section presents the distribution of community and practitioner level resilience indicators in Cumbria as presented in Figures 7.24-7.25. In doing so, patterns, relationships and gaps between indicator codes are revealed at each hierarchical scale. An exploration into the relationships between these weighted indicators at the city, town and village scales is presented in the flowing sections.

Figure 7.24 illustrates the extent of resilience indicator coding identified across the case-studies, at both the community and practitioner level. Coding was found to be highest at the town scale (Appleby), with significantly lower coding at the smaller village scale (Shap). At the town scale, high ‘risk communication’ (Indicator 2) and ‘multi-scalar interaction’ (Indicator 16), attributed to greater mobilisation of resources and capacities. Further, high ‘flood responsibility’ (Indicator 11) coding was also found at this scale as a result of the above mentioned multi-scalar interaction. ‘Cohesive community’ interaction was the most frequently coded indicator across all case-studies, albeit coding was significantly lower at the urban scale. This may be attributable to the transient nature of the city, as a consequence of high rental levels and a knock-on reduced sense of community (Chavis and Wandersman, 1990). As such, a relationship between low ‘cohesiveness’ (Indicator 15) and low ‘multi-scalar interaction’ (Indicator 16) may explain the root cause of limited resilience action at the urban scale. At the practitioner level the highest coding concerned ‘integrated planning and development’ (Indicator 19). This fact indicates higher-level recognition that historical development in flood plains has the potential to exacerbate flood risk.

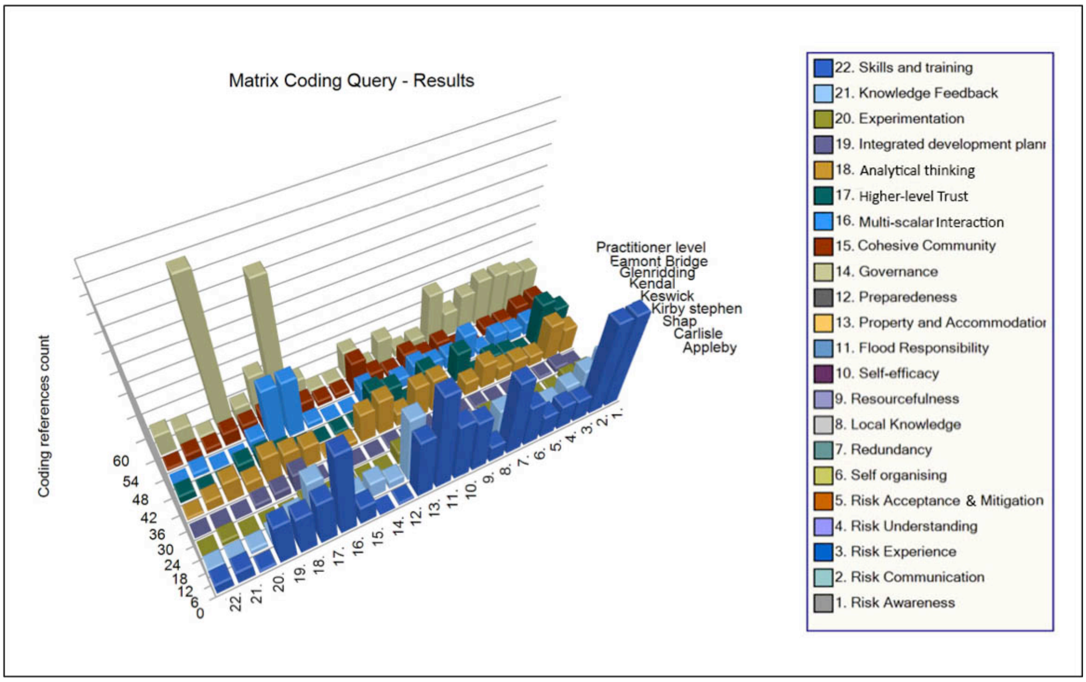

Figure 7.24 Matrix coding of community and practitioner level resilience indicators codes.

A heat map query, run in NVivo (Figure 7.25), shows the hierarchical coding for each indicator at the different settlement scales. The most frequently coded indicators are represented by a darker gradient of colour (ranging from 0.0-43.00). Complementing data presented in Figure 7.25, it was found that the highest coding was at the town scale (Appleby), which may be attributable to its high ‘multi-scalar interaction’ indicator coding. Further, historical flooding in the town has led to higher ‘risk awareness’ (Indicator 1) and ‘risk communication’ (Indicator 2) coding. Practitioner level coding results further highlight the fundamental role a ‘cohesive’ (Indicator 15) community plays in building community resilience, through its high coding of that indicator. The heat map reiterates higher-level acknowledgment of the role of ‘integrated planning and development’ through high coding of Indicator 19. Figure 7.24 serves as a useful point of reference for indicator comparison across the case-study hierarchies.

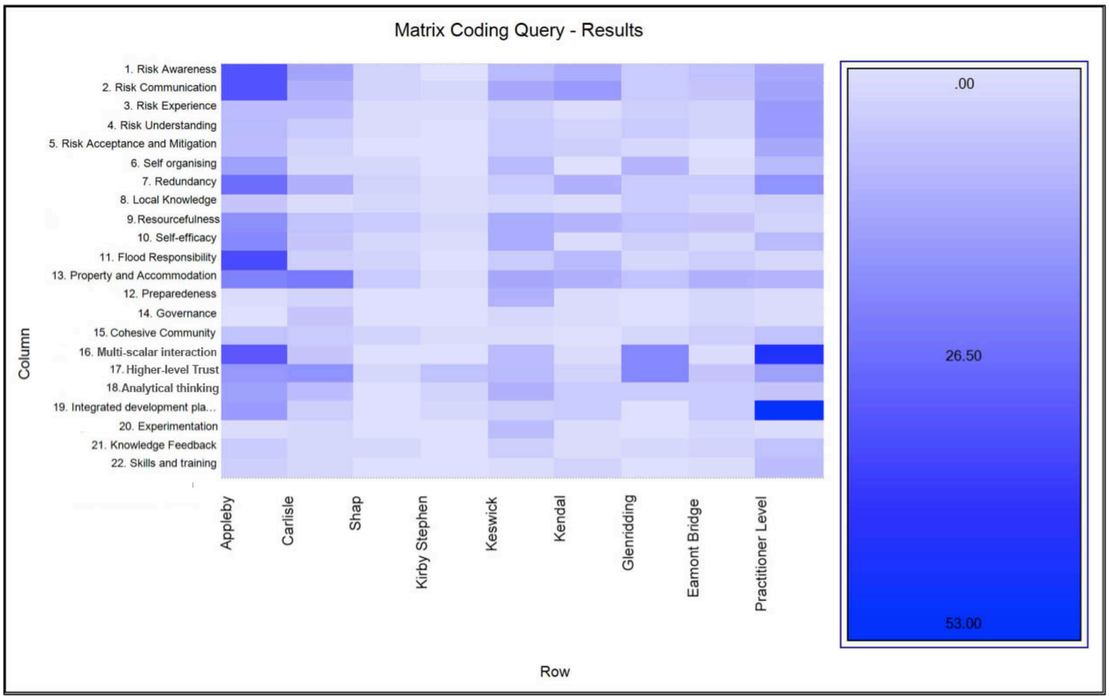

Figure 7.25 Matrix query heat map of community and practitioner level resilience indicator codes.

7.7.1 Village scale

The villages of Shap and Kirby Stephen had the lowest representation of coded resilience indicators (Figure 7.25). This is potentially attributable to the separate and isolated nature of the flood incidents. As a consequence of this, no widespread recovery plan was in place (no FAG). Affected residents predominantly relied on close bonding networks and evidence of outside assistance (bridging and linking) was limited (Figure 7.26). Consequently, instances of 'resources and capacities' being drawn upon was scant, with equally low evidence of 'learning' indicators revealed (Figure 7.26).

By contrast, Glenridding village exhibited high mobilisation of the 'resources and capacity' component and relatively significant evidence of 'learning'. The heat map query matrix (Figure 7.25) highlights four indicators that may help to explain this finding: (1) risk indicators; (2) cohesive community; (3) self-efficacy; and (4) redundancy. Indeed, of the four villages, Glenridding had the highest representation of indicators in the 'Risk' component (Figure 7.25). Importantly, these five risk indicators were balanced across the 'Risk' component. Conversely, Eamont Bridge presented a similarly high 'Risk' component representation (Figure 7.27), however, the higher 'risk awareness' (Indicator 1) and 'risk communication' (Indicator 3) did not lead to 'risk acceptance and mitigative action' (Indicator 5).

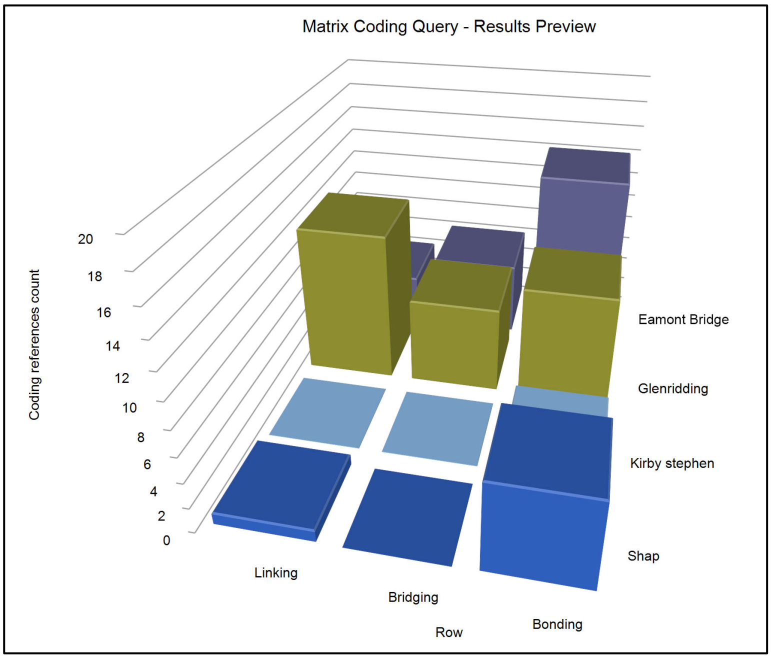

Figure 7.26 Matrix code of multi-scalar interaction (bonding, bridging and linking) at the village scale.

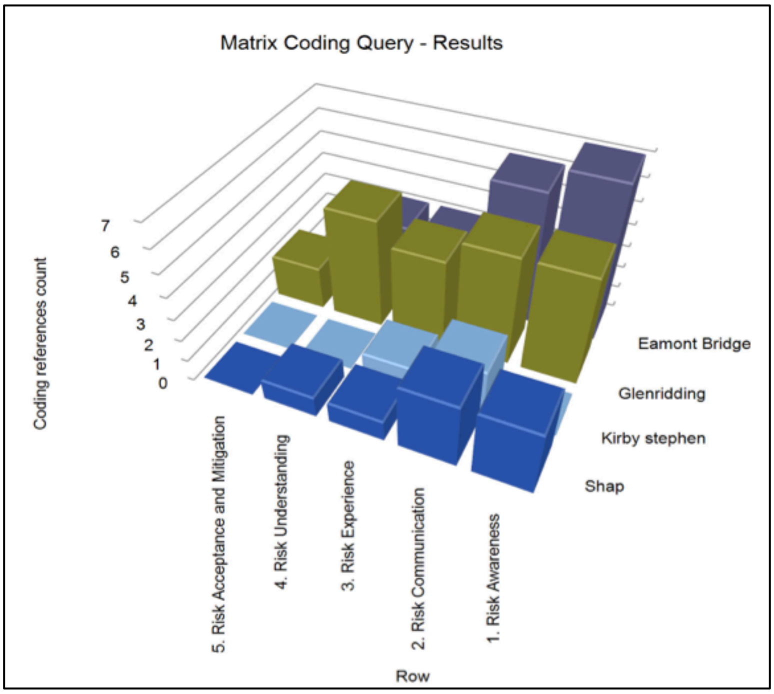

Figure 7.27 Matrix code presenting weighted risk indicators at the village scale.

The tight knit community of Glenridding exhibited stronger 'community cohesion' (Indicator 15) than the other village case-studies (Figure 7.25). This may be attributed to the fact that, unlike Glenridding, the other villages have no established flood group/FAG. This collaborative work in Glenridding potentially influences increased 'risk acceptance' (Indicator 5) and 'self efficacy' (Indicator 10) levels of the community, enabling them *"To crack on and get the work done"* (G 82). The evidence from Glenridding also corroborates the argument in literature that remote communities are more resourceful (redundancy) as a result of access to resources not easily accessed in urban areas. The remotest of all the case-studies, Glenridding, drew on 'redundancy' (Indicator 7) within their resilience system by acquiring chain saws and a tractor to remove debris blocking the bridge and borrowing heavy machinery from local contractors. In addition, they fundraised over £30,000 to assist further recovery efforts demonstrating the potential of community cohesion to act as a catalyst for the mobilisation of resources and capacities.

7.7.2 Town scale

The variety in resilience indicators uncovered across the town hierarchy settlements reinforces Taylor's (2011) argument that communities are not homogenous and a 'one size fits all' approach is not appropriate. Appleby's flood history was represented by its comparatively high 'risk awareness' (Indicator 1) and 'risk communication' (Indicator 2) weighting over the other town settlements, Keswick and Kendal (Figure 7.25). In the case of Kendal, lower 'risk awareness' (1) is attributable to the limited level of 'risk experience' (Indicator 3) as many properties (not on an EA flood map) were flooded for the first time in winter 2015. Keswick has a history of flooding, however, due to its location in an area of outstanding beauty in the Lake District, it has a higher than average second home ratio (or a lower than average 'usual residents') (Census, 2011). Consequently, its lack of full time inhabitants may influence its lower 'risk awareness' (Indicator 1) and 'risk communication' (Indicator 2) levels. For example a second homeowner commented: *"I stopped getting the flood alerts on my phone. What use are they when I live in Liverpool. There is nothing I can do to stop the water from there" (K138).*

In respect of the 'Resources and Capacity' and 'Learning' components, four findings emerged strongly from the interview discourse in the towns that were not as prominent at the village scale: (1) 'integrated planning and development'; (2) 'property and accommodation'; (3) flood responsibility; (4) redundancy (Figure 7.28). Firstly, 'integrated planning and development' (Indicator 19) played a greater role in interview discourse as a consequence of increased development pressure not typically found at the village scale. A potential driver of this development emerged at the town scale, through an apparent high demand for properties, consequently leading to a lack of alternative accommodation for those displaced post-flooding. For example, Appleby's high representation in the 'property' (Indicator

13) was a consequence of its conservation area status (Figure 7.28). As such, many affected residents expressed concerns over their inability to implement PLP as they were refused planning permission to do so. Unique to the Appleby case-study, this indicator was found to reduce resilience levels and further had a knock-on negative impact on 'higher-level trust' (Indicator 17).

Secondly, 'redundancy' (Indicator 7) was apparent in the interview discourse in relation to risk transfer through insurance. It was noted that those renting had no control over resilience measures opposite the building structure. Landlords were often underinsured and consequently slow to carry out resilience works. Being at *"the mercy of landlords"* highlighted a lack of regulatory protection for tenants and the importance to having *"enough savings for a deposit elsewhere" (A17).* In addition, a link was revealed between 'property' (Indicator 13) and economic 'redundancy' (Indicator 7) where affected residents were rehoused outside Appleby but lost their jobs as a consequence of being unable to get transport to work (Figure 7.28).

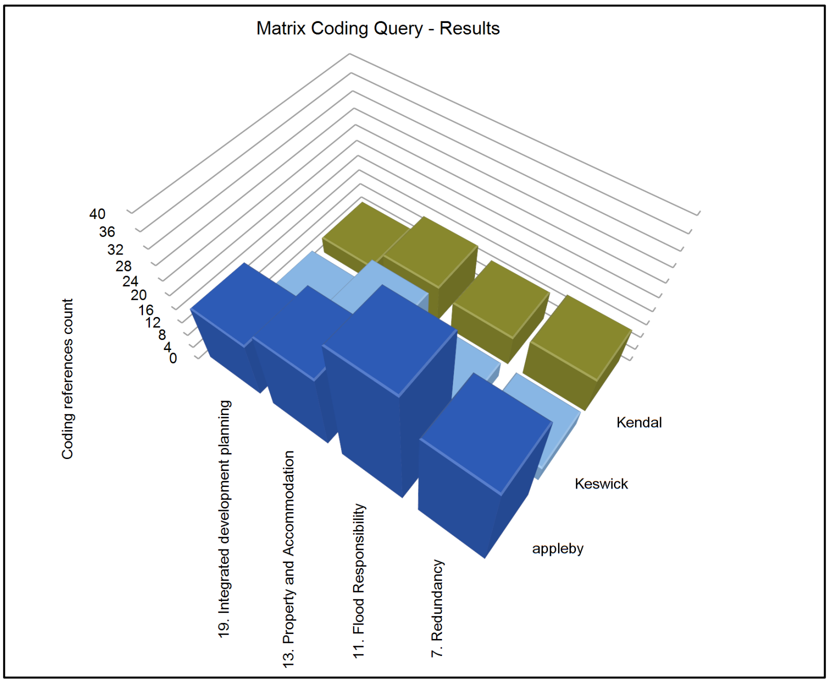

Figure 7.28 Matrix query highlighting four 'Resources and capacity' and 'Learning' indicators prominent at the town scale.

Third, "flood responsibility' (Indicator 11) in Appleby was found to be comparatively high relative to the other town hierarchies. An apparent relationship was found between 'flood responsibility' and the presence of high coding in 'higher-level trust' (Indicator 17); 'community cohesion' (Indicator 15); and self-efficacy (Indicator 10) indicators. High 'community cohesion' in Appleby was attributable to the small scale *“nodding hello”* (A19) nature of the town. In both Keswick and Appleby, it was found that community cohesion acted as a springboard towards the establishment of a formal or informal FAG or flood volunteer group. This led to greater ‘self-efficacy’ and, through collaboration with statutory agencies, ‘trust in authorities’ ultimately strengthened (Figure 7.29). By contrast, flooding in more populated Kendal, affected separate communities across the town. As such community cohesion was at a more micro scale that did not extend much beyond immediate neighbours. Consequently, collaborative interaction extending to the statutory scale was not evident. The contrast in cohesion levels across the village scale, together, with its knock on effect on self-efficacy and trust in authorities, is illustrated in Figure 7.29.

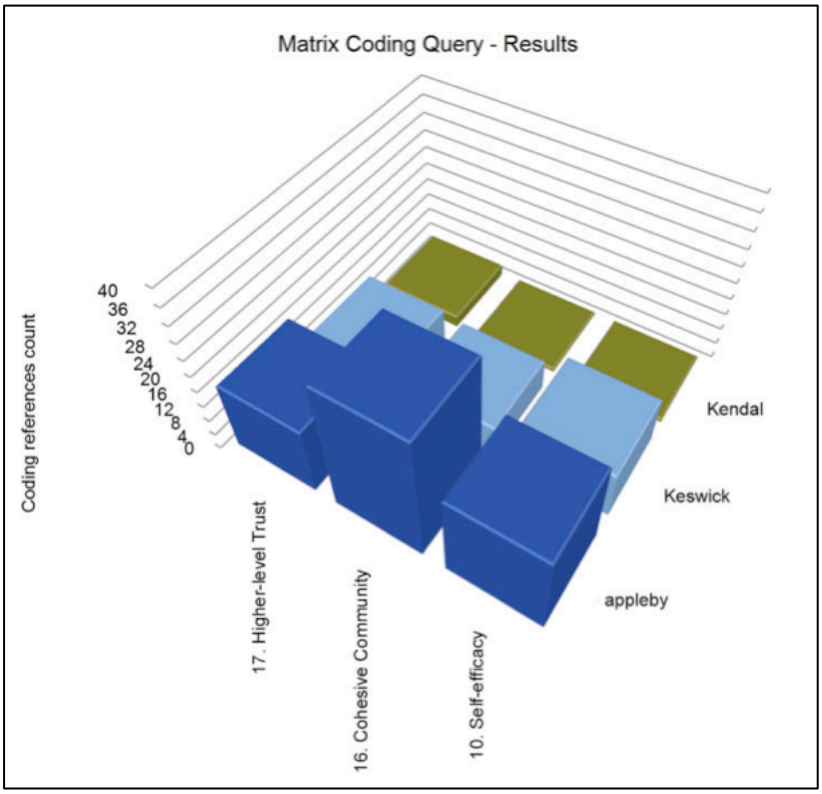

Figure 7.29 Matrix query highlighting prominent indicators at the town scale.

7.7.3 City scale

Carlisle presented high ‘risk awareness’ (Indicator 1), similar to the results identified at the town and village scales (with the exception of Kendal). The interview discourse was dominated by the process of property reconstruction. This may be attributable to the fact that a large part of resilience exhibited at the city scale was individual resilience rather than community resilience. The reduced presence of three indicators may contribute to the assumption that the city scale presented higher individual rather than community resilience: ‘cohesion’ (15), ‘self-efficacy’ (10) and ‘self organising’ (6). The SNA (Section 7.6) presented an active ‘virtual’ community and while a physical FAG exists, it is important to note the nature of the group which was established to “make Carlisle a safer city” however they also expressed a wish to “hold agencies to account” (C59). Known in the literature as a ‘pressure’ group, the indicator results show that this approach did not necessarily lead to positive community resilience, for example a low ‘community cohesion’ coding and its knock-on effect on ‘self organising’, which would normally be associated with action groups.

Carlisle’s high ‘higher-level trust’ (Indicator 17) is partially misleading, as the coding reference includes both positive and negative codes. Although engagement through the FAG strengthened links with authorities, the nature of these links were ‘pressure’ driven and not collaborative. As such, the sustainability of these relationships is arguably questionable. ‘Redundancy’ (indicator 7) was a further pronounced indicator due to job losses as a consequence of the temporary closure of a flooded factory (McVities) which is as a major employer in the city.

7.7.4 Overview of settlement comparative analysis (community level)

The comparative analysis presented similarities and variances of indicators across the scales. The matrix query ‘heat map’ visualisation presents a summative overview of the three scales (Figure 7.30). The heat map highlights high ‘risk awareness’ across all scales with the exception of Kendal (attributable to the high number of first time flood victims). However, ‘risk understanding’ (Indicator 4) and its spinoff effect on ‘risk acceptance and mitigation’ (Indicator 5) was generally low, particularly at the town and city scale. This infers a gap between risk awareness and ultimate translation into mitigative action with the level of ‘community cohesion’ (Indicator 15) playing a pivotal role in the resulting mobilisation of the ‘Resources and capacities’ component. Further, the interplay between ‘Resources and capacities’ and ‘higher-level trust’ (Indicator 17) significantly influenced the level of ‘multi-scalar interaction’ (Indicator 16). Communities that had an established FAG or flood group tended to exhibit higher ‘self efficacy’ (Indicator 10) and ‘flood responsibility’ (Indicator 11) levels.

‘Learning’ was the least represented component across all three hierarchies and is indicative of communities that have not fully realised the potential of multi-scalar social capital (Cutter et al, 2012). Indicators found to positively influence transformative, multi-scalar interaction included ‘resourcefulness’ (Indicator 9) and ‘redundancy’ (Indicator 7). Combining these two indicators with an established ‘cohesive community’ (relationships extending from bonding to linking social capital) assists the potential to realise transformational resilience action. Through the channel of formal FAGs and parish council flood groups examples of these actions were noted. The FAG in Keswick established a flood warden scheme that operates hand in glove with the emergency services. Complementing the work of the agencies and emergency services, the scheme acts as a warning and informing service prior to the event and offers support and advice post event. Throughout the year, flood memory was kept alive through dry-run table-top exercises in collaboration with the emergency services. In a similar vein, Glenridding established a parish flood group on the back of the 2015 floods. Over time, relationships have improved with the authorities and fundraising efforts by the locals are partially match-funded by the local authority to help drive long-term recovery reconstruction strategies in the village.

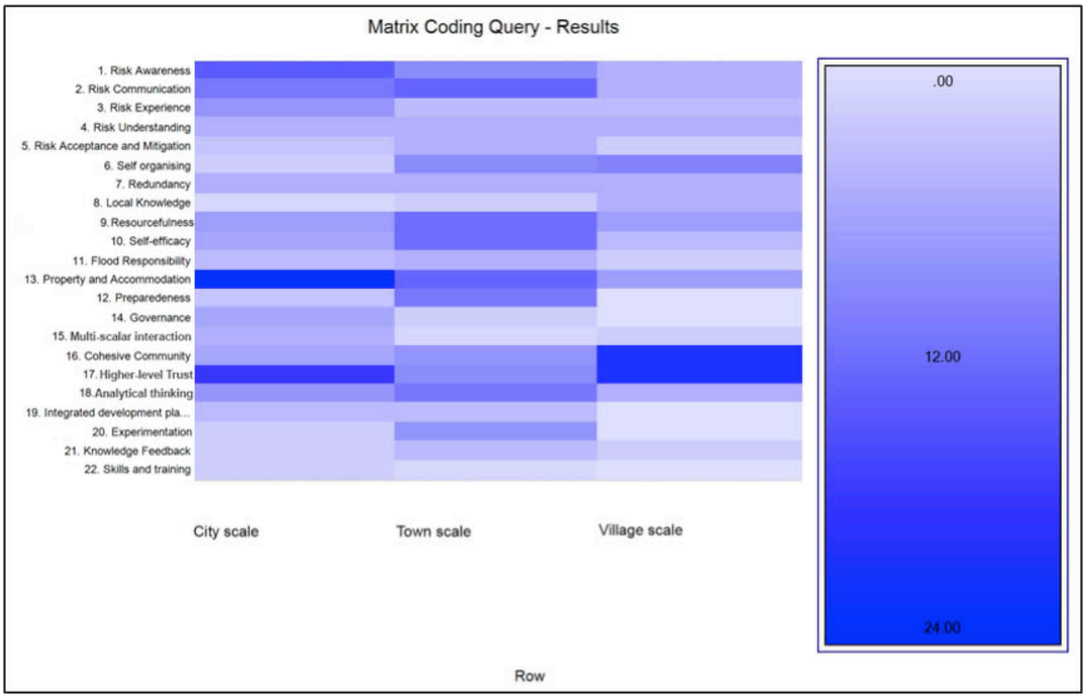

Figure 7.30 Matrix coding heat map representative of coding at the city, town and village scale.

7.7.5 Practitioner level analysis

This section outlines the distribution of practitioner level indicators (Figure 7.25; 7.31) and in doing so highlights the disparity in prioritisation relative to those at the community level. The even distribution of 'Risk' component indicators suggests an understanding of risk awareness at the practitioner level (Figure 7.31). Figure 7.31 illustrates two prominent indicators at this level are 'integrated planning and development' (Indicator 19) and 'cohesive community' (Indicator 15).

The interview discourse presented a shift away from 'isolated' planning decisions towards a catchment-wide (holistic) approach to 'Integrated planning and development', taking account of the effect of planning decisions on the whole catchment. The empirical evidence also presented an apparent understanding of the need to consider climate change within planning policy, decision-making process and enforcement strategy. Of note was an understanding of the need to *"Take on board local knowledge"*…as *"No one knows their area better than those that live in it" (P165).*

Practitioners described various levels of successful engagement at the community level, highlighting the practicality of the village scale as more *"manageable and effective".* (P163). The disparity in cohesion levels across the eight case-studies reflect this finding, highlighting the greater ease of engagement with cohesive communities who already have a FAG/flood group in place. The highly coded 'cohesive community' indicator (practitioner level) as shown in Figure 7.31, is somewhat indicative of the difficulties encountered by practitioners engaging across the different settlement scales.

By contrast to the community level, practitioners evidenced greater acknowledgement of the need to invest in 'learning' indicators as part of their long-term strategy. This is shown through the comparatively high learning indicators (18-22) at the practitioner level (Figure 7.31) compared to at the community level (Section 7.7.1-7.7.3). Acceptance that *"flood defences are not the only solution"* led practitioners to promote the idea of considering *"a portfolio of strategies to reduce flood risk"* (P163). Although *'governance'* (Indicator 14) did not emerge strongly from the practitioner data, acknowledgment of the 'Learning' component suggests potential for a more flexible approach to flood risk governance.

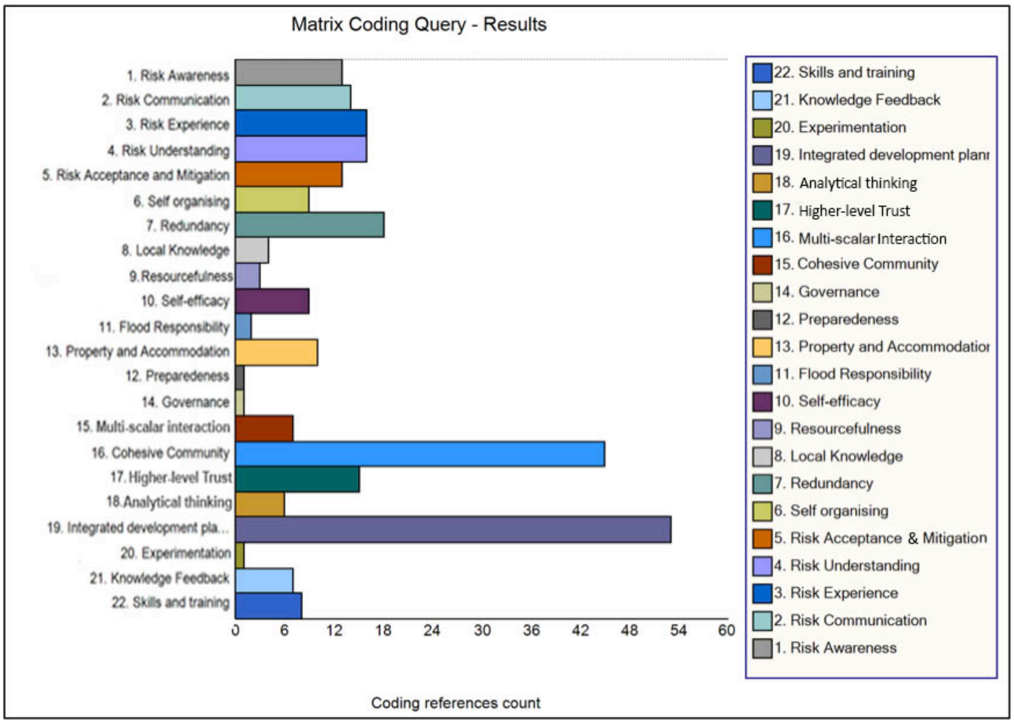

Figure 7.31 Practitioner level resilience indicators codes.

Having presented an overview of resilience indicators at the community and practitioner level, the following section explores the application of these indicators against the resilience weaknesses identified through the Phase 1 resilience baseline assessment (Section 7.5.1).

7.8 Feedback of indicators from Phase 2 to Phase 1

Taking each settlement hierarchy in turn, the application of Phase 2 indicators against Phase 1 weaknesses is discussed below in respect of Glenridding, Kendal and Carlisle.

7.8.1 Village scale

The Glenridding Phase 2 indicator results were analysed against the backdrop of the Phase 1 baseline assessment results (Figure 7.5.1). The empirical results found that the ‘environmental’ community asset was enhanced by resource ‘redundancy’ (Indicator 7), through the loaning of heavy machinery to clear 30,000 tonnes of rubble from the river. ‘Local knowledge’ (Indicator 8) of the changing *‘Behaviour of each beck (stream) and river’* (G89) informed appropriate environmental maintenance.

Further, maintenance of the ‘physical’ community asset was shown to be positively influenced by ‘flood responsibility’ (Indicator 11), through maintenance and removal of debris blocking water infrastructure (such as gulleys, culverts, drains, bridges). This further demonstrates ‘self-efficacy’ (10) and ‘self organising’ (6) on behalf of the community, adding a layer of resilience to maintenance work already carried out by authorities. ‘Resourcefulness’ (Indicator 9) in the form of property level protection were found to further enhance the physical resource. Likewise, ‘Integrated planning and development’ (Indicator 19) has the potential to positively influence the ‘environmental asset’ by maintaining open spaces free from development to act as natural water storage sponges. Reduced pressure on the sewage infrastructure would improve ‘physical’ resilience by limiting run-off water from impervious developed land.

The establishment of a parish flood group demonstrated the ‘self-organising’ (Indicator 6) and ‘cohesive’ (Indicator 15) capacity of the community. These highly coded indicators (Figure 7.32) influenced the extent of innovative and ‘resourceful’ (Indicator 9) actions undertaken and stood to bolster the human resource through enhanced ‘self-efficacy’ (Indicator 10) and empowerment. However, the tumultuous relationship with authorities ultimately affected ‘higher-level trust’ (Indicator 17). Whilst this indicator is coded heavily (Figure 7.32) the coding was negative, referring to distrust with authorities. Improved engagement with authorities has strengthened the relationship however the absence of ‘linking’ capital within the ‘multi-scalar interactions’ (Indicator 16) as shown in Figure 7.32, is indicative of the need for more collaborative work between the two levels.

Figure 7.32 presents low coding of the ‘Learning’ component, reflective of a dearth in ‘multi-scalar interaction’. The absence of an active FAG, working in parallel with the authorities, reduces opportunities for ‘learning’ and betterment. As such, the above-average education levels (Human resource) across Cumbria were not realised to their potential in respect of the ‘Learning’ component indicators: ‘knowledge feedback’ (21); ‘skills and training’ (22); ‘experimentation and Innovation’ (20) and ‘problem definition’ (18) (Figure 7.32).

The final ‘economic’ community resource presented an over-reliance on two industries within Glenridding: tourism and farming. Flooding badly affected both industries, with the impacts extending beyond those who flooded due to job losses in the area.

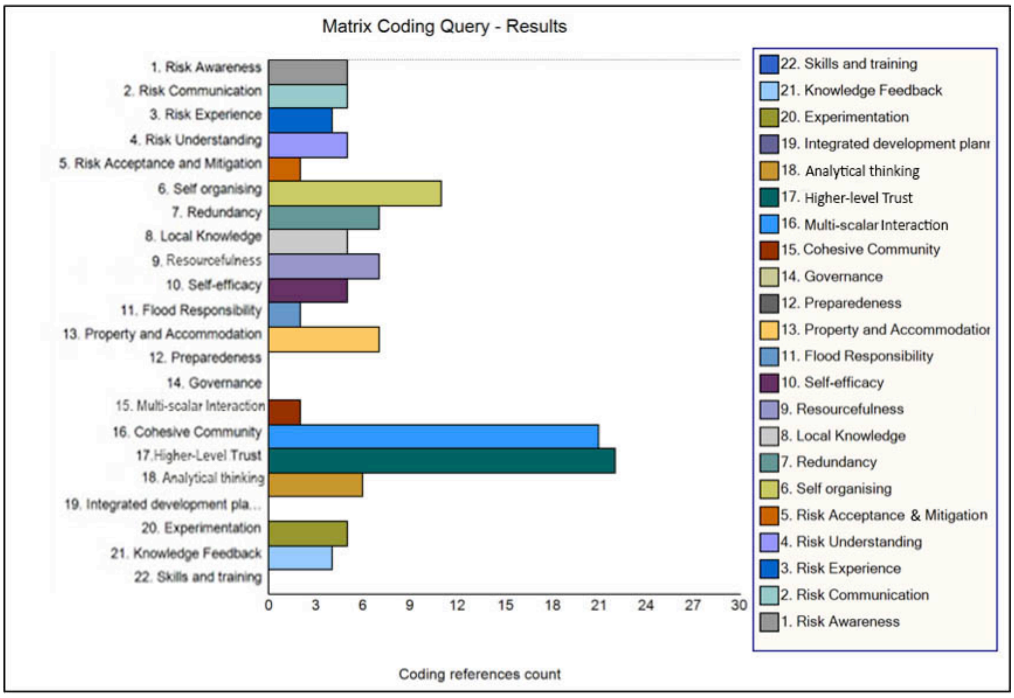

Figure 7.32 Glenridding community level resilience indicators codes, village scale.

Figure 7.33 illustrates how building in 'redundancy' (Indicator 7) through wider economic diversity, business continuity plans and insurance, could enhance economic resilience levels. In addition, Figure 7.33 illustrates how 'preparedness' (Indicator 12) measures (such as business resilience and evacuation plans) can lessen impact and expedite the recovery process.

Concluding the village scale analysis, the indicators discussed above can be targeted to enhance community asset weaknesses identified in Phase 1 (Section 7.5.1) and are presented in Figure 7.33.

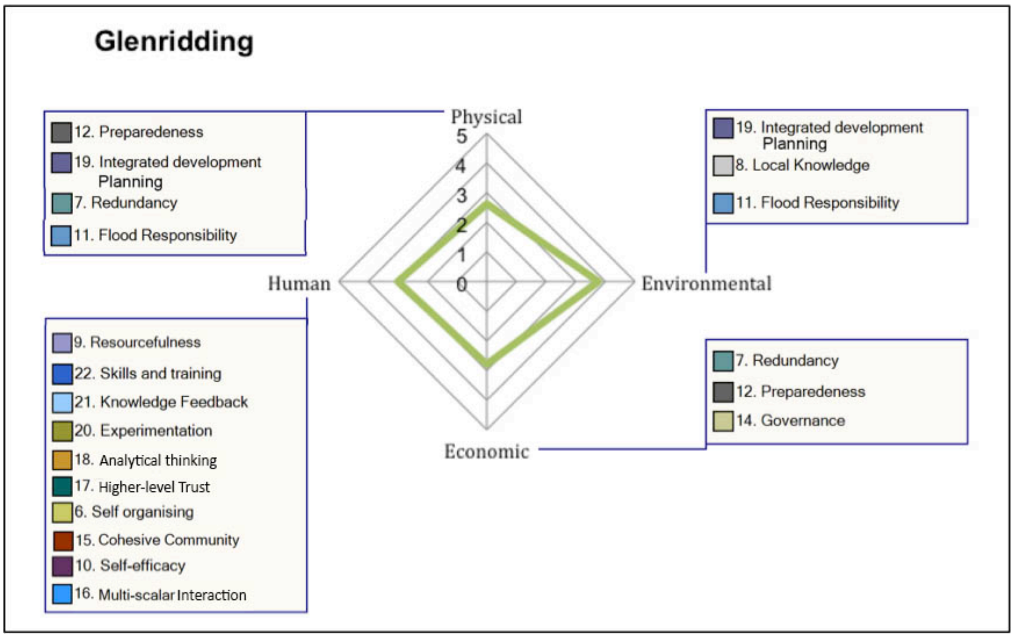

Figure 7.33 Application of Phase 2 indicators to Phase 1 resilience baseline assessment results, Glenridding.

7.8.2 Town scale

At the confluence of three rivers, Kendal's 'environmental' resource presents a high-risk challenge for the community. The empirical discourse revealed that the 'environmental' community asset was enhanced by clean-up days organised by the community, occasionally in partnership with third sector organisations such as 'Cumbria Action for Sustainability'. Despite this demonstration of community 'flood responsibility' (Indicator 11), it was found that resilience efforts were mostly limited to the individual rather than community level. As such, the majority of innovative and 'resourceful' (Indicator 9) actions were predominantly focused on household PLP measures. These measures increased protection of the 'physical' community asset by protecting property, but did not extend to protecting water infrastructure assets as in the Glenridding example. This apparent focus on individual resilience could be attributed to the fact that 2,150 properties within Kendal were flooded. Of those affected, 13 of those interviewed were first time flood victims. This fact further exacerbated the issue as a consequence of the community's low 'risk experience' (Indicator 3) and correspondingly low 'preparedness' levels (Indicator 12), as shown in Figure 7.34. The lack of a strategy to implement PLP within a conservation area raised frustrations and eroded 'higher-level trust' (Indicator 17), as illustrated through its low coding in Figure 7.34. A flexible and *"common sense approach"*

(K102) to recovery 'governance' (Indicator 14) was a clear request made by the community throughout the interview discourse.

'Human' investment in terms of an organisational structure to enhance 'community cohesion' (16), such as a FAG, could potentially enhance self-organising (6), self-efficacy (Indicator 10) and the utilisation of 'local knowledge' (8), as evidenced in the Glenridding example. Such an organisational structure could serve to build relationships and 'higher-level trust' (Indicator 17), leading to greater 'multi-scalar interaction' (Indicator 16). Empowering communities through the collaborative work of a FAG or flood/resilience group enables learning from 'flood experience' and tailors lessons learned (learning component) with appropriate innovative and 'resourceful' (Indicator 9) actions.

By contrast to Glenridding, Kendal presents greater employment opportunities as a consequence of its larger scale and the existence of an industrial park. However, this does not lead to an enhanced community 'economic' asset, as the industrial park is located within a flood plain. This example highlights the importance of economic 'redundancy' (Indicator 7) (highly coded, Figure 7.34) and diversity but also the influence of 'integrated planning and development' (Indicator 19) on the 'physical' and 'economic' community resource.

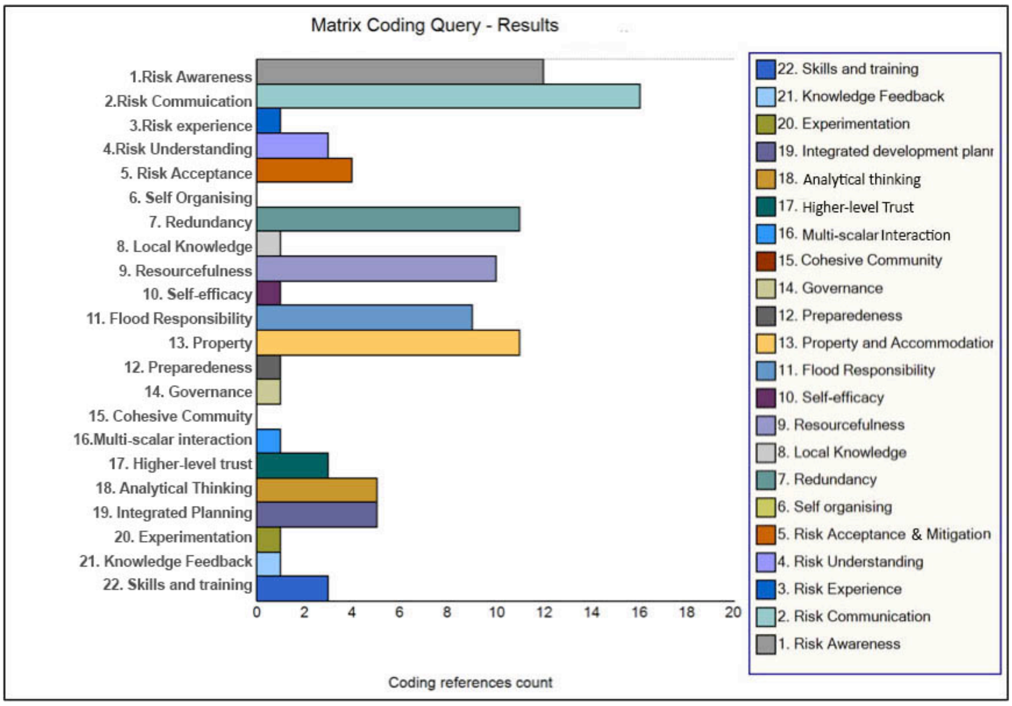

Figure 7.34 Kendal community level resilience indicators codes, town scale.

Concluding the town scale analysis, the indicators discussed above can be targeted to enhance community asset weaknesses identified in Phase 1 (Section 7.5.1) and are presented in Figure 7.35.

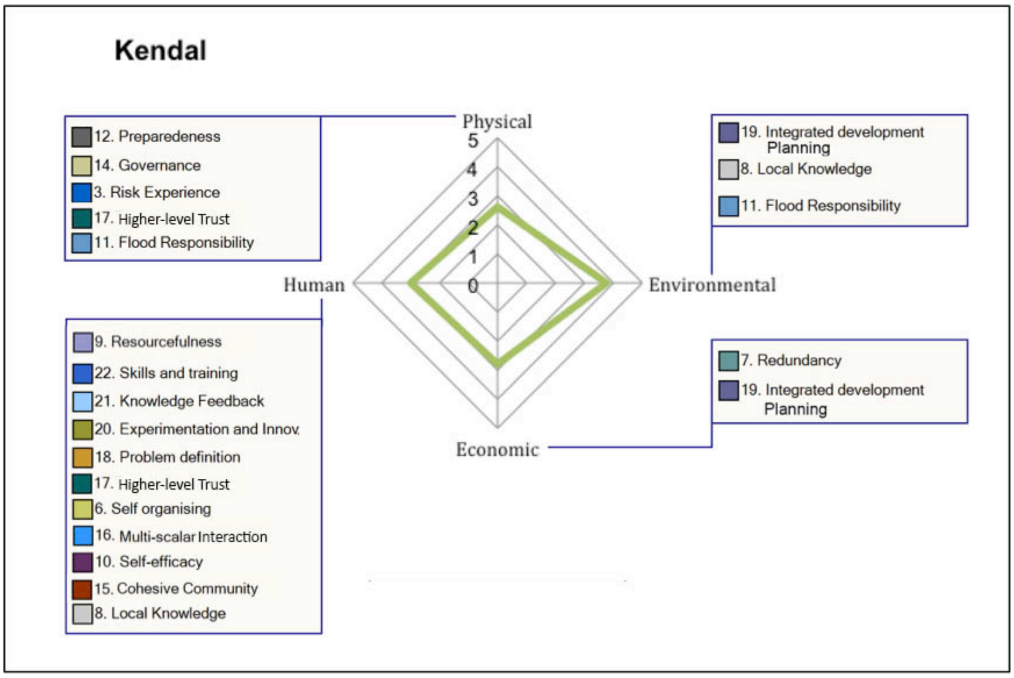

Figure 7.35 Application of Phase 2 indicators to Phase 1 resilience baseline assessment results, Kendal.

7.8.3 City scale

At the city scale a resilience gap was revealed through the lack of indicators directed towards enhancing the 'environment' community asset. Many residents viewed assisting flood risk activities as the authorities withdrawing from their obligations as a statutory authority. Rather than owning their own flood risk, few residents expressed an acceptance of the need to increase their 'flood responsibility' (Indicator 11) in line with increasing demands imposed by climate change.

The 'physical' community asset was found to be compromised by the lack of alternative temporary accommodation for displaced affected residents, leading to high coding for the indicator 'property' (Indicator 13). Accommodation demand and development pressures further reinforced the need for a more 'integrated approach to planning and development' (Indicator 19), ensuring future development reduces the exposes of properties in or near flood plains.

The city scale indicator results similarly reflect the importance of ‘multi-scalar interaction’ (Indicator 16) to enhance the “human’ community asset. “Flood experience’ (Indicator 3) was found to lead to high ‘risk awareness’ (Indicator 1), as indicated through its high coding in Figure 7.36. However, the difficulty uncovered at the city scale lies in translating this awareness into collaborative resilience action beyond individual resilience measures. Low ‘cohesion’ (Indicator 15) is indicative of a transient city with high rental tenure, consequently ‘local knowledge’ (Indicator 8) received a low coding percentage (Figure 7.36). The low cohesion call into question the nature of the ‘higher-level trust’ (Indicator 17) established through the medium of the new Carlisle FAG. For example, the previous section discussed how the nature of engagement between authorities and ‘pressure’ groups can actually serve to erode resilience if the intent of the group is to *“hold Government agencies to account”* (C59) rather than work together towards a similar goal.

Although Figure 7.36 indicates low ‘learning’ coding, the five ‘learning’ indicators were more highly coded than at the other settlement scales. Increased ‘learning’ is potentially attributed to the ‘analytical thinking’ (indicator 18) activities (problem definition) pursued through FAG meetings. Altering a revised ethos of the FAG from a ‘Pressure group’ towards a collaborative ‘Action group’ could potentially realise more of this ‘Learning’ potential.

Finally, the ‘economic’ resource presented a similar scenario to that of Kendal. Industrial development in flood plains further exacerbated the impact of some flood-affected members who also lost their jobs. This evidence emphasises the need for economic ‘redundancy’ in terms of financial savings for *“a rainy day”* (C45) and employment diversity. In addition, the above example highlights the relationship between ‘integrated planning and development’ (Indicator 19) and economic diversity.

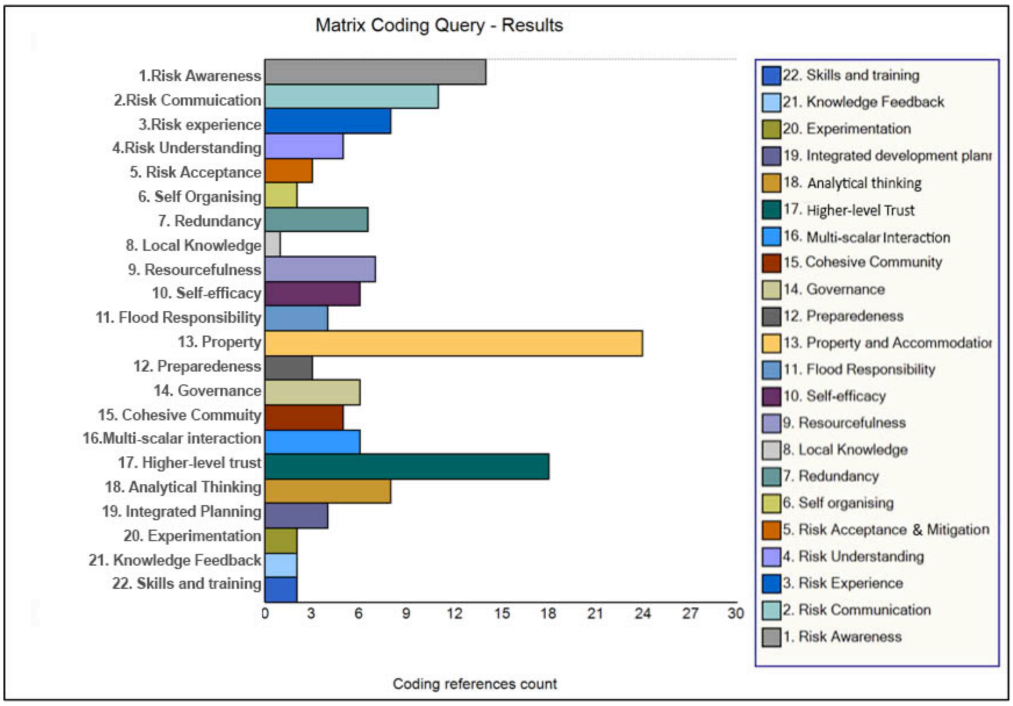

Figure 7.36 Carlisle community level resilience indicators codes, representative of the city scale.

Concluding the town scale analysis, the indicators discussed above can be targeted to enhance community asset weaknesses identified in Phase 1 (Section 7.5.1) and are presented in Figure 7.37.

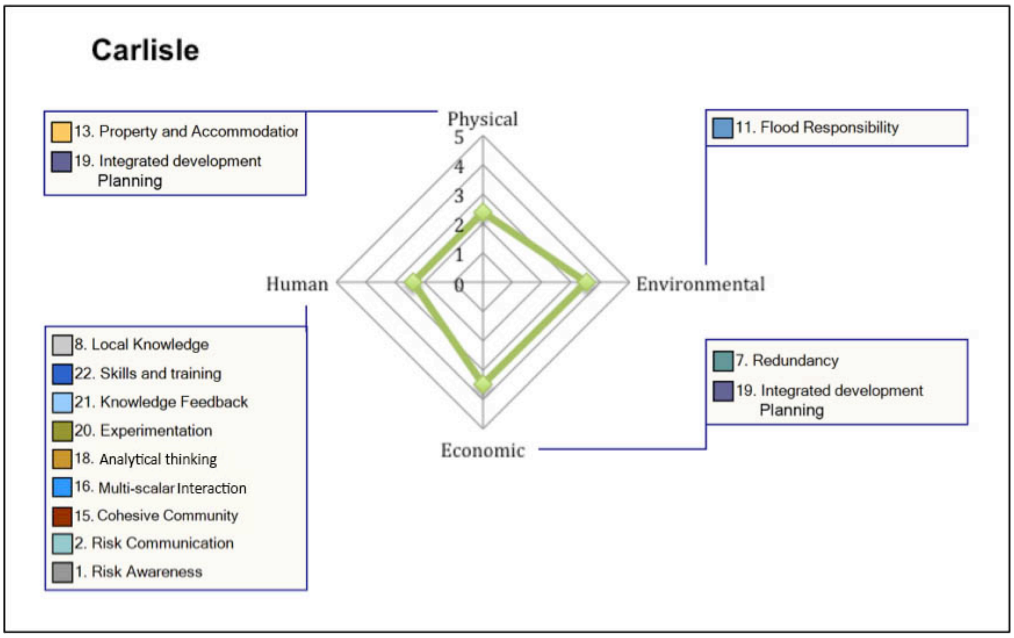

Figure 7.37 Application of Phase 2 indicators to Phase 1 resilience baseline assessment results, Carlisle.

7.9 Conclusion

This chapter has presented the application of the thesis Framework developed in Chapter 4. The Cumbria case-study region has been outlined generally, together with an overview of the eight micro case-studies. The baseline resilience assessments in Phase 1 highlighted the disparity in inhered resilience across the settlement hierarchies and, as such, emphasised the need for a bespoke resilience approach. Application of the highly structured 'framework method' (Phase 2) of analysis permitted the extraction of 22 realised (operational) resilience indicators. The interaction and relationship between these indicators was discussed at the three settlement hierarchies. Further, the prioritisation of these coded indictors against the practitioner perspective was also discussed.

The key finding emanating from this case-study is that the 'connectedness' of a community acts as a lynchpin for the successful mobilisation of resources and capacities. Those communities that exhibited a cohesive community core were more likely to engage in innovative and resourceful mitigative action. Risk awareness and experience critically influenced the extent of flood acceptance and responsibility by communities to undertake resilience action, however, it was the presence of an organisational structure such as a FAG that was the key to unlocking multi-scalar/collaborative action.

It was found that FAGs presented an opportunity to analytically assess risk together with agencies and through feedback of lessons learned, offered communities the potential to transform into a more sustainable trajectory ahead of the next disaster. In addition, the practitioner level reaffirmed the need for communities and authorities to work collaboratively towards a common goal. On a positive note, collaborative steps have been made through the implementation of Lead Local Flood Authorities (LLFA) under the Flood and Water Management Act (2010). However, of critical importance is the *nature* of this collaborative action with communities (pressure or action group), with authorities warning that a 'blame culture' is an unfruitful approach.

CHAPTER EIGHT

North-East Scotland Case-study

8.1 Introduction

Chapter 7 outlined findings from the application of the thesis Framework to the Cumbria case-study. This chapter explores whether the Framework's applicability can be transposed successfully to a different case-study location. The positioning of this chapter within the overall thesis structure is illustrated in Figure 8.1. Together with Chapters 6 and 7, this chapter provides empirical evidence to inform the overall conclusions of the study in Chapter 9.

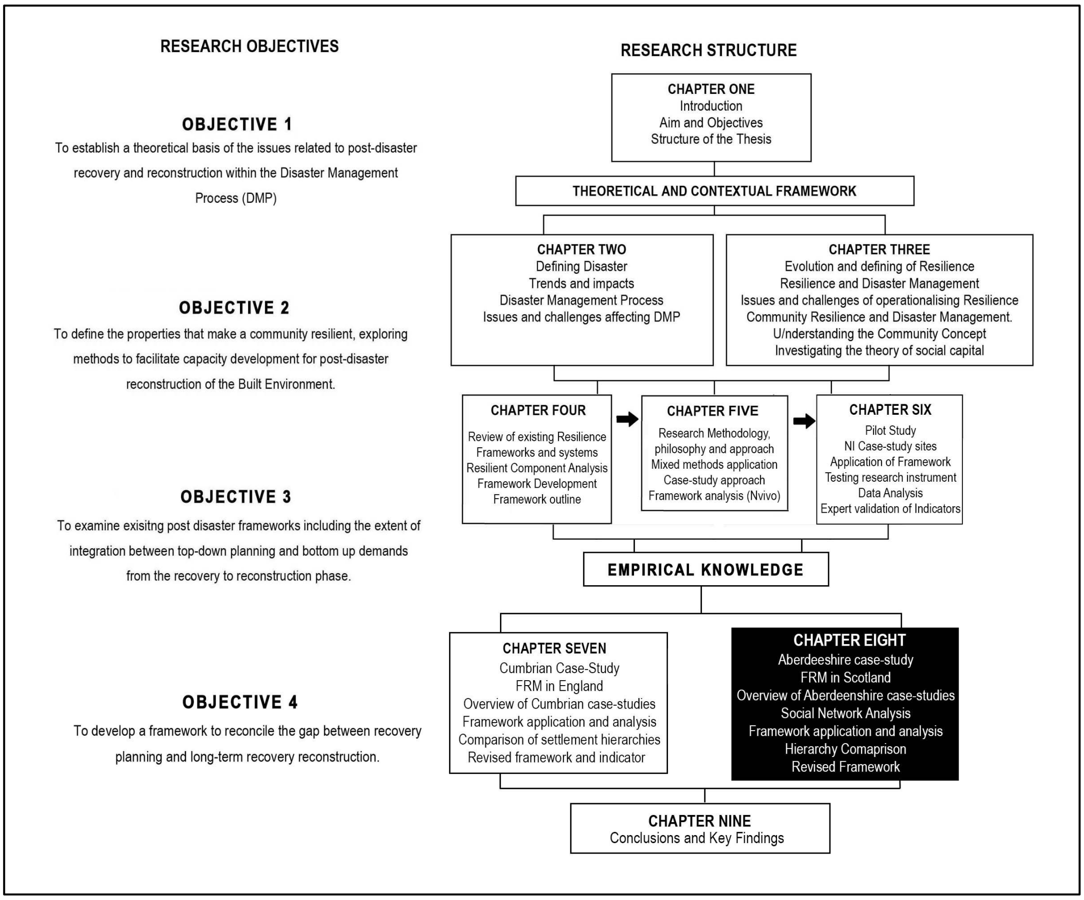

Figure 8.1 Position of Chapter 8 within the thesis structure

In particular, this chapter seeks to substantiate four key findings from the Cumbrian case-study as articulated in Chapter 7. Firstly, to establish whether FAGs or Resilience Groups demonstrate a similar level of connectedness as revealed in Cumbria. Secondly, to verify whether lower flood risk awareness (associated with lower incidence in North-East Scotland) acts as a barrier to resilience action. Thirdly, to explore variances in resilience levels as a consequence of urban and rural localities. Fourthly, to assess the extent of inappropriate planning and development and it's potential negative influence on resilience.

More generally, the Chapter seeks to corroborate the Cumbrian findings through the

North-East Scotland case-study. North-East Scotland sustained significant flooding as a consequence of Storm Frank in December 2015 and January 2016. The case-study focuses on four sites at the city, town and village scale.

Against this background, the Chapter starts by introducing the case-studies and outlines the legislative history in respect of flood risk management in North-East Scotland (Section 8.2). As regards the legislative history, the Chapter notes a policy shift from "flood defence" towards a more holistic and sustainable approach to flood-risk-reduction, as most recently represented by the Flood Risk Management (Scotland) Act 2009 (Scottish Government, 2009a). The key stakeholders involved in this transition are outlined in Section 8.3. Section 8.4 introduces the North-East Scotland case-study, outlining key aspects of the region's geography. It also includes an overview of the socio-economic profile and explains the varied flood issues faced by the four micro case-studies.

Sections 8.5 - 8.8 include the core analysis underpinning this case-study. Adopting a mixed-methods approach, Section 8.5 presents the application of the quantitative element (Phase 1) of the Framework, illustrating the baseline resilience levels of the four communities. The qualitative element follows (Phase 2), presenting an analysis of the affected communities' perception of resilience after the winter 2015/2016 floods. The critical role community networks play in expediting flood recovery is illustrated through Social Network Analysis (SNA) in Section 8.6. A comparative analysis of resilience indicators across the settlement hierarchies (city, town, village) is discussed in Section 8.7, while Section 8.8 critically evaluates the complementarities between Phase 1 and Phase 2 indicators.

The Chapter concludes with Section 8.9 drawing conclusions from the North-East Scotland region and considers the extent to which the four specific questions posed from the Cumbrian case-study are transferable to the North-East Scotland study.

8.2 History of flood risk management in Scotland

The following section explains the incremental Flood Risk Management policy shift in Scotland from a 'piecemeal', reactive and predominantly hard engineering approach, towards the current promotion of 'sustainable flood management'. In addition, this section highlights cross-cutting policy that supports the concept of building community resilience to flooding.

One of the earliest pieces of flood legislation in Scotland was the Land Drainage Act

1958. Introduced to improve the agricultural potential of land, the Act encouraged the use of hard-engineering flood protection. The Flood Prevention (Scotland) Act 1961 was introduced to give local authorities the power to mitigate the impact of river and tidal flooding on non-agricultural land. However, the Act was heavily criticised for its promotion of hard defenses, which created the impression that flooding can be 'prevented' (RSPB, 2007). In addition, surface water flooding was considered through The Roads (Scotland) Act 1984, which gave road authorities the power to take mitigative action. In contrast to the hard-engineering approach, The Water Environment and Water Services Act (2003) promoted a more sustainable approach to flood management, including soft engineering strategies. The distinct approaches impeded progress in overall flood risk reduction and ultimately created the impetus for the introduction of a new, sustainable approach to flood risk management (FRM). Furthermore, the Scottish Parliament identified that the siloed and fragmented responsibility of FRM required co-ordination from a single responsible body.

In response, the Flood Risk Management (Scotland) Act 2009 was introduced as the key legislation governing all flood types across Scotland. The Act established clear lines of responsibilities for the collaborative co-ordination of various stakeholders, including: the Forestry Commission, Scottish Environmental Protection Agency (SEPA), Scottish Water and Local authorities. The Act seeks to gather more data and information on the causes and impacts of floods (CREW, 2012). Indeed, it is argued that the promotion of sustainable flood management represents the biggest change brought about by the Act (CREW, 2012), by broadening the scope of strategic actions from a hard-engineering approach to include soft engineering strategies (SEPA, 2013).

Further, the sustainable focus of the Act stands as a response to the need for greater resilience development against climate change (Scottish Government, 2009b; Scottish Government, 2014). The Act promotes a joined-up approach to flood risk management by imposing new responsibilities on local authorities, SEPA and Scottish ministers to reduce flood risk in an integrated and collaborative manner. The Act marks a shift from a reactive, hard-engineered and siloed approach towards a joined-up, catchment-wide approach that acknowledges the benefits of both hard and soft engineering strategies (Spray et al, 2009).

In addition to the above Acts, cross-cutting resilience legislation in three fields: planning, resilience and emergency management supports the concept of building community resilience to flooding.

First, the control of new development is governed by the Planning etc. (Scotland) Act 2006, which outlines that planning applications within a flood plain require consultation with the Scottish Environment Protection Agency (SEPA). In addition, national guidance on appropriate planning and development is presented in Scottish Planning Policy (SPP)7. Preventative in nature, these policies advocate that built development should not be permitted in a functional flood plain. Further, SPP 7 states that development in a sparsely populated or undeveloped area should not be permitted in 'medium to high' flood risk areas. In addition, Planning Advice Note 69 further galvanises this preventative strategy to development in flood plains by outlining measures to ensure that future developments are restricted in flood risk areas (Aukerman et al, 2008).

Secondly, the Scottish Government takes responsibility for the implementation of the Civil Contingencies Act (2004) and (Scotland) Regulations (2005), aimed at reducing disruption from an emergency event. The legislation acknowledges the role actors both within and outside the local authority play in the reduction of flood risk. Further, the Act explicitly sets out and develops scenario-based plans to develop organisational capacity to maintain the functioning of infrastructure when faced with adverse events (Civil Contingencies Act, 2004).

Thirdly, in the Community Empowerment (Scotland) Act (Scottish Parliament, 2014), passed in 2015, acknowledges the important role communities play in flood risk reduction. Acknowledging the social impact of floods on Scottish society (Werritty et al, 2007), the Act strives to legitimise the community voice in flood decision-making by seeking to empower communities to manage their own flood risks and have greater control over community assets (Scottish Community Development Centre, 2015).

8.2.1 Flood history in Scotland and the North-East Scotland region

Across Scotland, 108,000 properties sit within flood risk areas, representing a key concern for the country (Kazmierczak et al, 2015). The UK Climate projections expect that an increased level of flood incidents is a trend that is set to continue and the current level of properties at risk (4%) in Scotland could rise further (Brooker et al, 2014; Sayers et al, 2014).

There is limited recorded information in respect of the country's detailed flood history, however, reports of flooding date back to the Muckle Spate flood of 1829. In more recent times surface water flooding has been reported as an issue in cities, with the most serious incidents occurring in Glasgow in 2002 and Aberdeen during July 2015 (Kazmierczak et al, 2015). Significant river flooding was also reported in Elgin, Moray in winter 2013, 2014 and 2015/2016. In terms of coastal flooding, Stonehaven as well as coastal towns and villages in Moray (e.g. Portknockie and Banff) sustained recurrent flooding in 1995, 2002, 2005 and 2009. Of the properties at risk across Scotland, 13,000 residential and 3,600 non-residential at risk properties lie within the North East Local Plan (Aberdeenshire Council, 2016c).

In late December 2015 and early January 2016, Storm Frank (and two subsequent periods of persistent rain) resulted in 'unprecedented' rainfall across North-East Scotland (Aberdeenshire Council, 2016a). A major incident was declared on two occasions (30th December, 2015 and 8th January, 2016), requiring extensive outside assistance from authorities. The situation was exacerbated by the extent of rainfall in November 2015 (the highest ever recorded) leading to ground saturation which was compounded by further rainfall from storm Eva and Frank. The Polhollick Monitoring station, near Ballater on the river Dee, recorded the highest water level on record of 3.3m (usually 1.5m) and, in Braemar, 64mm of rain fell between midnight to 2pm on 30th December 2015 (See Figure 8.2). The combined effects of these factors led to widespread flooding across North-East Scotland (Aberdeenshire Council, 2016a). Significant damage was caused, creating long term, high cost infrastructure and community impacts. Although many of the affected communities had experience of low-level flood incidents, the scale and intensity of flooding brought about by Storm Frank exceeded the capacity of the community and required outside assistance. The following section outlines the key stakeholders involved in this recovery process.

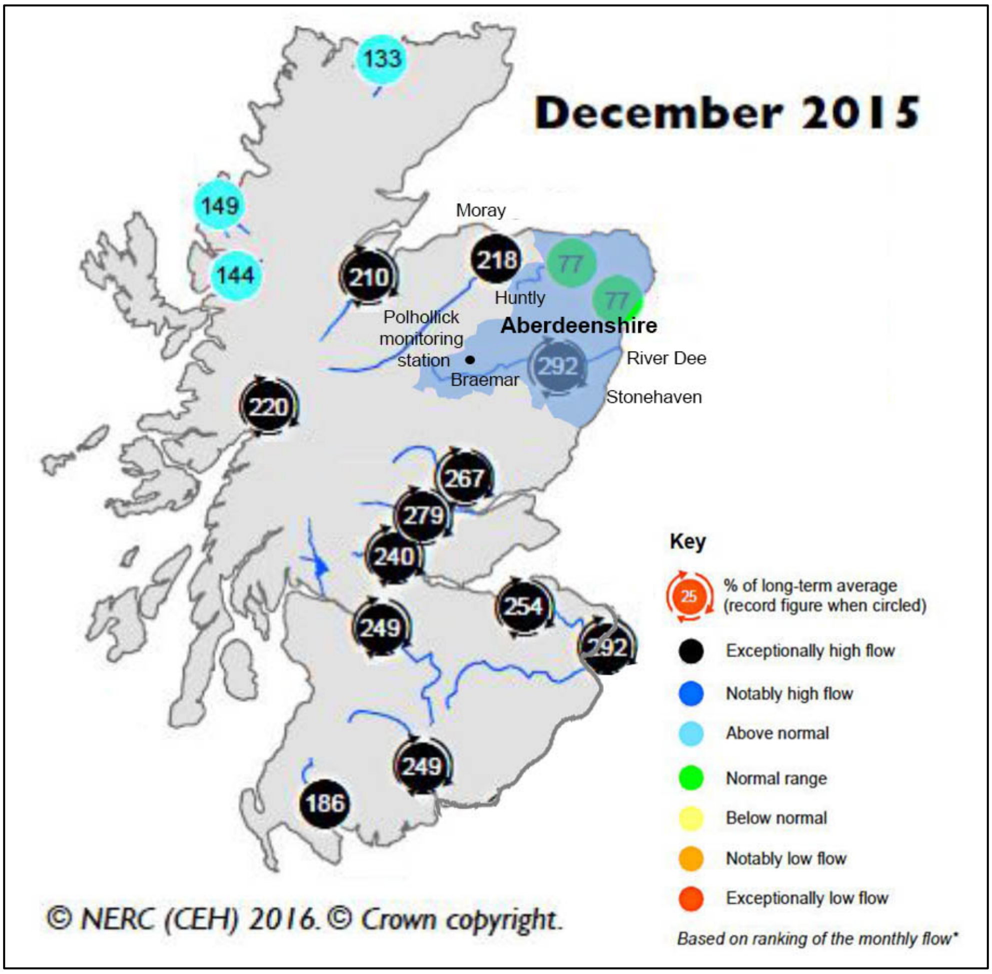

Figure 8.2 Localised flooding in North-East Scotland. Source: NERC (CEH), 2016.

8.3 Flood risk management stakeholders

Set against the backdrop of the Flood Risk Management (Scotland) Act (2009), the following section outlines the key stakeholders involved in the mobilisation of the Act and wider flood risk reduction strategies in North-East Scotland. A review of secondary data (policy documents) (Appendix 3), key stakeholders and institutes are identified. Consistent with the approach taken in the previous two chapters, stakeholders were broken down into three categories, namely: policy and prevention; recovery and reconstruction; emergency management and industry/independent organisations. The hierarchical stakeholder map (national, regional and local) is discussed below and presented in Figure 8.3.

8.3.1 National level

The Scottish Government is responsible for overseeing the implementation of the Flood Risk Management (Scotland) Act (2009). In addition, Scottish ministers are charged with raising awareness and disseminating information regarding flooding through the ‘Ready Scotland’ campaign. The National Government provides 80% of the funding to deal with flooding (Scottish Parliament, 2017).

Under the Flood Risk Management (Scotland) Act (2009), the Scottish Environment Protection Agency (SEPA) is assigned as the designated flood risk authority. SEPA also works alongside the Met Office to provide a flood warning service (Floodline) (SEPA, 2017c). Beyond its warning and informing duties, SEPA acts as a statutory consultee on planning applications within potential flood risk areas, however, the local authorities make the final judgment on applications. In collaboration with the ‘Ready Scotland’ campaign and local authorities, SEPA enhances education and awareness of flood risk management and preparedness in communities (Aberdeenshire Council 2017b).

8.3.2 Regional level

Local authorities are charged with the management of flood defences and flood prevention schemes. Their position as lead local flood authorities (LLFA)[39] under the Flood Risk Management (Scotland) Act (2009) extends their responsibilities to the maintenance and assessment of watercourses and drainage systems (gulleys and drains). Local authorities also assist with softer measures including raising awareness, capturing local knowledge and sharing information before a flood event. Of note, local authorities have no legal obligation to provide sandbags or similar property level protection as this is the responsibility of the homeowner. After a flood event, they assist by providing accommodation for evacuated residents and assistance through the coordination of emergency services.

Since the introduction of the Flood Risk Management (Scotland) Act (2009), Scottish Water works in partnership with SEPA, local authorities and other responsible organisations to implement flood risk management strategies. In particular, Scottish Water is responsible for monitoring the discharge of water from drainage systems and sewers and is tasked with organising the maintenance/repair of burst mains and water supply in reservoirs (Aberdeenshire Council 2017b).

Under the Flood Risk Management (Scotland) Act (2009), the Cairngorms National Park is also a designated a responsible authority in flood risk management. Working in partnership with SEPA, local authorities and other responsible bodies, they assist

[39] Lead Local Flood authority is charged with developing, maintaining and implementing a local flood risk strategy, including maintenance of flood risk assets register.

in the development of flood risk management strategies by informing on appropriate and sustainable land use (SEPA, 2017a). In addition, the Forestry Commission was designated a responsible authority in 2012, to complement the sustainability aspect of the Flood Risk Management (Scotland) Act 2009 by promoting natural flood management strategies (SEPA, 2017a).

8.3.3 Local level

In contrast to the Environment Agency (EA) in England, SEPA clearly outlines the responsibility of communities to assist in the management of their own flood risk. For example, affected communities are reminded of their responsibility to sign up to the flood warning system (Floodline), to check their risk level on publicly accessible flood maps and to avail of flood insurance. A newly created agreement between Scottish Government and the insurance industry (FloodRe, April 2016), means affordable home insurance is available for residential properties built prior to 2009 within a flood risk zone.

The Scottish Flood Forum acts as a communication channel between the community and authorities. Funded by the Scottish Government, the organisation seeks to create awareness, support and provide advice on flood related issues across Scotland. Working on behalf of the affected community, the overall aim of the organisation is to establish a network of resilient communities across Scotland who can learn from each other and promote best practice (Scottish Flood Forum, 2017). In addition to the work of the Scottish Flood Forum, Community Councils[40] are a formal representative of the community at the local level, acting as a channel for statutory agencies to engage with the community. They are the most local tier of statutory representation and serve to make the views and concerns of the community (regarding flooding issues) heard at the local authority level. Many resilience and flood action groups are formed through this medium.

[40] Made up of elected members, the Community Council is the representative voice of the community in statutory matters.

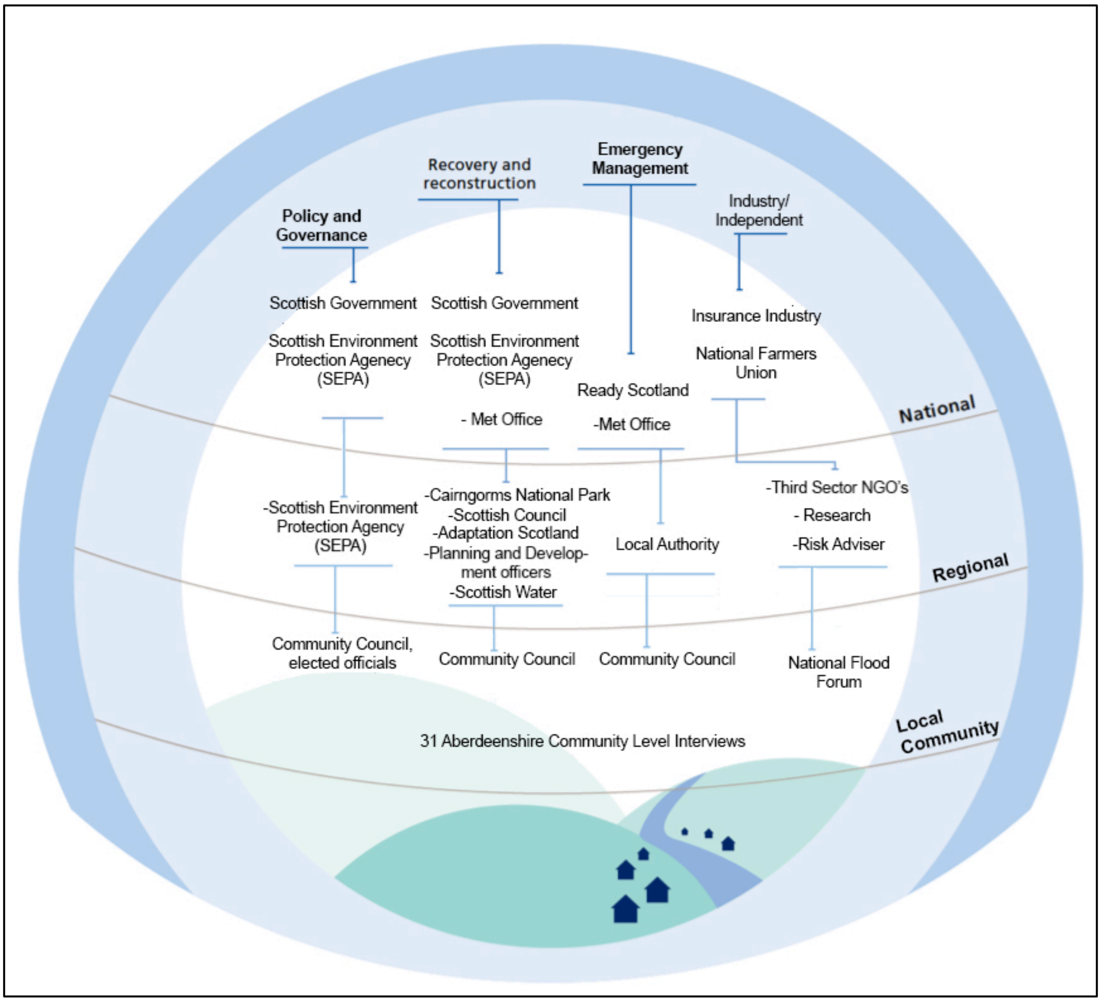

Figure 8.3 Institutional Disaster management landscape, North-East Scotland (Adapted from JBA, 2015).

The above section presented the policy backdrop against which the multi-scalar stakeholders operate in FRM. A contextual overview of the North-East Scotland case-studies is presented in the following section, by outlining the socio demographic background of the region. Further, it presents a more detailed profile of the four micro case-study areas (Appendix 7.5), namely: Aberdeen city (including the suburb of Peterculter), Inverurie town and Ballater village.

8.4 Introduction to North-East Scotland case-study context

This section presents an overview of the North-East Scotland region before outlining the socio-economic profile of the area. The North-East Scotland region is one of 32 council areas in Scotland and is divided into six devolved local area committees (Figure 8.4). The four micro case-studies that comprise the North-East Scotland case-study are located across the Aberdeenshire Council and Aberdeen City Council local authority areas. The North-East Scotland region is a predominently rural, with an economic base which extends beyond a heavy reliance on the oil and gas sector to include rural industries such as forestry, agriculture, fishing, milling, brewing, distilling and tourism. The area's industrial past relied on hydropower from the Dee, Don, Ythan and Ugie rivers to drive many of the paper and corn mills across the council area (Gazetteer for Scotland, 2017). Indeed, the historical use of hydropower hints at the fluvial flooding issue faced by the area.

Flooding from inland, minor watercourses and coastal streams is an on-going issue throughout Scotland (Aberdeenshire Council, 2017c; Aberdeenshire Council, 2017d). As a consequence of major flooding events over the last two decades, significant investment in hard-engineering protection can be seen through recent flood protection schemes in Huntly (2015-2018) and Stonehaven (July 2017) (Aberdeenshire Council, 2017c; Aberdeenshire Council, 2017d). However, the winter 2015/2016 floods across North-East Scotland highlighted the unpredictability of the flooding issue. The perceived high-risk areas of Huntly and Stonehaven emerged from storm Frank unscathed, however 850 properties and 120 businesses were affected across the region (Aberdeenshire Council, 2016a). Of these figures, a large proportion of the damage was sustained by the small village of Ballater, where 300 homes and 60 businesses were flooded. In Aberdeen city, the millside area of Peterculter, Granhholm in The Bridge of Don and commercial premises along Garthdee road in Deeside received the most damage. The commuter town of Inveruie sustained significant flooding in the south west suburb of Port Portelphinstone. Further details of the flood impact sustained by the thesis case-studies are outlined in Appendix 7.5.

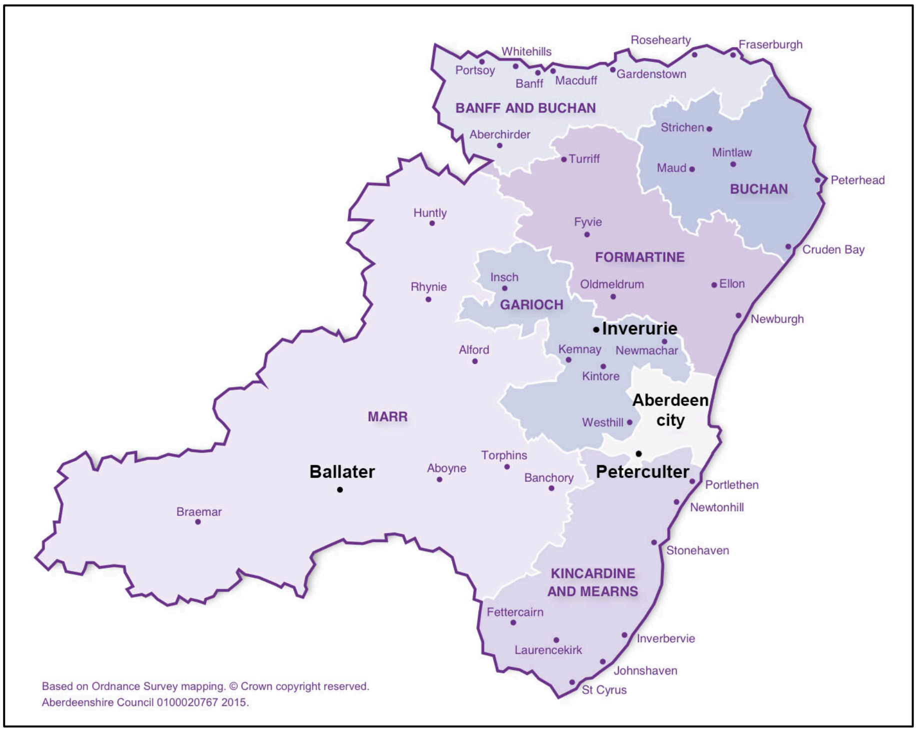

Figure 8.4 Map indicating the location of the four micro case-studies within North-East Scotland (Aberdeenshire Council, 2011).

This section presented the socio-economic profile of the four micro case-studies (Appendix 7.5) and situated the case-studies within the wider North-East Scotland Flood Risk Management context. The policy review highlighted a shift away from a hard engineering 'defence' approach to FRM towards a holistic catchment approach. Key to this approach is community centred resilience, by building the capacity to do more for themselves. As such, the following section is a practical response to this need, through the empirical application of thesis Framework within a Scottish context.

8.5 Application of thesis Framework

This section outlines the two-phased approach to Framework application as discussed in Chapter 5 (Section 5.5.1). It begins by explaining the application of Phase 1 before moving on to Phase 2 (Section 5.3.1). Chapter 5 discussed how Phase 1 comprised a top-down assessment of resilience variables by drawing on secondary publically available official data (Appendix 3). Chapter 5 further explained how the assessment drew upon the baseline resilience assessment as proposed by Cutter et al (2010), but was adapted to suit a flooding context. The adapted assessment comprised four key community assets namely: physical, economic, human and environment. The four community assets together with their corresponding variables are outlined in detail in Appendix 2. The list of 22 variables is largely consistent with those used in the previous case-studies (Chapter 6 and 7) however, due to data availability slight variations were unavoidable and are highlighted in bold in Table 8.1.

8.5.1 Data aggregation and normalisation

As discussed in Chapter 5, once the 26 variables were established, the process of normalising the variables took place (Section 5.5.3). The process of normalisation aggregated the raw data and allowed the variable scores to be presented on a uniform scale. The original data units were translated into a linear scale for comparison by applying a technique known as Min-Max normalisation. On the scale of 0 and 1, the value of 0.5 equated to neutral. In terms of resilience, 0 indicates low resilience whereas 1 indicates high resilience. The aggregated results for each 'asset' were subsequently illustrated on a radar diagram for comparison.

Chapter 5 (Section 5.5.3) further explained the decision to apply equal weighting across the variables, to avoid an artificially high resilience score across assets (physical, environmental, economic, human). This was due to the fact that variable numbers were unequal across the four community assets and more variables does not equate to higher resilience. A worked example of Ballater's 'Physical' asset is outlined in detail in Appendix 2. Table 8.1 presents the baseline assessment results in respect of the four case-study communities. Aggregated scores for the four case-study settlements are presented in Figure 8.9.

Table 8.1a Variable and aggregated scores for the 'Physical' resource.

Community Asset:	**Variable**	**Aberdeen**	**Peter-culter**	**Inverurie**	**Ballater**	**Data source**
1. Physical Resource						
Exposure	**Number of properties exposed to river flooding return period: 1 in 200 year**	0.9	0.9	0.8	0.8	SEPA Potentially Vulnerable Areas NFRA. ***1**
	Number of properties exposed to surface water flooding return period: 1 in 200 year	0.7	0.8	0.8	1.0	SEPA Potentially Vulnerable Areas NFRA ***1**

	Number of properties exposed to coastal water flooding return period: 1 in 200 year	0.8	N/A	N/A	N/A	SEPA Potentially Vulnerable Areas NFRA. ***1**
	SEPA Flood Priority	1.0	0.0	0.3	0.5	SEPA Potentially Vulnerable Areas NFRA. ***1**
Housing	**Housing domain rank *2**	0.3	0.7	0.6	0.5	Scottish index of Multiple Deprivation 2016 ***2**
Aggregated score per resource[41]		**3.7**	**3.0**	**3.2**	**3.5**	

Table 8.1b Variable and aggregated scores for the 'Environmental' resource.

Community Asset:	Variable	Aberdeen	Peter-culter	Inverurie	Ballater	Data source
2. Environmental resource						
Environmental exposure	**Parks per 1 mile radius *4**	0.4	0.6	0.7	0.6	Open space Audit , Aberdeenshire Council,
	Geographic domain rank*2	0.5	0.7	1.0	0.1	Environment : Model-Multiple Deprivation Measure 2010
Aggregated score per resource		**2.2**	**3.25**	**4.25**	**1.75**	

Table 8.1c Variable and aggregated scores for the 'Economic' resource.

Community Asset:	Variable	Aberdeen	Peter-culter	Inverurie	Ballater	Data source
3. Economic Resource						
Livelihood stability	% of working age that is economically active	0.7	0.7	0.6	0.7	Scotland's Census 2011
	% unemployed	0.5	0.8	0.6	0.8	Scotland's Census 2011
	Income domain rank*2	0.6	0.8	0.5	0.9	Multiple Deprivation Measure 2015.
	Employment domain rank*2	0.7	0.7	0.4	1.0	Multiple Deprivation Measure

41 Score (0 least resilient, 1 most resilient)

						2015.
Tenure	% households owner occupier	0.5	0.7	0.7	0.6	Scotland's Census 2011
Aggregated score per resource		**3.0**	**3.7**	**2.8**	**4.0**	

Table 8.1d Variable and aggregated scores for the 'Human' resource.

Community Asset:	Variable	Aberdeen	Peter-culter	Inverurie	Ballater	Data source
4. Human Resource						
Community capacity	% of population over the age of 65	0.5	0.6	0.4	0.0	Scottish Census 2011
	% of population <16	0.7	0.8	0.9	0.3	Scottish Census 2011
	% of population stated general health was good or very good	0.8	0.9	0.9	0.9	Scottish Census 2011
	Health domain rank *2	0.5	0.8	0.8	1.0	Multiple Deprivation Measure 2010.
Equity	% of college degree or higher (Level 4 or above)	0.8	0.8	0.6	0.7	Scottish Census 2011
	% of population with no or low qualifications (L1)	0.4	0.4	0.3	0.3	Scottish Census 2011
	Education, skills and training domain rank *2	0.4	0.8	0.5	0.8	Multiple Deprivation Measure 2016.
Social capital	**Crime domain rank *2**	0.3	0.8	0.1	1.0	Multiple Deprivation Measure 2016.
	% voter participation in last election *5	0.5	0.4	0.4	0.5	Aberdeen City Council (2017) ; Aberdeenshire Council (2017).
Local knowledge	% from outside the area	0.5	0.6	0.9	0.6	Scottish Census 2011
Aggregated score per resource		**2.7**	**3.4**	**2.9**	**3.0**	

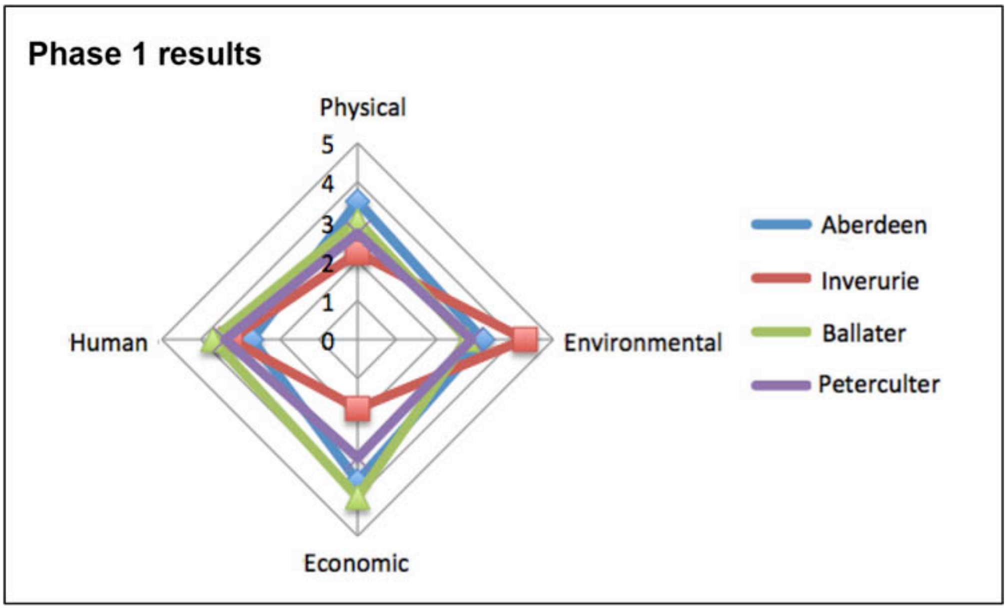

Figure 8.5 Radar results for the four micro case-studies within North-East Scotland: Aberdeen; Inverurie; Ballater; Peterculter.

The baseline assessment results (Phase 1) (Section 8.4.1), show that Aberdeen scored high in relation to the ‘physical’ asset due to prioritised investment received as a result of its high SEPA ‘Flood priority’ score. Overall, across the case-studies, high exposure from all three flood types (as indicated by historical flood maps), led to low scoring in this resource (Figure 8.9). The high employment rate in Ballater, coupled with its diverse range of industries from tourism, farming and employment further afield in the oil and gas industry, equated to a comparatively high score in this asset. Aberdeen served as an employment base for commuter villages and towns such as Inverurie. However, the city had a high unemployment figure relative to the area, which may be partly attributable to the low education level.

All four case-studies had a higher than UK-average proportion of their population within the 65 and above age category, particularly in rural areas. The crime rate in the city of Aberdeen and Inverurie town was comparatively greater than that found at the village scale, thus reducing the social capital score for both locations. This snapshot of Phase 1 resilience highlights the existing resilience of place (inherent resilience) by identifying areas of weakness where resilience intervention is needed most. The following section presents the application of Phase 2 of the Framework which seeks to capture evidence of resilience indicators through analysis of empirical case-study data.

8.5.2 Phase 2 recruitment and sampling

As with the previous pilot case-studies in Chapter 6 and the Cumbrian case-study in Chapter 7, a facilitator was engaged to ease the recruitment process and gain further contextual understanding of the case-study area. Initiating the community level purposive sampling process (Section 5.6.5), community champions and representatives were contacted through a mix of residents' associations; parish councils; a SEPA community resilience advisor; flood support groups and, in particular, resilience groups. As was the case in previous urban case-studies (Carlisle and Belfast), Aberdeen city was the most difficult case-study area to engage interviewees due to the lack of a facilitator. This was in part due to the dispersed nature of the flooding pockets across the city.

The interviews were undertaken almost 18 months after the winter 2015/2016 flooding, representing a different period of the reconstruction process compared to Cumbria. By the time of the North-East Scotland field study, the majority of residents had returned to their renovated properties (89% of interviewees) and had time to reflect on the recovery process. Indeed, the reflective nature of the interviews had the advantage (relative to Cumbria) of informing the 'learning' component of the Framework and thereby facilitated an added value component to this case-study.

Consistent with the approach discussed in the methodology (Section 5.6.5), in addition to purposive sampling, snowball sampling was also undertaken to ensure a balanced representation of those affected. In doing so, a comparable representation of gender, age profile, flood experience and length of time lived in the area was achieved. Table 8.2 summarises the number of community and practitioner level interviews across the four case-study settlements.

Table 8.2 Community level Interview logbook.

Case-study area	Aberdeen (city)	Peterculter (city)	Inverurie (town)	Ballater (village)	Practitioner
Properties Affected	Estimated at 35. (Exact figure not reported)	50	80	344	-
Number of Interviewees	9	9	5 (Inclusive of one focus group of 3 people)	8	15
Interview codes	A1-9	C23-31	I18-22	B10-17	P32-46

Chapter 5 (Section 5.6.5) outlined the purposive sampling techniques used to recruit practitioner interviewees. Consistent with this approach, participants were selected based on their respective roles and responsibilities within their organisation. In this context, Figure 8.10 illustrates the mapping exercise carried out to identify the key organisations within the fields of policy and prevention; emergency management; recovery and reconstruction; and industry/independent organisations.

Interviews within the 'policy and prevention arena', included representation from SEPA flood advisors and council members responsible for the implementation of the Flood Risk Management Strategies. The 'emergency management' field was represented by a resilience co-ordinator involved in the 'Ready Scotland' resilience campaign. In addition, emergency warning and informing (flood alerts) was discussed with the Met Office. The 'recovery and reconstruction' phase involved resilience co-ordinators from 'Ready Scotland' together with representation from both Aberdeen City Council and Aberdeenshire Council. Interviewee roles included: flood team manager, infrastructure engineer and planning and development officers. In addition, responsible authorities involved in the delivery of flood risk management strategies were interviewed, including, Scottish Water and the Cairngorms National Park Authority. Finally, the 'industry and independent' field incorporated views from the Scottish Farmers Union, risk advisors (insurance), property level protection company manager and third sector sustainability and research organisations. In total 15 interviews took place at the stakeholder level (Table 8.3), the details of which are included in Appendix 8.3.

Table 8.3 Number of practitioner level interviews.

Practitioner level interviews	Policy-Prevention	Emergency Management	Recovery and Reconstruction	Industry and Independent
Number of interviews	2	3	6	4

8.5.3 Data analysis using the Framework

In accordance with the structured 'Framework Method' data analysis (Chapter 5), Stage 1 was the 'Transcription and Familiarisation' of the interview recordings and field-notes. Stage 2 'Categorisation of the Codes' involved the creation of 'cases' for the participants as illustrated in Table 8.4 Consistent with the approach taken in Chapter 7, this involved categorisation into different case profiles, namely: gender; age; time in community; number of people in household; community location and flood experience.

Table 8.4 Stage 2: Screenshot example of 'case profiles' in NVivo to enable comparison between cases.

A : Gender	B : Age profile	C : Time in community	D : People in household	E : community location	F : Flood experience
Male	18-45	6-10 years	Business	Aberdeen	3 times and above
Female	65 and above	6-10 years	Business	Aberdeen	1st time
Male	18-45	11-20	Business	Aberdeen	1st time
Male	18-45	11-20	Business	Aberdeen	1st time
Male	18-45	11-20	Business	Aberdeen	1st time
Female	46-64	6-10 years	1 adult	Aberdeen	1st time
Male	Unassigned	6-10 years	2 adults	Aberdeen	1st time
Male	18-45	11-20	1 adult	Ballater	1st time
Unassigned	46-64	20 plus	2 adults	Ballater	1st time

The "Analytical Framework" as proposed in Chapter 5 was adhered to in Stage 3 of the analysis with transcripts 'coded' in line with the four components of the Framework namely: risk; resources and capacities; connectedness and learning (Table 8.5). The process of 'open coding' followed, where new or unique sub-components (child nodes) were allowed to emerge. The coding was largely consistent with the findings from Chapter 7, however variances were evident in terms of the coding weighting and interaction between indicators (Section 8.5.3).

Table 8.5 Stage 3: Coding framework of component 'nodes'.

Aberdeenshire (C) Stage 1-2 categorisation		
Name	Sources	References
Risk	19	24
Resources and Capaciti	15	26
Connectedness	16	21
Learning	27	33

Stage 4 involves the process of 'Charting' indicator data within a pre-defined spreadsheet as outlined in Chapter 6. Word frequency searches were run in NVivo to ensure that no key indicator themes were overlooked. Whilst descriptive in nature, the resulting 'clustering (tree) diagrams' (Figure 8.6a-d) acted as a starting point to assist the synthesis of indicators into a more manageable scale.

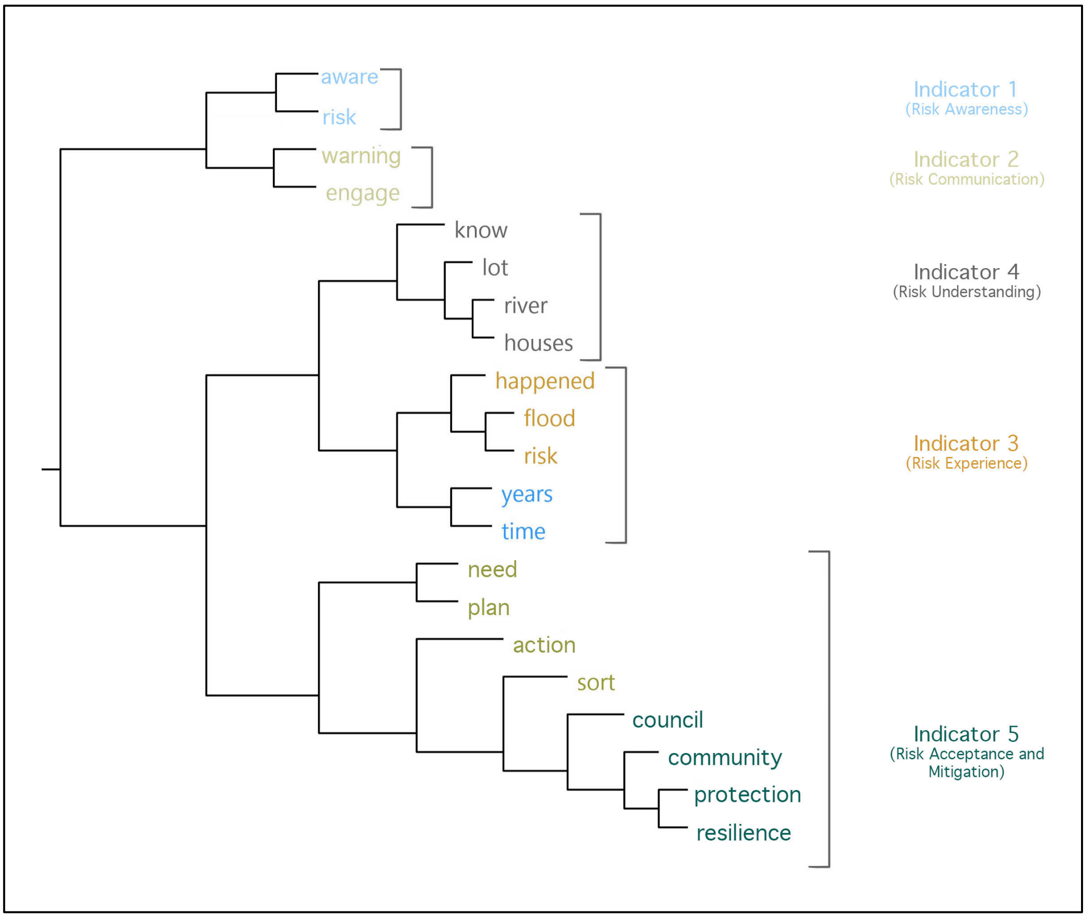

Figure 8.6a Stage 4: Process of charting the 'risk' component.

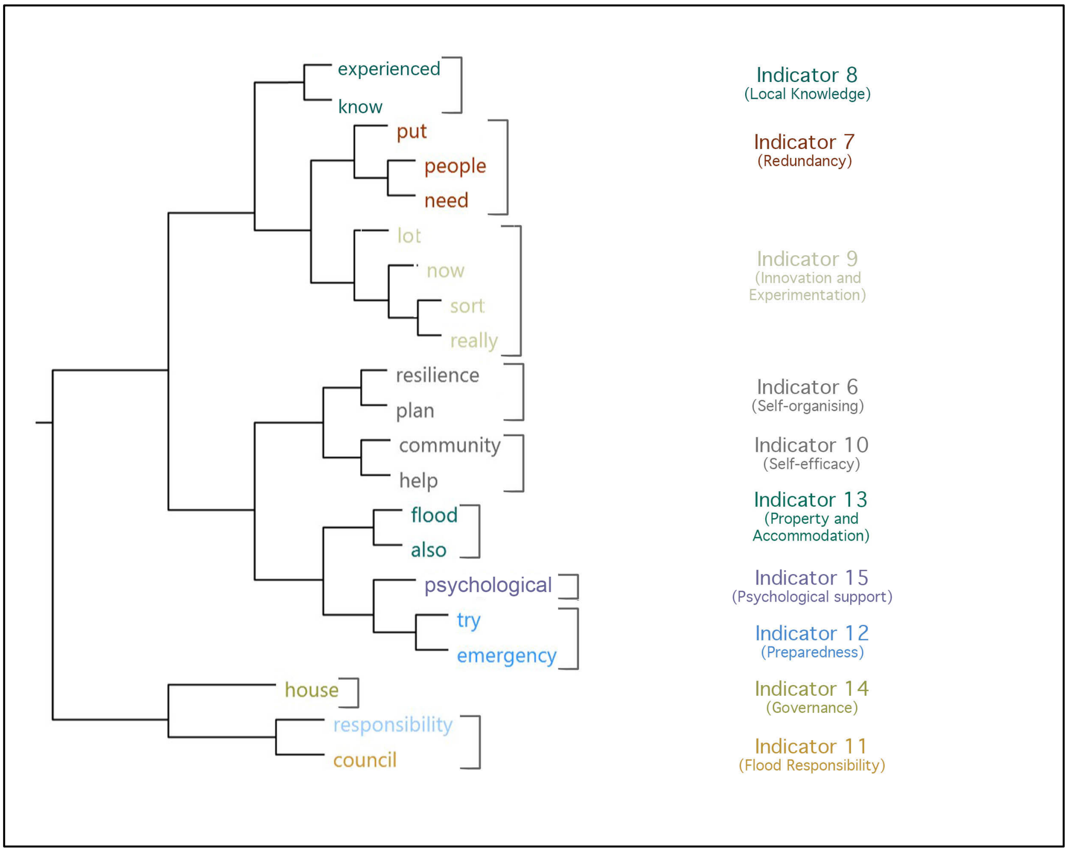

Figure 8.6b Stage 4: Process of charting the 'resources and capacity' component.

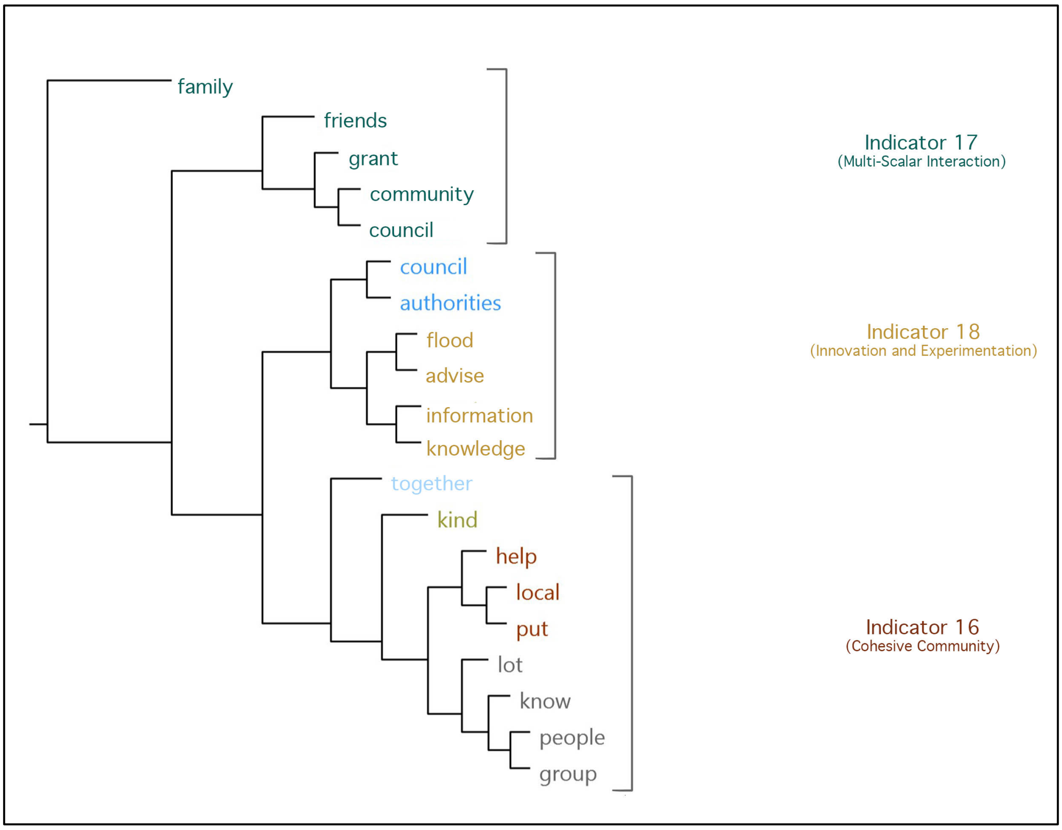

Figure 8.6c Stage 4: Process of charting the 'connectedness' component.

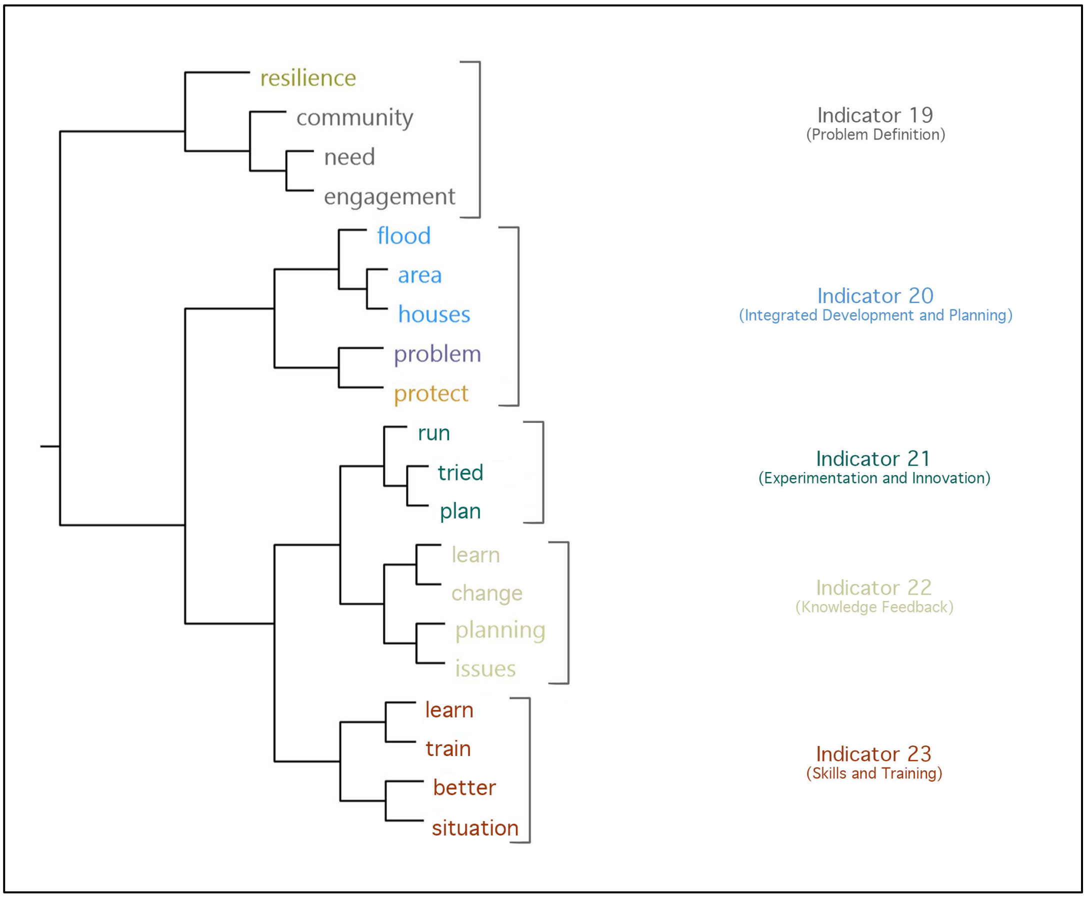

Figure 8.6d Stage 4: Process of charting the 'learning' component.

The final indicator output is compiled and presented in Stage 5 framework analysis or 'Indexing' (Table 8.6), as outlined in Chapter 7 (Section 7.5.3). In total 23 resilience indicators emerged from the North-East Scotland analysis that aligned with the the NI pilots and the Cumbria case-study. Whilst the weighting of indicators was found to present variances from the finding in the Cumbria context, the indicator labels were transferable, though one exception was the inclusion of 'Psychological support' (Indicator 15), which emerged strongly in the North-East Scotland interview discourse, particularly among the elderly.

Table 8.6 Comparison of indicator allocation for Northern Ireland pilot and Cumbrian case-studies (refinement of indicators is highlighted in bold).

Northern Ireland Pilot Study	**Cumbria**	**North-East Scotland**
Risk awareness		
1.Risk awareness	1. Risk awareness	1. Risk awareness
2. Risk communication	2.Risk experience	2.Risk experience
3. Risk acceptance and mitigation	3.Risk communication	3.Risk communication
4. Risk experience	**4. Risk understanding**	4. Risk understanding
5. Risk Knowledge	5. Risk acceptance and mitigation	5. Risk acceptance and mitigation
Resources and Capacities		
6. Self organising	6. Self organising	6. Self organising
7. Capacity building/upskilling	**7. Redundancy**	7. Redundancy
8. Insurance	**8. Local knowledge**	8. Local knowledge
9. Collaboration	9. Resourcefulness	9. Resourcefulness
10.Innovation	10. Self-efficacy	10. Self-efficacy
11. Self-efficacy	11. Flood responsibility	11. Flood responsibility
12. Flood responsibility	**12. Preparedness**	12. Preparedness
	13. Property	13. Property
	14. Governance	14. Governance
		15. Psychological support
Connectedness		
13. Social capital	**15. Cohesive community**	16. Cohesive community
14. Integration of Social networks	**16. Multi-scalar interaction**	17. Multi-scalar interaction
15. Sense of belonging	17. Higher-level trust	18. Higher-level trust
16. Higher-level trust		
Learning		
17. Problem definition	**18. Analytical thinking**	19. Analytical thinking
18. Critical Reflection	**19. Integrated development planning**	20. Integrated development planning
19. Experimentation	20. Experimentation	21. Experimentation
20. Transfer of (local) knowledge	**21. Knowledge feedback and review**	22. Knowledge feedback and review
21. Monitor and review	**22.Skills and training**	23.Skills and training

Figure 8.7 illustrates the even distribution of codes across the four key Framework components from the North-East Scotland case-study. In contrast to the Cumbrian results, the ‘Learning’ component was more pronounced, potentially as a consequence of the reflective nature of the interview discourse 18 months after the event. Further, it was found that ‘Risk’ was not as heavily coded, which may be attributed to the low awareness levels across North-East Scotland as a consequence of the high number of first time flood victims (58%).

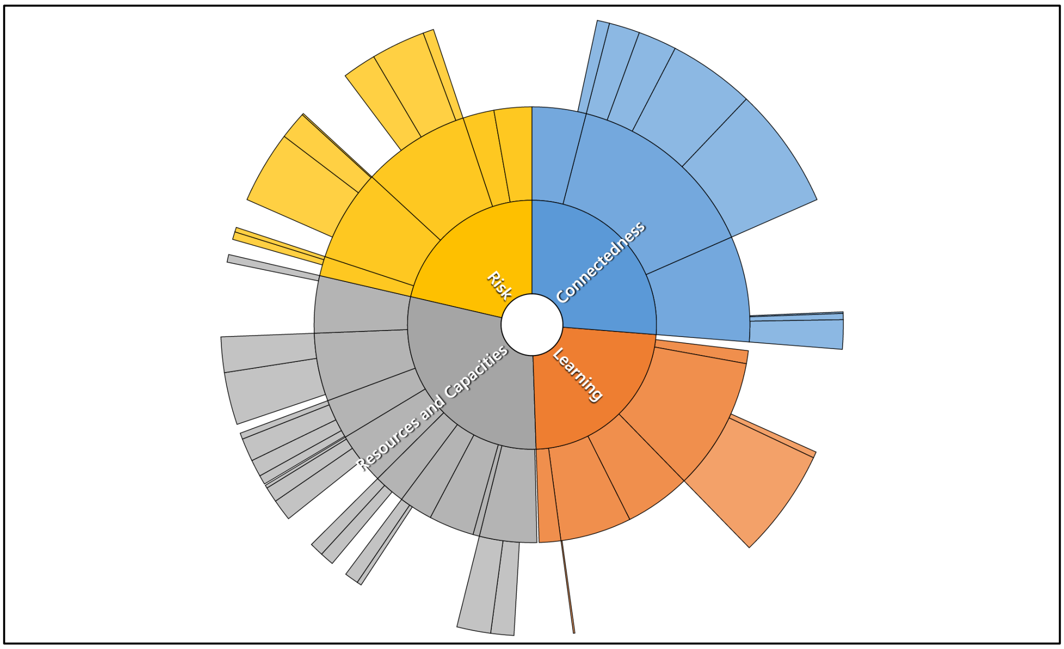

Figure 8.7 NVivo hierarchy visualisation of coded component ‘nodes’.

8.5.4 Risk Indicators

In Chapter 7 the complex relationship between risk awareness and mitigative resilience action was discussed. Consistent with the approach taken in both Chapters 6 and 7, knowledge of flood maps was used as a proxy indicator for ‘risk awareness’ (Indicator 1). The interview data revealed that 76% of first time flood victims were unaware of their proximity to or location within a flood zone. This observation supports findings from Chapter 7 that first time flood victims are unaware of their risk: *“I thought to myself at the time (of the floods) this area doesn’t flood. I wasn’t worried…I am now”* (A7).

In seeking to confirm this finding, a matrix query was run in Nvivo to isolate ‘flood experience’ case profiles enabling comparison between ‘risk experience’ case categories and the indicator node ‘risk awareness’ (Indicator 1). Figure 8.8

illustrates greater prominence in risk indicators amongst those with '3 or more times' experience and illustrates comparatively lower risk awareness amongst the first and second time flood victims.

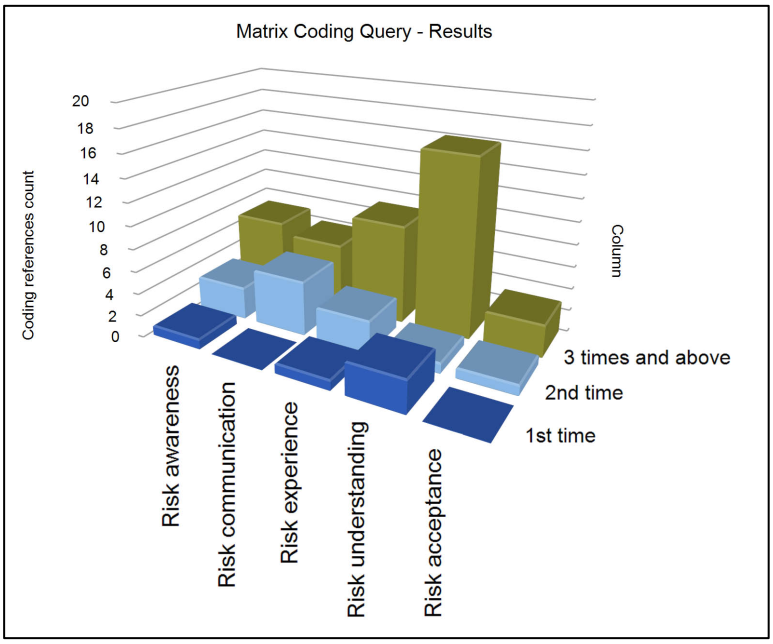

Figure 8.8 NVivo matrix: low risk awareness among first time flood victims.

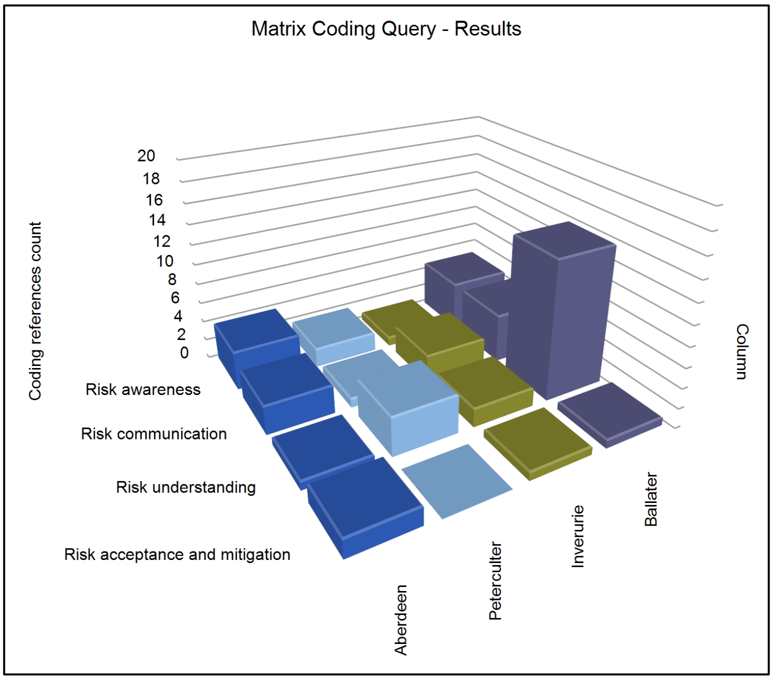

Figure 8.9 NVivo matrix: relationship between risk indicators across the four case-study communities.

Correlation between ‘risk awareness’ and ‘preparedness’ was evidenced in the Cumbrian case-study with those communities with higher awareness tending to have community disaster plans in place (Section 7.6). However, in North-East Scotland, Peterculter was the only community with an existing resilience plan in place, although Ballater had one in draft format. Figure 8.9 illustrates how these two communities demonstrated higher ‘preparedness’ as a consequence of ‘risk understanding’. In contrast, (with the exception of Peterculter), Aberdeen showed a reliance on authorities, revealing a situation where resilience activities were driven by the authorities and emergency services: *“The police came and told us to evacuate. They told some people to move their cars to higher ground. I’m not sure I’d have known what to do otherwise*” (A3).

Table 8.7 Indicator 1, Risk Awareness.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
1. Risk Awareness	Awareness of hazard risk information and exposure	_Awareness of whether property lies within a risk risk zone as indicated on a flood map _Existence of disaster management plan	Semi-structured interview	Positive	Individual, community

‘Risk experience’ (Indicator 2) from recurrent floods was found to contribute to greater risk acceptance in Chapter 7. In the North-East Scotland case-studies, communities flooded on a recurrent basis were found to implement greater property protection measures and also tended to be members of a resilience group.

“We flooded back in 2012 and to be honest I just accepted it as a freak event. Now that I’ve been flooded twice I need to think about this seriously. That’s why I’ve done all that I can (resilience measures). It was a considerable investment but it’s worth it knowing that I have done what I can to protect my home” (B13).

Relative to Cumbria (Chapter 7), risk experience was lower with 37 of 46 interviewees across the North-East Scotland case-studies first time flood victims. Whilst this experience prompted many to take resilience action, others adopted the attitude that this was an: *“Unprecedented event…you just need to accept it as one of those things…bad luck, and move on from it” (B11).*

In particular, a reluctance to accept risk was most prevalent in Aberdeen, where commercial rather than residential properties were most affected. A manager of a large commercial premises stated:

"It's never happened before and it more than likely won't happen again in my lifetime. Personally it didn't really affect me…I still had my job at the end of the day. We were back in operation within two weeks….We haven't taken any preventative steps. It's a case of we will deal with it at the time should it ever happen again"' (A6).

The evidence suggests that a lack of disruption to personal life reduces the likelihood to take mitigative action. On the whole the 'risk experience' indicator findings reaffirm that risk acceptance is potentially dependent upon the level of risk experience, however as noted, exceptions (lack of personal attachment) do exist.

Table 8.8 Indicator 2, Risk Experience.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
2.Risk Experience	Active flood memory-previous hazard experience leading to mitigative action.	_Knowledge and experience of past flood events	Semi-structured interview	Positive and Negative	Individual, community

The percentage of people signed up to the SEPA flood alert system was used as a proxy for 'Risk communication' (indicator 3). While the majority of communities in Aberdeen were signed up to the system, many misunderstood the alert warning system. One resident in Ballater explained the confusion and difficulties encountered with the system:

"Yes I get the warnings. But they don't make it clear what is the difference between a warning and an alert. Should I come home early from work or a weekend away if there is a warning?" (B16).

Further, residents expressed dissatisfaction over the extent of geographical detail attached to the warnings:

"I'm getting the same warning as someone in Moray…that's over 80 miles away. Can you imagine if they did that further south? That would be like sending the same flood warning for Edinburgh, Glasgow and Dundee. Well you can imagine the chaos that would cause" (I20).

Consistent with evidence from Cumbria (Chapter 7), one resident reaffirmed the value of multiple forms of risk communication:

"Yes, we get the flood warnings but it's hard to know how accurate they are. You often get warnings and then nothing happens. You get a better idea by looking at the river and there would be talk on the street too if we ever thought something was about to happen…. I knocked on the neighbours door to warn them" (B15).

By contrast, urban Aberdeen relied on social media, rather than word of mouth and local knowledge, commonly found with smaller close-knit communities:

"I was checking Fubar (Social media news page) for updates and that's when I started ringing the council for sandbags. People were forwarding me the alerts on Facebook and asking me if I was okay" (A5).

The evidence from North-East Scotland supports findings from Cumbria that a bespoke communication plan is necessary for each specific community. More rural communities relied on local knowledge and word of mouth. Conversely, fragmented urban areas relied on social media for risk informing. All four North-East Scotland case-studies expressed criticism that the flood warnings lacked specificity and frequently caused needless concern.

Table 8.9 Indicator 3, Risk Communication.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
3. Risk Communication	Existence of Early warning system	_Signed up to EA flood alert _River guage	Semi-structured interview	Positive	Individual, community

The Cumbrian findings suggested a potential correlation between 'risk understanding' (Indicator 4) and subsequent 'risk acceptance and mitigation' (Indicator 5). The Ballater case-study supports this finding, revealing that increased risk understanding led to greater risk acceptance and subsequent mitigative action.

However, evidence from Peterculter revealed how a low level of 'risk acceptance and mitigation' was the consequence of an unwillingness to accept risk. A local Resilience Group member explained:

"There are a few that view this resilience protection as scaremongering. Underneath it all is a fear that if we acknowledge our risk and put in flood doors or whatever then we will have issues selling our house" (C 26).

In this vein, Figure 8.14 illustrates contrasting levels of 'risk understanding' between the more established communities of Ballater and Peterculter suburb, and the more transient nature of parts of Aberdeen city. In addition, the above quote highlights the complexity attached to risk acceptance, as outside forces (perceived loss in property values) can potentially impede a community's ability to take mitigative action.

Table 8.10 Indicator 4, Risk Understanding.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
4. Risk Understanding	Knowledge and understanding of the extent of risk and cause of flooding	_Monitor and review flood risk _Utilising local knowledge _Critical thinking toward proposing risk solutions	Semi-structured interview	Positive	Individual, community

The above evidence illustrates that acceptance of risk as a by-product of risk understanding (Indicator 4) is not a certainty. Reaffirming findings from Cumbria, the overall evidence suggests a positive relationship between increased risk awareness (Indicator 1) and understanding (Indicator 4) as catalysts for 'risk mitigation and acceptance' (Indicator 5).

Evidence of 'risk acceptance' (Indicator 5) was visible through the establishment of flood resilience groups (both Peterculter and Ballater have resilience groups). However, in the case of Ballater it took a serious flood event to reignite the dormant group. Evidence of mitigative action within the groups included: "*Checking the gulleys and drains"* (B 11); "Monitoring river levels" (P35); *"Dry run of resilience plans"* (B12); *"Pushing for further research into what has happened"* (B15) and the promotion and education of the benefits of property level protection (PLP).

Flooding of properties was historically perceived as the responsibility of the local authorities. However, clearer understanding of the roles and responsibilities in FRM prompted communities to take control of their own flood risk. On the back of this understanding, Inverurie and Ballater established flood groups, and Peterculter continued to operate its existing flood group. No such group formed in Aberdeen which may be attributed to the low community cohesion associated with transient urban areas and that the properties flooded were largely commercial causing less personal disruption.

Table 8.11 Indicator 5, Risk Acceptance.

Indicator	Indicator description	Method of assessment	Empirical	Impact on resilience	Scale
5.Risk Acceptance/ Mitigation	Acceptance of risk and adjusting mitigative action appropriately	_Existing and practiced resileince plan _Member of FAG _Implementation of PLP _Current flood risk mapping _Community resileince initiatives _Flood risk maintenance	Semi-structured interview/ Observation	Positive	Individual, community
(Practitioner level)		_Commitment of long-term proactive funding for Flood Risk Reduction _Acknowledging increasing risk with updated codes,standards and enforcement.	Semi-structured interview	Positive	Community

The evidence from the North-East Scotland case-study corroborates evidence from Cumbria suggesting that an understanding of the multi-faceted nature of 'Risk' is the first step in any resilience strategy. However, the current risk communication strategy offered through SEPA was flagged as an impediment to resilience preparedness and indeed the lack of specificity caused many residents to ignore its warning. In support of the Cumbrian findings, the North-East Scotland evidence makes the case for a bespoke approach to risk-informing including a portfolio of communication channels (social media, text, email, word of mouth). Integral to this approach is an understanding that communities are not homogenous and a 'one size fit all' approach is not appropriate.

8.5.5 Resources and capacities indicators

The following section outlines the factors and processes used to assist communities to develop and engage with resources. As shown in Chapter 7, the extent of resource mobilisation can potentially expedite a community's recovery back to normality. Supporting the findings from Cumbria, communities with an existing resilience group were found to exhibit the highest level of 'self-organisation' (Indicator 6). A resilience group member in Ballater explained the rationale behind establishing a resilience group:

"We had a group in its raw form after a previous flood scare. However, the recent floods prompted us to formalise the resilience plan and activate the group…. With a firmed up plan, assigned roles with the group …(and) communication with the authorities….I think it is fair to say we are in a much better place" (B 13).

Further, Inverurie interviewees commented that creating the "Inverurie and Garioch flood support group galvanised connections in the town and facilitated the community to *"co-ordinate itself in a more effective way"* (I21).

Table 8.12 Indicator 6, Self organising.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
6. Self organising	Capacity of community to self organise	Establishing of Community Resilience Group/organisational reform	Semi-structured interview	Positive	Individual, community

The findings from Cumbria highlighted the need for four types of redundancy within a resilient system. Reinforcing these findings, North-East Scotland also revealed the need for redundancy in terms of: (1) access to specialist equipment; (2) stable and diverse economy; (3) risk transfer (insurance); and (4) access to public buildings. Firstly, it was found that access to equipment, such as vehicles for evacuation, was critical to the survival of some residents. An interviewee in Ballater commented: *"An elderly man who is deaf and blind in one eye had to be evacuated by sitting in the bucket of a local mans digger" (B14).*

Secondly, the temporary closure of many businesses significantly impacted the local economy through loss of sales and jobs. In response, the Ballater Business Group identified the need for a business resilience plan and for businesses to be part of the overall community resilience plan:

"Small businesses are critical to the sustainability of a community. Why is business treated as a dirty word sometimes? Businesses offer jobs to the community, attract tourists and need to be part of the community. Yes, some have closed and will not reopen. Others have had to adapt….selling books online when the shop was closed for business…. The bakery operated out of a pop-up van outside the shop (B15).

In addition, the crash of the oil and gas industry further compounded the adversity faced by many:

"I was left with my passport and the wet clothes I was wearing. That's all I had…. I lost my job a year ago during the oil crash. I really struggled to rent temporary accommodation as I couldn't get the money for a deposit together" (I20).

Thirdly, reinforcing evidence from Cumbria, insurance also emerged as a positive form of resilience through risk transfer. *"Thankfully we had insurance….I'm not sure how we would have coped otherwise"* (A6).

Fourthly, the need for a rest centre serving as a central hub for recovery organisation was highlighted at both the community and practitioner level. *"People gravitated towards the village hall"* in Ballater as it was *"Known as the central point for community activities"* (B13). Emergency accommodation was also offered in the "*army barracks for those who were evacuated. With the roads closed people had nowhere to go to and that resource was most needed". (B12).* In addition, donated funds were used to:

"Upgrade the village hall with internet, laptop, sleeping bags, kettles...allowing people to cope better should there be a crisis of any form" (B14).

Table 8.13 Indicator 7, Redundancy.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
7. Redundancy	Insurance as a risk transfer resource_ _Extra capacity to allow for flexible and adaptable resources _ Availability and access to specialist recovery equipment_ Balanced spread of economic industries	_Access to tractors, 4x4 vehicles,diggers, machinery. _Savings _Local Emergency shelter, centre _Diverse employment opportunites _Business resilience Continutity plan	Semi-structured interview/ observation	Positive	community

'Local knowledge' (Indicator 8) was evidenced as playing a critical role in warning and informing across North-East Scotland. Particularly at the village scale residents commented they *"knew by the look of the river that something bad was going to happen"* (B9). Word of mouth informed residents to be ready to evacuate: *"I phoned the neighbours and knocked on doors to let people know there was a risk of flooding" (B2).* In addition, those most at risk (elderly, disabled) were evacuated as a priority once locals informed emergency services: *"I knew the old man lived on his own and was partially deaf …so I let the police know and he was evacuated early on" (B2).*

Echoing evidence from Cumbria, it was found that local knowledge informed objections to inappropriate planning applications: *"It makes no sense to build there. We had to object. Poor planning is what has those poor people flooded" (C28).*

Table 8.14 Indicator 8, Local Knowledge.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
8.Local knowledge	Understading of the importance of local knowledge	_Object to inappropriate planning applications _Awareness of river behaviour and levels	Semi-structured interview/ observation	Positive	community

Evidence from Cumbria outlined the role innovation and 'resourcefulness' (Indicator 9) played in building transformational resilience. It was revealed that greater 'risk experience' led to an apparent increase in innovative and resourceful action. Figure 8.10 illustrates how increased exposure to flooding (3 times and above) in North-East Scotland demonstrated greater evidence of innovative and resourceful actions.

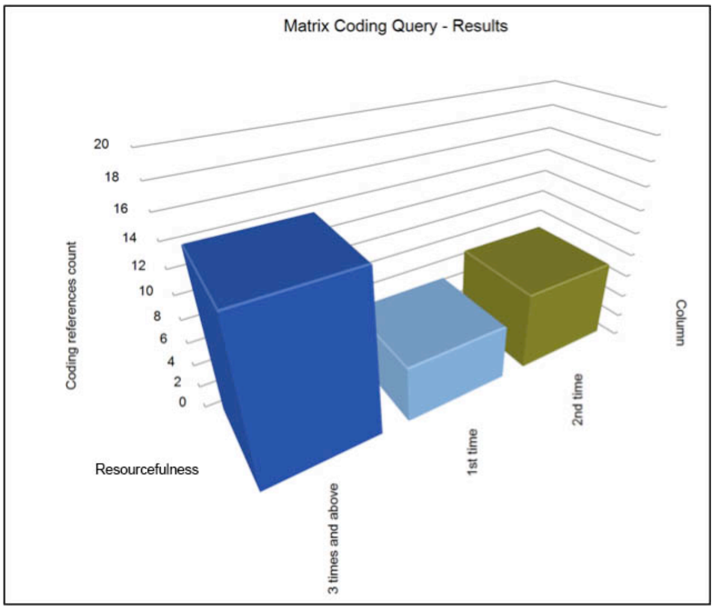

Figure 8.10 NVivo matrix: ‘risk experience’ on “Resourcefulness” across North-East Scotland communities.

All communities revealed some evidence of an attempt to protect properties with PLP to *“protect our investment” (I2).* However, as mentioned earlier, a fear of depreciated property values impeded residents in Peterculter from implementing these actions. Further, the £1500 contribution by the Government fell short of the funds needed to implement adequate PLP and coupled with the financial impact of the oil crisis, left some residents in Ballater to comment:

“PLP is not our priority right now. £1500 only touches the surface… They got £5000 in England... we still got the same amount of water through our living room. At the moment we are just focused on getting the house back together and putting food on the table...resilience will have to wait” (I18).

Proactive warning and informing at the local level, through *“door knocking”* (B3), *“facebook message” (*A6) and *“talk on the street”* (B4), prompted interviewees to take preventative measures. A resident in Peterculter commented:

“We moved our cars to higher ground and then we tried to move as much stuff upstairs as possible. It’s a three storey house so there was space to do that but we lost a lot in the garage” (C27).

Post flood, many communities have taken PLP measures where finances allowed: *“We used the £1500 from the council to cover air vents and a flood gate. When funds allows we will try and do more” (B10*). Another group of residents came together to raise the stone wall outside their properties which sat on the river bank: *"Yes, it cost us £1400 each but we were happy to pay it to protect our homes" (B13).*

A further resident in Ballater who was used to working with boats made his own flood door protection with wood and mastic glue:

"My wife came back from the hairdressers saying the village was about to flood. After years working on boats you learn ways of keeping water out of places it shouldn't be. I fashioned a flood door of sorts with wood and mastic glue and it actually worked" (B16).

The use of social media was seen to inform potential flood risk but also served to expedite the recovery process by efficiently matching resources and capacities almost instantaneously online. Facebook pages such as "Fubar', "Hope floats' and 'Inverurie and Garioch Flood Support Group" served as a catalyst for impromptu recovery actions. The founder of the 'Inverurie and Garioch Flood Support Page' commented:

"There was nothing there…we needed a way of communicating the help and support that was out there. After it (the Facebook page) was set up it just took off. We were getting donations from right across the country, it was incredible. Volunteers were reading the situation online and then turning up to support. When we put out a request, for example, for a sofa or a man with a van, we would get an offer in seconds sometimes. The page filled a gap that no authorities or council….were filling" (I19).

Resourcefulness was evidenced in Ballater through the use of diggers by locals as a means of evacuation transport: *" We would have liked a more orthodox method of evacuation but it came down to saving lives….the emergency services were inundated" (B13).*

Aligned with the Cumbrian findings, there was an apparent acknowledgement that flood defences were not the only approach to FRM. The process of developing resilience plans led communities to appreciate the need for a portfolio of solutions. However, this sentiment was not shared by all. The pressure group- 'Ballater Flood group' was established as a separate entity to the 'Ballater Resilience Group'. Its intention was to gain further information on flood risk and hold the authorities to account. By contrast, the 'Ballater Resilience Group' was set up collaboratively with the authorities and emergency services, thus adding an extra layer of resilience to the community. Initiatives included dry runs of the newly updated resilience plan with the approval of emergency services: *"delivery of laminated household flood plans to each household"; "creation of an up to date register of at risk residents" and the "organisation of a new rest centre" (B 13).*

Table 8.15 Indicator 9, Resourcefulness

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
9.Resourcefulness	Proactive actions in response to risk	_Implementaiton of PLP _Evidence of calibration of risk to proactive resilience actions	Semi-structured interviews/Observation	Positive	Individual, Community

Consistent with findings from Cumbria, it was found that a belief in a community's own potential to reduce risk is a critical component of community resilience. 'Self-efficacy' (Indicator 10) was demonstrated through membership a of resilience group, enabling communities to play an active part in preparedness and recovery operations. Speaking of the role of the community in multi-scalar resilience group collaboration, a Ballater resilience group member described how they: *"Developed the resilience plan together with the help of emergency services and the authorities".* Clear allocation of roles and responsibilities informed the community as to *"when to step in and when to step out during a flood*", empowering the community to feel *"more prepared should we get flooded again this winter"* (B13).

In line with the findings from Cumbria, the above quotes illustrate the potential of Resilience Groups to galvanise a community's potential to contribute to resilience action.

Table 8.16 Indicator 10, Self efficacy.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
10.Self efficacy	Empowerment and self belief in resileince capabilities	_Membership of Resilience Group/FAG	Semi-structured interview	Positive	Individual, community

The Cumbrian findings indicated a relationship between 'flood responsibility' (Indicator 11) and 'flood experience' (Indicator 2). To help compare these findings in a North-East Scotland context, a matrix query was run to isolate the node 'flood responsibility', thus allowing for comparison against 'flood experience'. The analysis substantiates evidence from Cumbria suggesting that flood responsibility increases as a consequence of flood experience (Figure 8.11) with flood responsibility greatest amongst those who were flooded three times or more. By contrast, those flooded for the first time demonstrated low uptake of flood responsibility.

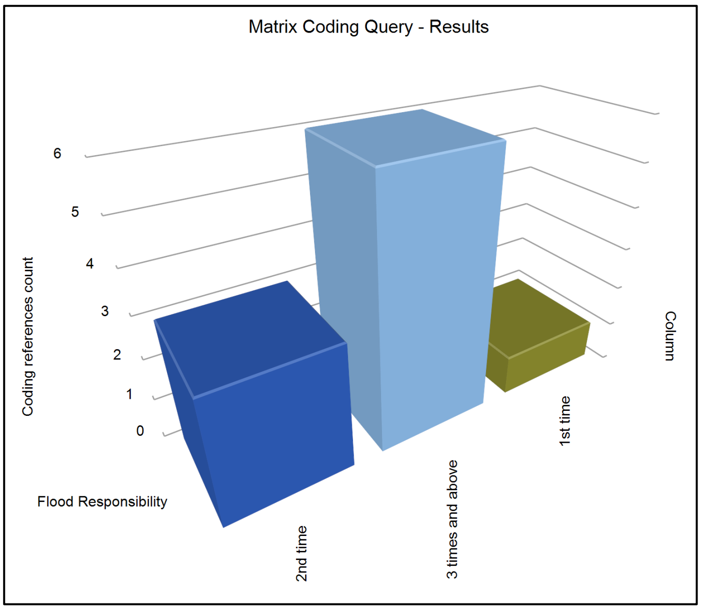

Figure 8.11 Matrix coding: influence of time living in an area on the resilience indicator 'Flood responsibility'.

A strong relationship was found between 'time spent in the community' (case profile) and subsequent acceptance of 'flood responsibility' in North-East Scotland. Corroborating evidence from Cumbria, Figure 8.12 clearly illustrates that flood responsibility increases with time spent in the community. A long-time resident in Ballater commented: *"I've grown up here. I'm not going to move at this stage am I? I need to protect my home" (*B14). By contrast, a tenant in Aberdeen remarked: "*We've been in the area a year now…it's the landlord's job to protect the property. If it were to happen again we would just move". (A7).*

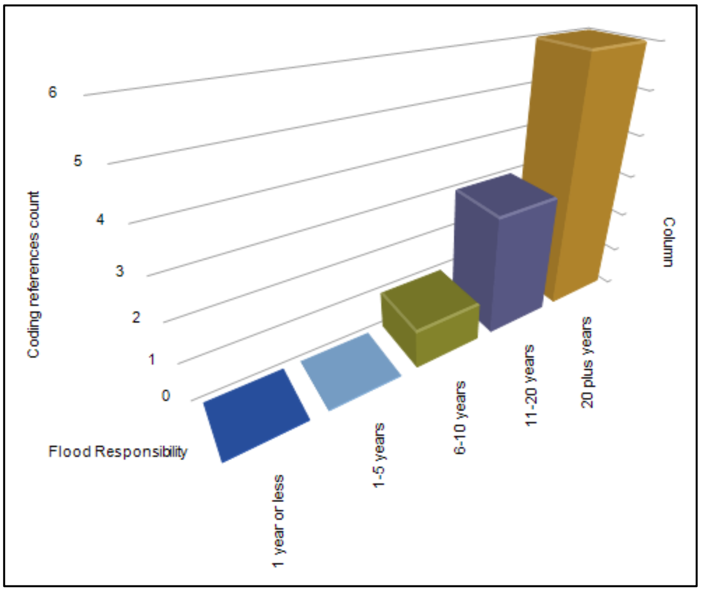

Figure 8.12 Matrix coding: influence of time living in an area on the resilience indicator 'Flood responsibility'.

Consistent with findings from Cumbria, it was noted that increased flood responsibility was exhibited through a *"need to protect my investment"* (C29) by implementing PLP and taking out insurance for *"financial piece of mind"* (I21). Further, flood risk awareness through monitoring and alerts also emerged as an indicator of flood responsibility: *"The SEPA text message is too vague. When I see it (water) inching up the stone wall there I know it could get bad (local knowledge)"* (B10).

Table 8.17 Indicator 11, Flood Responsibility.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
11. Flood responsibility	Personal flood mitigation actions	_Installing property level protection, insurance, signed up to early warning.	Semi-structured interview	Positive	Individual

Closely linked to 'flood responsibility' was 'preparedness' (Indicator 12) and paralleling findings from Cumbria, it was found that resilience groups played a significant role in enhancing preparedness through the creation and practice of resilience plans. Further, personal household plans were found to advance preparedness levels at the household scale. One elderly lady, flooded for the third time, commented: *"I keep my prescription and insurance documents in a waterproof pouch in a backpack … together with a spare change of clothes….I can just grab it when I'm being given five minutes to evacuate" (B14).*

Table 8.18 Indicator 12, Preparedness.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
12.Preparedness	Evacuation protocol	_Recognised public buildings as energency centre and shelter _Evacuation protocol _Evacuation 'Grab bag'	Semi-structure	Positive	Individual, community

The upheaval associated with relocation during property renovations emerged as an impediment to community resilience:

"My parents in law were relocated to another town….they don't drive and it was hard to check on the house and builder. I think the hardest part for them was that we were away from their friends in the community… no support, isolated" (B16).

In addition, ambiguity over post-flood renovation standards was raised as an issue: *"Absolute cowboy builders….they ripped out things that didn't need to come out. They pulled out my radiators yet next door kept theirs" (B9).* Further complaints, surrounding the efficiency of building standards and knowledge of flood renovations, emerged from the interview discourse:

"That poor elderly couple still aren't back in. They've had about three building firms in and because they can't stand up to the builders… The property is covered in mould….the builders blocked the air vents with timber and carpets from the strip out and never came to take it away. The building couldn't breathe and now they are in a worse off state than before…there needs to be some protocol or standards that these builders should follow" (B15).

Also, in corroborating evidence from Cumbria, issues related to the implementation of PLP within conservation areas emerged as a frustration amongst residents in Ballater:

"You can't realistically tell us to be more resilient and then refuse to allow us to put in sympathetic flood doors. There is an element of common sense missing there and the council need to get organised and sort out the issue" (B13).

Table 8.19 Indicator 13, Property

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
13. Property	Standard and availabilty of property	_Uptake of property level protection _Provision of alternative accommodation	Semi-structured interview	Positive	Process

Findings from Cumbria made the case for a more long-term Government approach to FRM. The practitioner level in North-East Scotland supported this view stating: *"We are glad to get funding for each project but we would prefer to know the long-term plan for funding streams. There is a risk that each project we do is just a one off and that funds don't exist to replicate the project across the country…and that is the approach needed" (P36).*

Further, some communities feel that the Government and authorities are not calibrating the risk faced by each community with appropriate action. This perception led the newly formed 'Ballater Flood Group' to write a letter to the First Minister asking that the situation in Ballater be recognised as a national catastrophe: *"We exchanged over 5000 correspondence in the space of 18 months (with Government and authorities)…we needed them to accept that our community should be assigned priority status" (B14).*

The above example signifies a degree of responsiveness by the Government, to engage directly with the community and understand their situation. However, "the piecemeal" (P36) approach to funding streams identified at the practitioner level is not conducive to a stable and equitable country-wide approach to FRM. The evidence from North-East Scotland is consistent with the findings from Cumbria, namely that a more adaptive approach to policy has the potential to meet the changing demands imposed by an uncertain environment.

Table 8.20 Indicator 14, Governance.

Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
14. Governance	Flexible Governance	_Governance and policy adapting to changes in risk environment _Communitis lobby Government for change	Semi-structured interview	Positive	Process

‘Psychological support’ (Indicator 15) is a new indicator which did not present itself as strongly in the other two case-study areas. As a consequence of the aging population across North-East Scotland, it was found that the elderly population living alone were the demographic *“that felt it the most”* (B11). Affected residents in Inverurie commented *“You can see it on their faces….people have physically aged as a consequence of the flooding ordeal” (I18).* Those responsible for establishing the ‘Inverurie and Garrioch Flood Support group’ commented:

“There was a real need for a place for people to come and chat ...just release their issues. They may come in for cleaning products and leave three hours later after a cup of tea and a biscuit, a cry and chat with others in the same boat” (I19).

Table 8.21 Indicator 15, Psychological support.

Indicator	**Indicator description**	**Method of assessment**	**Empirical evidence**	**Effect on resilience**	**Scale**
15. Psychological support	Availability of emotional support	_Availability of a space to discuss the recovery process and seek advice and support	Semi-structured interview	Positive	Community

8.5.6 Connectedness indicators

Evidence from Cumbria highlighted the catalysing influence ‘cohesive communities’ (Indicator 16) can have on the efficient mobilisation of resources and capacities. In addition, it was revealed that ‘multi-scalar interaction’ (Indicator 17) and ‘higher-level trust’ (Indicator 18) in authorities, were integral to establishing vertical ties with authorities. In the case of North-East Scotland and reiterating findings from Cumbria, it was found that ‘cohesiveness’ (Indicator 16) was highest among rural communities, thus cohesion levels in the village of Ballater were greater than those at the urban scale as evidenced by Aberdeen (Figure 8.13). Interestingly, cohesion levels were also high in Peterculter, a suburb of Aberdeen, but not in Aberdeen city itself. As such, the boundary between urban (non-cohesive) and rural (cohesive) was not clear cut. The suburb of Peterculter stands as an example of an administratively titled urban city, which masks a village up until 2006 (Appendix 7.5.2). The high level of engagement and cohesiveness is arguably attributable to residual ‘village’ institutions such as the ‘Village Hall’ and ‘Cutter Mills Social Club’, which are the hub of community/village life. As such, the high level of engagement found in Peterculter rebuts any universal concept of 'non-community' within suburban areas. The presence of cohesive social networks within the former village shows the potential for communities to be traceable within the urban scale, in the form of a 'village within a city' (Gans, 1962). The example of Peterculter highlights that cohesive neighbourhoods are not restricted to rural areas; rather, they can potentially emerge within cities through a feeling of solidarity over common territory, shared interest or employment.

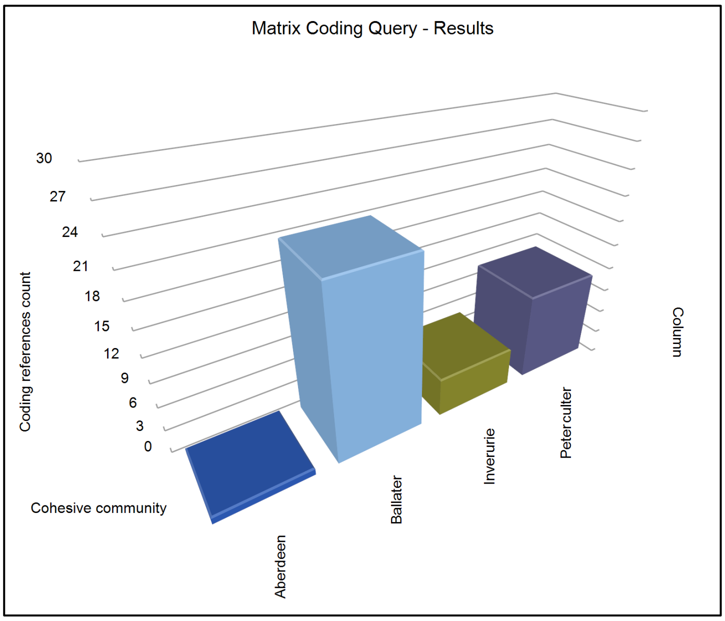

Figure 8.13 Matrix coding: cohesiveness evident at the different settlement scales.

Reaffirming the benefit of village institutions often associated with small scale villages, a member of the Ballater Resilience Group described the process of setting up a rest centre in a small village:

"People just sort of gravitated towards the village hall…they knew if there was help to be got it would happen there. You get a sense for these things in small villages" (B16).

Ballater Community Council lists 36 clubs within the small village, highlighting the cohesiveness of the community. Further examples of cohesiveness included voluntary community clean-up days to remove tonnes of stone and debris from the golf course. By contrast, Aberdeen city (excluding the suburb of Peterculter) mostly relied on social media for information and support:

"Friends were tagging me in news reports about the floods and asking if I was okay….It was through the Facebook page that I realised I was entitled to a grant from Foundation Scotland. I wouldn't have known otherwise to be honest" (A1).

Highlighting the lack of cohesion amongst transient urban areas (areas of high rental tenure), one tenant commented*: "If it were to happen again I'd just move. When it's not your property you're hardly going to stay and torture yourself with the hassle" (A6).*

Table 8.22 Indicator 16, Cohesive community

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
16.Cohesive community	Sense of belong within a community leading to participative action	_Number of social groups a community resident is a member of _Unwillingness to relocate after a flood __Place attachment (housing tenure) _Volunteer to clean up after a flood (Actively engaged)	Semi-structured interview	Positive and Negative	Individual, community

A key finding from the Cumbria Social Network Analysis (SNA) was the need for multi-scalar interaction to facilitate transformational resilience. It was found that resilience groups were integral to building 'bridging' and 'linking' ties. Likewise, in North-East Scotland resilience groups in Ballater and Peterculter served as a critical medium *for "Collaborative resilience building with communities (and authorities)"* (C23). A virtual community was established at the town scale in Inverurie to meet '*a support gap that the council was not offering" (I19).* The online community extended beyond the town of Inverurie to include other flood-affected areas across the Garioch area. Considering the wide geographical area it supported, an online network proved an effective means of connecting needs and capacities which otherwise would have remained untapped.

Figure 8.14 illustrates the higher linking capital amongst communities with physical resilience groups in place (Ballater, Peterculter), whilst linking capital in Aberdeen is presented as being high, it is important to note the nature of those relationships.

"I called the council for sandbags but once I'd done that it was really left up to them to control it" (A4).

The above comment suggests a lack of collaboration between the community and the authorities, indicating a reliance on the council for short-term action rather than long-term collaboration and engagement. The online Inverurie and Garioch Flood Support Group facilitated bridging ties in the town, however linking ties with authorities were not as prominent (Figure 8.14).

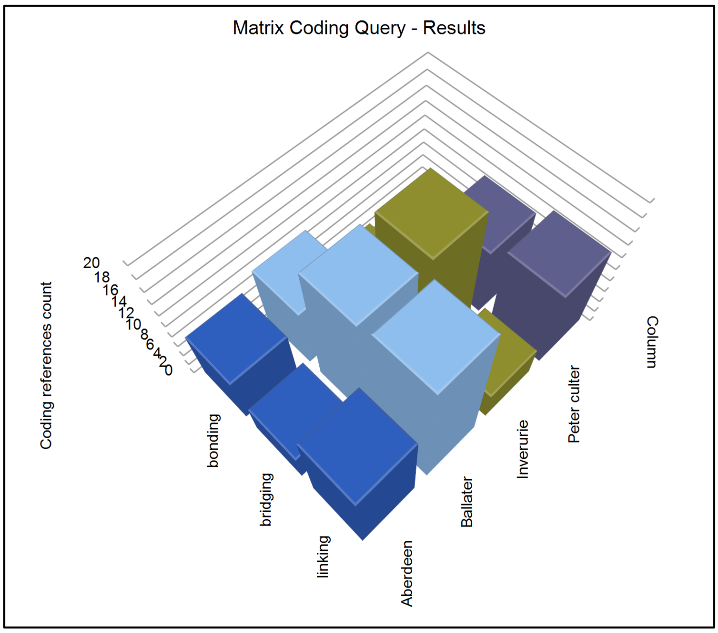

Figure 8.14 Matrix coding: multi-scalar action across the different settlement scales.

Further, the sustainability of resilience groups emerged as a concern, particularly in rural areas. Certain rural communities felt an onus to volunteer in order to *'keep the community afloat'* (B12). Highlighting the limited resource pool of volunteers, a resilience group member in Inverurie commented that it was *"The same faces"* (I21) at each community meeting, regardless of the purpose of the meeting. In a similar vein, a resident in Peterculter expressed concern over the sustainability of community groups who are heavily reliant upon elderly volunteers:

"At the moment a 70 year old man is ferrying people through the flooded streets in his 4x4. Do you think he will still be doing this in 5-10 years time?" (C27).

The above situations raise questions over the long-term sustainability of FAGs. Extant literature argues that passionate volunteers often ignore their own needs and end up with ‘Volunteer fatigue’ and burn-out (Jenkins and Baird, 2002; Cadieux, 2014).

Table 8.23 Indicator 17, Multi-scalar Interaction

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
17. Multi-scalar interaction	Effective communicatin through multi-scalar channels (bonding, bridging, linking)	_Support from a mix of bonding, bridging and linking sources. _Access to technical Advice (linking) _Colaborative support at local level (bonding) _ Emotional support (bonding) _Number of organisations and clubs in settlement _Membership of FAG	Semi-structured interview	Positive and Negative	Individual, community

The final connectedness indicator concerns the strength of relationships and collaboration between communities and authorities. The evidence suggests that an absence of higher-level engagement during the time between floods stands to erode trust in authorities*:*

“I think the council were caught completely off guard. They were totally unprepared….it’s no wonder really, we hadn’t seen them since the previous flood in 2012” (C27).

‘Higher-level trust’ (Indicator 18) was found to be highest in communities with an established communication structure in place, such as a local resilience group. They felt their *“Message is getting out there”* (B13) and that getting the *“Community council and the authorities around the table”* assisted the development of *“A good workable plan”* (B13).

The benefit of using the resilience group as a channel for multi-scalar interaction emerged from an interview with a council member, who described it as a *“robust”*

(P41) approach to communication between authorities and the community. Further he commented that residents in the FAG:

"Have my mobile number... I think it means a lot to them that they can contact me directly…it's more work for us admittedly but it's a successful joined-up approach" (P41).

Table 8.24 Indicator 18, Higher-level trust

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
18. Higher-level trust	Positive relationship with horizontal ties	Inclusion and liaise within Flood action Group activities (linking)	Semi-structured interview	Positive	Individual, community

8.5.7 Learning indicators

The learning component was evidenced in Cumbria as having a critical influence on positive transformational change. The analysis from North-East Scotland identified five indicators that are shown to assist transformational change. As discussed, the timing of the interviews almost 18 months after the flood event, was considered in this context to be more reflective in nature relative to Cumbria. 'Analytical thinking' (Indicator 19) emerged strongly in the interview discourse with affected communities presenting perceptions of the change needed ahead of the next potential flood, including: *"cleaning of the rivers" (B11); "improved flood warnings" (A6); "funding for PLP" (I19); and "reinstatement of bund (defence) walls" (B16).* In terms of recovery the community highlighted the need for a *"two way system" (C23)* of communication with authorities where the *"views of the community are taken into account" (P34).*

Reiterating findings from Cumbria, the practitioner level interview acknowledged a deficit in sustained engagement at the community level. A "lack of resources" (P33) to meet the needs of a large geographical area was attributed to this. However, improved engagement through resilience groups was put forward as a means to *"bridge the communication gap between authorities and the community"* (P42).

Table 8.25 Indicator 19, Analytical thinking.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
19.Analytical thinking	Reflective consideration of mitigative options based on past flood experience	_ Existence of a Flood Group to allow for reflection _Calibration of risk to community resilience plan	Semi-structured interview	Positive	Individual, community

In support of the findings from Cumbria, evidence of 'integrated planning and development' (Indicator 20) emerged strongly, due to development pressure driven by the oil and gas industry. Residents in Peterculter, as a commuter suburb of Aberdeen, thought that increased development demand had led to inappropriate development in flood plains:

"Yes we have a shortage of houses, as the 'oilies' want to live here and work in Aberdeen. I get that, but it is still not an excuse to build in a flood plain. Those houses at the old mill shouldn't have been built. Now look at them flooded" (C26).

In line with findings from Cumbria, it was found that local knowledge played a significant role in reducing development in flood plains by lodging objections to such development: *"I don't want to see history repeating itself like the flooding at Millside….houses should not be built in flood plains. Simple." (C27).*

The practitioner level also acknowledged the issue of development in flood plains and explained they *"worked closely with SEPA as a statutory consultee on all development in at-risk areas" (P38*). Referring to failings in the past the authorities commented that there is: *"A need to take account of future climate projections when granting application. Planning is a rigorous process and decisions can only be made with the information we have at the time….perhaps decisions struggle to keep pace with climate change" (P34).*

Table 8.26 Indicator 20, Integrated planning and development.

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
20. Integrated planning and development	Catchment wide approach to planning and development	_Consultation on planning process _Appropriate land-use planning _Stricter planning approval and enforcement	Semi-structured interview	Positive or negative	Individual, community

The Cumbrian findings identified examples of 'experimentation' (Indicator 21) through a combination of actions including: implementation of PLP; lobbying for policy change; acknowledgement of soft approaches to FRM. Further evidence from North-East Scotland highlighted that communities with low cohesion levels exhibited limited innovative and resourceful actions. In contrast, Ballater exhibited greater resilience innovation, which is largely attributable to the fact that cohesive communities are more likely to have a resilience group and are thus more conducive to experimentation and resilience action.

Table 8.27 Indicator 21, Experimentation

Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
21.Experimentation	Innovative Resilience actions that question the status quo and informed by lessons learned	_Policy change _Resileince strategies and plans _Soft approaches to flood risk reduction NFM _Build back better	Semi-structured interview/ observation	Positive	Community

The Cumbrian findings revealed how 'Knowledge feedback' (Indicator 22) facilitated the process of transforming lessons learned into positive resilient actions. Echoing evidence from Cumbria, a SEPA representative commented on advancements in communication strategies since the winter 2015 floods: *"Having a Resilience Group means we now have the ability to engage with the at-risk communities. They have a lot of knowledge, particularly in the more established, rural communities that we can tap into" (P41).* Reaffirming the value of local knowledge in relation to planning applications, a practitioner commented: *"As risk increases with climate change, flood maps need to be updated…. Scotland is a very rural area and many will tell you it is difficult to map everywhere. If a local objects and tells us a site historically flooded then we take this information seriously" (P 39).*

A notable finding from Cumbria was the lack of standards in flood renovation projects. Supporting this observation, evidence from North-East Scotland reaffirms the view that greater control and enforcement of newly established building codes is required: *"They put the house back together and then realised they hadn't sucked the water out from underneath the floorboards… The floor boards have to be ripped up now" (B9).*

Table 8.28 Indicator 22, Knowledge feedback

Sub-components	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
22.Knowledge feedback	Knowledge and information feedback and sharing _Feedback into risk awareness related actions	_Dissemination of results actions across stakeholders _Utilisation of local knowledge _Capacity/structure for feedback to be linked to risk awareness related actions	Semi-structured interview	Positive	Community

Thus knowledge feedback (as a consequence of lessons learned) can lead to positive resilience action, also and consistent with evidence from Cumbria, 'skills and training' (Indicator 23) were shown to expedite a community's recovery.

"Dry runs of the community resilience plan…meant we got to know everyone (authorities, emergency services)…..We learned a lot from the emergency services….they've been doing this for years and have a wealth of information for us novices" (B13).

The North-East Scotland interview discourse expressed an apparent acceptance that hard-engineering solutions are not the only solution and promoted the idea of natural flood management. A practitioner summed up the current attitude towards natural flood management stating:

"The public are very interested in NFM, particularly when there is an incentive like a grant for tree planting. That said, people were also quick to point the finger at the amount of debris in the river causing a backlog of water…there needs to be a greater understanding amongst the community of NFM but first we need the data. We need the data to show that it works, but we are not there yet unfortunately" (P36).

The above quote highlights an apparent acknowledgment also of the potential benefits of NFM. However, due to limited data in the field, it identifies a need for increased research and training on the potential benefits of NFM. A unique step that Scotland, and indeed North-East Scotland, has taken is to include resilience as part of the school curriculum:

"By educating the younger generation we are promoting awareness of extreme weather events, climate change and so on. Also we are encouraging students to be responsible citizens, resilient citizens…they are the future after all. They may even pass this information back to their parents at home" (P34).

This evidence suggests that a long-term approach to 'generational resilience' involving training and education from a young age is a fundamental step towards betterment for potential future floods.

Table 8.29 Indicator 23, Skills and training

Sub-components	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
23. Skills and training	Build capacity informed by past experience and integrate new knowledge	_Development of Business Resileince plans _First Aid training _Resileince plan dry run/tabletop exercises _Resilience training offered to Authorities and community leaders	Semi-structured interview and observation	Positive	Community

8.6 Social Network Analysis

The Cumbrian case-study demonstrated the potential for community social structures (physical) to expedite the flood recovery process. This section explores how wider social networks (physical and virtual) can enhance the mobilisation of resources and capacities. Data from the social media platform 'Facebook", together with interview discourse from a networking mapping exercise was analysed. Facebook data was 'mined'[42] to reveal wider, multi-scalar connections otherwise difficult to detect through interview discourse. Interview data informed network analysis of key 'brokers' or egos. The resulting network visualisation maps allow for analysis of network patterns and relations across case-study scales.

To this end, Social Network Analysis (SNA) was applied to (1) determine the structure of different support networks; (2) support findings from Cumbria (Chapter 7) that 'virtual' social networks facilitate the connectedness of disconnected communities; (3) explore findings from Cumbria on the valuable role resilience groups play in promoting multi-scalar interaction; and (4) provide ego-centric

[42] Data mining refers to the practice of analysing large pre-existing databases with the intention of revealing novel information.

analysis of key brokers facilitating multi-scalar interactions. It is anticipated that greater knowledge surrounding each of these four aims will inform how networks can positively influence the nature and level of resilience in a community.

8.6.1 Methods and application of SNA

Consistent with the approach taken in Chapter 7 (Section 7.6.2), a mixed methods approach was applied to fulfill the four aims of the SNA. Firstly, quantitative 'mined' data was analysed to determine the structure of existing support networks. Secondly, the quantitative (mined) data presented the opportunity to identify patterns of multi-scalar interactions in support and resilience groups through analysis of their visualised maps. Thirdly, qualitative analysis of interview discourse with key community members explored their role as brokers (ego-centric) in multi-scalar interactions.

8.6.2 Analysis of social network structure

The process of using the 'netvizz' application to 'mine' data from the social media platform 'Facebook' was outlined in detail in Chapter 7 (Section 7.6.2). Consistent with this approach, facebook pages were identified by searching for keywords in Netvizz, namely: 'Aberdeenshire', 'flood', 'Ballater', 'Inverurie', 'Aberdeen', 'Peterculter', 'Marr', 'Garioch' and 'Kintore'. Pages were selected based upon the number of members they held. Pages with the highest number of members representing the village, town and city scale were selected. 'Fubar news' served primarily as an information source for flooding across the Aberdeenshire commuter zone. The lack of a resilience group in Aberdeen city led this page to serve as a central point for connecting those in need with voluntary services and support, particularly in Aberdeen city. Whilst Inverurie is also located within the Aberdeenshire commuter zone, the town has an alternative flood support page. 'Inverurie and Garioch Flood Support' is a dedicated page set up directly after the winter floods (2015/2016) to offer support to Inverurie and its surrounds during the recovery process. 'Hope floats' represents flooded areas in Deeside where the worst affected village of Ballater is located. The three pages are presented in Table 8.30.

Table 8.30 Data sources representative of community groups within North-East Scotland (mined from Facebook)

Page ID	Name	Category	Members	Group/Page
402484413151679	Fubar News	Community	126416	Page
560443614110823	Inverurie and Garioch Flood Support	Community	1847	Page
1709854219245427	Hope floats- Deeside Flood Response Network	Cause	-	Group

8.6.3 Structural analysis findings

This section outlines the analysis of the 'mined' network data using the social network visualization software 'Gephi' (Chapter 7, Section 7.6.2). The mined data was sourced using 'Netvizz' software and presented in a .gdf (graph data format) file for further analysis and interpretation using the 'Gephi' software. Further detail on three 'mined' networks is set out in Table 8.31.The analysis included three structural measures. Firstly, a 'modularity' measure assessed the level of cohesiveness in a network, for example, by forming groups or communities. Secondly, a 'degree distribution' measure assessed the probability of connection across the network. Thirdly, the number of actual connections was assessed through a 'network density' measure. These measures are discussed in more detail opposite the visualised maps in the following section.

Table 8.31 Structural findings for community networks in Aberdeen, Peterculter, Inverurie and Ballater.

Community group/page	Nodes	Edges	Active Communities	Modularity Centrality	Degree Distribut-ion	Network Density
Fubar News	13583	16571	17	0.561	1.220	0.007
Inverurie and Garioch Flood Support	253	363	20	0.584	1.435	0.011
Hope floats- Deeside Flood Response Network	1549	819	30	0.513	1.891	0.018

8.6.4.1 SNA at the city scale

The results for "Fubar" (used as a proxy for Aberdeen city) revealed a 'sparse' network density of 0.007. As such, it was found that the ratio of the number of edges over the number of possible edges was comparatively low. This result is indicative of a community with a low network density, reliant on a key member or 'broker' to bridge connections. In the example of 'Fubar news', the administrator holds 87.21% of connections within the network (Figure 8.15). This is attributed to the fact that the site serves as a noticeboard for warning and informing on pertinent news items such as flooding. Triangulating this evidence, Figure 8.15 presents a colour coded spatial visualisation of the network using the 'degree centrality' metric to highlight key brokers. Key brokers with greater influence on connections are represented by larger nodes on the visualised map.

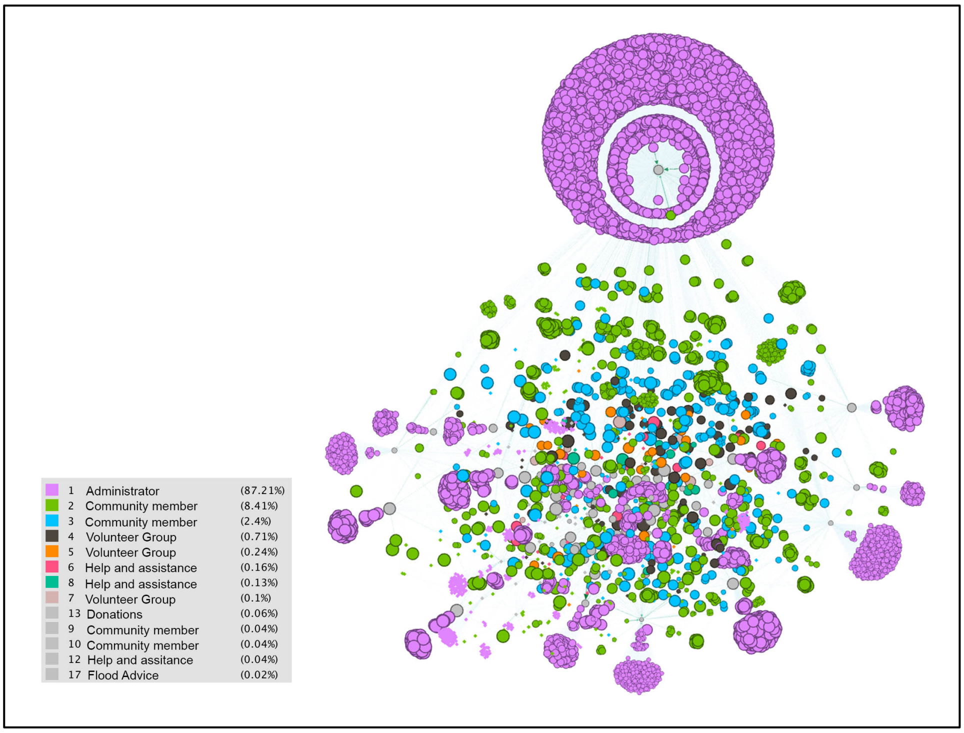

Figure 8.15 Gephi social network visualisation of "Fubar News". Visual representation using Force Atlas algorithm.

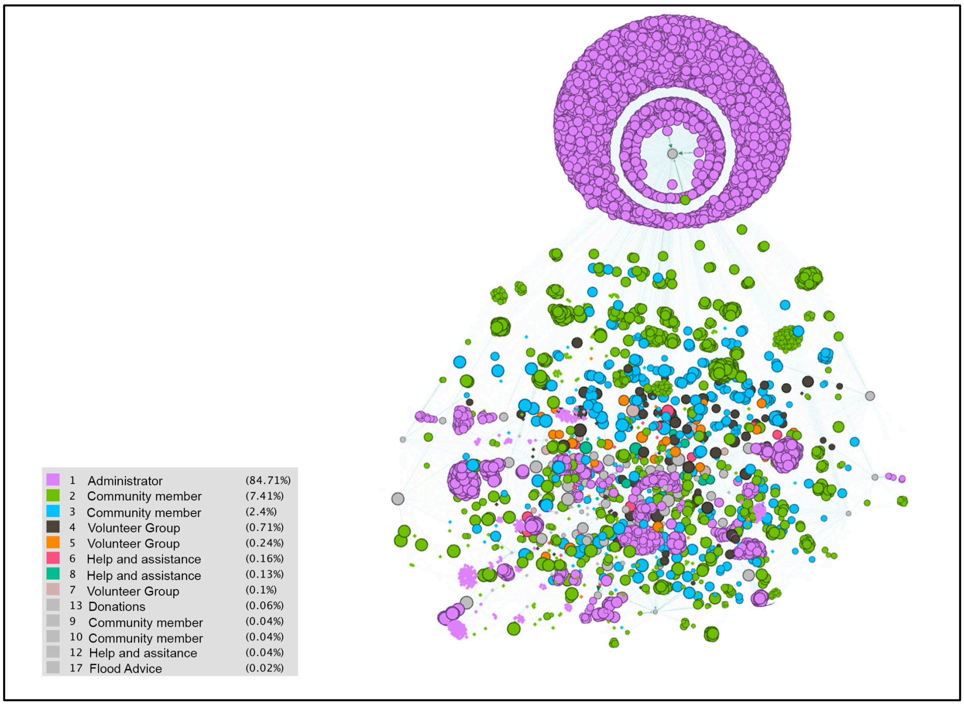

Figure 8.16 Gephi social network visualisation of K-core >1 for "Fubar News". Visual representation using Force Atlas algorithm.

The application of K-core[43] analysis at >1 removed only periphery node group: 1 (administrator) and 2 (community member), highlighting a cohesive core within the network. This may be attributable to the high response count generated by the 'broker' administrator.

Figure 8.16 highlights the low number of connections between nodes (degree distribution) for Fubar News. The average degree distribution measure stands at 1.220, a figure that is reflective of the low level of engagement between nodes, with the exception of those initiated by the administrator (broker). This imbalance in degree distribution (number of connections) across the network is illustrated through the limited cluster of nodes on the bottom left corner of the axis on Figure 8.17. Applying Crowe's (2007) network theory, this 'factional' (Section 7.6.2) clustering reaffirms the apparent imbalance of ties through their over-reliance on one 'administrator'. That said, there is evidence of bridging and linking connections emanating from the 'broker' administrator node, which is a positive sign towards multi-scalar interaction within the network.

[43] K-core is a visualisation of structural cohesiveness

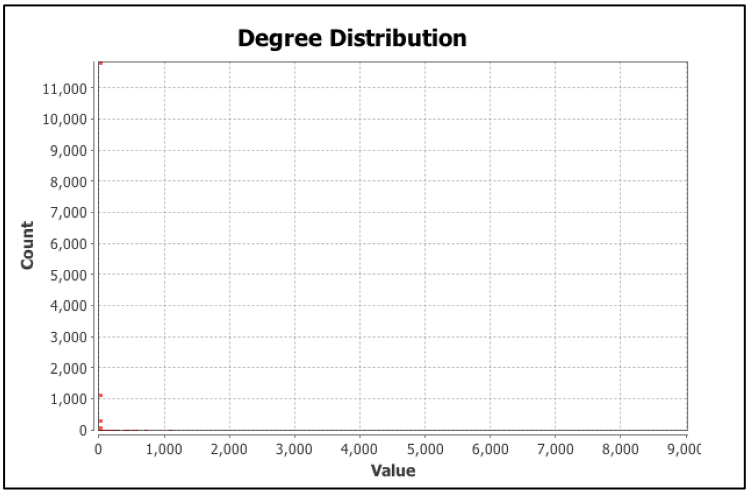

Figure 8.17 Gephi visualisation of average distribution measure 1.220. ‘Fubar News’ page.

The modularity distribution measure 0.561 (Figure 8.18) is illustrative of the densely connected network core for Fubar News. The balanced distribution of nodes across the structure is represented along the x-axis. The density of the ‘administrator’ node revealed a peak at 11 on the x-axis. However, rather than detracting from the network’s cohesiveness, it served as a catalyst for increased engagement amongst other nodes. The administrator node enhances the resilience of the community by disseminating information across the network, using social media to reach actors who otherwise would not be informed. Further, the ‘administrator’ node galvanises and builds upon existing nodes creating more cohesive communities. However, the long-term sustainability and resilience of the network is jeopardised by its reliance on one actor (the administrator node), making the network susceptible to structural collapse.

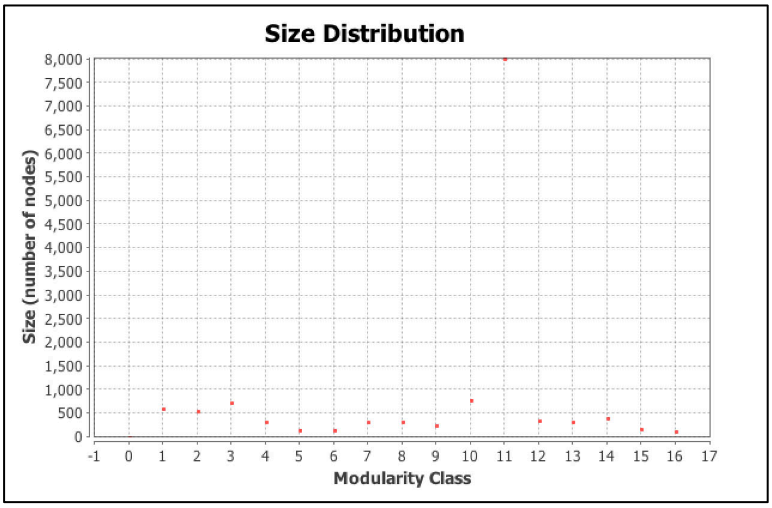

Figure 8.18 Gephi visualisation of modularity distribution measure 0.561, ‘Fubar News’

page.

8.6.3.2 SNA at the town scale

Similarities can be drawn between SNA at the town and city scale. Representative of the town scale, "The Inverurie and Garioch Flood Support Group" was set up to *"fill a support gap that was not offered by the authorities"* (I19). The group presented a similarly 'sparse' network density of 0.011. Standing at 1.435, the degree distribution scores echoed the results from the urban scale and represents an even distribution of communication ties across six key 'brokers', each responsible for 10-18% of interaction (Figure 8.19). Similarly, a comparatively even distribution of 'brokers' across the network is indicative of an evenly spread 'degree centrality'. The lack of larger nodes is indicative of an evenly weighted network. Wider engagement across the network should positively influence its long-term stability and sustainability. An increase in active 'brokers' reflects a more diverse and sustainable network, offering greater opportunity for community engagement.

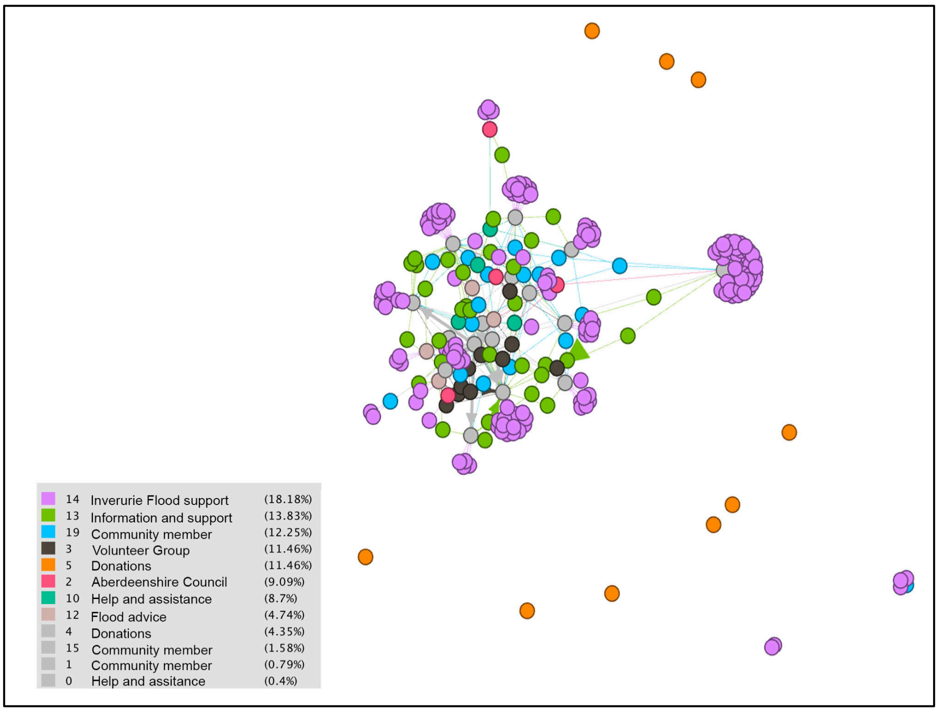

Figure 8.19 Gephi social network visualisation of "Inverurie and Garioch Flood Support". Visual representation using Force Atlas algorithm.

The dense 'degree centrality' is reaffirmed by K-core analysis of <1, where only a limited number of distant and/or temporary network connections were removed, for example 'Donations' nodes. On the other hand, the low degree distribution measure

(1.435) is representative of structural holes within the network. The modularity results (0.584) also reflect these gaps/weaknesses by highlighting the 'factional' (bridging) nature of the key brokers. Structural holes hinder the potential connectedness of the network, limiting access to information, resources and capacities. In particular, it reduces the potential for those least connected to receive the assistance and support they need to be resilient (McCann and Barlow, 2015).

Application of Crowe's theory reaffirms the above findings, highlighting evidence of 'Factional' and 'Coalitonal' clustering across the network. Key 'brokers' operate as an important bridging channel to connect isolated nodes. In addition they act as a means to disseminate 'Flood advice', 'Help and assistance' and 'Donations' which otherwise may be unattainable (Figure 8.19). The bridging of connections through a 'broker' is an important component in adaptive capacity building, for example by helping to engage outside knowledge and innovation, and preventing collapse or fragmentation of the network. As such, the fostering of bridging ties has the potential to galvanise existing networks by adding a layer of diversity and access to wider resources, critical for community recovery.

8.6.3.3 SNA at the village scale

The final SNA explores connections at the village scale. An individual Facebook page representative of the village scale was unattainable. As such, the "Hope floats- Deeside Flood Response Network" page, representing several villages in the rural Deeside area was used as a proxy for the village scale (Ballater). The lack of a dedicated page, representative at this scale, was also an issue encountered at the village scale in Cumbria (Section 7.6.3).

Taking in many villages, the network comprised 30 active communities, which surprisingly stands above figures at the town (20) and city scale (17) (Table 8.26). The figure for the nodes (1549) and edges (819) are comparatively higher than the other scales, indicating the high level of activity within the network. Further, degree distribution (1.891) and modularity (0.513) measures were higher than the other scales (Appendix 4.3.2).

Application of Crowe's theory reaffirms the high cohesiveness of the network as presented through high modularity and degree distribution scores. The 'complete' network is representative of dense 'bonding' capital (Crowe, 2007), often associated with cohesive rural communities (Cutter, 2010). Evidence of some 'coalitonal' and 'factional' clusters is evident in Figure 8.20. Despite these positive bridging and linking ties, the limited extent of their presence suggests that these ties are in their infancy and not representative of a 'complete' network.

K-core measures support the view that the network holds a strong cohesive core. Running k-core analysis at >1 eliminated only minor periphery nodes (Appendix x). Whilst the structural analysis results present a balanced network with a cohesive core, limited evidence of 'factional' (linking) and 'coalitonal' (bridging) and is indicative of a slightly 'closed' network that could potentially resist outside assistance. Closed networks have the potential to become homogenised, thereby limiting innovation, access to diverse resources and ultimately reducing adaptive resilience.

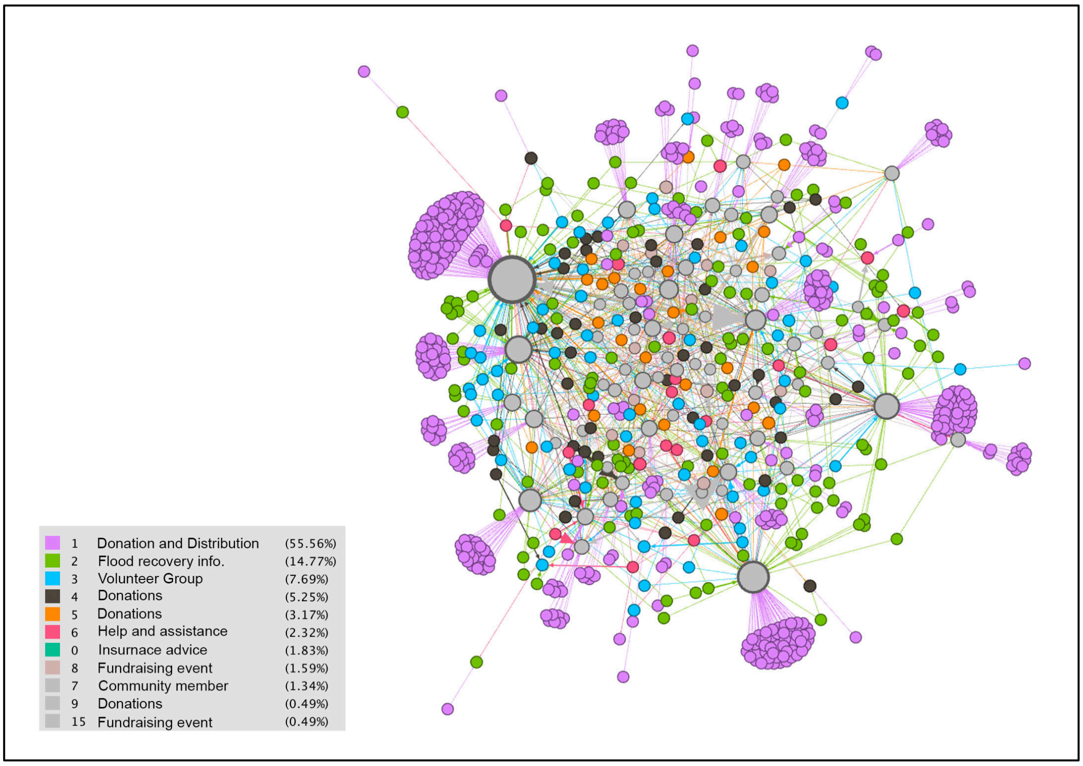

Figure 8.20 Gephi social network visualisation of "hope floats". Visual representation using Force Atlas algorithm.

The presentation of the three network structures in the above Figures (8.15; 8.19; 8.20) highlight variances across the different network scales. It became apparent that social networks played an important role in warning and informing at the urban scale. Once catalysed, these networks demonstrated a good level of engagement, however an over-reliance on a key broker created structural holes and potential network collapse was a possibility. ‘Factional’ and ‘coalitonal’ structures, associated with bridging and bonding ties were more prevalent at the town scale. By contrast, the village scale demonstrated the most ‘complete’ network representing strong bonding capital. Whilst it is acknowledged that bonding capital is a key element in a balanced network, Chapter 7 (Section 7.5.5.1) highlighted that sole reliance on this network tie has the potential to restrict innovative resilience action by acting as a barrier to outside assistance. The above social networks are in their infancy, which perhaps explains the lack of practitioner level engagement through this medium nevertheless, the potential for social media to expedite recovery at both the fragmented urban and dispersed rural geographical scale has been presented.

8.6.4 Ego-centric analysis

SNA highlighted the variances in network structures, which are indicative of bonding (complete), bridging (factional and coalitonal) and linking ties. Key to the engagement of these ties are ‘brokers’ who act as a catalyst for engagement by linking nodes together.

As outlined in Section 8.5.2, interview discourse was the data source for this analysis. Egos in each community were identified through the process of purposive sampling. Consistent with the approach taken in Chapter 7, the recall method was used to allow interviewees to identify sources of assistance during the recovery process (Wasserman and Faust, 1994). The raw data outputs from this process are presented in Appendix x. The emerging data (nodes and edges) were subsequently formatted in Excel columns and exported as a .CSV file for interpretation in ‘Gephi’ network analysis software. The results of this process are presented in the ego-centric maps, the degree of centrality is depicted by node size -those with more influence or ‘edges’ are illustrated through larger nodes.

The ego-centric maps presented in Appendix 4, support earlier findings of structural weaknesses and communication gaps across all three scales. Linking capital was evident to some extent across the networks, however it is the ‘form’ of linking capital that is important. For example, reliance on the authorities to *“sort out the flooding”* (A3), as evidenced in Aberdeen, is representative of linking capital, however it is not conducive to a collaborative response. By contrast, the resilience group in Ballater demonstrated its ability to act as an effective channel for multi-scalar co-operation between the community and authorities.

As such, the results from the SNA analysis reaffirm the findings from the Cumbrian case-study (Chapter 7) that it is not necessarily the scale of participation that is most important, rather the objective of the engagement. Further, evidence of effective multi-scalar interaction through the medium of resilience groups makes the case for enhanced investment in resilient social infrastructure. The example of the dormant resilience group, reignited as a consequence of the floods, highlights the fragility of the social asset. Reaffirming evidence from Chapter 7 (Section 7.6.7), it became apparent that social capital is not a constant and requires investment to keep ‘flood memory’ alive. Finally, and as noted in Chapter 7, this section indicates the need for investment in strategies to enhance trust between communities and authorities, thus facilitating positive linking capital.

8.7 Comparative settlement hierarchy

This section presents the distribution of community and practitioner level resilience indicators across North-East Scotland at the three settlement scales: city, town and village. Reference is made to Chapter 7 (Cumbria), highlighting patterns and relationships common to both case-studies. This approach is designed to reveal indicator gaps at the individual North-East Scotland scales, but also explores the transferability of the findings through comparison with Cumbria (Chapter 7). An overview of the indicators is illustrated in Figures 8.21-8.22 and the relationships between these indicators are outlined in the following sections.

Figure 8.33 illustrates the extent of resilience indicator coding found across the case- studies, at both the community and practitioner level. The level of coding was found to be highest at the village scale in Ballater and in the suburb (city scale) of Peterculter. High ‘cohesiveness’ (Indicator 16) (typical in small communities) may have enabled greater mobilisation of diverse internal resources. Further, the results show an attempt to reflect critically and build upon existing resilience through ‘learning’. High coding of ‘analytical thinking (Indicator 19) and ‘knowledge feedback’ (Indicator 22) corroborate this assumption. ‘Cohesive community’ (Indicator 16) was found to be the most commonly coded indicator across the case-studies, despite evidence of low collaboration, particularly at the urban scale. This highlights the potential for ‘multi-scalar interaction’ (Indicator 17) (bonding, bridging, linking), however the lack of an organisational structure to facilitate these connections (for example a resilience group) has prevented multi-level collaboration, particularly at the urban scale.

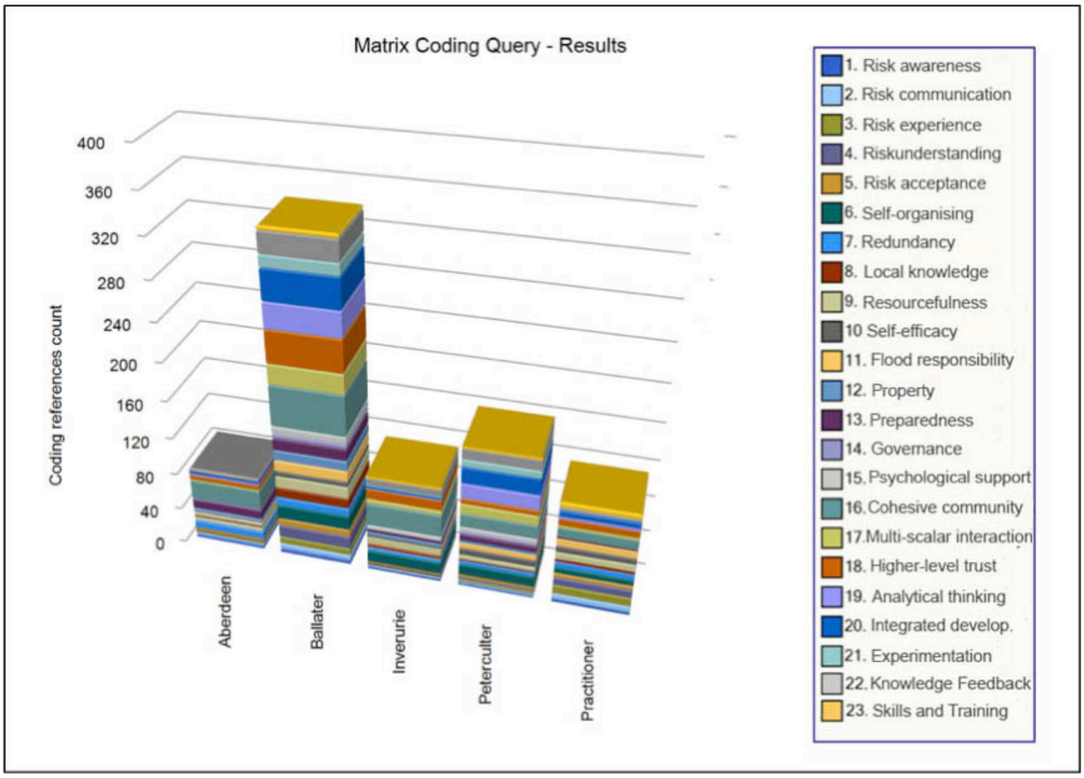

Figure 8.21 Matrix coding of community and practitioner level Indicators.

A heat map matrix query, run in NVivo, illustrates the varying density of indicators for each settlement and allows comparison across settlement scales. The heat map diagram (Figure 8.22) shows that the village scale displayed higher levels of resilience coding. Indicators that are coded more frequently are represented by a darker gradient of colour from 0.0- 43.00 and complementing data presented in Figure 8.21, it was found that cohesiveness (Indicator 16) was the most highly coded indicator across all case-studies. In this respect, the analysis presented in Figure 8.22 acts as a helpful point of reference for indicator comparison across each of the case-studies.

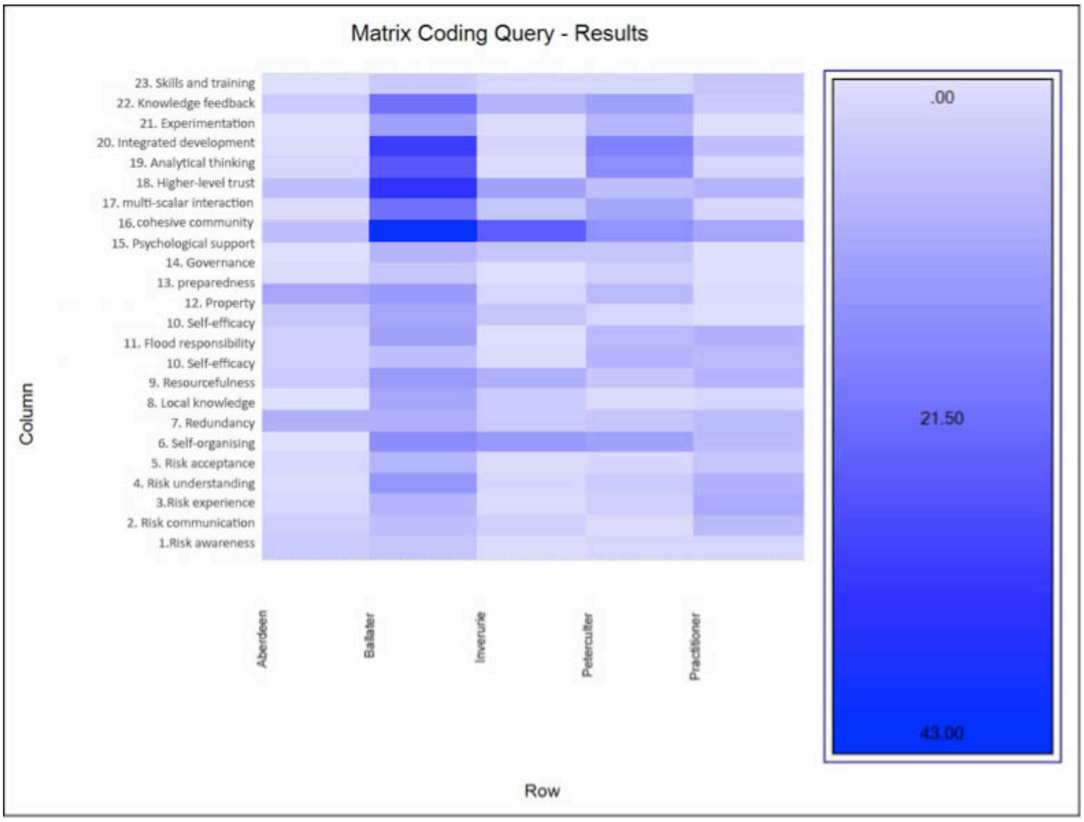

Figure 8.22 Matrix coding heat map of community and practitioner level Indicator.

8.7.1 City scale

Aberdeen city shows variability of coding across the four components as previously illustrated previously in Figure 8.22. Risk indicators were found to be low and (critically) 'learning' had a very poor coding representation.

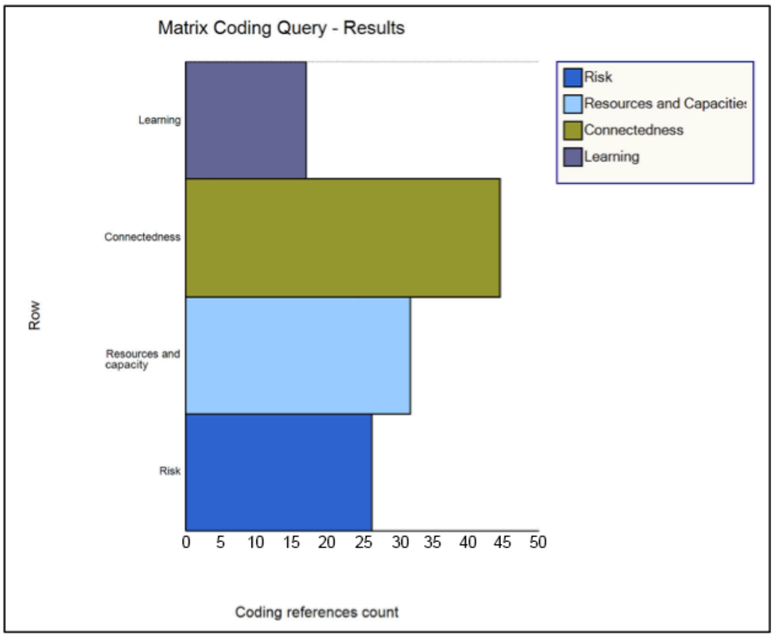

Figure 8.23 Matrix code query illustrating spread of coding for the four components at the city scale.

Nevertheless, Aberdeen shows high 'risk awareness' (Indicator 1) relative to the lower level of awareness found at the town scale supporting findings from Cumbria, where the city scale also exhibited high-risk awareness as a consequence of three severe floods in the past decade. However, as illustrated in Figure 8.24, the level of 'risk understanding' (Indicator 4) does not reflect the level of awareness. This may infer that residents and businesses accept that there is inevitably a risk attached to a *"city by the coast with rivers running through it…..but it's never that bad...we cope"* (A2). Despite a publicised near miss from tidal flooding in 2014, the interview discourse suggests a misinterpretation of the potential risk exposure amongst residents and businesses. Furthermore, while 'connectedness' coding was high (Figure 8.23), there is an imbalance across the Aberdeen 'connectedness' indicators (Figure 8.24). High 'cohesiveness' (Indicator 16) is closely linked with 'multi-scalar interaction' (Indicator 17) through bonding and bridging capital and 'higher-level trust' (Indicator 18), (as presented in the SNA, Section 8.6), is closely related to linking capital. However, interview discourse revealed a reliance on authorities to *"deal with the flooding"* (A3). As such, the relationship with authorities was not collaborative explaining the low cohesion levels in the community to self-organise and a lack of engagement with authorities leading to distrust.

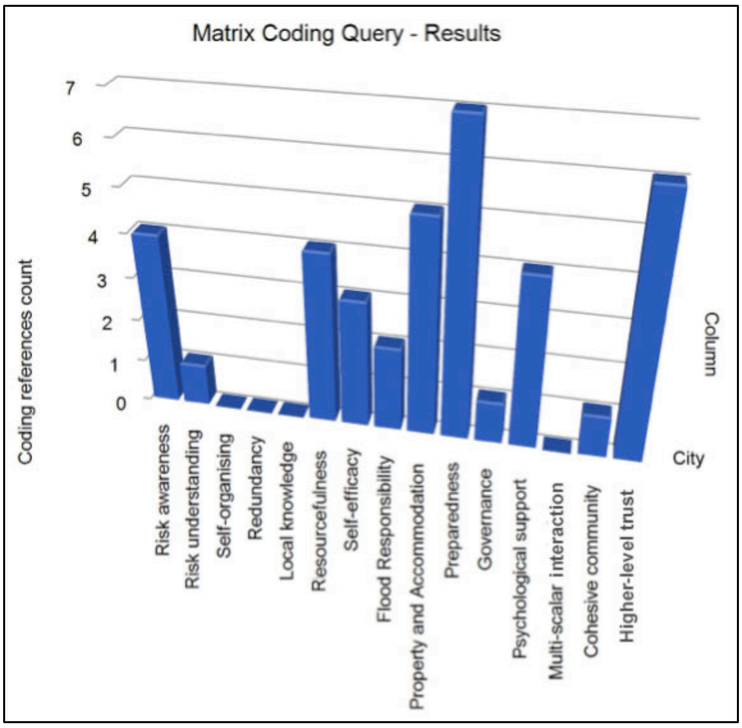

Figure 8.24 Matrix code of 'resources and capacity' and 'connectedness' component indicators at the city scale.

Reaffirming the lack of collaboration amongst the community, Figure 8.24 illustrates the relatively low levels of 'local knowledge' (Indicator 8) and 'self organising' (Indicator 6). The absence of a physical resilience group, together with low multi-scalar interaction' (indicator 17), led to low 'learning' in Aberdeen (excluding Peterculter suburb) (Figure 8.23) in contrast to the other three, highly coded components.

However, Figure 8.22 indicates that the higher 'connectedness' and 'learning' coding shown at the city scale (8.23) is heavily influenced by the higher extent of coding found in the city suburb of Peterculter. As such, it could be argued that the 'village within a city' (Perterculter) is inflating the level of city coding as a consequence of its more connected and established community.

8.7.2 Town scale

The low 'risk awareness' (Indicator 1) in Inverurie is likely to be attributable to the low level of flood incidence (Figure 8.25). Also as observed through SNA (Section 8.6) the newly established 'Inverurie and Garioch Flood Support' Facebook page in informing and disseminating information about flooding may have contributed to the higher 'risk communication' coding.

Consistent with the Cumbrian findings, 'property and accommodation' (Indicator 12) was also found to be coded highly (Figure 8.25). The disruption caused by *'relocation'* (Indicator 21) and potential *'devalued property'* (Indicator 22) were the key concerns raised. The establishment of the 'Inverurie Flood Support Group' and online Facebook page facilitated 'self-organisation' (Indicator 6) of 'resourcefulness' (Indicator 9) actions. In addition, it offered 'psychological support' (Indicator 15) to assist those *"wearing the floods on their faces"* (Indicator 19).

The extent of mobilised 'resources and capacities' is reliant upon the 'connectedness' (Indicators 16-18) of the community (Figure 8.25) and in this context Facebook formed the main channel of communication during the immediate recovery process, efficiently matching needs with capacities. However, due to the informal nature of the communication, it became apparent that the authorities were reticent to use the Facebook page. This could have reduced 'higher-level trust' (Indicator 18) and subsequently limited 'multi-scalar interaction' (Indicator 17).

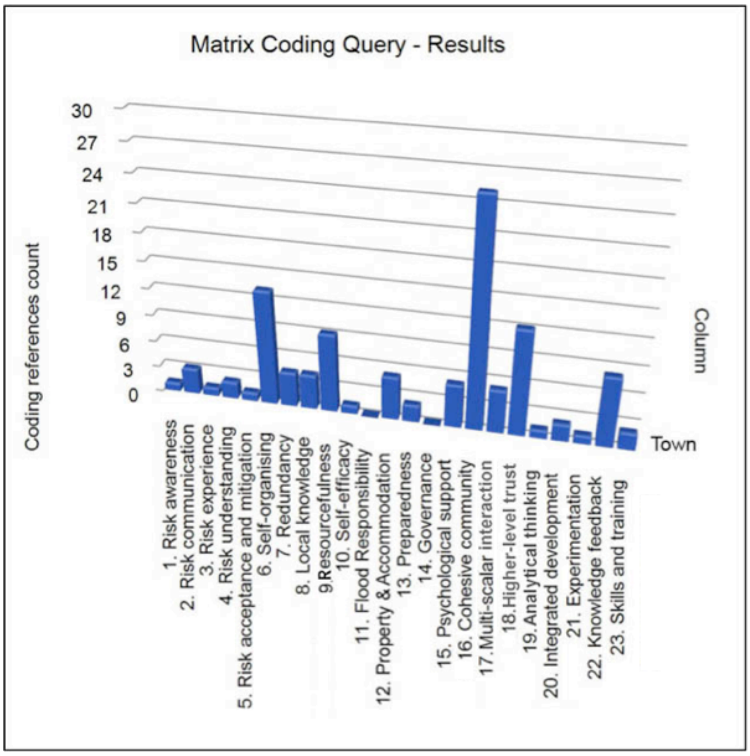

Figure 8.25 Matrix code query illustrating spread of coding for 'risk', 'resources and capacity' and 'learning' component, representative of the town scale, North-East Scotland.

The 'learning' component is characterised by average coding levels (Figure 8.22) though reflective interview discourse led to high coding in the 'knowledge feedback' (Indicator 22). However, as represented in Figure 8.22, the same extent of learning was not evident across the other 'learning' indicators. This may be attributable to the fact that a large proportion of the 'connectedness', which facilitated the mobilisation of resource and capacities, was communicated via social media. By contrast, physical resilience groups in Cumbria were shown to have higher coding in the learning component as a consequence of 'multi-scalar interaction' (Indicator 17) with authorities. The evidence from the town scale in North-East Scotland indicates that 'virtual' groups alone do not offer sufficient 'multi-scalar' and 'cohesive' activity to facilitate its full 'learning' potential.

8.7.3 Village scale

In comparison to the other settlement scales, the village scale (Ballater) exhibited the highest level of indicator coding across all four components (risk; resources and capacities; connectedness; learning) (Figure 8.26). Echoing findings from Cumbria, it is noteworthy that Ballater had an operational resilience group.

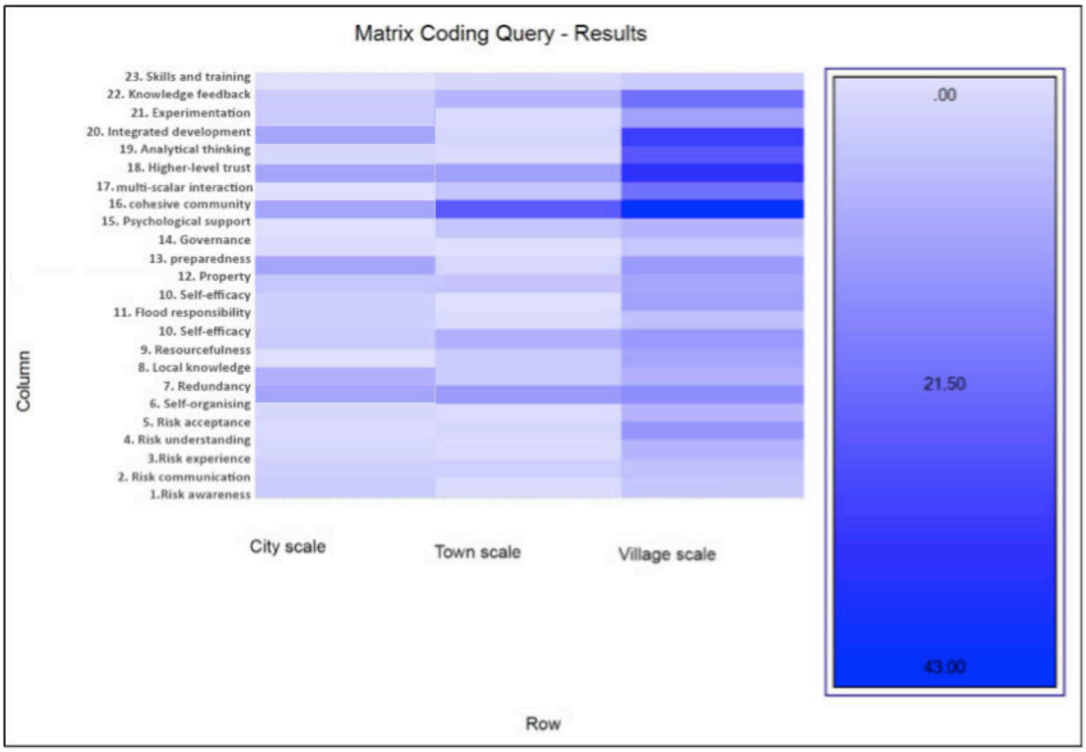

Figure 8.26 Matrix coding heat map representative of the city, town and village scale.

The low incidence of flooding relative to Cumbria is potentially reflected by the lower ‘risk awareness’ (Indicator 1) exhibited at the village scale. ‘Risk understanding’ (Indicator 4) was the highest represented risk indicator (Figure 8.26/8.28), a finding that potentially reflects the extent of discussion communities have undertaken in the post-flooding phase. For example, a founding member of the Ballater Flood Group commented that the group was set up *“with the objective of understanding the events that led to the unprecedented flooding in December 2015”* (B16).

The heat map query matrix (Figure 8.26) identifies a number of highly coded indicators which contribute to the overall high level of coding at the village scale. As illustrated in Figure 8.26/8.28 all indicators within the ‘resources and capacity’ component are highly coded, with the exception of ‘self-efficacy’ (Indicator 10) and ‘Governance’ (Indicator 14). The lower coding levels of ‘self efficacy’ contrast with the results from Cumbria and may be attributable to an aging population and the fact that Ballater is a popular retirement location where residents: *“often go away to visit family, stay with the grandchildren. Now that we are retired we have the time to do these things…. go on holiday”* (B13). The low ‘governance’ coding may be attributed to the perception by some locals that: *“We are forgotten about up here in the North East” (B9).*

Heavy coding was also evident in the ‘connectedness’ and ‘learning’ components, as illustrated in Figure 8.27. The highest coded indicator was ‘cohesiveness’ (Indicator 16). As shown in Chapter 7 (Section 7.5.5), this is illustrative of a tight-knit network who work collaboratively in pursuit of a shared goal and often engaging outside support from authorities (higher-level trust’, Indicator 18). Analysis from the SNA (Section 8.6) reaffirmed this finding, illustrating ‘factional’ (bridging) and ‘coalitonal’ (linking) ties within the network.

The medium of resilience groups facilitated discussion and review post flooding. The timing of the interviews, almost 18 months after the event, led to a more reflective interview discourse relative to Cumbria. This apparent increase in risk problemising and reflection is illustrated in Figure 8.27 through the highly coded ‘analytical thinking’ (Indicator 19); ‘Integrated development’ (Indicator 20); and ‘knowledge feedback’ (Indicator 22). The ‘Learning’ component is coded higher than Cumbria, however Figure 8.27 also illustrates that attention is needed to improve ‘skills and training’ (Indicator 23), which can increase evidence of ‘experimentation’ (Indicator 21).

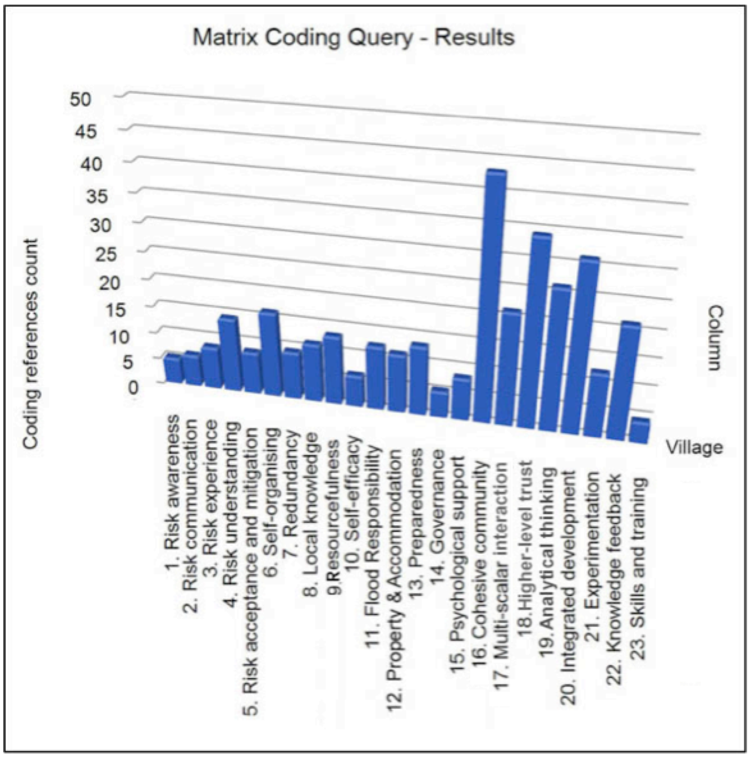

Figure 8.27 Matrix code query of ‘Resources and Capacity’ and ‘learning’ component indicators at the village scale.

The matrix query coding visualisation (Figure 8.28) provides an overview of the prominence of indicators at the different scales. The village scale is represented by heavy coding in the ‘resources and capacity’ component and dense ‘connectedness’ coding, as a consequence of engagement through physical flood resilience groups leading to a comparatively higher level of collaborative multi-scalar interaction (Indicator 17). In this context, a virtual flood support group efficiently mobilised ‘resources and capacities’ component indicators during the immediate recovery. However, long-term collaborative engagement through resilience planning was not evident through this ‘virtual’ medium. Consequently, the positive extent of ‘learning’ evident at the village scale was not represented at the town scale. Conversely, the city scale exhibited the lowest level of resilience due to the absence of a virtual or physical resilience group.

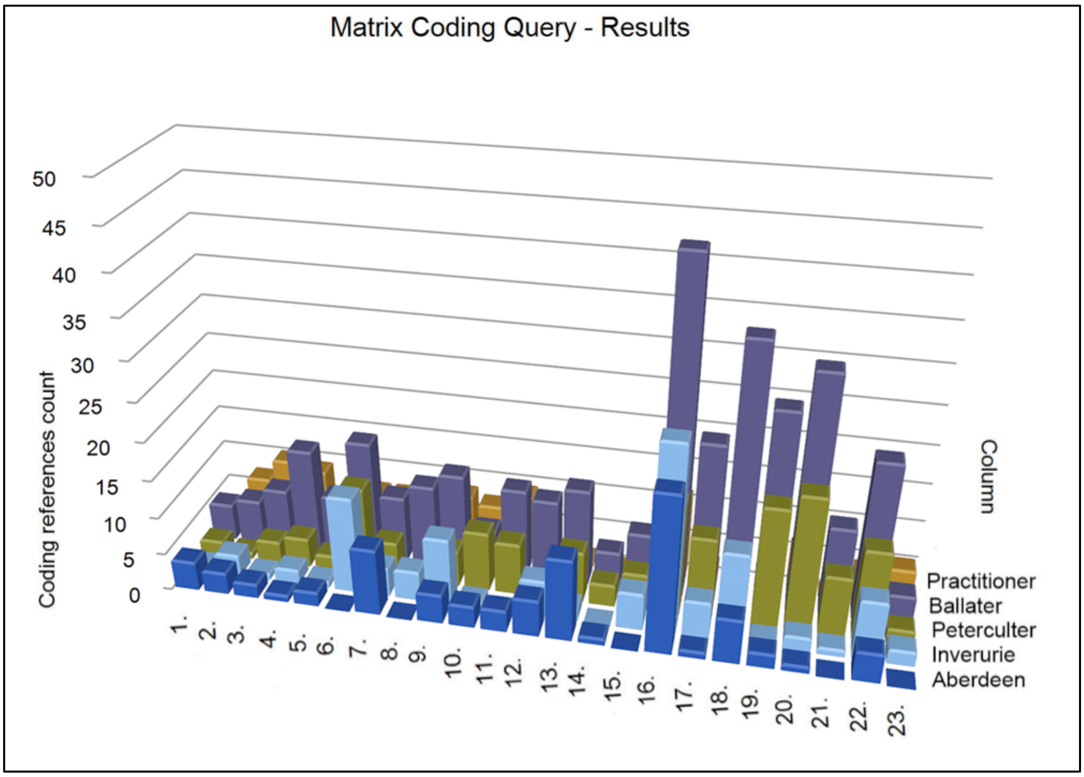

Figure 8.28 Matrix coding results for community and practitioner level Indicators.

8.7.4 Practitioner level

The following section outlines the distribution of practitioner level indicators (Figure 8.29) from the North-East Scotland case-study. In line with findings from Cumbria, the high ‘risk’ coding is indicative of ‘risk experience’ (Indicator 3) and ‘risk understanding’ (Indicator 4) (Figure 8.30). ‘Resources and capacities’ were well represented, however low coding in both the ‘connectedness’ and in particular ‘learning’ components is indicative of resilience weaknesses.

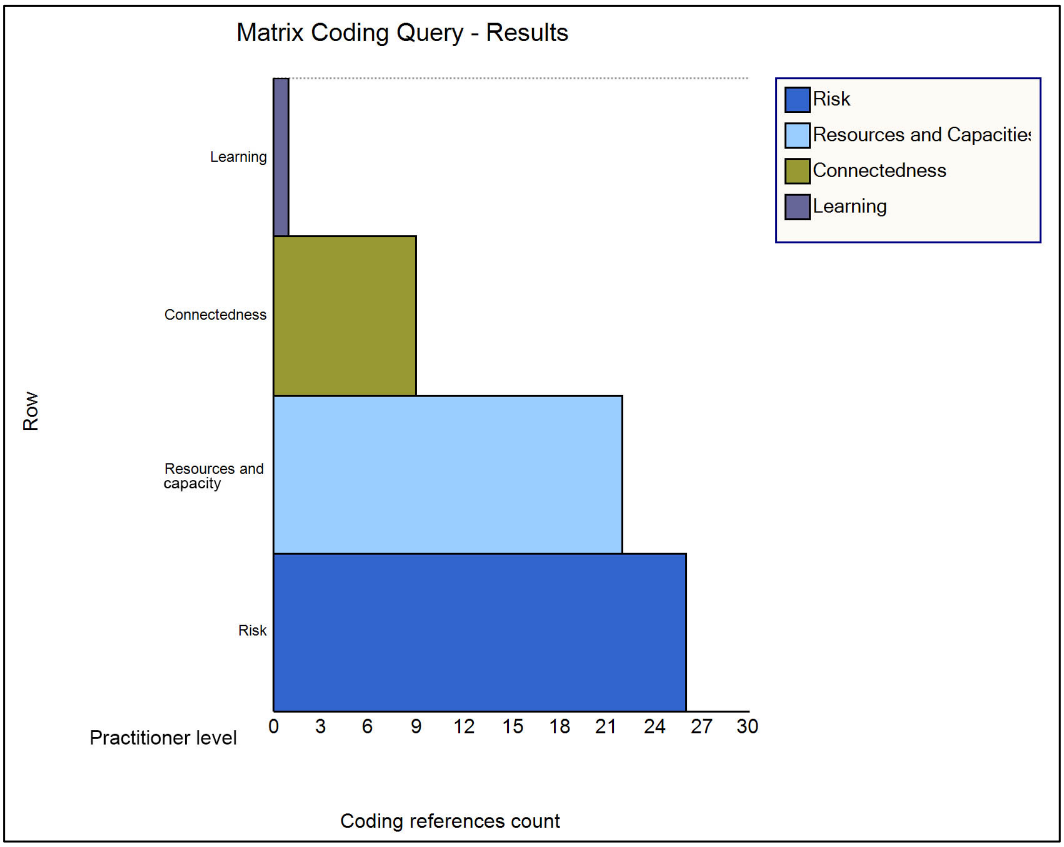

Figure 8.29 Matrix coding for the four Framework components at the practitioner level.

Above average ‘resources and capacities’ coding was particularly notable in the: ‘Flood Responsibility’ (Indicator 11); ‘Self-efficacy’ (Indicator 10); ‘Self-organising (Indicator 6) and ‘Redundancy’ (Indicator 7) indicators (Figure 8.45). These indicators emerged in the context of the Scottish Government’s push to encourage communities to *“do more for themselves”* (P40). The practitioner level interviewees were quick to point out that the responsibility for flooding of properties lies with the homeowner not the authorities. Beyond their role of *“warning and informing”* (P35), the authorities support the idea of communities taking responsibility for their risk and establishing Resilience Groups.

The lack of ‘learning’ coding is indicative of a reactive state of coping rather than striving for ‘betterment’ ahead of the next potential disaster. In particular, low ‘experimentation’ (Indicator 21) and ‘analytical thinking’ (Indicator 19) are indicative of a lack of proactive engagement. In particular, the Aberdeen Western Peripheral Route (AWPR) emerged as a key concern regarding potential future flooding.

Despite that “*water is collecting in places that it never collected before”* (P35) near the AWPR, the authorities commented that consent for the road underwent a thorough risk assessment process and “account for all future eventualities (flooding).” (P32) The practitioner interviews also expressed concern over short-term funding streams and “*austerity measures”* (P32), these were cited as roadblocks to resilience training, with budgets being described as *“peanuts”* (P33) in comparison to those in England.

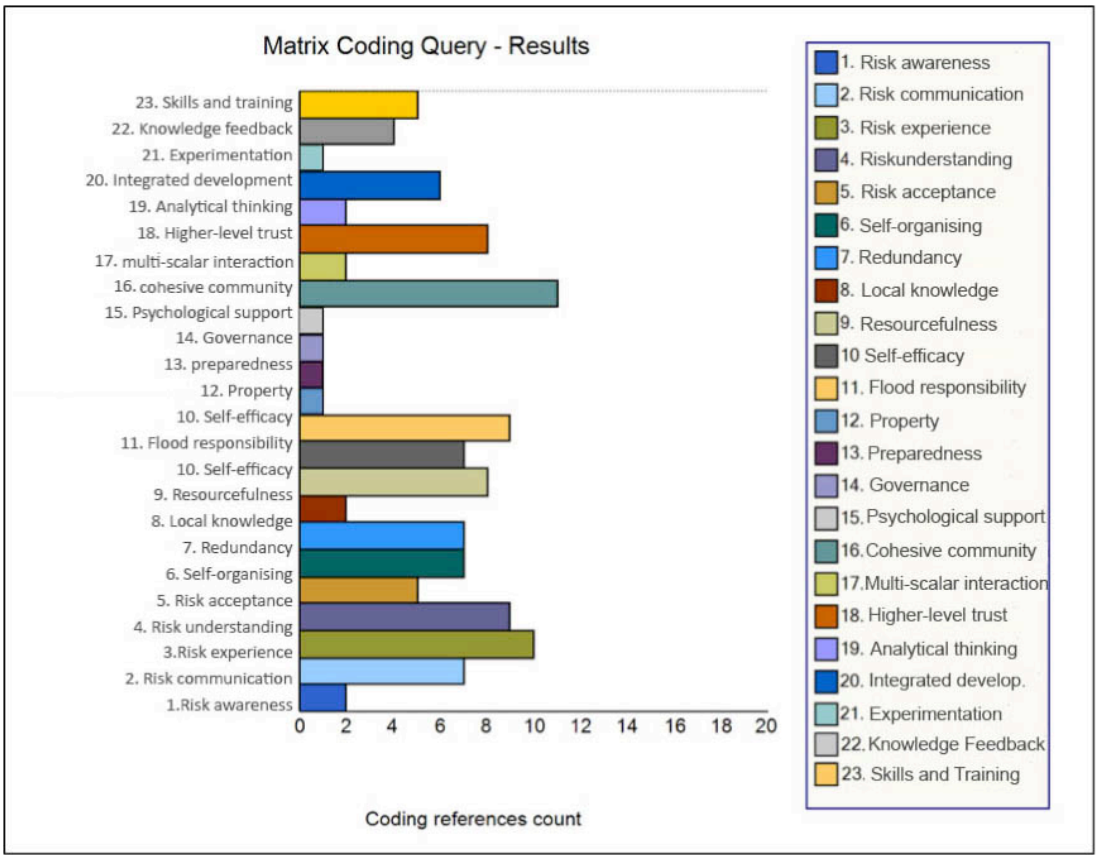

Figure 8.30 Overview of Practitioner level coding.

8.8 Feedback of indicators from Phase 2 to Phase 1

This section presents the process of applying Phase 2 indicators against Phase 1 perceived weaknesses (Section 8.5.1) identified within Aberdeen, Inverurie and Ballater.

8.8.1 City scale

Consistent with results in Cumbria, low ‘flood responsibility’ (Indicator 11) and ‘local knowledge’ (Indicator 8) were reflective of the perception many residents had that flooding of properties *“is for the authorities to deal with”* (A3). Compounding pressure on the 'environmental' community asset, high levels of impervious surface further attributed to surface water flooding across the city. Despite this risk, low 'risk acceptance and mitigation' (Indicator 5) echoed a lack of 'flood responsibility' at the community level (Figure 8.31). Increasing demand for properties led to inappropriate planning in flood risk areas, thus eroding the 'physical' community asset. However, the majority of properties flooded were largely commercial premises and did not impact at the household level. Nevertheless, the evidence highlights the importance of appropriate 'integrated planning and development' (Indicator 20) to mitigate against further floods.

As noted in Cumbria, 'multi-scalar interaction' (Indicator 17) emerged strongly in relation to the 'human' asset. However, the nature of the 'linking' capital revealed a reliance on authorities, rather than collaborative engagement between the community and authorities. Lack of participation at the community level is reaffirmed by the low 'cohesion' (Indicator 16) levels of the 'human' asset (Figure 8.31). However, the suburb of Peterculter was found to the exception. As a consequence of an active FAG the Peterculter community were found to exhibit high levels of cohesion. This may be attributable to the community's ability to meet in residual village institutions such as the Culter Village Hall.

In addition, holes in community capacity underlined further weaknesses in the 'human' asset. Figure 8.31 illustrates an absence of both 'self-organising' (Indicator 6) and 'local knowledge' (Indicator 8). The former can be attributed to the lack of an organisational structure to facilitate resilience action, such as a flood group. The suburb of Peterculter remains the exception, where an active FAG demonstrated a working organisational structure and strong resilience capacity. The absence of 'local knowledge' could be attributed to the transient nature of city inhabitants (with the exception of Peterculter), together with high rental tenure rates and the high percentage of flooded properties that were businesses.

From an 'economic' resource perspective, the lack of engagement by businesses raises concerns about the long-term sustainability of their 'preparedness' (Indicator 13) plans (Figure 8.31). Similar to the situation at the town scale, it was found that economic 'redundancy' (Indicator 7), in terms of financial savings and employment diversity, could enhance the vulnerability of those reliant on the oil and gas industry. In addition, the low representation of 'learning' indicators at the city scale is suggestive of limited lessons learned. Echoing findings from the village scale, it is apparent that business engagement is an integral component of any future community resilience plans. The indicators that form this discussion are presented (Figure 8.32) in relation to their respective community assets.

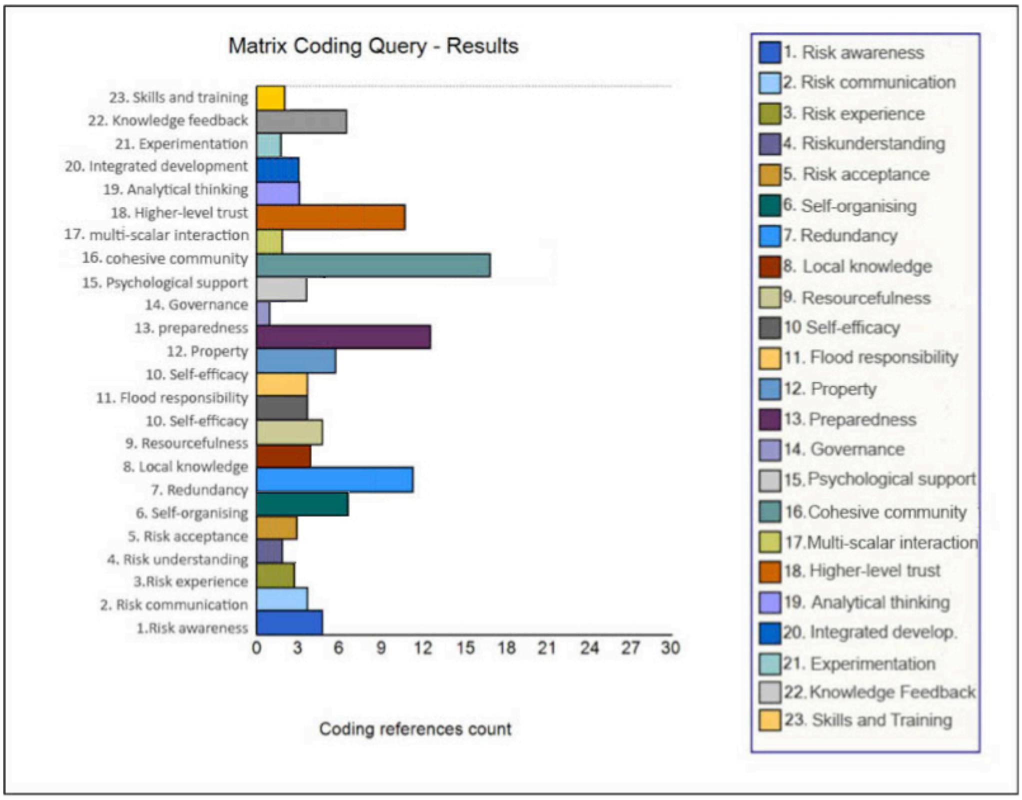

Figure 8.31 Aberdeen city scale resilience indicators.

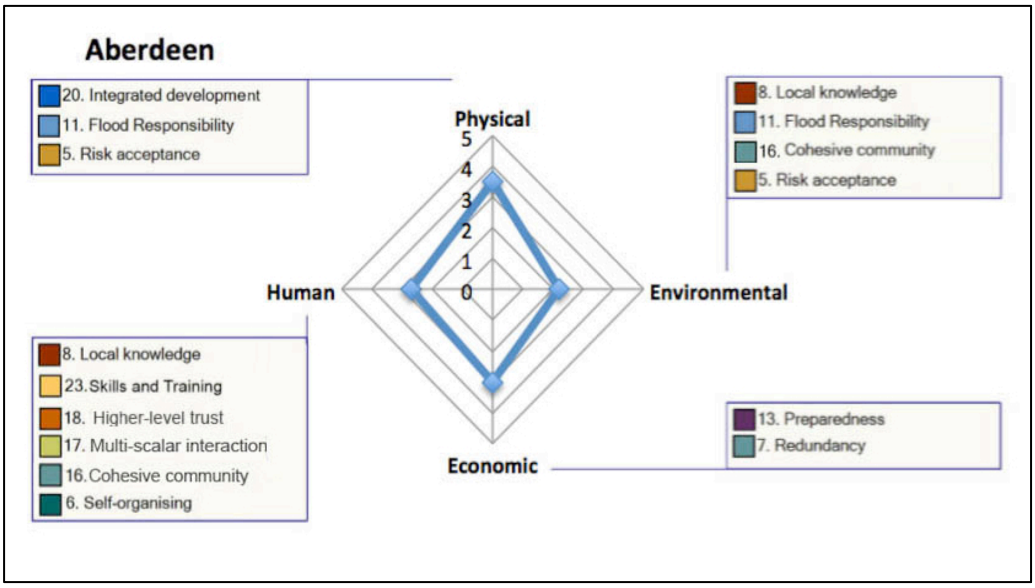

Figure 8.32 Application of Phase 2 indicators to Phase 1 resilience baseline assessment results, Aberdeen city.

8.8.2 Town scale

Inverurie is highly exposed to flooding arising from geographical setting between two rivers, yet there was little evidence of environmental protection strategies by the community in the town. The establishment of a physical resilience group could, for example, help generate environmental strategies through ‘multi-scalar interaction’ (Indicator 17) in collaboration with authorities.

The lack of previous flood incidents is illustrated in the low ‘risk’ component coding in Figure 8.33. Enhancing the ‘physical’ asset requires greater ‘risk awareness’ (Indicator 1) and ‘risk understanding’ (Indicator 2) in order for potential ‘risk acceptance and mitigation’ (Indicator 5) action to occur. Protection of the physical asset was predominantly through PLP at the individual level with limited ‘flood responsibility’ coding through the reinstatement of two bund walls to protect houses and businesses in the town. Further, ‘integrated planning and development’ (Indicator 20) through inappropriate planning consent in a flood plain emerged strongly in the interview discourse: *“We bought this house based on the protection offered by that bund …. because it got through planning we thought we were safe” (I 20).*

The ‘human’ asset was bolstered through the Facebook group ‘Inverurie and Garioch Flood Support Group’, which catalysed ‘innovative and resourceful action’ in the town. The open nature of the ‘virtual’ group led to evidence of ‘multi-scalar interaction’ (Indicator 17) through fundraising and donations from people both inside and outside the immediate Inverurie community. The establishment of the rest centre in the British Legion’s club offered a hub for the community to engage with authorities and strengthened ‘higher-level trust’ (Indicator 18) over time. As shown by the high ‘self-organising’ (Indicator 6) coding, the establishment of the ‘Inverurie Flood Support Group’ page efficiently matched needs with capacities in an ‘resourceful’ (Indicator 9) manner, meeting the direct coping needs of the community. However, the low representation of the ‘learning’ component (Figure 8.33) is indicative of the coping nature of the recovery effort. In the absence of a physical resilience group, there was limited opportunity for collaborative reflection. However, an exception was noted by Flood Support Group members who ‘analytically’ consider risk (Indicator 19) and acknowledged the need to *“formalise the flood group”* (I19) to assist long-term recovery.

As a consequence of the oil crash since late 2014 (PWC, 2015), increased unemployment compounded the financial impact of flooding in Inverurie. Accordingly, the interview discourse highlighted the need for ‘redundancy’ (Indicator 7) in terms of financial savings and diverse employment opportunities to avoid being *“left with only the wet clothes I was wearing”* (I21). The indicators discussed in the above section are presented in Figure 8.34 in relation to their respective community assets.

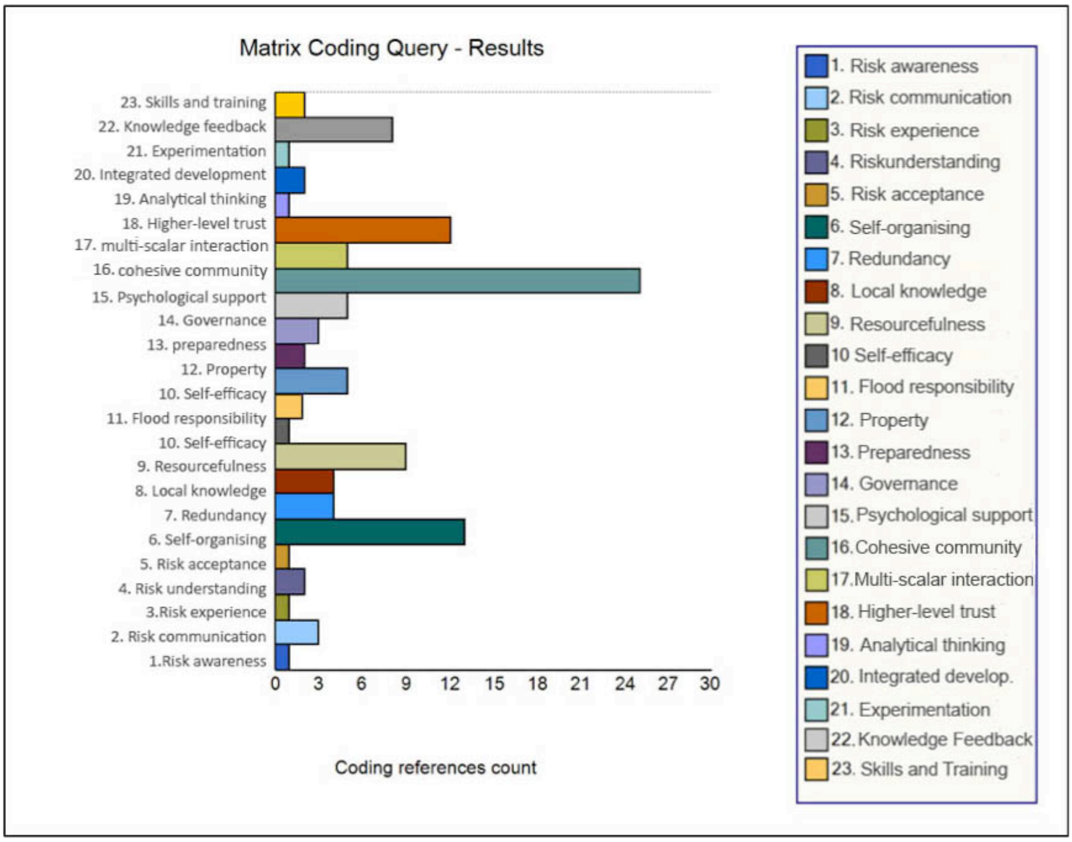

Figure 8.33 Inverurie town scale resilience indicators.

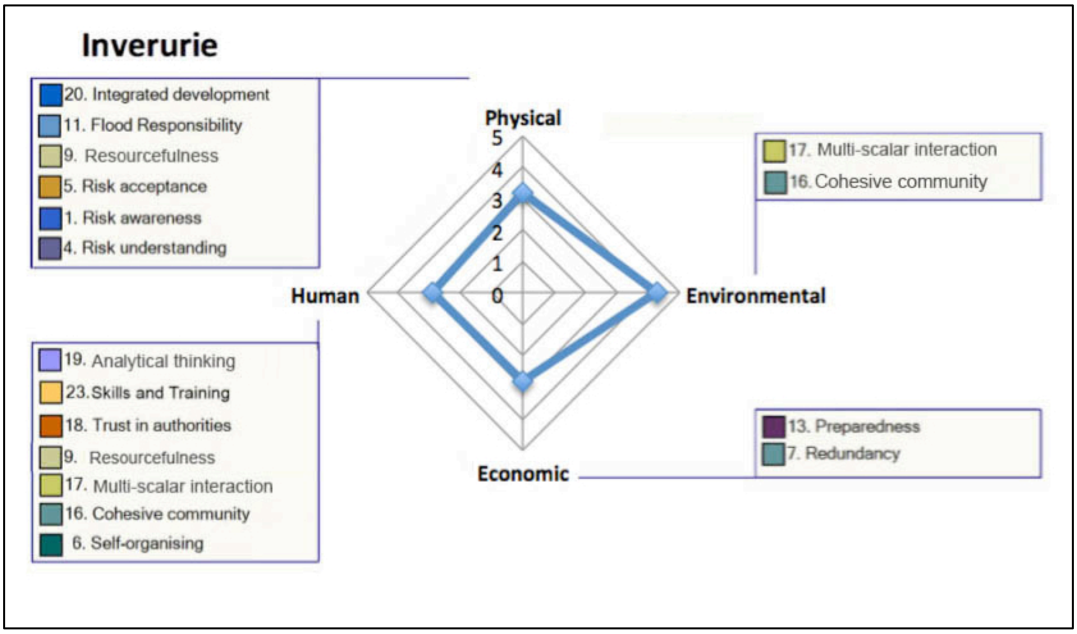

Figure 8.34 Application of Phase 2 indicators to Phase 1 resilience baseline assessment results, Inverurie town.

8.8.3 Village scale

It was found that Ballater's 'environmental' community asset was enhanced by a 'cohesive community' (Indicator 16) which through 'self-organising' (Indicator 6) cleared debris and stone from the golf course and river banks: *"The golf course was covered in rock… tonnes and tonnes were removed. An amazing community effort"* (B13). In support of findings from Cumbria, 'local knowledge' (Indicator 8) informed necessary river maintenance issues, which had been neglected prior to the flooding. Also consistent with findings from Cumbria, 'integrated planning and development' (Indicator 20) identified the need for stricter enforcement of planning rules to enhance the 'environmental' asset of the community. In addition, reduced pressure on the drainage infrastructure could potentially reduce risk to the 'physical' asset.

Echoing Cumbrian findings, it was also found that 'flood responsibility' (Indicator 11) and 'resourcefulness' (Indicator 9) led to increased protection of the 'physical' asset through implementation of PLP. 'Self organisation' (Indicator 6) was demonstrated by the establishment of the Ballater Resilience Group as an extra layer of resilience to the community. The 'cohesive community' (Indicator 16) demonstrated comparatively strong multi-scalar interaction (Indicator 17) by working collaboratively with the authorities and emergency services to enhance the preparedness (Indicator 13) of the community.

The ‘multi-scalar interaction’ between authorities and the community bolstered the human capacity of Ballater. Coding peaks in Figure 8.50 suggest that through ‘self-organising’ (Indicator 6), the ‘cohesive community’ (Indicator 16) demonstrated ‘flood responsibility’ (Indicator 8) by actioning ‘resourceful’ actions (Indicator 9) as part of their flood resilience plan. Conversely, the Ballater Flood Group was established to understand the events of the winter flooding by holding the authorities to account. ‘Higher-level trust’ (Indicator 18) in authorities was understandably poor at first. However, with time, these relationships strengthened as evidenced in the high ‘multi-scalar interaction’ and ‘trust in authorities’ indicator coding (Figure 8.35). In contrast to the Cumbrian results, a high representation of coding in the ‘learning’ component (Figure 8.35) is indicative of a reflective community which, as discussed, is potentially a consequence of the interviews taking place almost 18 months after the floods. However, the low ‘skills and training’ (Indicator 23) is reflective of the limited financial commitment from Scottish Government towards resilience training. The low ‘Governance’ (Indicator 14) coding further supports this concern.

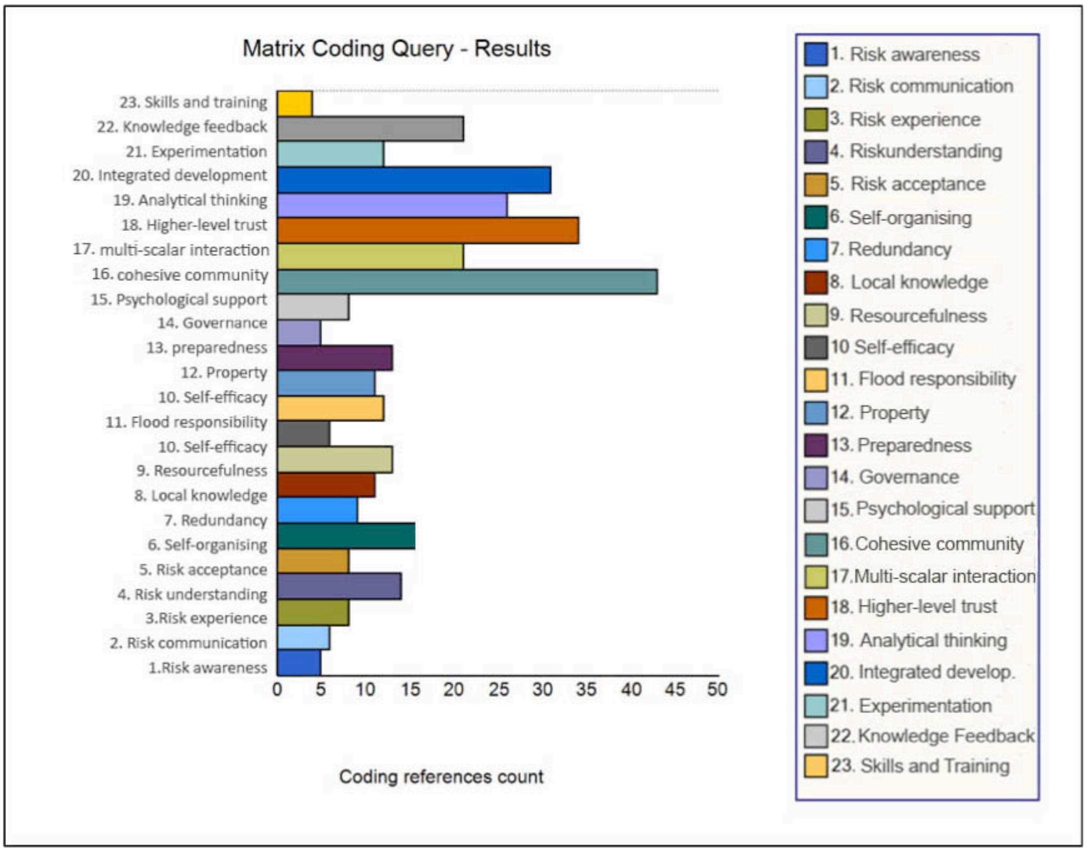

Figure 8.35 Ballater community level resilience indicators.

The ‘economic’ asset in Ballater (Figure 8.36) indicates a reliance on the tourism industry. Many small business, which make up the Ballater economy, were forced to temporarily close with local job losses further compounding the issue. The Ballater Business Group highlighted that small businesses are integral to the functioning of the village and *"need to be part of the community resilience plan"* (B16). Businesses need to build in 'redundancy' (Indicator 7) through continuity plans that assist diversity. Moreover, preparedness (Indicator 12) measures, such as evacuation and business resilience plans, need to be acknowledged as a means of expediting the recovery process.

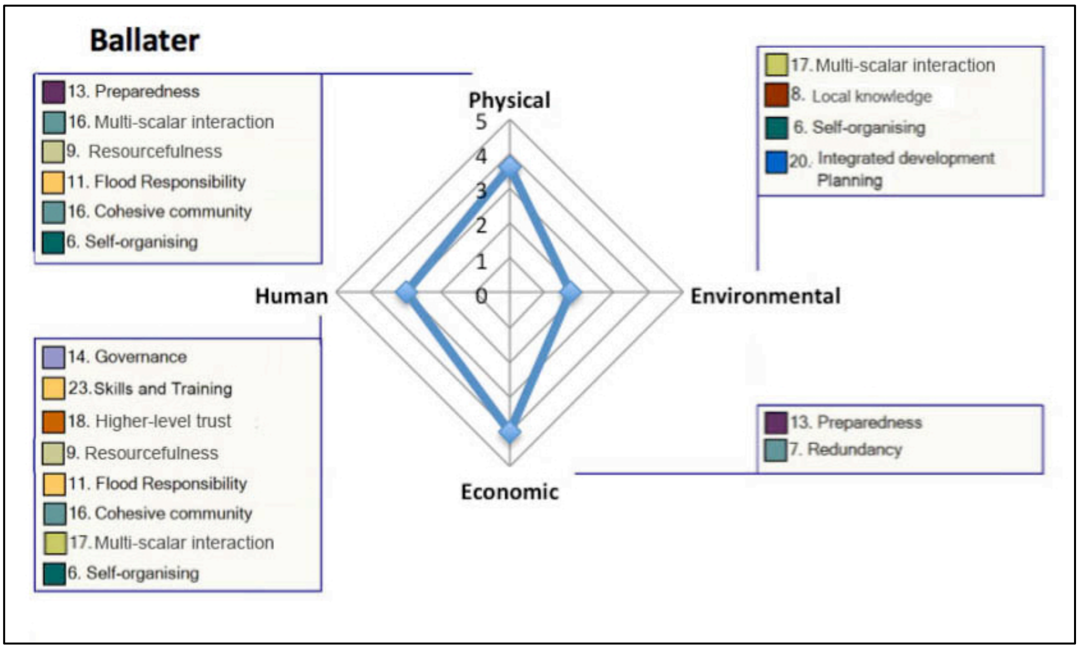

Figure 8.36 Application of Phase 2 indicators to Phase 1 resilience baseline assessment results, Ballater village.

8.9 Conclusion

As a consequence of the lower flood incidence, North-East Scotland displayed lower levels of 'risk awareness' relative to the findings of the Cumbrian case-study (Chapter 7). Consequently, fewer resilience groups were established, however two were founded subsequent to the floods with a 'virtual' resilience group (Inverurie) providing an efficient means to match needs with capacities during the immediate recovery phase. However, physical resilience groups in Ballater and Peterculter at the village and city (suburb) scale, provided evidence of multi-scalar interaction. The benefit of social media extended to the dissemination of flood advice and flood warning. In the absence of a resilience group, social media filled a critical communication gap by acting as an additional flood warning service. The lack of higher-level communication through this medium reduced its potential and made the call for the formalisation of social media as a legitimate resource in the immediate recovery process.

In line with the findings from Cumbria, it was noted that communities with established resilience groups exhibited the highest ‘cohesion’ (Indicator 16), ‘higher-level trust (Indicator 18) and subsequent evidence of ‘multi-scalar interaction’ (Indicator 17). By contrast, interaction with authorities in Aberdeen was largely limited to one-way reliance on the authorities to take responsibility for the flood issue. The lack of self-organisation (Indicator 6) and acceptance of ‘flood responsibility’ (Indicator 11) was found to be attributable to the transient nature of urban areas with high rental tenure and the fact that flooding predominantly occurred in large commercial premises where multi-national owners (with insurance cover) had little personal attachment to the property or area.

The ‘learning’ component was more prominent than in Cumbria, a finding which was attributable to the timing of the interviews almost 18 months into the recovery process and the effective problemising of risk through the medium of resilience groups. In addition, many of the settlements comprised a high percentage of residents who work/worked in the oil and gas industry. The unique skill set acquired by these highly educated residents using *“risk assessments on a daily basis”* (P33) greatly informed the design of the resilience plan with many perceiving that the oil and gas industry was driving demand for housing in flood risk areas. Consistent with findings from Cumbria, ‘integrated planning and development’ (Indicator 20) emerged as a prominent indicator. Seemingly collaboration with authorities, a holistic, catchment-wide approach to flooding comprising both hard and soft strategies is the chosen path forward for North-East Scotland.

CHAPTER NINE

Conclusions

9.1 Introduction

The main focus of this chapter is to present the overall conclusions and key findings emerging from the delivery of the thesis aim, which was to develop a framework to enhance community capacity and build resilience during the recovery and reconstruction phases of a disaster (Section 1.2).

The development of this Framework has been achieved through the fulfilment of four key objectives, namely:

1. to establish a theoretical and conceptual basis for the issues related to post-disaster recovery and reconstruction within the Disaster Management Process (DMP) (Chapter 2);
2. to define the properties that make a community resilient, exploring methods to facilitate capacity development for post-disaster reconstruction of the Built Environment (Chapter 3).
3. to examine the existing post-disaster frameworks, including the extent of integration between top-down planning and bottom-up demands from the recovery to reconstruction phase (Chapter 4).
4. to develop a framework to reconcile the gap between recovery planning and long-term recovery reconstruction. (Chapter 5, 6,7,8).

The development of a resilience Framework resulted in three core outcomes, which will frame the structure for this section. First, the overall conclusions taken from the process of developing a novel, theoretically-anchored framework (Section 9.2). Second, the key findings of both the theoretical and empirical strands of the research (Section 9.3). Third, it reflects on potential future testing of the framework, including: refinement; areas for possible application; and potential methods of evaluation (Section 9.4).

9.2 Overall conclusions

The overall conclusions of the research emerge from the development of a resilience Framework, involving both theoretical (Chapter 2 and 3) and empirical contexts (Chapters 4-8), aligned with the research objectives. From a theoretical perspective, the research identified and analysed a substantial and complex literature base that presented no common definition for the term ‘disaster’ to act as a reference point. As a consequence, there was a need to identify a definition that was appropriate for the purposes of this research. This was achieved through the synthesis of the literature and presented in Section 2.2. Further analysis of the literature also highlighted the significance of the recovery and reconstruction phases in the management of disasters. Chapter 3 analysed the factors considered important for the development and harnessing of community resilience. The research also reviewed the contemporary frameworks for assessing resilience and identified a number of interoperable deficiencies. This research sought to overcome these deficiencies through the development, testing and evaluation of a new conceptual framework for enhancing community resilience (Chapter 4-8). The overall findings emerging from this Framework development are presented below and relate to the following areas: the role of recovery and reconstruction; the community's role in enhancing resilience; and gaps in the existing resilience frameworks.

9.2.1 The role of recovery and reconstruction

In reviewing the knowledge base positioned within a disaster management context (Chapter 2) the research highlights the increased frequency and magnitude of disasters, particularly in urbanised areas and the growing challenges that this poses for those tasked with managing and mitigating the potential impact of disasters. Indeed, as articulated in Section 2.2, these challenges were furthered by the absence of an agreed 'disaster' definition which in turn, inhibited a consistent approach to resilience frameworks. In response to this gap, the thesis sought to define a 'disaster' by reference to the context in which this research is set, within an affected community. A synthesis of literature helped construct a succinct definition, appropriate to the aim of this thesis:

> *an unforeseen event ,derived from natural, partially human or entirely human created sources, causing physical and social disruption which exceeds the capacity of the affected community, rendering them unable to function normally using their own resources.*

This definition characterised a disaster by reference to its agents: natural, man-made or hybrid, and referred to the physical agent (hazard) as well as its impact on society (social), all common elements of other disaster definitions. Importantly, the definition adopted in this research distinguishes between a disaster and a less critical event, with the former characterised as an incident that only constitutes a 'disaster' when the capacity of the community is exceeded and normal life is significantly disrupted.

The examination of the disaster management process (DMP) (mitigation, preparedness, response, recovery/reconstruction) in Chapter 2 (Objective 1.2.1), identified an underexploited 'window of opportunity' within the recovery and reconstruction phase. It became apparent that several factors (increased awareness, proactive planning, increased engagement and funding) can be capitalised upon in the aftermath of a disaster and that, by shifting the emphasis from a 'bounce back' to a 'bounce forward' approach, the disaster recovery period could in fact provide a 'window of opportunity' for the impacted community. Acknowledging the 'window of opportunity' that the post-disaster phases present, the thesis and related analysis was focused upon and situated within the recovery and reconstruction phases.

In practice, and as noted in the literature, it is not always possible for communities to take advantage of the opportunities presented following a disaster event. Evidence of poor co-ordination of actors, communication gaps and a lack of planning were commonly found to act as barriers to long-term recovery (Section 2.5). Further, the reconstruction phase struggled to balance the need for timely reconstruction with long-term resilience development. In response to these challenges, the literature placed reliance on the ability of communities to harness their own capacity and mitigate against such effects as a means of reducing the impact of disasters on society.

9.2.2 Role of the community in enhancing resilience

Enabling community resilience has become a key thread in the literature (Chapter 3; Objective 1.2.2). Through the literature, communities were shown to make significant contributions to disaster recovery and, accordingly, should be viewed as active rather that passive agents in resilience efforts. The literature indicated other additional benefits emerging from community level initiatives, for example use of local knowledge; resources and capacity; cost effectiveness; project ownership and empowerment. However, despite advances in the realisation of the resilience concept, the literature (Section 3.3) highlighted inconsistencies in how the concept is applied in theory, policy and practice. Consequently, the decision was taken to locate the thesis at the community level, so as to identify the characteristics that make a community resilient, and explore methods to facilitate capacity development for post-flooding recovery at the community level (Objective 1.2.2).

9.2.3 Gaps in existing resilience frameworks

A review of extant resilience frameworks (Chapter 4) highlighted inconsistencies in how resilience was assessed and developed at the community level. When the Qualitative Data Analysis package NVivo was used to analyse existing frameworks, a number of potential gaps were identified: a lack of frameworks that were empirically grounded at the community level; limited evaluation of current, post-disaster resilience on an empirical basis; and a limited number of frameworks that were practical in nature (Objective 1.2.3).

To meet the first of these points, the thesis Framework was located at the community level to capture resilience needs often overlooked in top-down frameworks (Section 4.2). In order to address the latter two points, a Framework was developed and practically applied to empirically assess resilience at the community level. A review of existing frameworks identified the most prominent community resilience components as follows: risk; resources and capacities; connectedness and learning. To help take these concepts from theoretical insights to operationalisation, they were used as the underpinning components of the developed Framework (Section 4.6). Basing the case-study analysis on these components, the Framework acted as an analytical tool capable of assessing resilience in practice. The proposed Framework was then applied and validated across three UK case-study regions (Northern Ireland, Cumbria and North-East Scotland), thereby contributing to an empirical assessment of post-disaster community resilience (Chapter 6-8).

After applying the Framework, the highly structured 'Framework Method' of analysis, (most commonly used in medical research) was applied (for the first time) in a disaster resilience context. This pioneering method of structured analysis acts as a significant step forward in the identification of more robust and tangible indicators of resilience, sometimes criticised in the literature for their ambiguous nature (Levine, 2014; Sharifi, 2016). The systematic approach enables the in-depth exploration of data while simultaneously providing a transparent audit trail and ensuring more credible findings (Ritchie and Lewis 2003). Through its application in a number of empirical case-studies, the research documents the application of this rigorous process and highlights its valuable contribution to qualitative methods in this disaster field. In doing so, the research demonstrates the ability of the

'Framework Method' to offer a methodical, flexible and pragmatic approach to data analysis.

The methodical process of staged analysis provided a means to extract empirical indicators of performed/dynamic resilience, resulting in a synthesised list of 23 indicators (Section 8.5, Table 8.10). The list of indicators (Figure 9.1) serves as a knowledge base to draw from and inform long-term resilience-building strategies (Objective 1.2.4). Further, as they are derived from the bottom up, these 23 resilience proxies (indicators) can inform communities of the resources and the capacities required to help build their own resilience. Significantly, the transparent nature of the 'Framework Method' permits easy access to original textual data, which allows others (researchers, community groups etc.) to formulate judgements and agree on appropriate indicators relevant to their particular community context. To this end, the Framework addresses the call for a transition from a theoretical to practical understanding of resilience (NRC, 2012; Levine, 2014; Keating et al, 2015), by offering a practical tool for the empirical analysis of resilience drivers at the local level (Objective 1.2.4). The final list of indicators are presented opposite their framework components in Figure 9.2.

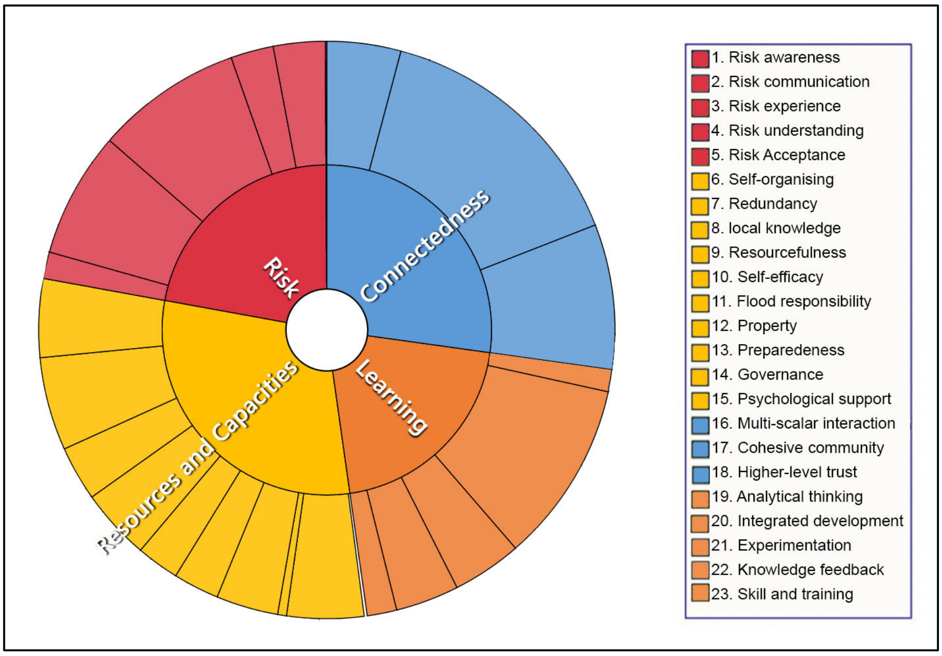

Figure 9.1 Synthesised list of resilience indicators across the three case-studies.

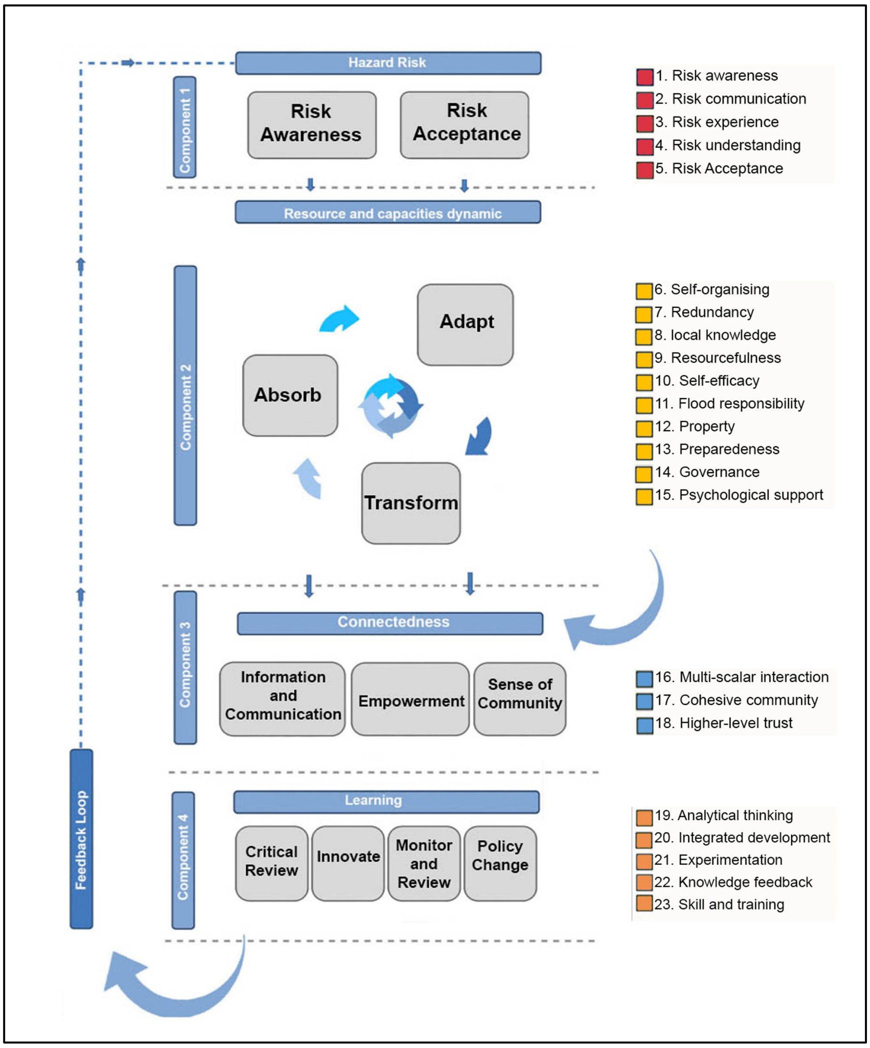

Figure 9.2 Overview of indicators mapped onto framework.

9.3 Key findings

The following section outlines the five key findings from the multi-case application, population and rollout of the thesis Framework. First, the research highlighted the central role risk understanding plays in resilience building and how misinterpretation of ‘risk language’ can reduce resilience. Second, the research revealed nuances between how urban and rural resilience presents itself in practice. Third, the thesis underlines the necessity of a catchment-wide approach to integrated planning and development. Fourth, the research uncovered how ‘learning’ components acted as drivers of transformational resilience, allowing communities not only to return to a stable state but also transform to a more sustainable trajectory. Fifth, the research highlights the capacity for social networks to assist and leverage capacity building and resilience.

9.3.1 The role of 'risk' in resilience building

The research is testament to the need for greater risk awareness as a first step in resilience building activities. Risk awareness and understanding were found to be the pillars of the resilience Framework. In particular, and corroborating evidence from wider resilience studies (Kung and Chen, 2012), this thesis concludes that communities with greater risk experience were more willing to take mitigative action. The research shows that the relationship between risk awareness and subsequent resilience action is dynamic in nature and requires continued refreshing to avoid complacency and the erosion of resilience. The analysis stresses that risk awareness is not a constant asset and requires practice to avoid erosion of 'flood memory'. As such, maintenance of 'risk literacy' through access to risk information, collaborative learning and engagement should remain a key element in any resilience Framework.

The study found risk 'language' to be a key influencer in the way that risks are communicated at the community level. The use of probabilistic language has, for example, given communities a false sense of security through technical terms such as 1-in-100 year chance of a flood. The findings of this thesis across the different regions reveals that such terminology encouraged certain community members to ignore residual risk and purchase properties based on their misinterpretation of the term. The use of percentages within a more relatable time period, such as a forty-year mortgage term, may be a more appropriate means of risk communication. As such, this research identifies the need for greater investment in risk understanding to foster more resilient behaviour.

9.3.2 Urban and rural resilience in practice

A second key finding relates to how resilience presents itself differently at the urban and rural scale. It was found that a variety of factors influence urban and rural resilience levels, including economic capital, practicalities of small-scale communities, remote geographic location, socio-economic profile, government funding priorities and 'volunteer fatigue'. Taking each point in turn, the research confirmed assumptions from Cutter et al (2016) that greater economic capital, typically found in urban areas, led to increased coping capacity relative to small businesses in rural areas. By contrast, limited access to excess resources, coupled with single sector economic dependence, proved a challenge for small businesses continuity in rural areas. Small business owners residing locally often had to contend with the double hit of reconstruction works to their home and business, exacerbating their vulnerability.

Second, by virtue of their smaller scale, coupled with a high degree of local knowledge and tight knit connections, rural communities were found to be more proficient at mobilising resources than their urban counterparts. This capacity was assisted/bolstered in part by village institutions such as the ‘Village hall’ or ‘Legions Club’ (Ballater, Glenridding), which served as spaces to develop mutual understanding, trust and the development of social capital.

Third, it was found that rural communities demonstrated greater adaptive capacity, stemming from a perceived vulnerability as a consequence of their remote geographical location. Isolation from external resources prompted greater adaptive capacity in the form of self-organisation and flood responsibility. Further, prioritisation of urban areas, in terms of public funding for infrastructure, such as flood defences, represented a significant spur to action for rural communities. However, it must be noted that the culture of independence, self-reliance and occasional skepticism of authorities found among rural communities (particularly Glenridding), was also shown to have the potential to inhibit collaborative growth and the effectiveness of potential outside assistance.

Fourth, the economic profile and age demographic of some rural communities helped to catalyse resilience action. It was found that rural communities in comparatively affluent areas (such as Keswick, Ballater), displayed comparatively higher levels of community participation than that of their urban counterparts. The resilience momentum was driven by the higher number of ‘young retirees’ who were active members of FAGs. By contrast, the absence of a community led-catalyst (such as a FAG) in urban areas was found to impede individuals from coming together. In particular, commercial areas with a low residential population were found to have lower cohesion levels than more established (often rural) residential communities. However, urban areas were found to demonstrate stronger institutional resilience by nature of reliance on local or public authorities. Unfortunately, the nature of this engagement was not reciprocal and did not extend to collaborative resilience building at the community level.

Fifth, the prioritisation of Government funded ‘hard’ flood prevention measures was found to be higher in urban areas with higher populations and a greater accumulation of assets. Counter intuitively, the prevalence of hard engineering measures in urban areas was found to limit the potential for FAGs to add 'soft' resilience value.

The sixth and final point relates to the sustainability of FAGs and recovery volunteerism in general in rural areas. Instances of 'volunteer fatigue', where an over-reliance on the 'usual suspects' and 'the same faces', was found to be an issue. This highlights a perceived obligation on rural communities to participate in volunteerism, in order to 'keep the community afloat'. This can, unfortunately, place community members in hazardous situations such as transporting flood evacuees in digger buckets or cutting post-flood debris with a chainsaw in dangerous weather conditions. In addition, 'dry guilt' was found to prompt engagement, placing a perceived onus on those who escaped flooding to assist with the recovery process within their community. As such, the research finds that volunteer expectations and potentially high-risk situations are significant contributors to 'volunteer fatigue' and burn-out, affecting the long-term sustainability of community resilience participation in rural areas.

Importantly, the research contributes empirical evidence to the nuances between how resilience presents itself at the urban and rural scale. Understanding the resilience drivers at both scales stands as an empirical foundation for better targeted, more efficient resilience interventions and wider resilience policy. As such, the findings highlight that the different fabrics of urban and rural communities need to be understood and reflected in resilience policy and strategies.

9.3.3 A catchment-wide approach to planning and development

The third key finding of the study highlights the need for development of a catchment wide approach to planning and development. In view of increased flood exposure across the UK, a shift in thinking was noted, acknowledging that no single strategy to prevent flooding existed. Similarly, practitioner level discourse across the case studies argued the need for a portfolio of 'hard' and 'soft' solutions. Moving beyond traditional flood management practice (flood defences), the findings of the study shows that by promoting measures that work with the natural features and processes of the landscape helps to reduce risk at the local level. However, to date, a lack of empirical evidence has hindered wide-scale implementation of such measures. Whilst the thesis findings do not quantitatively test the benefit of this ‘softer’ approach to flood management, it is apparent that significant appetite for such measures exists with practitioners. Indeed the research findings substantiate the call for a holistic approach to integrated planning and development, thereby enabling flood risk stakeholders to emerge out of their silos to collaboratively explore a portfolio of solutions across the catchment.

One critical barrier to this approach was found to be the community’s reluctance to shift from the ‘safety net’ of flood defences towards a holistic ‘softer’ catchment wide approach to FRM. The results indicate that building trust by strengthening relationships between communities and authorities offset much of this early sceptism and can stand as a critical first step towards acceptance of this approach. In this vein, Flood Action Groups (FAGs) prove a most effective conduit to build trust and shape mind-sets towards collaboratively embracing softer approaches to FRM. Despite these efforts, the research shows that awareness and testing of a portfolio of catchment wide approaches (natural flood management, ‘slowing the flow’, sustainable urban drainage (SuDs) and policy change) are in their infancy and require further development beyond ‘piecemeal’ pilot studies. More data on the benefits of these wider options would make for a more convincing argument and enhance collaboration in such efforts. It is anticipated that long-term catchment-wide approaches have the potential to offer a more cost-effective means of reducing risk, which hold social and environmental benefits also.

Planning enforcement was found to be a crucial element in a catchment wide approach to FRM. Practitioners identified the role of planning policy, and its corresponding control of land-use, as the most significant tool to effectively reduce flood risk. However, a conflict was noted between increasing demand for housing and the preventative approach advocated by authorities to building restrictions in floodplains. Acknowledgment that ‘flooding does not respect county borders’, calls for a break down of the existing siloed approach to planning communication. Ultimately, findings stemming from this research highlight that the absence of a joined up approach to planning and development, significantly attributed to inappropriate planning across catchments.

9.3.4 'Learning' as a driver of transformational resilience

The fourth key finding highlights the role 'learning' plays in assisting communities to 'thrive' rather than 'survive' in response to uncertain environments. Leverage of 'learning' component indicators (analytical thinking; integrated planning and development; experimentation; knowledge feedback; and skills and training) demonstrated the potential for communities to advance beyond the mere reinstatement of the status quo towards an improved state ahead of future disasters. This thread highlighted the need for communities to modify their behaviour to accommodate new knowledge and transform themselves into a more sustainable trajectory ahead of the next adverse event. In particular, the 'problem definition' indicator illuminated the need for communities to self-diagnose through reflection upon their risk experience. Doing so enabled communities to re-orient resilience action to reflect lessons learned, marking a critical step towards resilience betterment.

The case-studies undertaken in this research offered practical insight into how resilience groups or Flood Action Groups (FAGs) presented an effective conduit for innovation, knowledge feedback and up-skilling at the community level. Resilience groups empowered communities to cultivate their own knowledge through self-reflection in collaboration with authorities. However, this process was not without its challenges. Bureaucracy constraints and inflexible governance mechanisms at the regional level were found to impede the learning capabilities at the local level. Constrained by budgets, resources and competing priorities, the transformational culture was not found to be as pervasive at the higher level. As such, this research promotes a 'learning' agenda that responds to uncertain adversity and promotes 'betterment' through implementation of lessons learned.

9.3.5 The role of social networks in disaster recovery

The fifth key finding focuses on the 'connectedness' component of the Framework, revealing the valuable role of social capital in community disaster recovery. In particular, empirical Social Network Analysis (SNA) revealed that the synergistic capabilities of network ties (bonding, bridging and linking) were found to expedite a community's recovery process through: information dissemination; self-organisation; and resource access.

SNA revealed that a strong cohesive foundation of bonding capital was found to be the first step towards the development of ‘connectedness’ interaction. The process of visually mapping networks illustrated that ‘Key brokers’ acted as a lynchpin for successful transition from horizontal bonding connections towards vertical bridging and linking (multi-scalar) interaction. The presence of resilience groups was found to be higher in communities with high bonding capital and a strong cohesive core. Such resilience groups acted as a platform to bridge connections and promote sustained multi-scalar interaction and provided community members with a stake in resilience initiatives, thus increasing interest as flood memory fades. However, strong bonding capital was not always found to have a positive relationship with resilience. Engagement with outside bridging and linking ties was shown to be a slow burn for the more densely networked communities. In particular, isolated rural communities showed reluctance to engage with outside support unless prior links were established through trusted ‘brokers’. As such, the research highlighted that low linking capital (Sections 7.6, 8.6) acted as an impediment to multi-scalar interaction and the attainment of ‘transformative’ resilience. Further, SNA highlighted that over-reliance on one source of capital, or indeed one ‘broker’, risks network collapse. Ultimately, the SNA evidence base suggests that effort needs to be targeted on the development of ‘key brokers’ or ‘Egos’ who establish trust with their community over time. Bridging this link between horizontal and vertical ties, helps to access greater resources, and paves the way for the successful implementation of transformative strategies.

SNA also revealed the important role social media played in connecting communities. Mined data from social media platforms (Facebook and webpages), were imported into network visualization software (Gephi) to analyse network connections. The network maps revealed that ‘virtual’ social networks form an added layer of communication beyond the typical, top-down approach to formal communication in the post-disaster environment. In particular, it provided an alternative, timely means to connect communities, which felt that formal communication strategies were lacking. The SNA within this study clearly highlighted the ability of social media to efficiently disseminate information and match urgent need with capacities. However, the nature of their establishment leaves a question over the long-term sustainability of the connections. The transformation of this virtual group into a functional long-term community will require formalisation to ensure its sustainability when the catalyst for its establishment fades. In addition, concerns were raised over monitoring the reliability of data through a designated administrator. These issues will need to be resolved before higher-level engagement from risk averse authorities is likely.

Analysis of 'virtual' networks in Gephi revealed that social media has the ability to reach a wider audience than physical communities, particularly in dispersed rural communities. Reflecting findings from Chapter 3 that no community is homogenous, communication strategies should be tailored to the community for which it is intended. As such, social media should not be considered a panacea for recovery communication. Rather, it should be considered as an extra layer of resilience to complement existing, more formal communication strategies.

The results from this study underscore the need to invest in the 'social infrastructure' of communities. A combination of resilience groups/FAGs and social media groups offer a suitable means to bridge local-level needs and national-level policymaking. In addition, social media has proven to offer a timely means of communication during disaster recovery, and should be recognised as a valuable complement to formal communication strategies. This thesis has illuminated how empowered, cohesive communities can enhance their transformative capacity through collaboration with higher-level ties, thus ensuring national policies echo local needs and priorities.

9.4 Future research

Building on this research, further areas for potential study have been identified. Firstly, wider application of the Framework would help to generate a database of consistent, empirically grounded resilience indicators, enabling greater comparison across communities. It is, however, critical that the Framework is implemented at the appropriate scale to ensure transparent, accurate data set. In this regard, the research found that low engagement in urban community resilience was partly attributable to the diffuse nature of boundaries in urban areas, making it difficult to identify an appropriate 'community' scale for collaborative resilience activity. For example, the suburb of Peterculter in Aberdeen, stands as an example of an administratively titled urban city, but whose façade masks a former village up until 2006. Far removed from the cultural institutions of the city centre, Peterculter acted like a 'village within a city', owing in part to the residual 'village' institution of the 'Village Hall' and 'Cutter Mills Social Club'. Peterculter therefore represents a cohesive 'urban village' within a city, where investment in community organisational structures at the urban scale, helped promote community engagement.

The Framework can also serve as a scalable approach to resilience building which, with minor adaptation, has the potential to be applied across multiple hazards. To promote wider use of the Framework, the data could be augmented by the development of a user-friendly web platform to serve as central point to collect, store and share this indicator data. This evidence base could serve as a building block towards the development of resilience strategies relevant to different scales (local, regional, national) and contexts (urban, rural). In the long-term, embedding guidelines and best practices within the platform design could serve to strengthen the Framework.

Secondly, the investigation shed light on the demand for resilience standards in the built environment. In particular, 'property and accommodation' (Indicator 13) highlighted a need for assistance and guidance on appropriate resilience approaches and measures. The research highlighted that current property level protection plans are reactive and do not meet the long-term demands of increasing risk. Existing studies on resilience standards are in their infancy and require further investment to advance from a situation of expert opinion to technical evidence.

Cooperation from industry, including built environment professional bodies such as the Royal Institute of British Architects (RIBA), Institute of Civil Engineers (ICE), Royal Institution of Chartered Surveyors (RICS), could strengthen the argument for increased investment in resilience standards. In the absence of resilient building guidance, the development of resilience building regulations and, in due course, broader guidance would benefit design professionals faced with renovating at-risk properties.

The research identified current insurance processes as a barrier to resilience by discouraging mitigative action, such as property level protection. However, if the financial benefit of resilience standards is not calculated, then insurance companies are not in a position to incentivise clients through reduced premiums in exchange for meeting resilience standards. Clear articulation of monetary benefit attached to resilience standards could serve as a positive step towards acceptance of a standards agenda by insurance companies.

As such, this thesis highlights how improved resilience standards within the built environment, could act as a benchmark for 'betterment' ahead of future disasters. Such 'resilience standards' could vary in scale from certificates, building codes and resilient products at the household scale, towards wider benchmarking systems and resilience design guidelines to foster resilient communities. Going forward, parallels could be drawn from sustainability accreditation such as Building Research Establishment Environmental Assessment Method (BREEAM). Such resilience benchmarking structures could serve as a means of assessing, rating and certifying the resilience of buildings. The development of resilience standards, therefore, has the potential to foster a long-term, proactive approach to resilience 'betterment' in the built environment.

Thirdly, it was found that more work is needed to further unpack the critical role of 'learning' in enabling communities to transform into a more sustainable trajectory ahead of future disasters. Whilst this study and others (Kelman, 2016; Parsons et al, 2016) have added to the argument for investment in 'learning', little is known about the exact triggers that prompt communities to transition from a state of coping towards adaptation and eventual transformation.

The investigation highlighted that the extent of learning undertaken by a community is closely linked to their 'risk experience' over time. However, the time constraints of a PhD study did not allow this research to be truly longitudinal. As such, the findings highlight the necessity for further investigation into 'learning' triggers that foster resilience building over longer periods of time. Specifically, research is needed to understand the triggers that drive change at the different scales.

Finally, a fourth area of further research is the potential for social media to enhance recovery communication. Removing the constraints of time and geography, social media has been shown to have the potential to galvanise community networks. In addition to the preservation of existing ties, interaction through social media offers potential to forge new connections otherwise untapped by traditional communication strategies.

Increased use of information technology and communication through for example, mobile phones, and tablets and PCs has surpassed the use of traditional media forms such as television and radio. Creation of online, wider communication channels, unrestricted by geographical boundaries, act as an added layer of 'connectedness' to build more resilient communities. Going forward, failure to leverage the potential of this rapidly developing communication medium could prove detrimental to the future of disaster communication. In particular, the research highlighted a lack of higher-level participation in social media. There is currently an absence of guidance on how to harness the potential of social media in a systematic, coordinated manner. The findings from this research, for example, highlight the reluctance of practitioners to engage with social media (which would benefit from further research). Going forward, the development of strategic guidelines for practitioners could help to encourage greater uptake of social media tools in disaster management.

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APPENDIX 1

Appendix 1: Existing Disaster databases

As outlined in Chapter 2 (Section 2.3), three main electronic databases dominate the global disaster data coverage, namely; Sigma; NatCAtSERVICE; and CRED (Table 4.12). The 'Sigma' database, which covers both man-made and natural catastrophe losses, was established in 1970 by reinsurer Swiss Re. Munich Re's NatCatSERVICE was established closely after in 1974, seeking to build on earlier disaster loss databases. Its focus lies on natural disasters (Munich Re, 2003), with historical data going back to the eruption of Mount Vesuvious in AD 79. The Centre for Research on the Epidemiology of Disasters (CRED) at Louvain University in Belgium is potentially the most recognised database, dominating the literature. EM-Dat developed its Emergency Events Database in 1988 with the backing of the World Health Organisation (WHO) and the Belgian Government (CRED 2010). At a Europe-wide level, several initiatives have or are currently being developed to meet the standardisation of the disaster data gap. However, attempts to systemise data from organisations, such as various European Commission co-funded projects are still in their infancy.

The standardised entry criteria and methodologies used by the above databases only allow for comparison at a global and national level. However, the information available for disaster impacts at lower, sub-national level or for smaller scale disasters is not detailed enough to enable comparison at this level. Given that the thesis is located at the community level, these databases are not useful for informing disaster indicators for the purposes of this research. As such, in line with the selection of indicators approach taken by Cutter et al (2008), the research identifies resilience variables already existing within framework literature.

Table 1.1 Overview of existing disaster databases globally.

Database	**Organisation**	**Created**	**Geographic coverage**
Global			
EM-DAT	CRED	1500-present	Global
Disaster Inventory System	UNISDR.	1994-present	Global (partial)
SIGMA	SwissRe	1970-present	Global
GFDRR Global DL- DAT	World Bank	1972-present	Global
Global-disaster specific			
Global Active Archive of Large Flood Events	DFO	1985-present	Global
Significant earthquake database	USGS	1977-present	Global

Cambridge Earthquake Impact Database	Cambridge Architectural Research LTD	1906-present	Global
Europe			
EFIS European Forest Fire Information System	EC Joint Research Centre (JRC)	1980-present	Europe
DIS-ALP Event Database	Federal Ministry of Agriculture forestry, Environment and Water Management	1800-2010	Austria, Slovenia, Italian Alps, Bavarian Alps, Swiss Alps.
PREEMPT	FEEM	2000-2010	Belgium, Germany, Italy, Spain

APPENDIX 2

Appendix 2: List of asset/resource variables for the three case-studies

2.1 Example of individual variables in the context of Northern Ireland.

Phase 1 variables selected for the three case-studies (Northern Ireland; Cumbria and North East Scotland). Variance in data sources used are highlighted in bold.

Table 2.1 Example of individual variables in the context of Northern Ireland.

Community Asset:	**Variable**	**Data source**
1. Physical resource		
Exposure	**Flood risk from rivers AEP**[44]	Rivers Agency historical flood zones (DfI)***1**
	Flood risk from surface water AEP	Rivers Agency historical flood zones (DfI) ***1**
	Tidal flood risk AEP	Rivers Agency historical flood zones (DfI) ***1**
Access to services	**Proximity to services score**	Income: Multiple Deprivation Measure 2017**.*2**
	% of people working further than 30k from home	UK Census, 2011 ***3**

Community Asset:	**Variable**	**Data source**
2. Environmental resource		
Environmental exposure	**Shortfall of playing pitches**	Sport Northern Ireland's (SNI) ***4**
	No. of public parks in 1 mile radius	Belfast city council/ Fermanagh and Omagh District Council ***5**
	Living Environment domain	Environment: Model- Multiple Deprivation Measure 2017 ***2**

Community Asset:	**Variable**	**Data source**
3.Economic resource		
Livelihood stability	% of working age that is employed	Census 2011
	% unemployed	Census 2011 /Labour market report 2017. (NISRA - Economic and Labour Market Statistics)
Income	**Income Deprivation domain**	Multiple Deprivation Measure 2017 ***2**

[44] Annual exceedance probability (AEP), where 1:30 is a 3.3 % of flooding in any one year.

	Employment Deprivation domain	Multiple Deprivation Measure 2017 ***2**
Tenure	% households owner occupier	Census 2011

Community Asset:	Variable	Data source
4. Human resource		
Community capacity	% of population over the age of 65	UK Census 2011
	% of population <15	UK Census 2011
	% of population stated general health was good or very good	UK Census 2011
Equity	% of college degree or higher ((Level 4 or above)	UK Census 2011
	% of population with no or low qualifications (L1)	UK Census 2011
	Education, skills and training rank	Multiple Deprivation Measure 2017 ***2**
Social capital	**Crime and disorder rank**	Multiple Deprivation Measure 2017 ***2**
	% voter participation in last election	Elections NI (2017) ***6**
Local knowledge	% from outside the area	UK Census 2011

Table 2.1b Variable data sources, Northern Ireland.

#	Variable data set
1.	Rivers Agency historical flood zones (DfI). https://dfi-ni.maps.arcgis.com/apps/webappviewer/index.html?id=fd6c0a01b07840269a50a2f596b3daf6 (Accessed on 01.01.18)
2.	Northern Ireland Multiple Deprivation Measure 2017, LSOA Level, Office of National Statistics. http://www.ninis2.nisra.gov.uk/InteractiveMaps/Deprivation/Deprivation%202017/SOA_Deprivation_Map/atlas.html (Accessed on 01.01.18)
3.	UK Census data (2011). Northern Ireland Statistics and Research agency. https://www.nisra.gov.uk/statistics/census/2011-census (Accessed on 01.01.18)

4.	Sport Northern Ireland's (SNI), Active Places Report (2009). http://www.sportni.net/facilities/develop-a-sports-facility/does-my-area-need-a-new-sports-facility/ (Accessed on 01.01.18)
5.	Belfast city council, Fermanagh and Omagh District Council. http://www.belfastcity.gov.uk/leisure/parks-openspaces/parksAtoZ.aspx. (Accessed on 01.01.18)
6.	Elections NI. http://electionsni.org.s3-website-eu-west-1.amazonaws.com (Accessed on 01.01.18)

Table 2.2. Example of individual variables in the context of Cumbria.

Community Asset:	Variable	Data source
1. Physical resource		
	Flood risk from rivers or the sea *2	Environment Agency, Long-term flood risk maps
	Flood risk from surface water *2	Environment Agency, Long-term flood risk maps
	Flood risk from reservoirs *2	Environment Agency, Long-term flood risk maps
Access to services	**Barriers to housing and services rank *3**	Income: Multiple Deprivation Measure 2011.*4
	% of people working further than 30k from home	UK Census, 2011.

Community Asset:	Variable	Data source
2. Environmental resource		
Environmental exposure	**Number of public parks per 1 mile radius**	Cumbria County Council *5
	Living Environment rank *3	English Indices of Deprivation 2015.*4

Community Asset:	Variable	Data source
3. Economic resource		
Livelihood stability	% of working age that is economically active	UK Census 2011
	% population unemployed	UK Census 2011
	Employment Rank*3	English Indices of Deprivation 2015.

	Income rank*3	English Indices of Deprivation 2015.
Tenure	% households owner occupier	UK Census 2011

Community Asset:	Variable	Data source
4. Human resource		
Community capacity	% of population over the age of 65	UK Census 2011
	% of population <15	UK Census 2011
	% of population stated general health was 'good' or 'very good'	UK Census 2011
	Health deprivation and disability rank *3	English Indices of Deprivation 2015.
Equity	% of college degree or higher (Level 4 or above)	UK Census 2011
	% of population with no qualifications	UK Census 2011
	Education, skills and training rank *3	English Indices of Deprivation 2015.
Social capital	**Crime rank *3**	English Indices of Deprivation 2015.
	% voter participation in last election *5	Cumbria County Council (2017) *6
Local knowledge	% from outside the area	UK Census 2011

Table 2.2b Variable data sources, Cumbria.

#	Variable data set
1.	Environment Agency, historical flood zone maps**. http://apps.environment-agency.gov.uk/wiyby/151367.aspx** (Accessed on 01.01.18)
2.	English Indices of Deprivation 2015, LSOA Level, Office of National Statistics. http://dclgapps.communities.gov.uk/imd/idmap.html (Accessed on 01.01.18)
3.	UK Census data (2011). UK data service Census. http://www.ukcensusdata.com/england-e92000001#sthash.LyekO134.dpbs (Accessed on 01.01.18)
4.	Cumbria County Council**,** Parks and Green Space. **http://www.cumbria.gov.uk/az.asp?filter=P** (Accessed on 01.01.18).
5.	UK Electoral Commission https://www.electoralcommission.org.uk/our-work/our-research/electoral-data (Accessed on 01.01.18)

Table 2.3 Example of individual variables in the context of North East Scotland.

Community Asset:	Variable	Data source
1.Physical resource		
	Number of properties exposed to river flooding return period: 1 in 100	SEPA Potentially Vulnerable Areas NFRA ***1**

	year	
	Number of properties exposed to surface water flooding return period: 1 in 100 year	SEPA Potentially Vulnerable Areas NFRA ***1**
	Number of properties exposed to coastal water flooding return period: 1 in 100 year	SEPA Potentially Vulnerable Areas NFRA ***1**
	SEPA Flood Priority	SEPA Potentially Vulnerable Areas NFRA***1**
Access to services	**Geographic access to services**	Scottish index of Multiple Deprivation 2016 ***2**

Community Asset:	**Variable**	**Data source**
2. Environmental resource		
Environmental exposure	**Parks per 1 mile radius**	Open space Audit , Aberdeenshire Council/Aberdeen City Council ***3**
	Land cover map Scotland-% urban land cover	Eunis Land Cover map Scotland ***4**

Community Asset:	**Variable**	**Data source**
3.economic resource		
Livelihood stability	% of working age that is economically active	Scotland's Census 2011 ***5**
	% economically inactive	Scotland's Census 2011
	Income domain rank	Multiple Deprivation Measure 2015 ***2**
	Employment domain rank	Multiple Deprivation Measure 2015 ***2**
Tenure	% renting	Scotland's Census 2011
	% households owner occupier	Scotland's Census 2011

Community Asset:	**Variable**	**Data source**
4. Human resource		
Community capacity	% of population over the age of 65	Scottish Census 2011
	% of population <16	Scottish Census 2011
	% of population stated general health was good	Scottish Census 2011
	Health domain rank	Multiple Deprivation Measure 2010 ***2**
Education	% of college degree or higher (Level 4 or above)	Scottish Census 2011
	% of population with no or low qualifications (L1)	Scottish Census 2011

	Education, skills and training domain rank	Multiple Deprivation Measure 2016 ***2**
Social capital	**Crime domain rank**	Multiple Deprivation Measure 2016 ***2**
	% pensioner households	Scottish Census 2011
	% voter participation in last election	Aberdeenshire County Council (2017) ***6**
Local knowledge	% from outside the area	Scottish Census 2011

Table 2.3b. Variable data sources, North East Scotland.

#	Variable data set
1.	Scottish Environment Protection Agency (SEPA), Potentially Vulnerable Areas NFRA ***1.** **http://map.sepa.org.uk/floodmap/map.htm/** **http://map.sepa.org.uk/nfra/map.htm** (Accessed on 01.01.18)
2.	Scottish Index of Multiple Deprivation 2016. http://simd.scot/2016/#/simd2016/BTTTFTT/9/-4.0000/55.9000/(Accessed on 01.01.18)
3.	Aberdeenshire Council open Space Audit. https://www.aberdeenshire.gov.uk/communities-and-events/parks-and-open-spaces/open-space-strategy-audit/ https://www.aberdeencity.gov.uk/services/environment/open-space-audit (Accessed on 01.01.18)
4.	Scottish Census data explorer (2011). http://www.scotlandscensus.gov.uk (Accessed on 01.01.18)
5.	Eunis Land Cover map Scotland (Scotland's Environment web): https://map.environment.gov.scot/sewebmap/?layers=eunisLandCoverScotland,natWoodSurvey,habmosNVCToAnnexIAndEUNIS,HabVegSurvey1,saltmarshSurvey1,habmos-OtherLanduse,coastalVegShingle1&extent=-245528,573191,665472,1169192 NIS,HabVegSurvey1,saltmarshSurvey1,habmos-OtherLanduse,coastalVegShingle1&extent=-245528,573191,665472,1169192. (Accessed on 01.01.18)

2.2 Northern Ireland worked example, village scale.

Table 2.4: Phase 1 ‘Human’ resource, in the context of Kendal town.

Community Asset:	**Variable**	**Fintona**	**Data source**
3. Economic resource			
Livelihood stability	% of working age that is employed	0.6	Census 2011
	% unemployed	0.2	Census 2011 /Labour market report 2017. (NISRA - Economic and Labour Market Statistics)
Income	**Income Deprivation domain *4**	0.1	Multiple Deprivation Measure 2017 *4
	Employment Deprivation domain *4	0.1	Multiple Deprivation Measure 2017 *4
Tenure	% households owner occupier	0.6	Census 2011
Aggregated score per resource		**2.3**	**Total asset score (scale 1-5)= 1.9**

<u>Variable 1:</u>

Community Asset:	**Variable**	**Assumption**	**Data source**	**East Belfast**
3. Economic resource				
Livlihood stability	% of working age that is employed	The higher the % of population the greater the economic resource.	Census, 2011.	**0.6**

Table KS402NI of the NI Census 2011 found that 61% of all residents in Fintona ‘owned’ their property, either outright or through a mortgage or loan.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0

Max: Maximum value of the given attribute. Max is 100
V: V is the respective value of attribute. V=61
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.61, rounded off to 0.6, which remains constant, when converted.

Variable 2:

Community Asset:	Variable	Assumption	Data source	East Belfast
3. Economic resource				
Livlihood stability	% of working age that is unemployed	The higher the % of population that is unemployed the lower the economic resource. (This variable is inverted)	Census, 2011.	0.2

According to the Census (2011), the % that never worked/ long term unemployed (Economic Activity - KS601NI) was found to be 6.3%. The highest unemployment rate in northern Ireland was found to be 7.53% (max) and the minimum was found to be 3.2% (min).

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - \ Min\ marks}(newMax - \ newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 3.26
Max: Maximum value of the given attribute. Max is 7.53
V: V is the respective value of attribute. V=6.3%
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.83, rounded off to 0.8. However, when reverse percentage is applied (i.e low unemployment equates to high resilience) then the new score equals 0.2, when converted.

Variable 3:

Community Asset:	Variable	Assumption	Data source	East Belfast
3. Economic resource				
Income	Income Deprivation domain	The higher the income domain rank, the greater the resilience.	Multiple Deprivation Measure 2017	0.1

The Income Deprivation domain forms one of the seven domains of deprivation. The indicator assesses the proportion of the population living in households with incomes below 60 per cent of the NI median (NIMDM, 2017). The indicators range from 1 (most deprived) to 890 (least deprived) (NIMDM, 2017). The rank for the Fintona area (95YY11W1) was found to be 99.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin) + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 890
V: V is the respective value of attribute. V=99
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.11, rounded off to 0.1.

Variable 4:

Community Asset:	**Variable**	**Assumption**	**Data source**	**East Belfast**
3. Economic resource				
Income	Employment Deprivation domain	The higher the Employment domain rank, the greater the resilience.	Multiple Deprivation Measure 2017	0.1

The Employment Deprivation domain forms one of the seven domains of deprivation. The indicator assesses the proportion of the population living in households with incomes below 60 per cent of the NI median (NIMDM, 2017). The indicators range from 1 (most deprived) to 890 (least deprived) (NIMDM, 2017). The rank for the Fintona area (95YY11W1) was found to be 126.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin) + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 890
V: V is the respective value of attribute. V=99
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.14 rounded off to 0.1.

Variable 5:

Community Asset:	Variable	Assumption	Data source	East Belfast
3. Economic resource				
Tenure	% households owner occupier	The higher the % of home ownership the higher the economic resource.	Census 2011	0.6

The final variable in the Economic resource, assesses the % of households owner occupier. This figure stands at 63.78% according to Table: Tenure and Household, KS402N1 (Census, 2011).

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 100
V: V is the respective value of attribute. V=63.78
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.64.9 and rounded off to 0.6.

2.3 Cumbria worked example, town scale.

Table 2.5 Phase 1 'Human' resource, in the context of Kendal town.

Community Asset	Variable	Kendal	Data Source
4. Human resource			
Community capacity	% of population over the age of 65	0.3	UK Census 2011
	% of population <15	0.9	UK Census 2011
	% of population stated general health was 'good' or 'very good'	0.8	UK Census 2011
	Health deprivation and disability rank *3	0.8	English Indices of Deprivation 2015.
Equity	% of college degree or higher (Level 4 or above)	0.9	UK Census 2011
	% of population with no qualifications	0.4	UK Census 2011
	Education, skills and training rank *3	0.7	English Indices of Deprivation 2015.
Social capital	**Crime rank *3**	0.6	English Indices of Deprivation 2015.
	% voter participation in last election *5	0.4	Cumbria County Council (2017) *6
Local knowledge	% from outside the area	0.9	UK Census 2011
Aggregated score per resource		**3.4**	

Variable 1:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	% of population over the age of 65	The higher the population over 65, the potentially lower the resilience capacity.	UK Census, 2011	0.3

The highest % population above the age of 65 in the UK stands at 28.05% (Sussex County council, 2011). The UK Census 2011 found that 19.7% of residents in Kendal were above the age of 65.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 28.05
V: V is the respective value of attribute. V=19.7%
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.70 and is inverted to 0.3.

Variable 2:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	% of population <15	Young, active and healthy communities are characteristics associated with resilient communities. Access to a vehicle further enhances a community's resilience capacity.	UK Census, 2011	0.9

The UK Census 2011 found that 17.2% of residents in Kendal were under the age of 15. The maximum percentage of population under 15 across England was found to be 19%.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 19
V: V is the respective value of attribute. V=17.2
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.90, rounded off to 0.9.

Variable 3:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	% of population with 'very good' or 'good' health.	Young, active and healthy communities are characteristics associated with resilient communities.	UK Census, 2011	0.8

According to the UK Census (2011), 82.2% of the Kendal population had 'very good' or 'good' health.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - \ Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 100
V: V is the respective value of attribute. V=82.2
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.82, rounded off to 0.8.

Variable 4:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	**Health deprivation and disability rank**	Young, active and healthy communities are characteristics associated with resilient communities.	UK Census, 2011	0.8

According to the Index of Multiple Deprivation (IMD, 2015) Kendal (South Lakeland 003C) ranks 25,093 out of 32844 LSOA's in terms of health deprivation and disability.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 32844
V: V is the respective value of attribute. V= 25,093
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.76, rounded off to 0.8.

<u>Variable 5:</u>

Community Asset:	**Variable**	**Assumption**	**Data source**	**Kendal town**
1. Human resource				
Community capacity	% of college degree or higher (Level 4 or above)	Knowledge and skills enable a community to adapt to uncertainty.	UK Census, 2011	0.7

According to the UK Census (2011) 29.1% of the population have a Level 4 or above qualification. The highest percentage of Level 4 and above qualifications across England was found to be 43.9% (max) (Census, 2011)

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 43.9%
V: V is the respective value of attribute. V=29
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.66, rounded off to 0.7.

Variable 6:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	% of population with no qualifications	Knowledge and skills enable a community to adapt to uncertainty.	UK Census, 2011	0.6

According to the UK Census (2011) 21% of the population have no or low Level 1 qualifications. The highest % of unqualified residents across England was found to be 37.23.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 37.23
V: V is the respective value of attribute. V=21
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.56, rounded off to 0.6 and inverted to 0.4

Variable 7:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	**Education, skills and training rank**	Knowledge and skills enable a community to adapt to uncertainty.	UK Census, 2011	0.7

According to the Index of Multiple Deprivation (IMD, 2015) Kendal (South Lakeland 003C) ranks 23,411 out of 32844 LSOA's in terms of health deprivation and disability.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - \ Min\ marks}(newMax - \ newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 32844
V: V is the respective value of attribute. V=23411
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.71, rounded off to 0.7.

Variable 8:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	**Crime and disorder rank**	Social capital is evidenced to produce synergistic resilience action. This is referred to in the literature as the 'social infrastructure' needed to effectively mobilise essential.	UK Census, 2011	0.6

According to the Index of Multiple Deprivation (IMD, 2015) Kendal (South Lakeland 003C) ranks 19,863 out of 32844 LSOA's in terms of crime and disorder rank.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - \ Min\ marks}(newMax - \ newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 32844
V: V is the respective value of attribute. V= 19,863
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.60, rounded off to 0.6.

Variable 9:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Community capacity	**% voter participation in last election**	High voting rate is indicative of a tight-knit community, willing to work collaboratively with community residents.	Kendal Town Council (2016)	0.4

According to a Hansard Society report (2015) the lowest % of recorded voters nationally was 12% and the highest percentage was 76.9%. Kendal had a voting turnout of 39.7%.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin) + newMin$$

Min: Minimum value of the given attribute. Min is 12
Max: Maximum value of the given attribute. Max is 76.9
V: V is the respective value of attribute. V=39.7
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.36, rounded off to 0.4.

Variable 10:

Community Asset:	Variable	Assumption	Data source	Kendal town
1. Human resource				
Local knowledge	% from outside the area	Local knowledge is higher in established communities.	UK Census 2011	0.9

According the census (2011), only 1.6% of all Kendal residents are from outside the area compared to 13% nationally.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin) + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 13
V: V is the respective value of attribute. V=1.6
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.12, rounded off to 0.1 and inverts to 0.9.

Table 2.6. Phase 1 'Physical' resource in the context of Ballater.

Community Asset:	Variable	Assumption	Data source	Ballater
1. Physical asset				
Exposure	**River flooding return period: 1 in 100 year *1**	The higher the number of properties at risk, the higher the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	0.8
	Surface water return period 1 in 100 year	The higher the number of properties at risk, the higher the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	1.0
	Coastal flood return period 1 in 100 years *1	The higher the number of properties at risk, the higher the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	N/A
	SEPA Flood Priority	The higher the priority the greater the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	0.5
Housing	**Housing domain rank *2**	This variable represents the sum of people in households that are overcrowded or have no central heating. Such conditions are assumed to impede relocation and subsequent recovery after a flood.	Scottish index of Multiple Deprivation 2016	0.5
Physical access	% of people working further than 30k from home	The higher the number of people travelling long distances to place of work or study, the more vulnerable the population	Scotland's census	0.8
Aggregated score per resource[45]				**3.6**

[45] Score (0 least resilient, 1 most resilient)

As per Min-Max normalization technique,

$$\boxed{v' = \frac{v - \min_A}{\max_A - \min_A}(new\_\max_A - new\_\min_A) + new\_\min_A}$$

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin) + newMin$$

Where,

Min: Minimum value of the given attribute.
Max: Maximum value of the given attribute.
V: V is the respective value of attribute.
newMax: 1
newMin: 0

By means of explanation, this section will outline the long-hand process of normalization and aggregation of data for the 'Physical' community asset, as shown in Table 8.1 above.

Variable 1:

Community Asset:	**Variable**	**Assumption**	**Data source**	**Community-Ballater**
1. Physical asset				
Exposure	**Number of properties exposed to river flooding return period: 1 in 100 year *1**	The higher the number of properties at risk, the higher the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	0.8

Flood exposure is represented by the percentage of properties that are potentially affected by flooding within each community. This was deemed more representative than the proportion of the land surface of the community potentially affected by coastal or fluvial flooding. For example, a community may have a large land area, potentially affected by flooding, but this land area may not be associated with housing.

All case studies were chosen as they are affected by flooding and, as such they all lie within Potentially Vulnerable Areas (PVA) as part of the National Flood Risk Assessment carried out by SEPA. The number of properties at risk within each PVA area were obtained from the NFRA as outlined by SEPA[46]. This figure includes both residential and commercial properties.

The 'max' number (960) was derived from the total population within the PVA. Of this max figure, 237 of the properties are at risk from flooding.

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 960
V: V is the respective value of attribute. V=237
newMax: 1
newMin: 0

After application the results yield a figure of 0.24 rounded down to 0.2. However, the lower the figure (%), the higher the resilience. This meant that the figure had to be inverted and became 0.8 on the scale.

Variable 2:

Community Asset:	**Variable**	**Assumption**	**Data source**	**Community-Ballater**
1. Physical asset				
Exposure	**Surface water return period 1 in 100 year**	The higher the number of properties at risk, the higher the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	1.0

Of the 960 properties in Ballater, 3 (1% of all flooding) are at risk from flooding as outlined by SEPA on their flood maps and stated by SEPA in the PVA areas[47].

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 960
V: V is the respective value of attribute. V=3
newMax: 1
newMin: 0

46 http://apps.sepa.org.uk/FRMStrategies/pdf/pva/PVA_06_22_Full.pdf
47 http://apps.sepa.org.uk/FRMStrategies/pdf/pva/PVA_06_22_Full.pdf

After application the results yield a figure of 0.03 rounded down to 0. However, as with the previous example, the figure then needed to be inverted, giving Ballater a score of 1.0 rounded up.

Variable 3

Community Asset:	Variable	Assumption	Data source	Community- Ballater
1. Physical asset				
Exposure	**Coastal flood return period 1 in 100 years *1**	The higher the number of properties at risk, the higher the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	N/A

Ballater community lies inland and, as such, applying a score to this variable would artificially inflate the resilience of the area.

Variable 4

Community Asset:	Variable	Assumption	Data source	Community- Ballater
1. Physical asset				
Exposure	Potentially vulnerable area (PVA) priority rank.	The higher the priority the greater the resilience exposure.	SEPA Potentially Vulnerable areas, NFRA.	**0.5**

This variable refers to areas which are acknowledged to be at a significant risk of flooding now or is likely to flood in the future. Ballater is ranked 90 out of 168 PVA nationally (North East Local Plan District, 2016).

Applying the formula:

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 168
V: V is the respective value of attribute. V=90
newMax: 1
newMin: 0

Once applied the formula yields a result of 0.53, rounded off to 0.5, which remains constant, when converted.

Variable 5

Community Asset:	Variable	Assumption	Data source	Community-Ballater
1. Physical asset				
Housing	**Housing domain rank *2**	This variable represents the sum of people in households that are overcrowded or have no central heating. Such conditions are assumed to impede relocation and subsequent recovery after a flood.	Scottish index of Multiple Deprivation 2016	0.5

This variable is drawn from the housing indices of deprivation. The indices rank each datazone from 1 being most deprived to 6,505 being least deprived. The domain score is a simple percentage, drawn from the Scottish Index of Multiple Deprivation (SIMD)[48] housing rank. Ballater is represented by the two data zones: (S01006789) and (S01006790) as shown in Figure 8.1 below. Their housing domain ratings of 3731 and 2500.5 had a combined average of 3115 (3731+2500.5 ÷2= 3115).

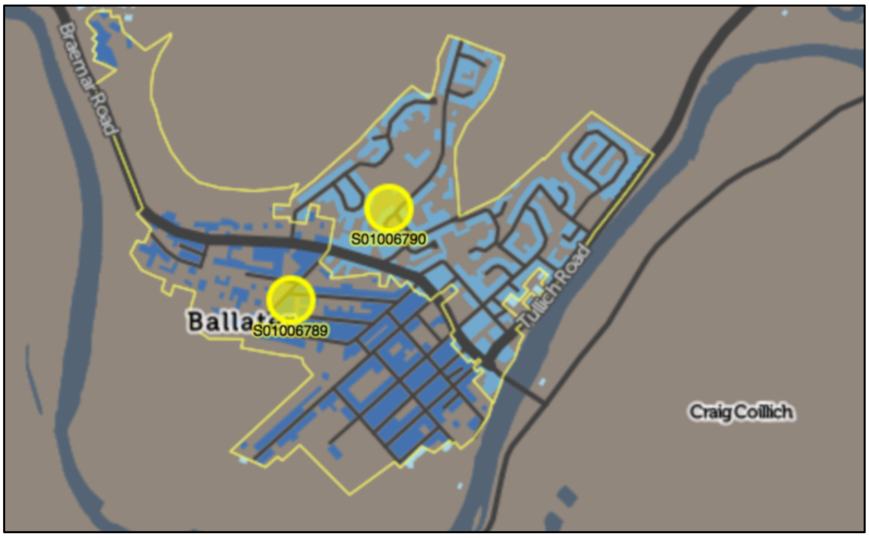

Figure 8.1. The two data zones representing Ballater. Source:SIMD, 2016.

Applying the formula:

[48] http://simd.scot/2016/#/simd2016/BTTTFTT/9/-2.6279/57.2442/

$$MinMax = \frac{(V - Min\ marks)}{Max\ omarks - Min\ marks}(newMax - newMin)^{\square} + newMin$$

Min: Minimum value of the given attribute. Min is 0
Max: Maximum value of the given attribute. Max is 6,505
V: V is the respective value of attribute. V=3115
newMax: 1
newMin: 0

Applying this information to the equation, the results were found to be 0.47 which was rounded up to 0.5.

Variable 6

Community Asset:	**Variable**	**Assumption**	**Data source**	**Community-Ballater**
1. Physical asset				
Physical access	% of people working further than 30k from home	The higher the number of people travelling long distances to place of work or study, the more vulnerable the population (Lindley et al, 2013)	Scotland's census	0.8

Drawn from the Scottish census (2011 Output area: LC7402SC), the figure for the output area are presented below.

Table 8.2. Census data areas for Ballater.

Ballater (2011 output area)	All people aged 16 to 74 in households in employment	Number of people who travel 30km or more to work
S00091444	35	14
S00091543	49	8
S00091544	38	13
S00092448	80	20
S00092634	51	15
S00092633	30	6
S00091541	76	13
S00092925	78	15
Average	(437 ÷8) 55	(104 ÷8) 13

APPENDIX 3

Appendix 3: Secondary and observational data sources

3.1 Secondary data sources

List of secondary data material utilised in relation to the selected case study area of Scotland. Variations to England highlighted in bold.

Documentary analysis: Northern Ireland			
1.	Local Development Plan 2020-2035. Topic paper: Flood Risk	BCC	2016
2.	North Eastern Flood Risk Management Plan, Available at: https:// www.infrastructure-ni.gov.uk/sites/default/files/publications/dard/north-eastern-frmp.PDF (accessed 30.11.17).	DARD	2015
3.	Planning Policy Statement 15 (PPS 15)	DOE	2014
4.	Sustainable Water: A Long Term Water Strategy for Northern Ireland Part 3: Flood Risk Management and Drainage,	DRD	2014
5.	Review of Response to Flooding on 27th and 28th June 2012.	PEDU	2012
6.	Preliminary flood risk assessment and methodology for the identification of significant flood risk areas.	Rivers Agency	2011
7.	Floods Directive – Local Flood Forums – Terms of Reference. Available at: https://www.infrastructure-ni.gov.uk/publications/local-flood-forums- minutes-meetings	DARD	n.d
8.	Draft Belfast Metropolitan Area Plan (BMAP) 2015: Technical Supplement Volume 1: Population and Housing,	DOE	2004
Documentary analysis: England			
1.	Managing flood and coastal erosion risks in England.	Environment Agency	2016
2.	Managing flood and coastal erosion risks in England.	Environment Agency	2016
3.	Delivery benefits through evidence: Issues and options concerning FRCM volunteering	Environment Agency	2015
4.	Public dialogues on flood risk communication	Environment Agency	2015
5.	Quantifying the benefits of flood risk management actions and advice	Environment Agency	2015
6.	Quantifying the benefits of Flood and Coastal Erosion Risk Management Stakeholder and community engagement and modeling, mapping and data	Environment Agency	2015
7.	Flood Risk Management Plans: what they are and who's responsible for them	Environment Agency	2014
8.	Understanding the risks, empowering communities, building resilience: the national flood and coastal erosion risk management strategy for England	Environment Agency	2011
9.	Flooding in England: A National Assessment of Flood Risk	Environment Agency	2009
10.	Synthesis of flood social science evidence for policy decision and delivery improvement	DEFRA	2014
11.	The National Flood Emergency Framework for England	DEFRA	2014
12.	Community and Public Participation: Risk Communication and Improving Decision Making in Flood and Coastal Defence	DEFRA	2007

13.	Flood Resilience Community Pathfinder Evaluation Final Evaluation Report	DEFRA	2015
14.	Flooding in England: Lead Government Department Plan	DEFRA	2013
15.	Obtaining flood insurance in high risk areas	DEFRA	
16.	Flood Resilience Community Pathfinder Evaluation Rapid Evidence Assessment	DEFRA	2014
17.	Making space for water. Developing a new Government strategy for flood and coastal erosion risk management in England	DEFRA	2010
18.	Community Flood Risk Management: Improving effectiveness and efficiency: Early Lessons from the Flood Resilience Community Pathfinders	National Flood Forum (NFF)	2015
Documentary analysis: Scotland			
1.	Flood Risk Management Plans.	Aberdeenshire Council	2016
2.	The river basin management plan for the Scotland river basin district: 2015 – 2027	SEPA	2015
3.	Flood Risk Management Strategies, http://apps.sepa.org.uk/FRMStrategies/ (Accessed on 17.12.17).	SEPA	2015
4.	Scotland's National Flood Risk Assessment	SEPA	2011
5.	Scottish Planning Policy (SPP).	Scottish Executive	2014
6.	Surface Water Management Planning Guidance.	Scottish Government	2013
7.	Delivering Sustainable Flood Risk Management – Principles of Appraisal: a policy statement.	Scottish Government	2011
8.	The Flood Risk Management (Scotland) Act 2009: Delivering Sustainable Flood Risk Management.	Scottish Government	2011
9.	The Flood Risk Management (Scotland) Act 2009.	Scottish Government	2011
10.	Flood Risk Management Planning in Scotland: Arrangements for 2012 – 2016	Scottish Government	2012
11.	Final Report of the National Technical Advisory Group on Flooding.	Scottish Executive	2005
12.	Planning Advice Note 69: Planning and building standards advice on flooding.	Scottish Government	2004

3.2 Observational data sources

Observation events attended by the researcher

Date	Observation Type	Location
5/7/16-12/7/16	Community Flood meetings in Cumbria (x7) held by the Lead Local Flood Authority and the Environment Agency.	Kendal (x2), Glenridding, Shap, Eamont Bridge, Carlisle.
7/07/16	North West Regional Flood Conference	Kendal, Cumbria
30/06/16	Floods 2017, Institute of Civil Engineers.	London
02/06/16	RTPI Ireland, Flood Risk in Planning Conference.	Limerick, Ireland
18/05/16	Resilience 2017, conference.	Cardiff, Wales.
30-31/06/16	Facing the Future, resilience conference. CECHR.	Aberdeen, Scotland.
18/10/16	Sustainable Urban Drainage, Workshop. Institute of Civil Engineers, Northern Ireland.	Belfast, Northern Ireland.
09/01/17	Community resilience in Urban Areas, Conference. Red Cross, Northern Ireland.	Belfast, Northern Ireland.
09/01/17	Flood Review on Northern Ireland. Institute of Civil Engineers, Northern Ireland.	Belfast, Northern Ireland.

APPENDIX 4

Appendix 4: Analysis of Social Network data

4.1 SNA as applied in the thesis

The following descriptive values and measures were undertaken as part of SNA across the three case-studies.Network density or ‘modularity’ is a measure of network structure that determines the connectedness of a network. Dense networks are indicative of communities that can easily self-organise, collaborate and transfer information efficiently (Nakagawa and Shaw, 2004). Gephi assisted this analysis by calculating degree distribution for each network. The analysis was achieved by analysing the ratio of existing ties against to the total number of potential ties within a network (O’Malley and Marsden, 2008).

Modularity measures adopted Blondel’s algorithm (2008) to calculate network density or “strength of division of a network into modules” (Xiaonan Ji et al, 2015). Networks with dense connections between actors are indicative of high modularity. The choice to use Blondel’s algorithm was attributed to four key reasons. It is easy to implement and has the capacity to handle and compute large dense networks (Blondel, 2008). Further, it has been applied and tested successfully in numerous SNA studies (Lancichinetti et al, 2008) and it is supported by the Gephi platform.

With network density established, attention turned to assessing network centrality, to determine the most influential actors within a network. Centrality is cited as being an indicator of the “structural power” of a network (O’Malley and Marsden, 2008). Centrality was calculated by ‘betweenness centrality’,[49] ‘degree centrality’[50] and ‘degree distribution’[51] measures. The first centrality calculation sough to determine the number of direct connections or nodes an actor has within a network. Freeman (1979) refers to this as an actors ’degree’. ‘Degree distribution’ charts were used to illustrate frequency distribution of actors in numerical degrees. Analysis of degree distribution reveals variances of connectedness levels across network actors. For example, actors with higher ‘degree’ are often associated with having greater influence within a network (Snijders 1981). Further, knowledge of high network density may also be indicative of a ‘closed’ network which is reluctant to accept outside help or new ideas, essential for transformation (Granovetter, 1983).

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[49] Betweenness centrality measures the number of connections an actors connects with others who normally would not be part of his network (McCann et al, 2016). .
[50] Degree centrality calculates the number of links an actor has within the network.
[51] Degree distribution refers to the probability distribution of potential ties ‘degrees’ across a network.

Betweenness centrality is based on the number of times a node acts as a 'gatekeeper' on the shortest path between other nodes within the networked analysis (if that node was not there then the transfer of information and resources would cease at that node). It is the metric used to convert this concept of the shortest path influencing centrality (most important node in a network) and converting it into a calculated score which represents the percentage of shortest paths that include a given node. Once all the shortest paths are calculated for each node they are aggregated and the betweenness centrality score produced. Betweenness centrality informs which actors are most influential can be useful in assessing which nodes are central with respect to spreading information and influencing others in their immediate community.

Degree centrality is a less complex calculation, measuring the number of connections or ties an actor has within a network. It serves to identify how many direct, 'one hop' connections each node has to other nodes within the network. Within the case-studies this is used to identify very connected individuals, who are critical to the operationalisation of resource distribution (for example the Chair of the Flood Resilience Group, community champions). These key individuals or organisations are likely to hold most information or influence on individuals who can quickly connect with the wider network. By means of explanation Figure 4.1 serves as an example to highlight 'R' has the highest Degree score with 9 direct connections.

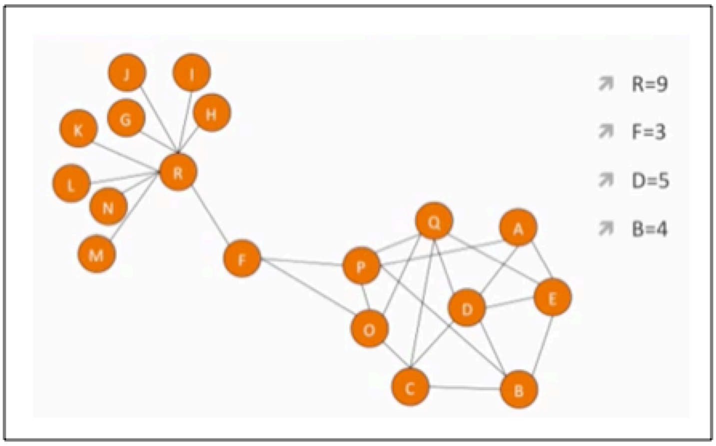

Figure 4.1 Illustrated example of Betweenness and Degree Centrality.

Once betweenness centrality and degree centrality had been calculated, key actors could be identified based on their scoring in the aforementioned tests. Ego-centric analysis followed in order to ascertain how key figures (those with high levels of betweenness and degree centrality), influenced relations within the network. These ‘key actors’ were chosen to highlight the extent of their influence through (either directly or indirectly) connection with the community and how they assist the access and mobilisation of resources and assistance. For example, Figure 4.2 illustrates the extent of connectedness and influence (or lack thereof) of a key node (actor) across the network. The map legend lists the source of the connection and is indicative of the nature of the assistance or resource. Further, by way of percentage calculations the legend highlights source hierarchy across the network. The network visualisation map serves to highlight how a key actor connects and interacts with a diversity of flood stakeholders, both formal and informal, to access and mobilise resources.

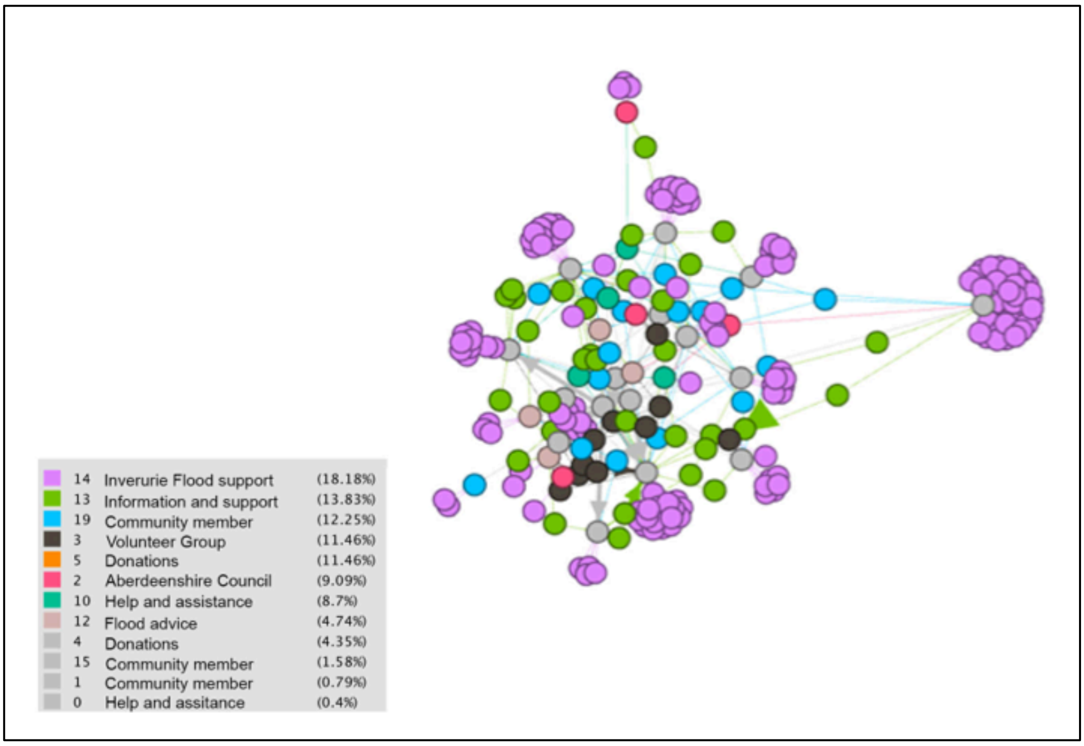

Figure 4.2 Example of Gephi social network visualisation of “Inverurie Support Group”. Visual representation using Force Atlas algorithm.

In addition to the network structure calculations described above, a K-core filter was applied in Gephi. K-core analyses cohesiveness of the overall network structure, by calculating the maximum number of actors who are connected to a particular actor (k). The K-core filter in Gephi prunes all nodes (and respective edges) which have of connectedness K-core of -2 (Seidman, 1983; Bollobas and Thomason, 1985). Maps with limited ‘pruning’ are indicative of higher cohesiveness and less structural holes. Such networks are more stable and less likely to experience system collapse (Tierney et al, 2001).

4.2 Cumbrian SNA graphs

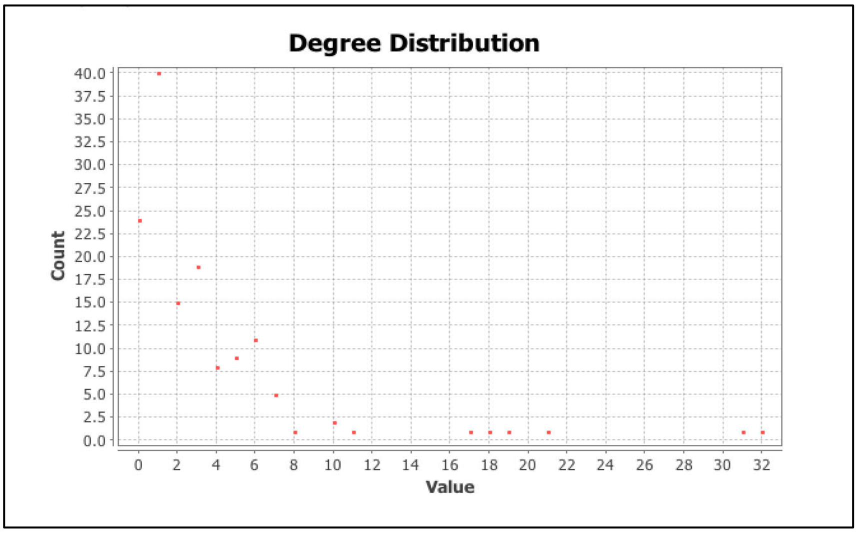

Figure 4.3 Gephi visualisation of average distribution measure 1.709. North East Kendal Flood Action Group.

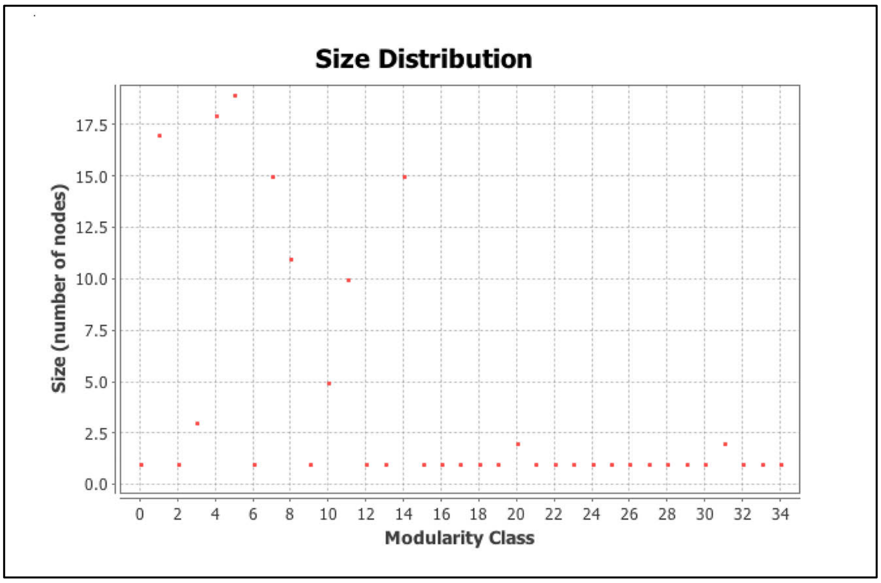

Figure 4.4 Gephi visualisation of modularity distribution measure 0.47. North East Kendal Flood Action Group.[52]

[52] Algorithm; Vincent D Blondel, Jean-Loup Guillaume, Renaud Lambiotte, Etienne Lefebvre, Fast unfolding of communities in large networks, in Journal of Statistical Mechanics: Theory and Experiment 2008 (10), P1000.

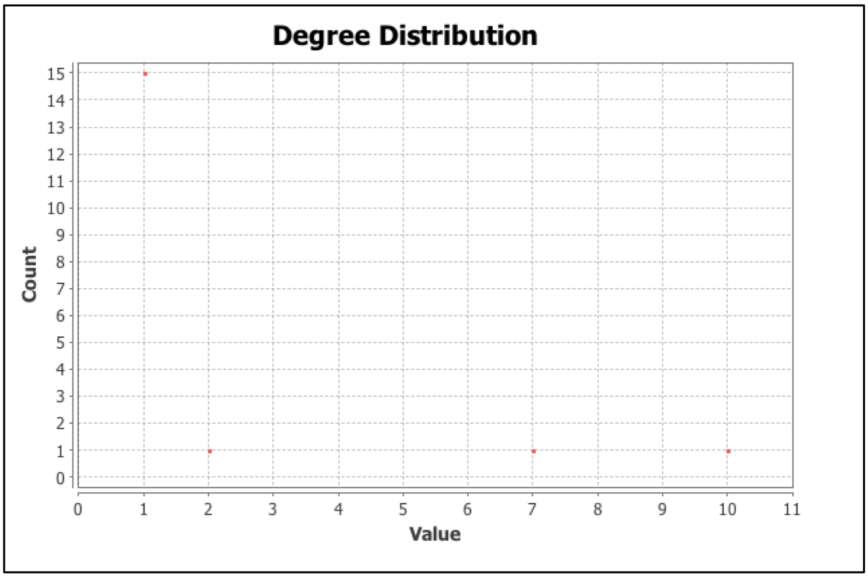

Figure 4.5 Gephi visualisation of average distribution measure 0.944; Support Eden Flood Volunteers.

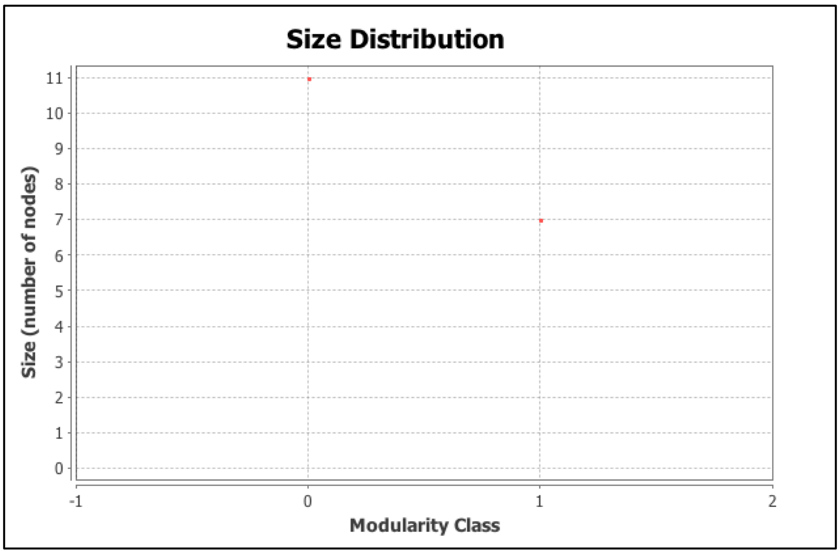

Figure 4.6 Gephi visualisation of modularity distribution measure 0.443, Support Eden Flood Volunteers.

4.3 Barriers and drivers to multi-scalar engagement

The analysis above further affirms that communities possessing multi-scalar relationship ties (bonding, bridging, linking) (Putman, 2000; emBRACE,2015b) are likely to be more adaptable along the continuum of resilience (cope, adapt, transform). The section outlined the integral role 'linking social capital' plays in facilitating the mobilisation of resources and capacities necessary for transformative resilience. Despite this, linking ties were found to be the least used of the multi-scalar ties. In view of the unrealised potential of this relationship tie, it was necessary to explore the barriers and drivers toward effective practice of this tie. Respondents were asked if they received any formal assistance (e.g. Statutory agencies, Government) during the recovery period. Responses illuminated both barriers and drivers in engagement with authorities through the medium of FAGs. Barriers were found to concern four main issues: (1) lack of 'risk awareness' (Indicator 1); (2) reluctance to take on 'flood responsibility' (Indicator 11); (3) lack of 'risk communication' (Indicator 3) of the complex statutory organisational workings; and (4) misunderstanding of perceived capabilities of communities or 'self efficacy' (Indicator 10). On the other hand, drivers of horizontal ties were found to include: (1) 'risk experience' (Indicator 3); (2) space to form a 'analytical thinking' (Indicator 18) and (3) an established 'cohesive community' (Indicator 15). Taking each of these barriers and drivers in turn the following section explores 'risk awareness' as a barrier to linking capital.

Risk awareness (Indicator 1)

All eight communities had a history of flooding, however, changes to the catchment area through increased development, farm drainage practices, flood defenses (changing path of flood water) and aging infrastructure mean that places that had not previously flooded in living memory experienced flooding in winter 2015. Areas such as Kendal and Appleby which had flooded numerous times in the past, included a large percentage of first time flood victims: 13 and 3 interviewees respectively. In addition, the episodic nature of flooding means that those who have not been flooded in recent years were less engaged in community/flood resilience groups; *"I stopped going to the meetings. We had been dry for three years and I kind of thought it was a one off and lost interest to go to meetings"* (K141). There is a strong correlation between the extent of the flood experience and participation levels in Flood Action Groups:

"We started to become a bit complacent I guess when they put the flood defenses in. We thought we were safe, we let the (group) contact information of members go a bit stale. Yeah, we were caught off guard but I think we've learned from that …. now we are bang up to date again with contact numbers. You could say you need to get your feet wet before you take action" (K138).

The above evidence highlights that flood awareness of current risk has the propensity to fade as a consequence of reduced frequency and a false sense of safety brought about by new flood defenses.

Flood responsibility (Indicator 11)

Resistance to engage with higher-level ties attributed to an apparent lack of acceptance of new roles imposed on the community. Many residents accepted that they needed to be flood aware and take responsibility for individual precautionary measures such as using property level protection, moving their car to higher ground and valuable items upstairs. Beyond these measures, there was resistance to taking responsibility for roles formerly the sole responsibility of statutory agencies, project planning and management.

"If they can't help us after a flood you do start to question why the hell my pay packet loses a third in taxes. I am happy to help where I can but at the end of the day we as a community are not going to pay their wages and then go and do their job for them". (K148)

The above quote corroborates with Gidden's (2013) assumption that some community members are opposed to the idea of taking on roles that were formerly the sole responsibility of the statutory agencies.

'Risk communication' (Indicator 3)

A further barrier to communities enacting 'linking ties' with agencies is the complex institutional setup seen in public sector agencies, which communities find difficult to communicate with. A community member in Appleby commented:

"You ring them up (Council) and you either get through to a switchboard and get cut off or an answering machine. I can tell you one thing, they don't make it easy for us

to contact them". (K139)

In addition to direct communication barriers, communities were often unaware of who to contact and what the exact role of agencies was in the overall picture of FRM. Community members were asked if they were aware of who to contact should they wish to offer or receive assistance during the recovery period. Across the 8 case-studies, 78% responded 'no', highlighting the extent of fragmentation within the existing communication structure.

Unsurprisingly, the literature argues for a more joined up approach to FRM (Pitt Review, 2008; Bosher et al, 2009). Progress has been made within Cumbria and England as a whole, in particular through the implementation of the Flood Risk Management Act 2010. Its introduction has led the local council to act as an umbrella for FRM through its role as the LLFA, with the EA, and utility companies working alongside them (Section 7.3). Despite this movement towards a more unified approach, in practice the roles and responsibilities of each agency remains fragmented, acting as a barrier to inclusion from the community level. A member of the Carlisle community commented:

"You don't see them (statutory agencies) from one flood to the next. I rang the Environment Agency once and they said it wasn't their issue as it wasn't river flooding. I was told then to ring the council and that went nowhere. I don't care what type of flood water it is, it destroys my property either way". (C35)

'Self efficacy' (Indicator 10)

The final barrier to vertical interaction stems from a lack of understanding of community capacity. Greaves (2012) reiterates the need for practical defined community roles that have an empowering effect on the community (Giddens and Sutton, 2013). In a similar vein, a flood-affected resident in Kendal commented;

"But sure what can I do anyway. I'm a lady in my 60's, I'm not exactly going to build a flood wall myself now, am I?". (K145)

The evidence suggests there's a need for greater awareness of community capacity both by the community themselves and also how the community and agencies can work in parallel for mutual benefit. Keswick FAG is an example of a community which bridged this gap: *"We as volunteers know when to step in and when to step out"* (K145). In this instance, the community were recognised as equal members of the emergency team, however their role was in warning and informing residents by door knocking prior to the flood event. Once there was a risk to life, they were stood down and the emergency services took over. Clearly defined roles meant that *"Toes were not stepped on"* (K137), and once danger to life had passed the FAG could continue their work by supporting the community through the recovery process:

"We called ourselves the stanley knife brigade and went door to door cutting up wet carpets, bringing food and cups of tea, helping with donations like dry clothes. Later our role became more advisory and we helped with form filling and we had a base where people could just come for a chat". (K143)

Further instances of the community working in collaboration with authorities to help buttress overall resilience were cited in the interviews. Examples of communities and authorities sharing the same common goal included: matched funding by the council, drain and gulley maintenance, river gauge monitoring, warning and informing (flood wardens).

Risk experience (Indicator 3)

It was found that the frequency of flooding played a significant role in whether communities chose to engage with outside help. This section looks at settlements with established FAGs, however, it is important to note that other flood-affected communities (frequency not magnitude) chose to utilise existing connection ties rather than form new ones through FAGs. For instance, in Shap, one interviewee commented:

"It's mainly just us on this street that got the worst of it (in Shap). We just sort it out between ourselves and help each other out where we can. I'm not sure they know we flood here because we're not near a river ". (S158)

Case-study evidence from isolated (Shap) and low impact (Kirby Stephen) flood incidents revealed that residents opted to deal with the event at the local level themselves, rather than establish a distinct Flood Action Group: "*We get our local councillor to fight our [Kirby Stephen] corner*". (K150)

At the opposite end of the scale, areas with a long, almost bi-annual flood history (Keswick and Carlisle) were found to have established FAGs in place. Keswick FAG operated as an extra layer of support and did not view itself as a “finger pointing”(K151) group. By contrast, pressure groups such as Carlisle FAG emerged partially to lobby against a perceived breach of contract by the agencies to keep residents safe from flooding.

The above evidence conflicts with Lichtermann’s (2009) belief that flood action is linked to the severity of the event. The evidence from Cumbria suggests that flood action will occur regardless of the severity of impact, however the form of “coming together”(G86), be it a formal (FAG) or informal (county councilor) flood group, is dependent on the severity and magnitude of the event.

‘Analytical thinking’ (Indicator 18)

An important finding from the interviews was the role spatial and physical *‘place’* plays in facilitating social interaction. Networks at the village and town scale commonly met in public spaces including *“church”, “parish hall”, “shops” and “post office”.* By contrast, the density of the city offered less opportunity to maintain social capital. “Third spaces”, where community members can meet and interact on an impromptu basis, were less pronounced at the city scale. This evidence may be attributed to why social media communities (facebook, twitter) were more common at the top of the settlement hierarchy. Following the flood events, many third sector organisations identified the need for physical places for communities to meet as a form of support and act as a medium through which communities can discuss the flooding issue:

“I go down to the church for support. They were flooded too but they have a temporary building its called the Encouragement Cabin and I get a lot of support there….just a cup of tea and a chat with other who were flooded….you can get advice there…. many meet and discuss what can be done better in order to be in a better situation if God forbid it happens again” (K 120)

‘Cohesive community’ (Indicator 15)

The argument within the literature is clear: enhanced social infrastructure facilitates greater community capacity and, consequently improved resilience (Aldrich et al, 2015). Accepting that flood events are ‘acts of man’ not ‘acts of God’ (White, 1945), there is a clear need to understand how communities interact during these ‘social events’ through analysis of how they communicate, mobilise resources and plan to allow communities to effectively recover and reconstruct after a disaster. This viewpoint resonates clearly with the findings from the Cumbria communities, which exhibit a strong ‘social infrastructure’ to stimulate their recovery process. Bonding capital was evidenced at the village scale and during low-impact events, whilst other communities evidenced multi-scalar ties by coming together through the medium of FAGs (Carlisle, Kendal, Keswick).

FAGs have proven to be an efficient means for communities to self-organise and manage flood impacts from advance preparation through to the reconstruction phase. Indeed, social capital ties were found to have a temporal nature. In the immediate aftermath of the flood event, bonding (close friends and family) social capital was predominantly accessed. Particularly in rural areas where there was acknowledgement that the services would not arrive immediately, communities relied on close bonding ties to cope. However, as the immediate danger receded and the focus turned to recovery and reconstruction, there was greater evidence of bridging (organisations, third sector) and linking (authorities) ties.

Beyond the direct value of FAGs in helping to reduce flood impact, they further serve as a valuable means of building and sustaining social capital. For example, FAGs were found to facilitate building expertise (skills and training, Indicator 22) and local community understanding of flooding and appropriateness of various flood alleviation mechanisms within their community. In addition, they acted as a vehicle to increase community participation by coming together with the common goal of addressing flood risk and maintaining flood memory. Regular meetings of FAGs illustrated in ego-centric maps (Figures 7.27-29) show that frequent group meetings generate higher levels of trust within the group, but also assist the community as a whole in *“coming together”* (K141). Residents commented that through the process of risk planning and management they felt “empowered” and that as a group they can *“Begin to feel in control and …. safe again in your own home”.* (K142)

4.4 SNA in North-East Scotland

4.4.1 SNA applied at the town scale

Increased engagement amongst actors may lead to greater mobilisation of resources and capacities, thus potentially enhancing long-term resilient adaptation and recovery (Murphy et al, 2016). In addition, engaged communities are more likely to maintain 'flood memory' after the flood water fades, limiting the risk of complacency and reduced awareness often associated with 'unprecedented' events (Hansen et al, 2016).

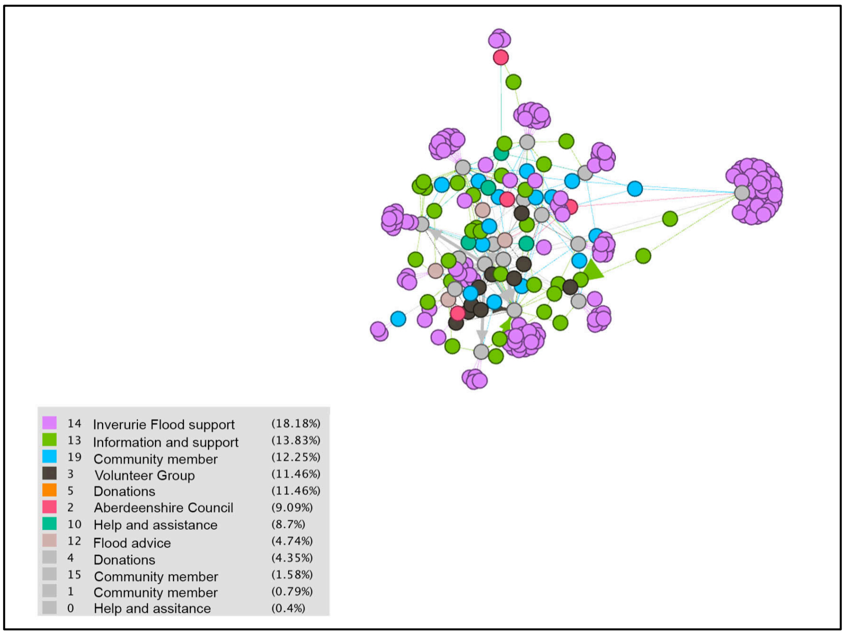

Figure 4.7 Gephi social network visualisation of K-core >1 for "Inverurie and Garioch Flood Support". Visual representation using Force Atlas algorithm.

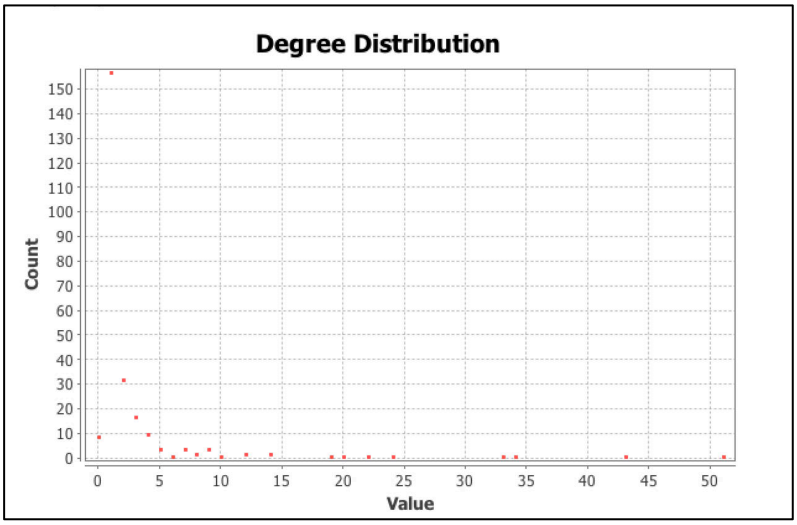

Figure 4.8 Gephi visualisation of average distribution measure 1.435. 'Inverurie and Garioch Flood Support' page.

On the other hand, the low degree distribution measure (1.435) is representative of structural holes within the network. These weaknesses are illustrated as gaps across the x-axis (15-18; 24-33; 35-43) in Figure 4.8. The modularity results (0.584) also reflect these findings by highlighting the 'factional' (bridging) nature of the key brokers. These 'factional' brokers are represented by node peaks across the x-axis in Figure 4.9, (14, 13, 19). Structural holes hinder the potential connectedness of the network, limiting access to information, resources and capacities. In particular, it reduces the potential for those least connected to receive the assistance and support they need to be resilient (McCann and Barlow, 2015).

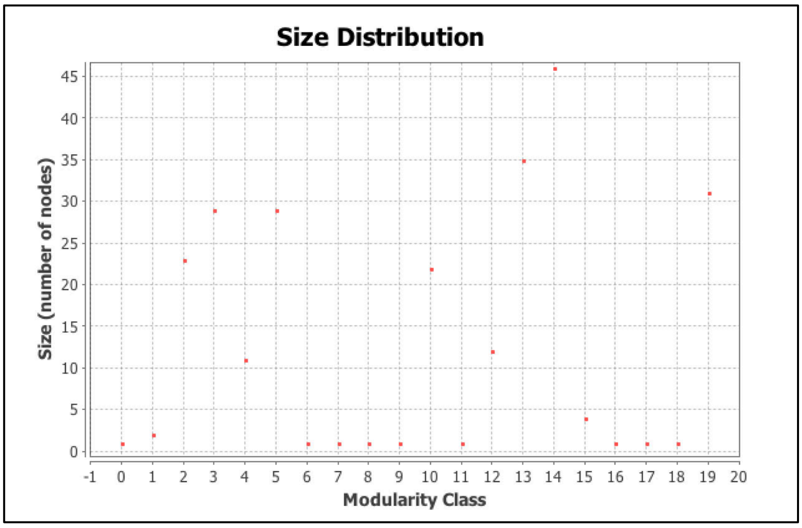

Figure 4.9 Gephi visualisation of modularity distribution measure 0.584, 'Inverurie and Garioch Flood Support' page.

4.3.2 Village scale SNA

Key 'brokers' (14,13,19,3,5) operate as an important bridging channel to connect isolated nodes. In addition they act as a means to disseminate 'Flood advice', 'Help and assistance' and 'Donations' which otherwise may be unattainable (Figure 4.12). The bridging of connections through a 'broker' is an important component in adaptive capacity building, for example by helping to engage outside knowledge and innovation, and preventing collapse or fragmentation of the network. As such, the fostering of bridging ties has the potential to galvanise existing networks by adding a layer of diversity and access to wider resources, critical for community recovery.

A balanced spread of connections was evident across the network (Figure 4.11). However, the Degree Distribution Graph highlights the exception of (1) 'Donations and distributions' presenting itself as a node peak on the x-axis (Figure 4.10). This is attributable to the fact that the node (1) acted as a network 'broker', encouraging engagement through its capacity as an unofficial relief centre for donations and distributions.

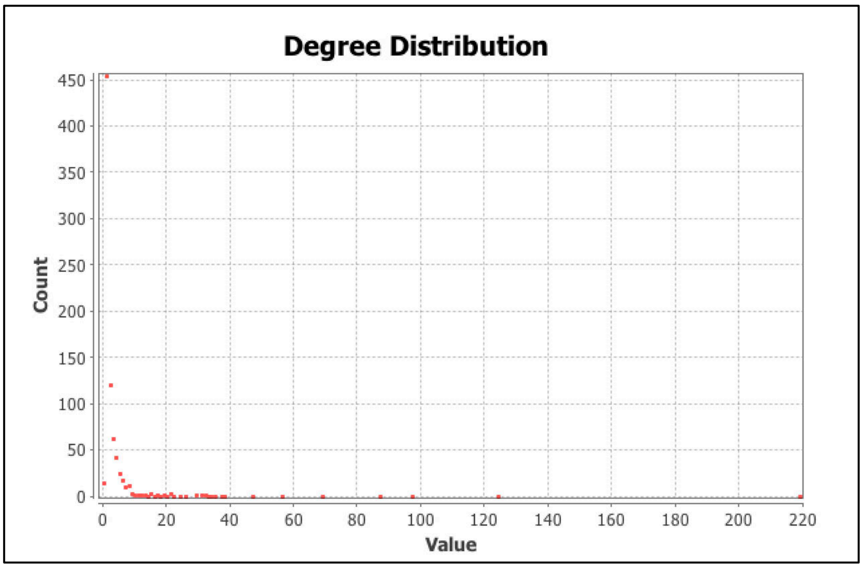

Figure 4.10 Gephi visualisation of average distribution measure 1.891. 'Hope Floats' page.

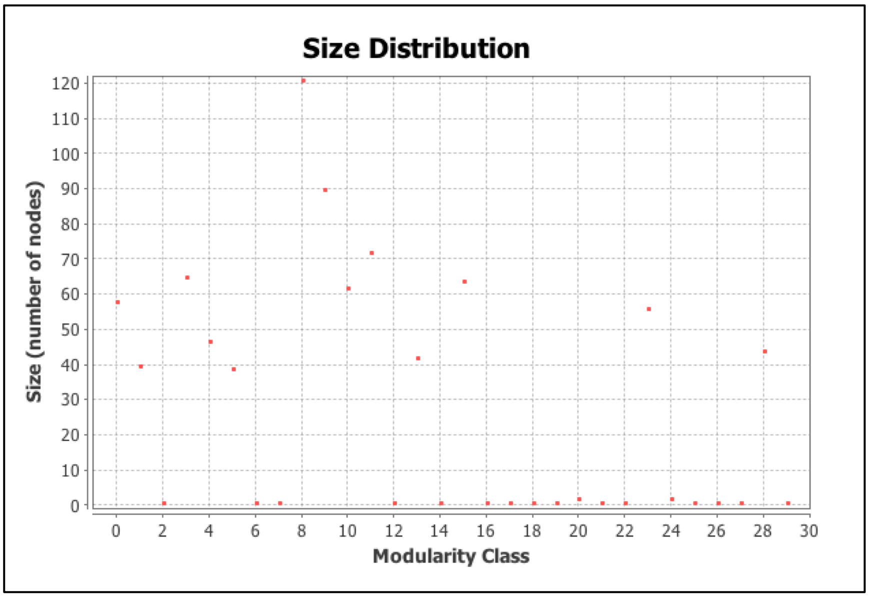

Figure 4.11 Gephi visualisation of modularity distribution measure 0.513, ‘Inverurie and Garioch Flood Support’ page.

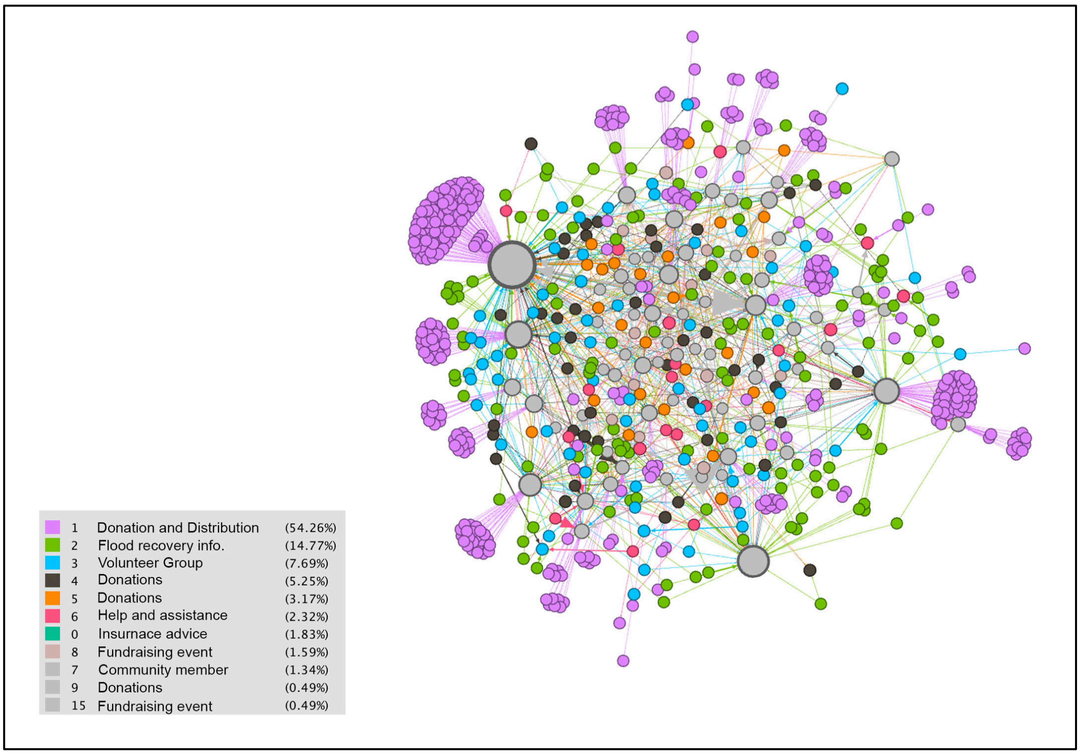

Figure 4.12 Gephi social network visualisation of K-core >1 for “Hope floats”. Visual representation using Force Atlas algorithm.

4.5 Ego Centric Analysis in North-East Scotland

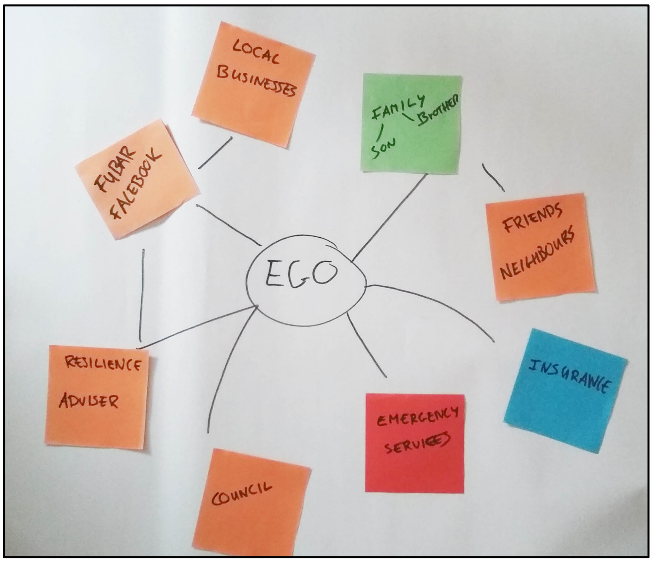

Figure 4.13a Raw ego-centric data outputs from interview discourse, Aberdeen.

Figure 4.13b Raw ego-centric data outputs from interview discourse, Inverurie.

Figure 4.13c Raw ego-centric data outputs from interview discourse, Ballater.

4.5.1 City scale Ego-centric analysis

The urban scale reveals a reliance on authorities (Council, SEPA) and emergency services (police, ambulance) for assistance. The map shown in Figure 4.14, highlights how information sources are drawn mostly from the social media site 'Fubar' and informal communication between local businesses. As a significant proportion of the flooding across Aberdeen affected commercial premises, it was found that many businesses related to the impact sustained by other businesses. In particular, local businesses became a significant source of support (donations) for small businesses across North-East Scotland, as shown by 'local businesses' in Figure 8.30. The apparent lack of engagement at the community level is potentially attributable to the commercial nature of the area (non-established residential area) and the lack of a resilience group.

Figure 4.14 also illustrates strong 'bonding' capital through support from family, however the network lacked bridging social capital. Reaffirming the nature of linking capital in North-East Scotland, the quote below highlights the perception of flood responsibility during a flooding incident:

"I coped with help from family….raising valuables and putting sandbags down. After that we left it to the services (Council, SEPA, Emergency services) to do what they had to do" (A3).

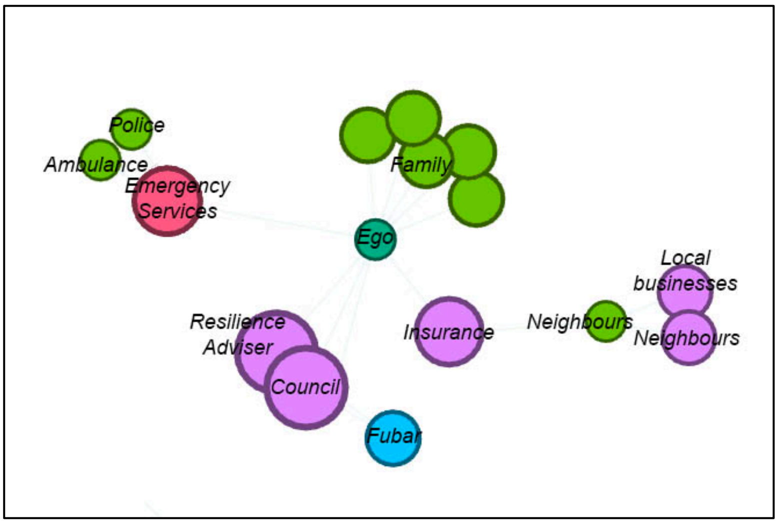

Figure 4.14 Ego-centric map for key actor in Aberdeen.

4.4.2 Town scale Ego-centric analysis

The importance of social media is highlighted as a connector of nodes in the Inverurie ego-centric map (Figure 4.15). In the absence of a resilience group, ‘The Inverurie and Garoich Flood Group’ Facebook page was set up after the floods as a means of providing information and support, but also as a way of connecting those in need with available resources. This medium was also used a channel to disseminate information from authorities (SEPA, local authority) to the affected community. The map further highlights the extent of civic spirit through the prominent ‘donations’ node, comprising Foundation Scotland and local businesses. Support for home renovations was mentioned in terms of financial support from insurance companies but also through the relationship with builders and tradesmen.

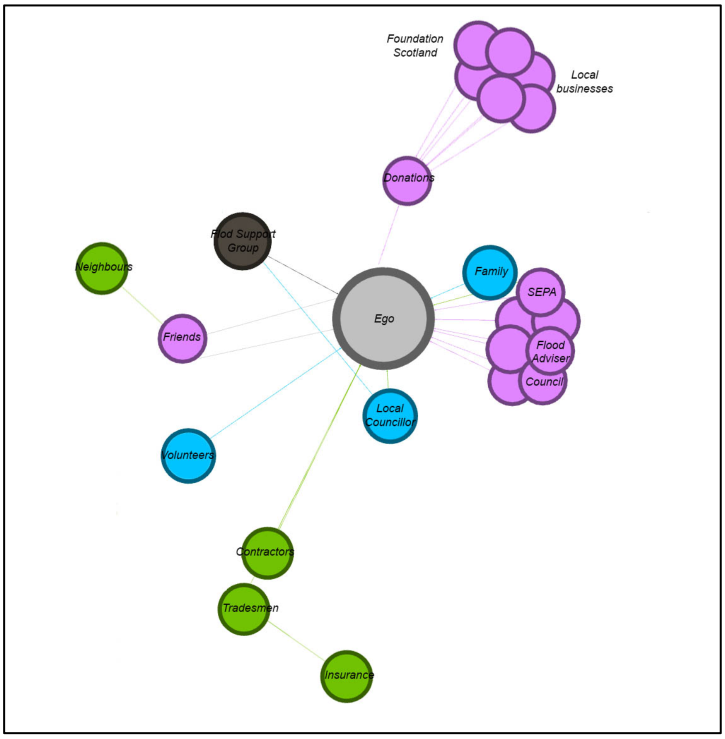

Figure 4.15 Ego-centric map for key actor in Inverurie Flood Support Group.

4.4.3 Village scale Ego-centric analysis

The ego-centric map in Ballater is illustrative of a close-knit community (Figure 4.16). The floods prompted the mobilisation of a flood resilience group in its early stages and strong bonding capital was evident through friends and family, however bridging and linking capital was also present. It is apparent from Figure 4.16 that the resilience group acted as the catalyst for engagement with authorities as indicated by the black nodes (CNPA, local authority, SEPA, highways). The Church was represented by a large node, indicative of its very strong influence throughout the recovery process. Of note was the amount of fundraising within the community (Charitable Chiels) which is demonstrative of the cohesive characteristic of the community. The presence of over 36 community groups (Community Council, 2016) within a population of 1,500 reaffirms the close-knit nature of the community.

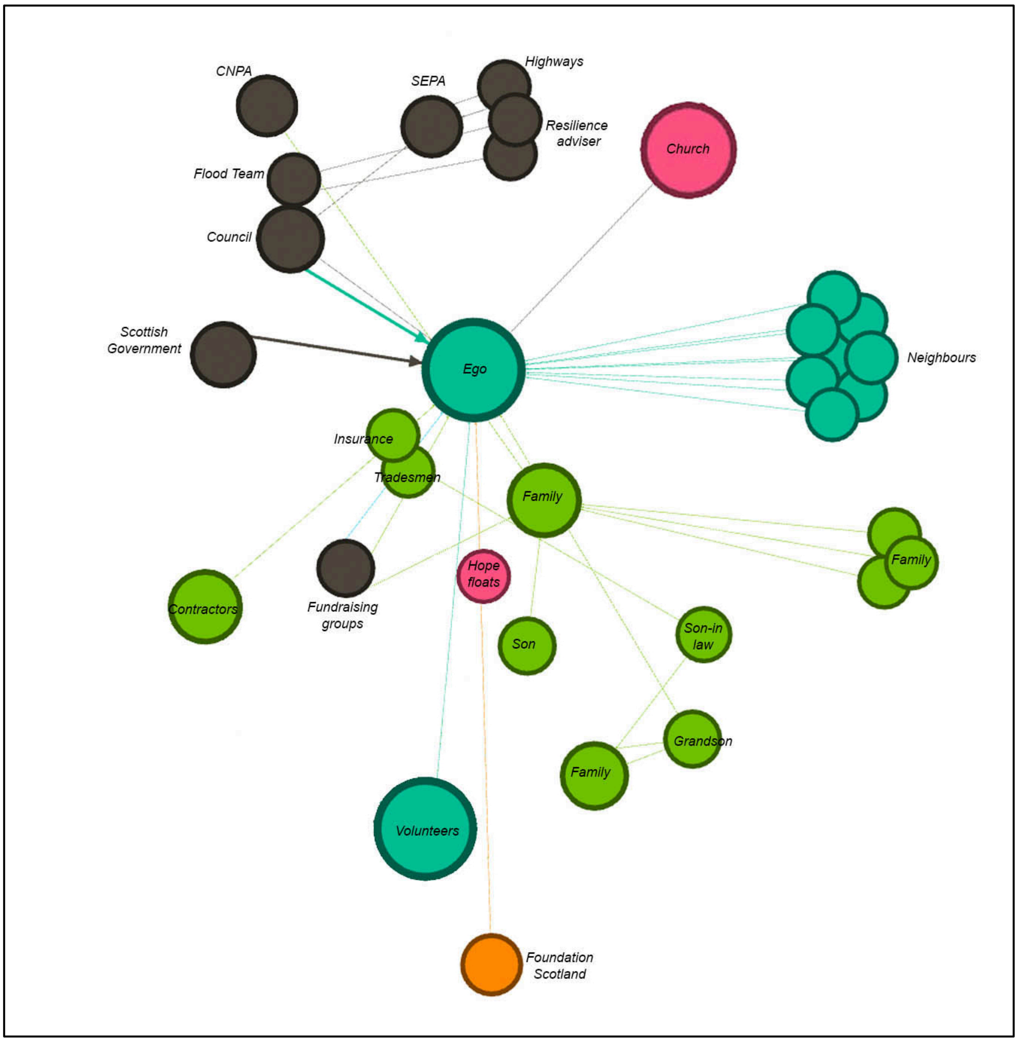

Figure 4.16 Ego-centric map for key actor in Ballater Resilience Group.

APPENDIX 5

Appendix 5: Interview question set and participation forms

5.1 Community level semi-structured interview question set

Flooding impact

1. How did your household situation change as a consequence of the recent floods in 2015? (Relocate, extensive repairs, financial worries etc)

(Note: The severity of case-specific flooding and the subsequent impact on the communities will be taken into account during analysis).

2. How long was it before normal life resumed after the flood event?

Risk awareness and responsibility

3. Did you know prior to acquiring or buying your property that you lived in a flood risk area?

- If no. At what point did you become aware of this and through what mechanisms ?
- If yes. What made you decide to take on this risk?

4. During the most recent flooding in 2015, what medium was used to communicate to you that there was a potential threat of flooding?
(e.g Telephone, mobile, text, email, social media, TV, radio, local flood warden, word of mouth)

- Who informed you via this method?
- Were you informed formally, informally or both?

(Note: Questions relating to flood alert systems will be case dependent taking into account the existence and structure of flood alert systems already in place)

Social connections

5. From who did you receive formal assistance in the weeks and months after the flood event to facilitate the restoration and resumption of normal life?

6.From who did you receive informal assistance in the weeks and months after the flood event to facilitate restoration and the resumption of normal life?

7. Think of organisations, networks, associations that you or any of your household belong to. These can be both formally or informally organised groups.

-How many of such groups are you or anyone in your household a member of? Please describe them? Did any of these groups form in a different capacity in the weeks and months after the flooding to assist in the recovery and reconstruction? (e.g clean up groups, sandbag distribution etc). Pease describe them.

8. If you wanted to offer assistance during the recovery and reconstruction process after a flood event, do you know if there is an identifiable means of facilitating this?

9. Having experienced a flooding event this year, what lessons have you learned and actions undertaken from the experience to make you more resilient in the future?

10. Have you or would you be willing to pay for flood prevention measures to improve the resilience of your home?

- In your view who should be responsible for paying for such interventions?
- Should insurance be proactive or reactive in this regard? (E.g incentivise policy holders to implement flood prevention measures through lower premiums)

Background information

1. How long have you been living in (xxxxx) community (inclusive of moving property within the community) ?

---- years ---- months

Have you moved property whilst living in this community?

2. How many people live in your household? ------ adults
------ school-age children
------ children under 5

3. Age (Tick box)

18-24	25-29	30-44	45-59	60-64	65-74	75 +
☐	☐	☐	☐	☐	☐	☐

Closing

4. Do you have any additional comments about resilience and your community that you wish to mention?

5. Would you be willing to participate in a follow up focus group as part of this study?

5. Can you suggest anyone else who I should talk to in your community?

5.2 Sample participant information sheet

Recruitment Details

Re: request for short interview

Dear community resident,

An Ulster University research project assessing the perception of resilience within flood-affected communities is due to take place within your community. Ulster University is seeking the participation of residents of your community who were affected by the recent flooding, to be interviewed about the perception of resilience within flood affected communities.

The interview will take approximately 15- 20 minutes. Participants can participate during one of several interview sessions in your area between (insert date) and (insert date). Additional dates are pending and a phone interview may also be scheduled at your convenience.

Whether or not you are willing to participate, please consider passing this notice to someone else living in your community who has been affected by flooding.

Please contact Kate Crinion
Crinion-k@email.ulster.ac.uk to learn more about how to participate.

Thank you very much,
Kate Crinion
PhD researcher
Ulster University
Department of the Built Environment.

5.3 Sample informed consent form

Informed Consent Form
Semi-structured interviews

Project Title: Disaster recovery and reconstruction: Harnessing capacity and improving resilience within affected communities.
Investigator: Kate Crinion
Supervisors: Prof Stanley McGreal, Prof Martin Haran, Dr. David McIlhatton.

Invitation:
You are being invited to take part in a research study as part of a PhD research programme at Ulster University, Northern Ireland. Please take time to read the following information carefully.

Purpose:
The purpose of this study is to evaluate communities and practitioners' perceptions of resilience through an evaluation of the key dimensions of resilience currently existing within flood affected communities.

Procedure:
Your participation in this study, will entail an interview of approximately 15-20 minutes. You will be asked a series of questions about your community, including what kinds of social groups you encounter, the kinds of resources available to you after a flood event and what actions the community took to recover after the flooding events.

Do I have to take part?
It is up to you to decide whether or not to take part and you are free to withdraw at any time. If you decide not to finish the study, you have the right to withdraw any data collected about you. If you withdraw, all records of your input and participation will be destroyed.

Confidentiality:
All information collected for this study will be kept strictly confidential and full anonymity of participants will be ensured during the collection, storage and publication of research material in accordance with Ulster University.

What will happen to the results of the research study?
The results will be used in a postgraduate PhD thesis that will be held in the Library at Ulster University.

Questions about the Study:
If you require further information about this study, or information about the research findings, please do not hesitate to contact me.

Contact details for information about the research:

Researcher: Kate Crinion
Department of the Built Environment
Ulster University
Room 1k07
Shore Road
Newtownabbey
Co. Antrim
BT37 0QB
Email: Crinion-k@email.ulster.ac.uk

Questions about the Study:

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

____

Participant Name (printed)

____ ______________

Participant Signature Date

____ ______________

Signature of Person Obtaining Consent Date

APPENDIX 6

Appendix 6: Adherence to ESRC Ethical Framework (2015)

1.	**Research should be designed, reviewed and undertaken to ensure integrity, quality and transparency.**
	Donovan (2010) notes that researchers should be mindful that questioning a disaster events context/event may be upsetting and traumatic for the affected interviewee. In order to mitigate causing undue offense, the questions were asked at the respondent's pace and the line of enquiry steered from content that made the interviewee uncomfortable. It was outlined in the interview consent form that the respondents could end the interview at any point without the need for an explanation. Fortunately this infrequently happened but respondents did comment *"Today has been a bit too much for me"* then the interview was stopped immediately without any further questioning.
2.	**Research staff and participants must normally be informed fully about the purpose, methods and intended possible uses of the research, what their participation in the research entails and what risks, if any are involved.**
	The purpose of the study was explained to all participants within the research. Prior to commencing the research interviews, respondents were informed that data collection would not directly benefit them or their community resilience plans and was merely for the purpose of gaining a better understanding of their situation. Informed consent forms were issued to all potential participants, providing them with the information required to allow them to make a decision on whether they wished to participate. Permission was sought to record interviews, to ensure transcription accuracy. On occasions when interviewees did not feel comfortable being recorded, note taking was used instead.
	The confidentiality of information supplied by the research participants and the anonymity of respondents must be respected.
	The names of participants involved in the statutory/key informant interviews were recorded for organisational purposes and to allow for contextual analysis of the transcripts. However, the names of respondents were not included within the analysis write up in order to maintain their anonymity. Anonymity allowed participants to speak more freely whilst protecting their privacy. As such, respondents were addressed in respect of their general demographic or professional details.
	Research participants must take part voluntarily, free from any coercion.
	The informed consent form outlined clearly that respondents could withdraw from the research at any point without the need for a reason. Only adults were interviewed.

	Harm to research participants must be avoided in all instances. The pilot study permitted the identification of questions which are sensitive or may cause offence to the respondents.
	Respondent selection was open and facilitated through a known community champion. Approaching sample recruitment in this open manner ensured respondents were not victimised. The interviews were carried out during daylight hours and in a public place including: church halls: residents homes; coffee shops; or on the street. In situations where a community champion acted as a facilitator, interviews did take place in respondents homes but in the presence of the facilitator.
	The independence of research must be clear, and any conflicts of interest or partiality must be explicit.
	Respondents were made aware that the interviews were part of an independent PhD project that was not influenced by any external agency.

APPENDIX 7

Appendix 7: Case-study Context and Profiles

7.1 Fintona Case-study Profile, Northern Ireland

The village of Fintona sits in the townland of County Tyrone and is located within the Fermanagh and Omagh District Council area. The West Tyrone Area Plan describes Fintona as a “deprived area”, despite it being one of the three biggest towns in the Omagh district (Community Technical Aid, 2005). The socio-economic profile of Fintona described in this section discusses: population; education and qualifications; employment; deprivation; and health levels in the village.

Population:

The population of Fintona was estimated at 2,063 in 2016, of which 1,048 (50.8%) were male and 1,015 (49.2%) were female (NINIS, 2016). Fintona has an increasing ageing population where currently 16% of the current population are aged 65 years or above (Figure 7.1); this is projected to increase to 20% by 2025. 71.99% of the Fintona population identify themselves as being Catholic and 26.59% are considered part of the 'Protestant and Other Christian religion’. Through the interviewing process it became apparent that the community is not homogenous despite living in close proximity and sharing a ‘common interest’ of flooding.

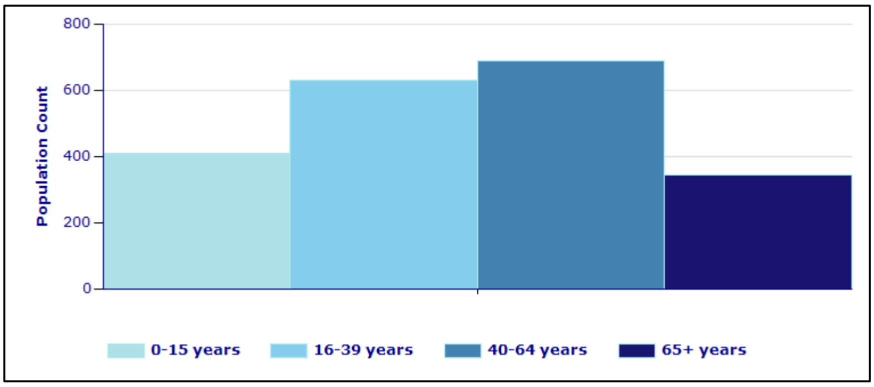

Figure 7.1. Population profiles by broad age bands, 2016. Source: NISRA Demography Branch, 2016.

Education and Qualifications:

Census data (2011) revealed that, 51.5% of 16-64 year olds in Fintona had no formal qualifications (above level 1). This figure is significantly higher than the Northern Ireland average rate of 40.5%. Moreover, the proportion of the working age population qualified to degree or higher standard (19%) does not compare favorably with the overall Northern Ireland rate of 23.65%.

Employment:

Analysis of the population considered to be of working age (16 to 74), highlighted 60.68% were employed and 39.32% unemployed. In total 51.92% were in paid employment. The annual claimant count for Fintona stood at 7.1% average in 2014 (NINIS, 2016).

Deprivation levels:

The Northern Ireland Multiple Deprivation Measure (NIMDM) (2017) was used to provide an accurate insight into socio-economic make-up of the area. The deprivation measure ranks areas (Super Output Areas) from those most deprived (rank 1) to those least deprived (rank 890). The composite measure takes account of seven deprivation 'domains' namely: "Income, Employment, Health, Education, Proximity to Services, Living Environment and Crime and Disorder" (NIMDM,2017). Fintona was found to have an overall deprivation rank of 200 (Figure 7.2).

	Rank **Fintona**
Multiple Deprivation Measure	132
Income Deprivation	124
Employment Deprivation	139
Health Deprivation and Disability Deprivation	105
Education Skills and Training Disability	201
Proximity to Services Deprivation	134
Crime and Disorder	79
Living Environment	388

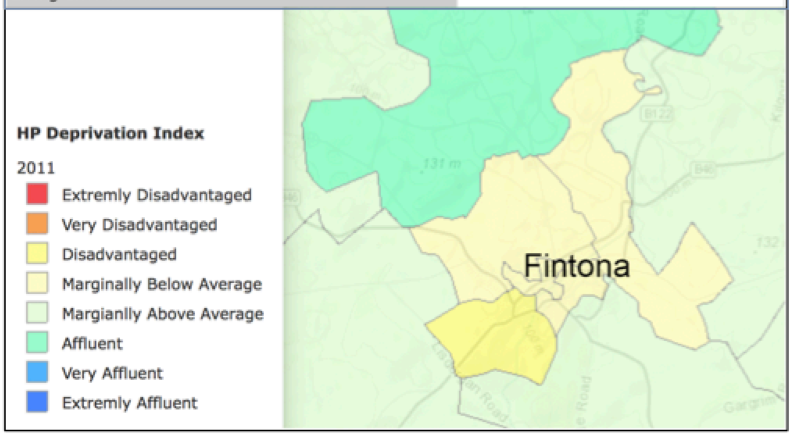

Figure 7.2. Deprivation rank of Fintona. Source: NIMDM, 2017.

Rental tenure was used to determine the economic status of the area. Housing Census statistics (2011) revealed that 63.78% of the majority (63.78%) of households were owner occupied, while 30.98% were rented.

Health

On the last Census (2011), 25.27% stated they suffered from a limiting long-term illness (LLTI). The areas health deprivation issue was further highlighted by the number of people providing unpaid care to family, standing at 10.85%.

7.1.2 Fintona flood history

According to a Regional Community Resilience Group (RCRG) in 2015, Fintona was described as receiving flooding to “a greater or lesser extent on an annual basis” (RCRG,2015:p66). Significant internal flooding to properties in 2011 and 2014 led to the proposal of a £127,000 flood alleviation scheme for the village in 2016. The extent of the flooding issue also led to Fintona being chosen as one of the 10 RCRG pilot studies across Northern Ireland. In partnership with the Red Cross, consumer council and endorsement from the Civil Contingencies NI group, the intention of the pilot study was to review of regional resilience. The aim of the group was to assist communities to do more for themselves by assisting them to “deliver consistent, prioritorised and focused community activities” to reduce flood risk (RCRG, 2015:p3).

Figure 7.3. Flooded street in Fintona. Source: Ulster Herald, 2014.

7.2 East Belfast Case-study Profile

Consistent with the approach taken in Appendix 7.1, this section outlines the socio-economic profile of East Belfast outlines. It does so in relation to its: population; education and qualifications; employment; deprivation; and health levels in the area.

Population:

The population of three communities comprising the East Belfast study is estimated at 11,000 (Census, 2011). Of this population 48.05% are male and 51.95% are female (NISRA, 2011). The population is on an upward trend since 2010 (Census, 2011). In relation to the three communities, 77%-81% of the East Belfast population identify themselves as belonging to a 'Protestant and other Christian religion' community, while 5.8 - 11% identify themselves as Catholic.

Education and Qualifications:

Data from the 2012 Labour Force Survey shows that 64% of Clarawood, 43% of the Sydenham and 34% of Orangefield population had no or low (level 1) qualifications. These figures do not compare favorably with the mean rate of 27.9% across Northern Ireland. The percentage of the population considered as economically active ranged from 61% Clarawood, 69.67% Sydenham and 74.53% in Orangefield (Census, 2011).

Deprivation levels:

Despite the close proximity of the three communities along the Connswater River, the respective deprivation profiles varied considerably. As outlined in Appendix 7.1 above, deprivation rankings range from the least deprived (rank 1) to most deprived (rank 890). Sydenham has an overall deprivation rank of 206 while Clarawood Park and Orangefield rank at 485 (NIMDM, 2017).

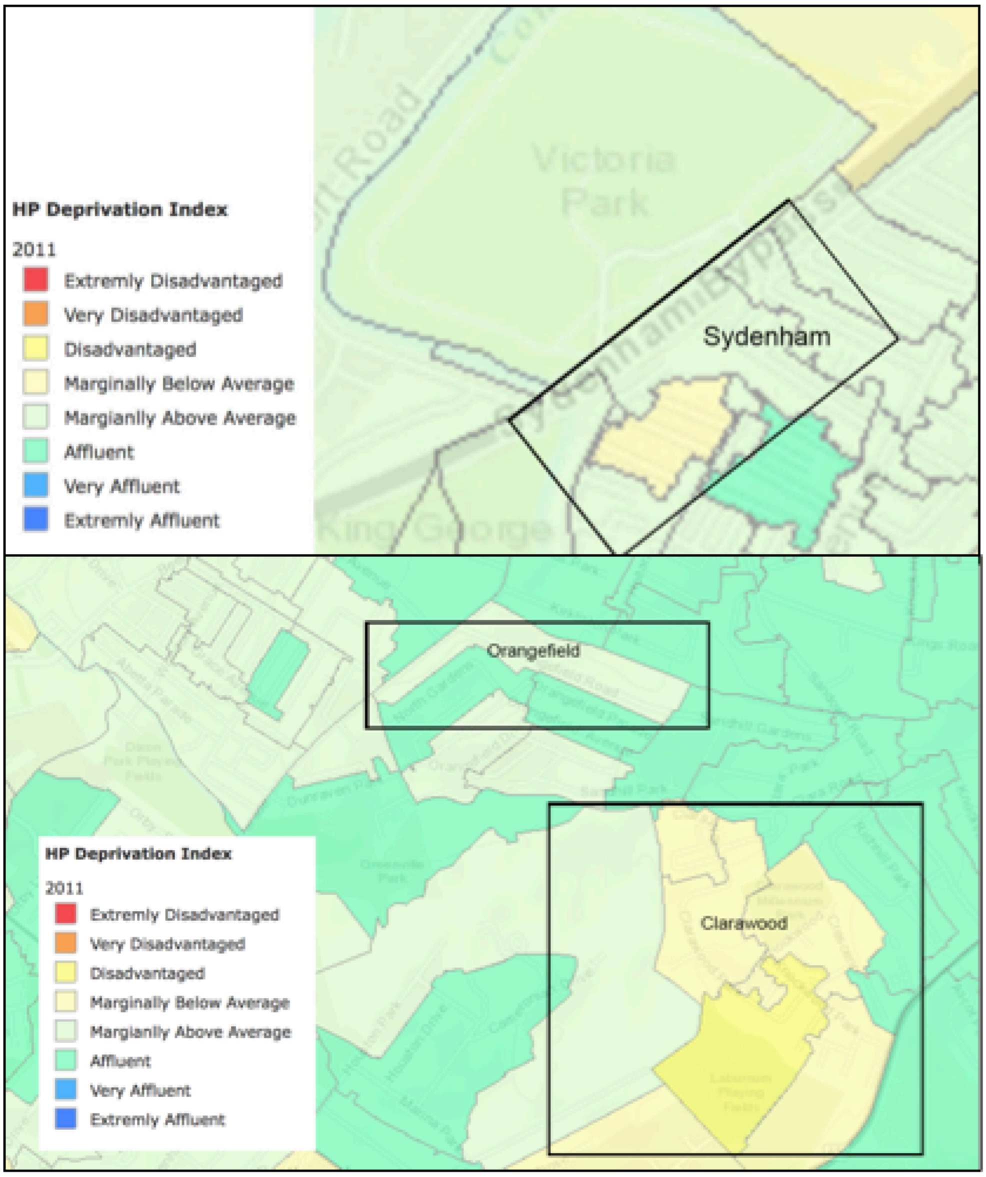

Figure 7.4 Deprivation Index maps for Sydenham, Orangefield and Clarawood. Source: NIMDN, 2017.

Further, home ownership is often used to assess economic levels. Housing and accommodation statistics from the last census revealed that the level of owner-occupation ranged from 58.88% to 77.83% and that between 20.52-36.98% rented. The latter was lowest in more affluent areas.

Health:

On the last Census in 2011, 20.43% of people in Orangefield suffered from long-term health issues or a disability. This figure rose to 34.6% in Clarawood highlighting the health deprivation in the area.

7.2.1 Historical flooding context

The River Agency (2017) estimates the East Belfast has had a recurrent flooding issue since the year 2000. In particular, increased development within East Belfast, has increased river flows leading to significant flooding in the area. Beyond surface water and river flooding (knock river), tidal flooding from Belfast Lough is also a concern. A tidal surge in January 2014 led to a near miss in the Sydenham area (Northern Ireland Assembly, 2016). Further, Sydenham resident have to contest with sewage flooding due to its proximity to the Sydenham Wastewater Pumping Station. In recent years failure of the pumping station has led to flooding in the area, in particular properties along flooding Park Avenue and Lisavon Street (BCC, 2014) (Figure 7.5)

7.2.2 Belfast flood history

Reports of flooding in Belfast date back to the 1600s (Prior and Betts, 1990). Flooding in the city became more frequent in the 1900s with flooding 'Beyond any like occurrence for 50 years' (Belfast Telagraph) in 1901 and 1902. A major event in 1916 led to widespread flooding across the city in particular the Connswater and surrounding areas, which sit within this case study (Rivers Agency, 2015b).

Figure 7.5 Belfast Flooding, 1916. Source: Belfast Telegraph,1916.

The frequency of flood incidents has increased in recent years within the city. A chronology of recent significant flood events illustrates the multiple flood risks affecting Belfast: “rivers, surface water, sewage (wastewater treatment plant) and the sea” (Rivers Agency, 2015a). East Belfast continued to suffer significant flood events in 2005, 2007 and 2008. More recently, extreme rainfall in 2012 led to 44mm of rainfall in three hours (Rivers Agency, 2015a). Such was the scale of the flooding that 1400 households received flood relief payments[53]. On this occasion, flood relief payments were made to in excess of 1400 property owners. It was this major flooding that prompted the Northern Ireland Executive to commission a report by “Performance and Efficiency Delivery Unit” PEDU, to investigate the response to flooding in Northern Ireland (Rivers Agency, 2015a). A further tidal surge hit Belfast in 2014 and narrowly missed severe flooding in the area. Existing flood banks and defences held back the surge, however evacuations were organised for the Sydneham area, reflecting the level of risk (Rivers Agency, 2015a).

[53] Prior to the Homeowner Flood Protection Scheme introduced in 2015, Flood relief payments were given to household who suffered internal flooding to their property.

7.3 Cumbrian Socio-demographic Profiles

An above-average aging profile, together with sustained outward migration of younger populations, reduces Cumbria's resilience capacity. Literature indicates that the elderly demographic group its most affected by flood events (Sharkey, 2007), revealing a significant resilience gap in the Cumbria population. A further weakness is the high percentage of communities (28%) lying within the 10% of the most deprived areas nationally. A GIS based analysis of deprivation levels within Environment Agency flood risk map areas (low, medium, high) revealed that deprived areas are more susceptible to flooding (SEPA, 2011a).

Propensity to recover from flood risk is closely related to a community's ability to learn new skills and knowledge (UNDP, 2012). Education levels in Cumbria were found to be on par with the national average, indicative of potential future learned resilience. However, eroding this potential is the high percentage of young people leaving the area for employment, typical of rural areas. A lack of timely access to services and resources, further depletes resilience levels in rural areas. The aging population negatively impacted upon the region's health and well-being assessment. The above average aging demographic had a knock on effect on higher than average poor health and disability (20.3% of the population).

Housing is a complex mix of high home ownership (indicative of established communities) in rural areas, positively impacting upon resilience level. By contrast, increasing rental tenure in urban areas (representative of transient communities) revealed a low sense of belonging (Miron, 1990; Leviten-Reid and Matthew, 2017). In particular, areas of above average deprivation in urban areas are found to be more susceptible to impacts of flooding (Lindley et al, 2011). The following section takes a detailed look at these socio-demographic influences across Cumbria.

Population

Cumbria is regarded as having an aging population profile relative to the rest of the UK. The 2011 Census indicates that the number of Cumbrian residents in the 65+ age demographic has risen faster than the national average (11%), increasing by 15%(Table 7.1). The growing elderly population can be attributed to Cumbria's popularity as a retirement destination. Within Cumbria 21,900 people reported they had a second address. This equates to 44 persons per 1,000 residents of the county (Census, 2011), representing a higher average in relation to England & Wales generally (28 per 1,000) (Cumbria County Council, 2013).

Table 7.1. Proportion of Persons by broad age group. Source: Office for National Statistics, Mid-2013 Estimates.

	0 - 15 Years	16 - 64 Years	65+ Years
England & Wales	18.9	63.7	17.4
Cumbria	16.5	61.4	22.2
Allerdale	16.6	61.1	20.3
Carlisle	17.1	63.2	19.6
Copeland	16.8	62.7	20.5
Eden	15.8	60.4	23.8
South Lakeland	15.0	58.8	26.2

An investigation into vulnerable groups across Cumbria revealed that of the population affected, the 65+ age profile (22.2% of population), represented 63% of all flood victims and (CIO, 2016). As discussed in Chapter 3, elderly population groupings are reported as having a higher level of flood vulnerability (Sharkey, 2007). The UN predicts that the aging population of developed countries is on an upward trend and those aged 60 years or above is projected to grow by 56% by 2030 (UN, 2015).

Deprivation Levels

A report by the Institute of Environment and Sustainability Research (IESR) (2009) revealed a relationship between deprived areas and disproportionately higher levels of flooding risk. The results indicated that deprived populations (based on Index of Multiple Deprivation data) are 62% more likely to be at risk of flooding relative to those in moderately or highly affluent areas. Within Cumbria, 29 (out of 166) community wards are found to be within the 10% most deprived areas in England (Cumbria Intelligence Observatory, 2015). According to a LLFA report (2016), two of the five wards are reported as 'flood hotspots', namely 'Belle Vue' and Upperby ward in Carlisle. Cumbria county council report that both areas suffer from recurrent low and medium level flooding (Cumbria County Council, 2016).

Acknowledging the compounding effect of flooding on deprived areas, the Indices of Multiple Deprivation (IMD) 2015 was used as a framework to analyse the Cumbrian socio-economic profile. The analysis presented investigates multiple deprivation factors including education; rurality and accessibility; health and disability and housing.

Education

Education and learning is an important component of community resilience (UNDP, 2012). Dufty (2012) highlights the importance of education in fostering community resilience by describing education as "well-placed to help communities build their resilience to flooding" through the ability to help people learn and improve as a result of learning. Levels of educational attainment are an import factor to investigate in terms of a community's potential future resilience. The 2011 Census showed that Cumbria's education level is above the national average (27%), with 30.9% of adults holding a level 4 or above qualification (Census, 2011). Evidence of disparity in the levels of educational attainment was noted, with Kendal in South Lakelands holding the highest rate of academic achievement with 91.7% of pupils gaining five A*-C grades compared to just 25.9% in some areas of Carlisle (Census, 2011).

Rurality and Accessibility

According to the literature, rural area vulnerability may be increased by patterns of migration and rural depopulation, leaving behind those residents who are most vulnerable to disasters (for example the old, young, and disadvantaged/disabled) (IRNH, 2011). Cumbria with an above average ageing demographic has heightened vulnerability due to a lack of access to timely outside services and resources. Conversely, as argued by Mercer (2010), it is the actual acknowledgement that 'the cavalry' may not arrive that can lead to the enhanced utilisation of local knowledge and participatory approaches to disaster management.

According to Cumbria County Council, 54% of its residents live in rural setting compared to UK average of 18%. Of the 54%, Allerdale and Eden have the greatest proportions of residents living in rural areas (72% and 71% respectively) (CCC, 2013). Carlisle is the county's densest settlement however it is still 27% more rural than the national average (CCC, 2013). Figure 7.6 emphasises the disparity between this largely rural area and its low percentage of urban settlements. Furthermore, the rural nature of the county explains its high “geographical barriers to services” score, where 84 (of 320) of the county’s (LSOAs[54]) rank in the 10% most deprived areas nationally.

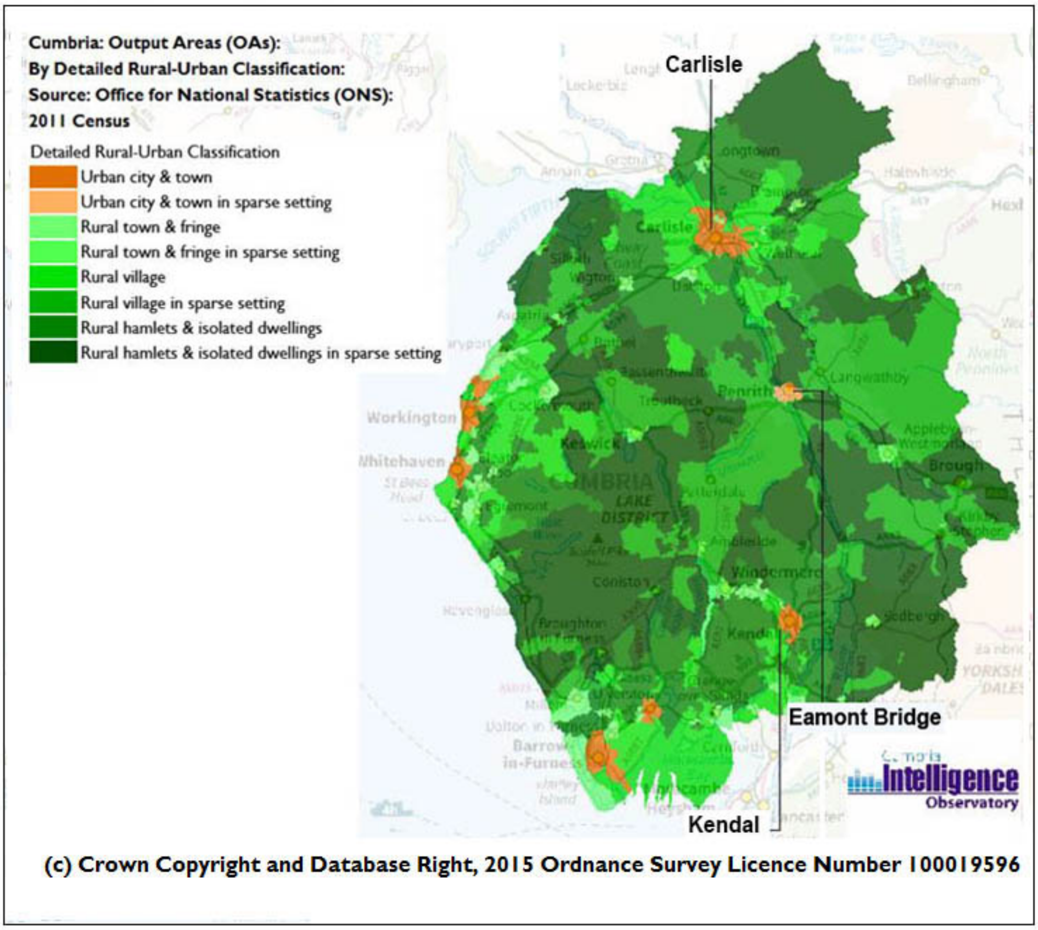

Figure 7.6. Rural Urban Classification in Cumbria. Source: CIO, 2015.

Health and disability

The 2011 Census reports that the proportion of Cumbrian residents limited in their day-to-day activities due to poor health or disability stood at 20.3%, above the national average of 17.9%. However, the average score for Cumbria conceals stark variations between districts. Health scores in the districts of Eden and South Lakeland were above average, whilst the Barrow district was shown to be the third most deprived district nationally in terms of health. In total, it was found that 61 of Cumbria’s LSOA (total of 320) ranked in the 10% most deprived areas in terms of

[54] A Lower Super Output Area (LSOA) is a geographic hierarchy used to present small area statistics in the UK Census.

health nationally. However Ullswater ward in Eden was the exception, ranking in the 10% least deprived nationally in terms of health. The level of limiting illness and its knock-on effect on social connectedness will be qualitatively investigated in more detail (Section 7.5) to ascertain its impact on individual and community resilience.

Housing

In areas of high socio-economic insecurity, Oven (2009) argues that communities have little choice but to live in locations that are more exposed to hazards. Conversely, literature suggests that others chose to substitute higher exposure to hazards for a better quality of life including factors such as accessibility to schools and services (Halverson, 2010).

The disparity in housing quality across Cumbria is evident in the high number of sub-standard rental properties, particularly in the private sector (Cumbria County Council, 2012). Reaffirming the above point, over 25% of private sector properties in the districts of Allerdale, Copeland and Eden were found to be ‘dangerous’ and considered Category One hazards[55] (Cumbria County Council, 2012; Allerdale Borough Council, 2015). According to the 2011 Census, of the 222,042 households across Cumbria, 18,107 (7.5%) of the properties had no usual residents compared to the national average of 4.4.%. It is argued that this figure is a function of the higher than average number of second properties used as holiday homes in the region. The census further highlights that 87,019 (39.2%) of properties are owned outright, (non-mortgaged), above the average national figure. This figure represents an increase of 19.3% in comparison to the previous Census and a 6.4% rise above the national average.

Rental tenure across Cumbria is on par or below the national average (27.1%) with the exception of Carlisle city, which had a significant increase in the number of privately rented households. Private housing association households (social) rose by 4,795, equating to a proportional increase of 364.4% in comparison to the previous census (Census, 2011). This dramatic rise is largely attributable to an 81% decrease in socially (social housing organisations) rented properties, with private housing associations meeting the rental gap brought about by a reduced number of available social housing (Census, 2011). It is possible that these increased rental

[55] Category 1 hazard refers to the severity of risk posed to a potential occupant. When a property scores above 1000 on the housing Health and Safety Rating, it is deemed a category 1 risk.

figures are attributed to the fact that many house owners, who were unable to sell their homes without incurring a financial hit (post-flood), opted to rent out their property after the 2009 floods. Renting out their own property while renting another property for themselves elsewhere partially explains the inflated rental figure in Carlisle. Reiterating this thinking, the Citizen Advice Bureau (CAB) in Carlisle (2011) propose that increased rental tenure is directly linked to the 2009 floods. The CAB further reports that increased post-flooding demand pushed private rents "up overnight" and they continued to rise after the "situation improved". Displacement after the floods significantly increased the number of private rents, however it is assumed that this figure remains artificially high and will reduce within a two-year period when flooded homeowners return to their renovated properties.

7.4 Overview of Cumbrian case-study profiles

The case-study settlements are in line with the three river catchments that comprise the new Cumbria Flood Action Plan (2016); Eden, Derwent and Kent and Leven catchment.

7.4.1 Overview of Eden catchment case-study profile

The Eden catchment Flood Management Plans state the catchment comprises 1490 square miles and is predominately rural in nature (EA, 2009a) It has a population of 244,000, comprising principal settlements: Carlisle, Appleby, Penrith and a nearby village Eamont Bridge, all of which form part of the research case study. The market town of Kirkby Stephen and Shap are also included as indicated on Figure 7.7.

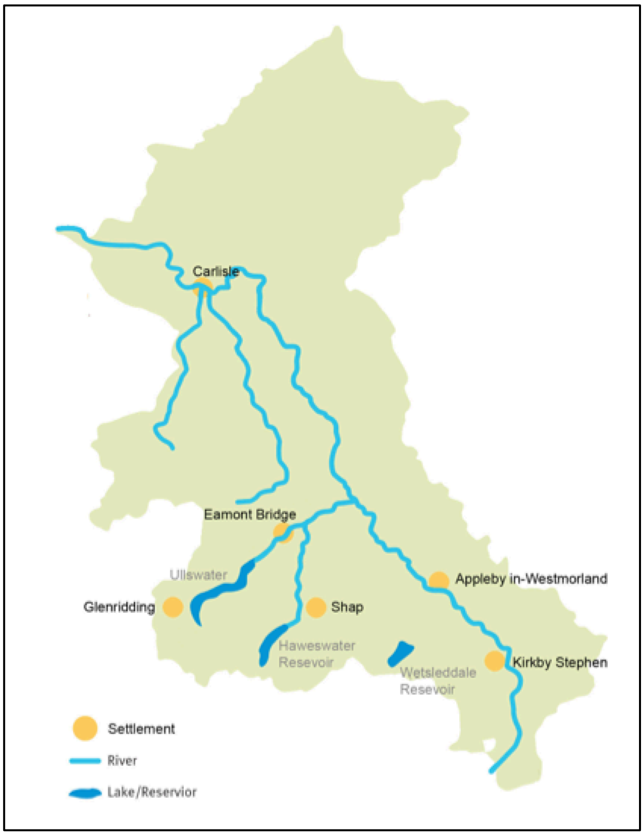

Figure 7.7. Map illustrating the spread of case study settlements across the Eden catchment. Annotated from EA, 2016.

Carlisle City profile

Representing the urban case study, Carlisle city is the largest metropolitan area in Cumbria with a population of 107,524 (Census, 2011). The industrial city is considered an economic hub in Northern England as a result of position at the confluence of three major rivers.[56] Its proximity to three significant watercourses has however led to numerous flood events in the city. Carlisle has experienced a long history of widespread flooding across the city, including: 1771, 1822, 1856, 1925, 1968, 2005 and 2009. The House of Commons Winter Flood report 2015-2016, described the floods as 'unprecedented' (House of Commons, 2016), with Eden river levels reaching a height of 0.6m above the highest recorded flood level in 2005 (CCC, 2016). The January 2005 flood affected approximately 1600 properties, by contrast, 2125 properties were affected in 2015 - despite expenditure of £4.4 million on flood defences in the intervening period. The areas most affected were Warrick Road (St.Aidans and Botchery LSOA), Viaduct Estate and Willow Holmes (Denton Home and Castle LSOA) areas of the city. On the back of the 2015 flood, the

[56] Carlisle city is situated at the confluence of three rivers namely: the Eden, Caldew and Petteril.

Carlisle Flood Action group was established. The city presently has an AEP of 0.59% (CCC, 2016).

Appleby town profile

Appleby is a market town with a population of 3,048 (Census, 2011). The River Eden flows through the town splitting it in two. Given its proximity to the river, the town has a long flood history dating back to 1571. This trend has continued in recent years with flood events occurring in 2005, 2009 and 2015. The severity and impact of the 2015 flood in Appleby was above levels previously witnessed. The EA report that river levels were at the highest ever recorded in the town. The number of properties damaged also exceeded previous years, with 176 properties affected compared to 4 in 2009 and 53 in 2005. The long history of flooding in Appleby prompted the development of structural flood defences (AEP +1%) in 1995, protecting part of the town (EA, 2009e). Other protection measures included property level protection and development of a flood action plan collaboratively with the Environment Agency, however the town has no formal FAG.

Kirkby Stephen town profile

Kirkby Stephen is a market town with a population of 1,804 (Census, 2011), situated at the head of the Eden Valley. Three watercourses flow through the town, explaining its long flood history dated back to 1985. More recently the town suffered flooding in 2009, 2013 and most significantly in 2105 (CCC,2016). The Winter 2015 event caused internal flooding to twenty properties as a result of the run off from the unnamed watercourse that overwhelmed a culvert (closed drain) on the private land of the caravan park site. Further flood incidents across the town included the areas of Quarry Close, High Street and north Road (CCC, 2016). The town does not benefit from any structural defences or a FAG.

Eamont Bridge village profile

Eamont Bridge is a small village of 535 residents (Census, 2011) located near the town on Penrith. Flowing east from Ullswater lake, the River Eamont directly passes many properties in the village. Bearing the name of the village, the bridge is the main cause of flooding. “Acting like a dam” the bridge restricts river water flow, leading to historical floods and more recently in 1997, 2002, 2005 and 2009 (CCC, 2016).

During the 2009 flood event, 43 residential properties and 2 commercial properties were flooded in the village. This figure rose to 72 residential properties in 2015. No formal flood defences protect the village however, a property level protection scheme was implemented after the floods in 2009 (EA, 2009e; EA, 2009a). The EA and the local community worked together and of the 45 affected houses, 37 availed of funding for property level protection measures, including air brick covers and flood gates (Cumbria County Council, 2015). Whilst the village has an active parish council engaged in flood issues, it does not have a formal FAG.

Glenridding village profile

Glenridding with a population of 450 residents (Census, 2011) is located within the Lake District National Park. Tourism is one of its main industries as a consequence of its unique geography. However, its location at the shores of the second largest lake within the Lake District, and surrounded by mountains, render the village highly susceptible to flooding with no structural defences. Its recent flood history includes 1997, 2005, 2009 and 2015. The Winter 2015 event resulted in 15 properties being flooded and the town further suffered infrastructure and utilities disruption, rendering the village inaccessible for several days and without electricity, phone or mobile signal (CCC, 2016). The village has a very active parish council to deal with flooding issues however it does not have a formal FAG.

Shap village profile

Shap, a village of 1,264 residents (Census, 2011) is located approximately 10 miles south of Penrith. Much of the watercourse is culverted through Shap village. Shap has flooded previously in 2005 and 2010 (CCC, 2016). On the 5th of December 2015, 25 homes and businesses were flooded in Shap (CCC, 2016). The majority of the properties affected were located along Main Street with lesser, more isolated properties in the other areas of the village affected. There are no structural defences in Shap, however works carried out by Network Rail are reported to have helped reduce the issue (CCC, 2016).

7.4.2 Overview of the Derwent Catchment Case-study

The Derwent catchment is situated within North West Cumbria (Figure 7.8). It contains four major river systems and several lakes across a total area of 760 miles. There are several lakes which play a key role in the Derwent catchment, including Thirlmere Reservoir near the town of Keswick. Above average rainfall in the area, combined with the impermeable underlying geology, has led to severe run-off and flooding. In particular, this research will focus on the catchment market town of Keswick (EA,2009b).

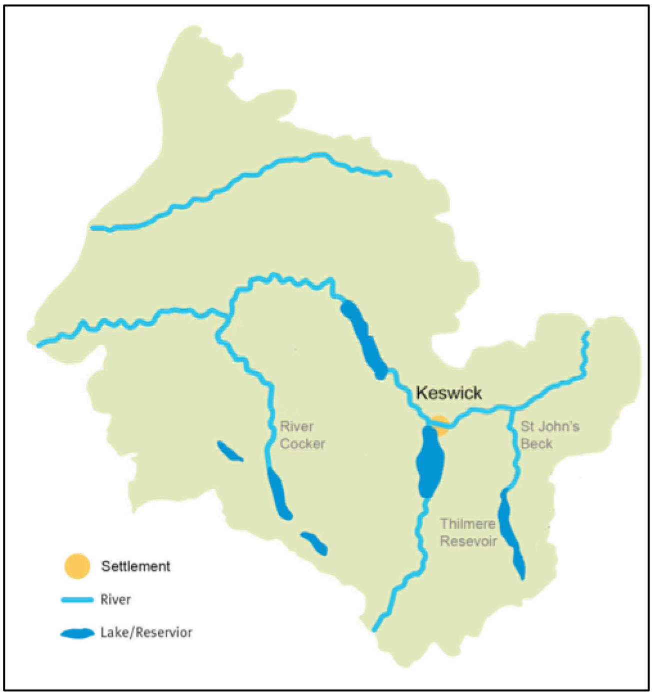

Figure 7.8. Keswick case study in Derwent catchment area. Annotated from EA, 2016.

Keswick town Profile

Keswick is a market town of approximately 5000 residents (Census, 2011), located immediately north of Derwent Water, and lies within the Lake District National Park (EA, 2009b). Owing to its popularity as a tourist destination, Keswick's population is increased by the number of temporary visiting tourists. The town suffers from fluvial flooding from the two main watercourses running close to or through Keswick and a major United Utilities reservoir upstream of the town is reported to compound the flooding issue (CCC, 2016).

Keswick has a long flood history dating back to 1822. In the years leading up to the significant floods of 2005 and 2009, there was a history of recurrent flooding with a total of 20 individual floods detailed in the archives (EA, 2009b). In total, 175 properties were flooded in 2005, 250 in 2009 and most recently 515 properties (the highest figure to date) in December 2015 (CCC,2016). As a consequence of earlier floods, substantial investment in flood defences have been constructed and the current AEP stands at 1.43% (CCC, 2016). In terms of social resilience, the FAG in Keswick is widely recognized in the region as being an exemplar for other communities to try and emulate.

7.4.3 The Leven and Kent Catchment

Similar to other two catchment areas, the Leven and Kent Catchment (Figure 7.9) is set within the Lake District National Park and is predominately rural (EA, 2009c). It also suffers from extreme rainfall run off from the fells due to its mountainous topography.

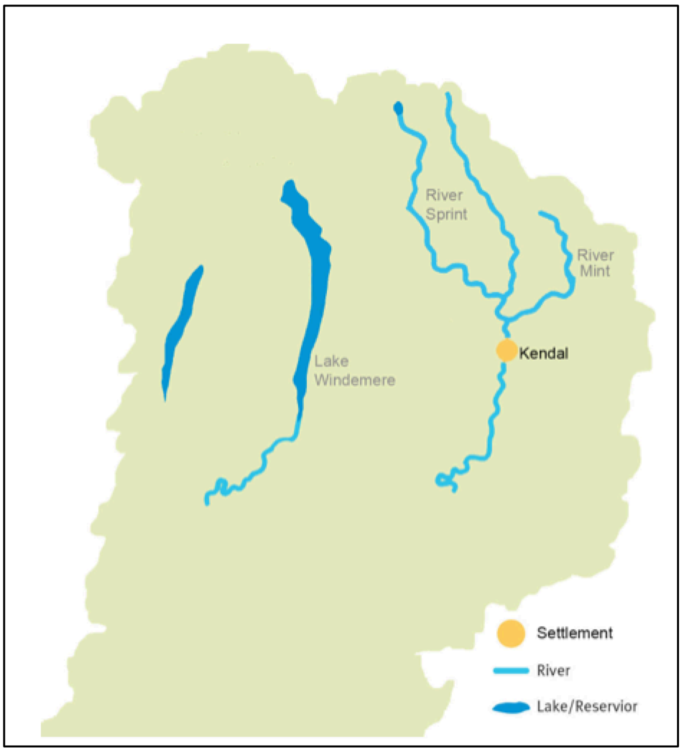

Figure 7.9. Kendal case study within Derwent catchment. Annotated from EA, 2016.

Kendal town profile

The market town of Kendal is the third largest settlement in Cumbria. A large percentage of its 30,000 residents are susceptible to flooding due to its location at the confluence of three rivers (EA, 2009c). Consequently the river Kent which flows through the town has been altered (deepening and widening) and flood defences erected in order to reduce risk to the town. Industrial development in designated floodplains further adds to the flood risk in the town. Kendal has a prolonged flood history dating back to the 17th century, experiencing repeat floods in 1954, 2004, 2005, 2009 and most recently in 2015 (EA, 2009d; CCC, 2016). The town has benefitted from numerous flood defence and alleviation schemes.

7.5 North-East Scotland Case-study context and Profiles

The following section outlines the socio-economic profile of North-East Scotland. It does so by detailing the factors affecting a community's resilience, such as: population, deprivation levels, education, rurality and accessibility, health/disability and housing.

7.5.1 North-East Scotland socio-economic profile

Population

North-East Scotland's rurality is reflected in its low population. The estimated population of North-East Scotland's largest city, Aberdeen, stands at 230,350, with a further 261,960 residents in Aberdeenshire (National Records of Scotland, 2016b). The population has been steadily rising over the last century, with annual increases of 0.5 per cent being typical (National Records of Scotland, 2016a). During the period 2012-14, the number of people entering North-East Scotland (9,652 per year) exceeded the number leaving (7,965 per year) the area (National Records of Scotland, 2016a).

However, outside of Aberdeen city, there is a growing elderly demographic particularly in the smaller towns and villages (National Records of Scotland, 2016a). Specifically, persons aged 60 and over make up 24.1% of Aberdeenshire. Of note is the fact that Aberdeen's suburb, Peterculter, has a higher elderly age profile than both Aberdeen city and Scotland generally. At the opposite end of the age demographics, 15% of Aberdeenshire's population were aged 16 to 29 years, standing below the national average of 18.2%.

Deprivation levels

The Scottish Index of Multiple Deprivation (SIMD) reports that the Aberdeenshire council area comprises 1.8% of the most deprived areas nationally. In addition, Aberdeen city (which sits outside Aberdeenshire Council area) comprises 7.8% of the most deprived areas nationally (SIMD, 2016). By contrast, a third of Aberdeenshire's data zones (121) stand in the "20% overall least deprived" nationally (Lindley et al, 2013). The above statistics highlight the disparity in deprivation levels across the Aberdeenshire council area and highlight ‘pockets’ of social deprivation. On the whole, however, the residents are reported as having comparatively “good health” and “affluence” relative to national (Scottish) deprivation levels (National Records of Scotland, 2016a).

Education

Education is integral to the capacity of communities to act upon lessons learned in order to enhance their future resilience. The 2011 Census statistics highlighted that 79.8% of the Aberdeenshire population had some level of qualifications (above the national average of 73.2%). Of these, 33.2 % were level 4 or above, which places Aberdeenshire above the national average of 26.1%.

Access to services

The literature demonstrates that a lack of access to services has the potential to restrict community resilience (Cutter, 2010). According to the SIMD (2016), access to services is calculated through proximity to essential services (doctor, schools, petrol station, post office, retail). In this regard, Aberdeenshire comprises 5% of the most deprived areas in Scotland for geographical access to services, reflecting the rural nature of the county. However, the Rural Facilities Monitor (2015) also highlight that the case study settlements of Garioch (Inverurie) and Marr (Ballater) have reportedly benefitted from an increase in key services in the period between 2013-2015.

Health and Disability

The literature reports high levels of health have the potential to positively influence community resilience (Ray-Bennett, 2016). General health in Aberdeenshire was described as ‘very good’ by 55.4 % of the population, above the national average of 52.5% (Census, 2011). In addition, long-term health was described as ‘not limited’ by 84.5% of residents (national average 80.4 %).

Housing

The sharp population growth in Aberdeenshire as a consequence of the oil and gas industry has led to issues relating to the provision of housing and transport infrastructure (Aberdeen City Council, 2015; Gazetteer for Scotland, 2017). Consequently, Aberdeenshire now holds the second highest average house price in Scotland (ASPC, 2016). The above average wealth in Aberdeenshire has led to an overall low rental tenure in the area. Of the 112,000 houses across Aberdeenshire, 68% are owner-occupied compared to the average of 58% in Scotland (Census, 2011). This is important as the literature notes a correlation between high resilience and established areas with high owner-occupier figures (Cutter, 2010).

Employment

Much of the employment in Aberdeenshire is underpinned by the oil and gas sector, directly employing 11% of the population and having a knock-on effect on the services industry (PWC, 2015). However, an over-reliance on this sector of the economy has ultimately led to increased unemployment, with a loss of 10,000 jobs across the Aberdeenshire area as a consequence of the oil crash (Scottish Parliament, 2016). The Scottish Parliament Information Centre (Spice) report indicates that the number of claimants of 'out of work benefits' has risen by 92% in Aberdeenshire and 69% in Aberdeen city (Scottish Parliament, 2016). However, despite the economic strain of the oil crash, Aberdeenshire still holds a lower unemployment (claimant count) of 1.1% (Jan-march 2016) compared to the national average of 1.8% (Aberdeenshire Council, 2016b).

7.5.2 Overview of North-East Scotland case-study areas

As outlined in Chapter 5 (applied in Chapter 6), the case-studies selected are representative of the village, town and city settlement hierarchies. The unique and varied flood history across Aberdeenshire allowed for a spread of case-studies, ranging from first-time flood affected communities to those which have experienced recurrent flooding. Largely, the communities did not benefit from hard engineered flood defences, however bunds[57] were present in Inverurie and Ballater. A hierarchy of settlements with and without resilience groups was included in order to assess the social connectedness and dynamics between settlements of various densities. The section below outlines the cultural history of the individual case-studies, together with their respective flood histories and flood protection plans.

[57] A bund is a protective embankment typically made from reinforced earth that serves to prevent flooding.

Aberdeen city profile

Aberdeen is the third most populous city in Scotland, with an estimated population of 230,350 (National Records of Scotland, 2016b). The city is situated between two river mouths, the Dee and the Don, and comprises four main flood risk areas: Deeside, Bridge of Don and Denmore[58] (Figure 7.10). The fourth flood risk area comprises the suburb of Peterculter or 'Culter' which is subject to significant flood risk as illustrated in Figure 7.11 below. Together, these four areas represent flood risk for 10,440 residential properties and 3,240 commercial properties (Aberdeenshire Council, 2016c).

The Scottish House Conditions survey (2011-2013) reports above average (£24,700) household income levels for the region, standing at £28,800 in Aberdeen city and rising to £29,600 in Aberdeenshire generally. Indeed, one Aberdeen postcode reportedly had the second highest number of millionaires of any postcode in the UK (The Times, 2008).

The complexity of the flooding issue in Aberdeen is exacerbated by the multiple potential sources of flooding (fluvial river flooding, surface water, culverted watercourses, sewage and coastal tidal surges). Further compounding the issue is the fact that much of the city's critical infrastructure is located in at-risk areas, ranging from schools, healthcare and emergency services to transport links such as rail, roads and bridges. Specifically, 3240 of Aberdeen's business properties are located in a flood plain, highlighting a significant risk to the economy (Aberdeenshire Council, 2016c).

The Deeside area (Figure 8.4), located within the city centre, has had a recurrent flood history dating back to the 1970s and continuing through the 1980s. These flood incidents caused substantial damage to agricultural land, properties, facilities (such as a golf course) and critical infrastructure, including railway lines and roads (Aberdeenshire Council, 2016c).

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[58] The village of Peterculter also lies within the boundaries of Aberdeen City Council area however due to its rural nature it is dealt with separately at the village scale.

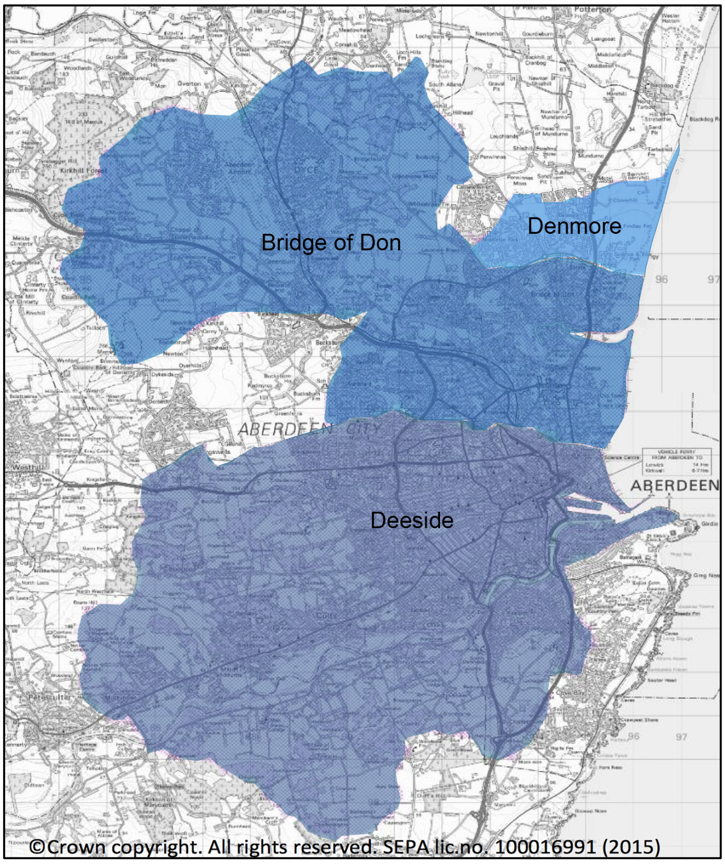

Figure 7.10. Aberdeen flood risk area including the potentially vulnerable areas of Deeside, Bridge of don and Denmore.

In 2000 and 2001, surface water impacted the Denmore and Bridge of Don flood risk areas (Figure 7.10), when floodwater exceeded the capacity of the drainage systems. The Bridge of Don area predominantly suffered from surface water flooding as a result of blockages in the drainage system and built up debris blocking the watercourse (Aberdeenshire Council, 2016c). This surface water flooding extended across large parts of the city in July 2015, when manhole covers became displaced by the force of the water (Aberdeenshire Council, 2016c). In December 2015, flooding devastated homes and businesses across Aberdeen city, in particular Grandholm and the surrounding areas, which led to the evacuation of seven nearby care homes (FSHC, 2016).

The Aberdeen suburb of Peterculter, with a population of 7,220 (Census, 2011), lies within the boundary of Aberdeen city council area. Its locationon the northern banks of the River Dee at the confluences of the Crynoch Burn and Leuchar Burn rivers, has contributed to its long flood history. An estimated 380 residential properties and 20 non-residential properties are reported in SEPA's flood maps to be in an area at risk of flooding in Peterculter (Figure 7.11). Peterculter's recorded flood history dates back to 1827, when intense rainfall caused the failure of several small dams, resulting in the flooding of crops and the paper mill. Flooding as a consequence of 'blocked and inadequate drainage' reportedly caused damage to approximately 50 properties in 2012 as well as further flooding in winter 2015/2016 (Aberdeenshire Council, 2016c). Of the three case-studies considered, Peterculter in Aberdeen was the only community to have a Resilience Plan in place prior to winter 2015.

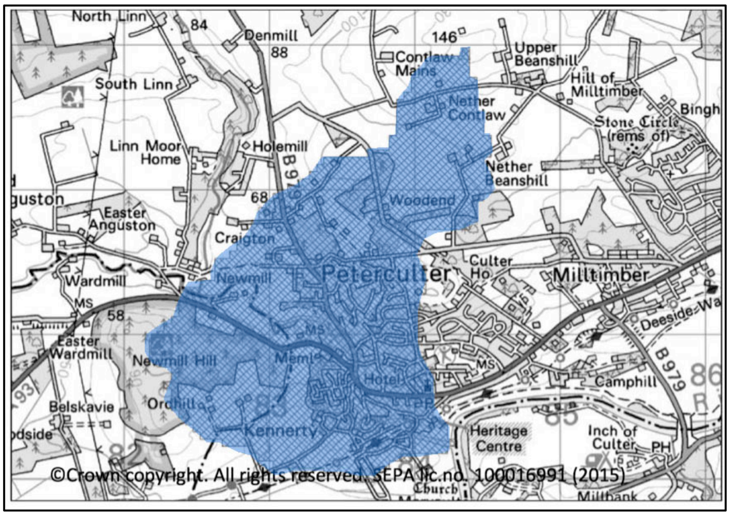

Figure 7.11. Peterculter flood risk area.

Whilst officially part of Aberdeen city, Perterculter has an atypical profile and is referred to as the "the village in a city" (Miles and Ebrey, 2017). To this end, Peterculter has a relatively new attachment to the city and was first incorporated into Aberdeen city in 2006. As such, its urban façade hides a semi- rural culture. The ' village in a city' remains distant from the cultural institutions and amenities of Aberdeen city centre, with its social activities evolving around Culter Village Hall, Culter Mills Social club and other social/community clubs (as advertised on the village website). Residual village forms such as these highlight Culter's geographical position as a place 'on the edge', with a foot firmly placed in its rural past.

Inverurie town profile

Inverurie is a market town located in the valley of the river Don. The town, including the suburb of Port Elphinstone, has a population of 12,760 (Census, 2011) rising 17.3% since the 2001 census (Census, 2001). Situated 16 miles (26 km) north west of Aberdeen, it serves as a commuter town for 30% of its inhabitants (Census, 2011). There are approximately 230 residential and 19 business properties at risk of flooding from the confluence of the River Don and Urie at the southern end of the town (Figure 7.12). In addition to fluvial flooding, the area suffers from surface water flooding due to the overwhelming of culverts at the Strath Burn) and Over Burn (Aberdeenshire Council, 2016c). In addition, the critical infrastructure (such as the A96 road and the railway/line) are exposed to flooding (Aberdeenshire Council, 2016c).

Inverurie's flood history extends back to 1768. More recently the river Don has caused flooding in 1995, 2002, 2003, 2004 and 2009 (Aberdeenshire Council, 2016c). On the 2nd January 2016 a total of 80 residential properties were affected in Inverurie, of which six were businesses (Aberdeen and Grampian Chamber of Commerce, 2016). At present the town has flood protection from a bund wall along Keithhall Road and Riverside Park. However, the structural integrity of both bunds were compromised as a consequence of rabbit burrows. Local businesses have taken it upon themselves to reinstate the bund with a hard-engineered flood wall along Keithhall, after negotiations with Aberdeenshire Council were deemed too lengthy (The Press and Journal, 2016).

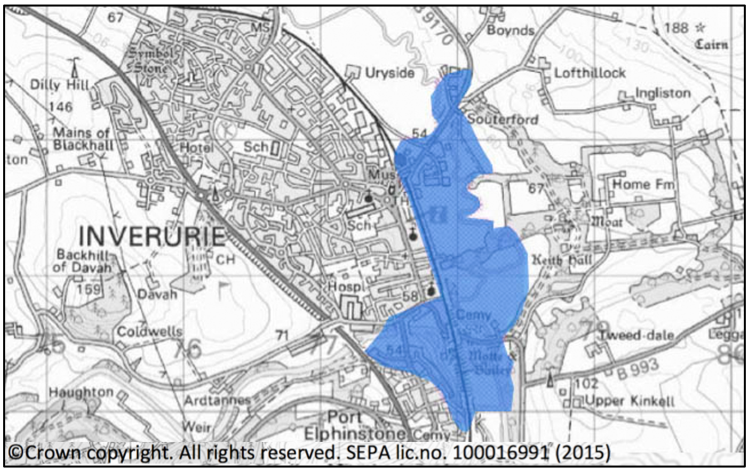

Figure 7.12. Flood risk in Inverurie from river Don and river Urie.

Ballater village profile

Ballater is a village located on the River Dee in Aberdeenshire and has a population of approximately 1,500 residents (Census, 2011). The village sits within a 4.3

square miles 'potentially vulnerable area' (Figure 7.13) and has a flood history extending back to the Muckle Spate in 1829 (Aberdeenshire Council, 2016c).

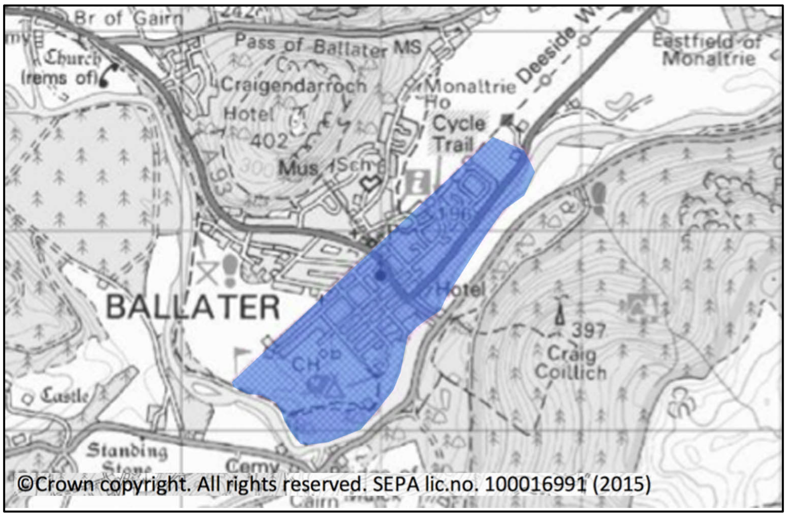

Figure 7.13. Flood risk in Ballater from river Don.

Flooding continued in 1877, when the village suffered basement flooding to cellars and road flooding in 1920 and 1929. Lower parts of the town suffered repeat floods in the 1980s, largely as a consequence of blocked drains which became overwhelmed. In 2008, surface runoff also caused internal flooding to some properties in the village. More recently flooding of roads and the caravan park in August 2014 led to the evacuation of 150 people from the site. Rainfall in December 2015 also affected large areas of the village but not to the extent of the December 2016 floods which affected over 300 properties and 60 businesses (Aberdeenshire Council, 2016c). Over 100 residents had to be evacuated from their homes and the area suffered significant disruption to critical infrastructure, with a section of a major road (A93) connecting Ballater and Balmoral Castle being washed away (Figure 7.14). The location of critical services (police station, ambulance and fire station) within the flood area impacted upon the response and recovery service after the event. A flood risk assessment carried out in 2009 identified that approximately 200 residential and 40 non-residential properties were at risk of flooding. Hard structural defences in response to this risk are limited to a bund wall near Ballater golf club.

Figure 7.14. Damage to A93 road connecting the villages Ballater and Braemar. Source: BBC, 2016c.

APPENDIX 8

Appendix 8: Codebook of Practitioner Level Interviews

8.1 Codebook of practitioner level interviews, Northern Ireland.

Organisation	Responsibility	Interview codes
Policy-Prevention		
NI Water	Strategic Flood planning	P29
DOE	Tactical Flood Planning	P30
Recovery and Reconstruction		
Rivers Agency	Head of operations	P31
Fermangh and Omagh Planning Department	Planning officer	P32
Fermanagh and Omagh District Council	Community Development Planning	P33
Rivers Agency	Site Engineer	P34
Belfast City Council	Connswater Greenway Project Manager	P35
Belfast City Council	Urban Development	P36
Belfast City Council	Community engagement (Belfast)	P37
Fermanagh and Omagh District Council	Councillor (Fintona)	P38
Emergency Management		
Met Office	Flood forecasting and communicating.	P39
Rivers Agency	Community Resilience	P40
Transport NI	Emergency Planning Officer (EPO)	P41
Rivers Agency	Flood Engineering	P42
Belfast City Council	Emergency Manager	P43
Belfast City Council	Resilience Forum Director	P44
Industry and Independent		
Red Cross	Researcher	P45
NI Housing Executive	Property level protection	P46
Environmental Link	Senior policy officer	P47
Climate NI	Adaptation	P48
Ulster Farmers Union	Vice president	P49
Design Consultants	Water engineer	P50
UpSkill Enterprises	Community resilience and capacity	P51
Consumer Council	RCRG community representative	P52
ABI representative	Risk adviser	P53

8.2 Codebook of practitioner level interviews, Cumbria.

Organisation	Responsibility	Interview codes (NVivo)
Policy and prevention		
Environment Agency	Asset Engineer	P165
United Utilities	Head of water programme	P167
Carlisle City Council	Principal planning officer	P171
Eden District Council	Principal Development and Management Officer	P173
Emergency Management		
Met Office	Flood forecasting and communicating.	P174
Environment Agency	Resilience officer	P163
Allerdale Borough Council	Flood Risk Team	P175
Cumbria County Council	Flood Risk Management Team	P168
Recovery and Reconstruction		
Environment Agency	Asset manager	P176
Cumbria County Council	Development and infrastructure planning	P177
Cumbria County Council	Community planning and development	P178
Cumbria County Council	Councillor	P179
Carlisle City Council	Community and economic development	P162
Carlisle Churches	Flood Recovery Team	P164
Cumbria CVS	Flood Recovery Manager	P166
Industry and Independent		
Red Cross	Community adviser	P180
Farmers Network	Managing director	P161
Cumbria action for sustainability	Property resilience manager	P170
National Farmers Union	Vice president	P169
Property level Protection	Business manager	P181
ABI representative	Risk adviser	P182

8.3 Codebook of practitioner level interviews, North-East Scotland

Organisation	Responsibility	Interview codes (NVivo)
Policy and Prevention		
Scottish Environment Protection Agency	Flood adviser	P34
Aberdeen City Council	Team Leader (Flooding and Coastal Protection)	P41
Emergency Management		
Ready Scotland	Resilience co-ordinator	P37
Ready Scotland (Grampian)	Grampian Resilience Adviser	P33
Met Office	Regional Adviser	P40
Recovery and Reconstruction		
Adaptation Scotland	Sustainable Development Officer	P36
Cairngorms National Park Authority	Director of Planning and Rural Development	P38
Cairngorms National Park Authority	Head of Land Management and Conservation	P39
Cairngorms National Park Authority	Community Support Manager	P42
Aberdeenshire Council	Infrastructure Services Director	P32
Aberdeenshire Council	Principal Engineer, Flood Risk & Coast Protection	P35
Independent and Industry		
Sniffer	Climate Resilience Project Coordinator	P43
National Farmers Union Scotland	North East Regional manager	P44
Property Flood protection Company	Director	P45
Risk Adviser	Flood insurance adviser	P46

APPENDIX 9

Appendix 9: Lessons from the pilot study

9.1 Alterations made to community level case-study questions

A brief description of the significant changes to the methodology going forward are listed below:

- The question under flooding impact altered to include more specific wording on ‘after’ the flood event to include ‘weeks and months after’ to ensure the focus is on the recovery and reconstruction phase and not on the direct response phase.
- The question on social connections sequenced later as the question on ‘formal assistance’ tended to receive a negative emotive response which side-tracked the interview focus.
- The question on informal connections, organisations and associations re-sequenced as it yielded a poor response. This can be attributed to genuine low engagement with the community but also some residents related community groups to low class areas. “There are no community groups here, you have to go to low class areas for them”. Further, the proportion of elderly and those suffering from poor health and confined to their home, could also be attributed to the poor response.
- In locations where availability of data on tenure and education level are not available they are included in the background questions. The reasoning for this is to further investigate if education levels have an affect on the capacity of a community to utilise lessons learned and the strength of skill and competency levels.
- The strategic level questioning proved largely effective with the exception of community planning. Limited ‘community planning’ data may be attributed to Northern Ireland’s newly devolved local councils, where the community planning department is in an embryonic stage and requires a bedding-in period. As a consequence of this stakeholder is included in the main case study (studies).

9.2 Expert validation of data indicator results

The Framework approach articulated in Chapters 4 and 5 resulted in a list of 21 higher-level indicators (Tables 6.7 - 6.10). The research acknowledges that qualitative research inevitably runs the risk of encapsulating some form of research bias through its subjective coding process (Norris, 1997). In order to mitigate against this, the results were disseminated through a presentation to a group of statutory level participants in Belfast, in September 2016. The group comprised 16 representatives of organisations involved in flood risk management and climate adaptation in Northern Ireland (Table 6.14).

Table 6.14 List of organisations from which validation feedback was received

Members of climate NI steering group in attendance
Bryson Group
BT Group
Business in the Community Northern Ireland/ARENA Network
Chartered Institute of Environmental Health
Construction Employers Federation
Department of Agriculture, Environment and Rural Affairs (Climate Change)
Department for Infrastructure (Planning)
Institution of Civil Engineers Northern Ireland
Northern Ireland Electricity Networks (NIEN)
Rivers Agency
Northern Ireland Environment Link
Northern Ireland Local Government Association
Northern Ireland Water
Royal Society of Ulster Architects (RSUA)
Ulster Farmers Union
Ulster University

Feedback from participants confirmed that the synthesised results reflected their overall perceptions of resilience indicators within a Belfast and Northern Ireland context. In particular, the feedback also noted that Phase 1 (quantitative) scores were useful for initiating discussions of resilience, however the contextualised indicator level results from Phase 2 (qualitative) were found to be the more useful in understanding the overall pattern of resilience performance across the two communities. It was agreed that Phase 2 indicator results provided a more useful measure of the performance of the systems, assets and functions of a community, which contribute to resilience. The feedback further indicated that all participants understood the value of the Phase 1 quantitative profiles as baselines for monitoring, however groups questioned whether the profiles in some way masked important trends due to aggregation of results. In particular, feedback from a Northern Ireland Water representative, noted that the results from Phase 1 in East Belfast did not reflect the investment made on flood alleviation measures in the area in recent years, however this point was captured in the qualitative Phase 2. As such, going forward into the main case-study it is important to note that quantitative assessments may have a lagging effect (Keerthiratne et al, 2017).

"I think the difficulty here (Phase 1 results) is that a lot of important, community specific details can be lost" (Northern Ireland Water representative).

APPENDIX 10

Appendix 10: Framework component charts for Northern Ireland case-studies[59]

10.1 Risk component

Chart 1 Risk	1 Risk Awareness	2 Risk Communication	3 Risk Mitigation	4. Risk Experience	5. Risk Knowledge
Fintona Community Level case-study	"I knew the place flooded…I mean it did years ago but I never though it would happen this often or this bad"(F14)	*"Sure the community doesn't even know we flood down here….you only understand flooding when you've had wet feet yourself" (F21).*	Installation of a SMS flood-warning strategy	*"It's a nightmare scenario everytime there is heavy rain" (F13)*	*"Get on with it" (F 21).*
	"I'm constantly looking out the window when it's raining to see what's happening" (F15).	*"There has been no communication or support I feel let down" (F25)*	Establishment of the Regional Community Resilience Group (RCRG).	*"It was never an issue before but its bad now these last few years" (F 23)*	*"You need to move on or it'll get in on you*" (F21).
	"No I didn't know (house was on a flood map). I even bought a few properties across the road that flood too but I didn't know. I never imagined it could get as bad as it is now"(F16).	"I'm fed up ringing the council and getting through to some girl in England who keeps asking me my post code. There has to be a better system"(F16).	Developemnt of community emergency plans	*"We used not flood but these last few years it's become a real problem. They've started to map it now online its that much of a problem" (F27).*	*"Sure what can an old lady like me do about the flooding situation?...nothing" (F25).*
	"We used not flood but these last few years it's become a real problem. They've started to map it now online it's that much of a problem" (F17).		No community emergency plan	*"This house flooded when I was here 40 odd years ago" (F15)*	*"Feeling of helplessness…what can I do" (F27)*
	"We used not flood but these last few years it's become a real problem. They've started to map it now online its that much of a problem" (F17).				*"I knew about it sure I live right beside the river but I didn't think it would actually come into the house" (F28)*
	"We used not flood but these last few years it's become a real problem. They've started to map it now online its that much of a problem" (F17).				*"If it happens one more time I don't think I could handle it, I'd just move out honestly"* (F31).
	"Flooding cannot be entirely avoided…. Have to manage the risks" (F13).				*"We know what to do now" (F12)*
Risk	**1 Risk Awareness**	**2 Risk Communication**	**3 Risk Mitigation**	**4. Risk Experience**	**5. Risk Knowledge**
Fintona Practitioner Level case-study	*"Locals are very vigilant and very risk aware. It is not hard to engage them" (P40).*	*"It is difficult at time to engage with the community and as a result we have had to look for more inventive methods of engagement" (P 40).*	*"Our role in the planning process is to advise and our message is simple… Don't build in flood plains of flood prone areas..that's how you avoid flooding"(P33).*	*"They are aware from past flooding" (P 31).*	*"Well I think it is fare to say with all these cuts and redundancies of course knowledge is going to be lost" (P39)*
	"They sleep with an eye open when there is heavy rain" (P40).	*The use of terminology such as a 1 in 100 return periods event hampered progress and inclusion(P26).*	*"We are very against development in a flood plain. Once we know an area does flood it's a no go area" (P30).*		
	"They wouldn't know about flood maps but they do know they live in a flooded area" (P 30).	*Jargon is unhelpfull .. its important that a softer speak is used to communicate the message. (P 40).*	"We strictly enforce PPS 15 since 1994" (P 33).		
	"The number one problem is how to get people aware of flooding who don't think they are at risk" (P 43).	*"Standard weather warnings, social media, Twitter account for Northern Ireland. We try not to use it too often to dilute it" (P 29).*	*"New build shouldn't be in a flood risk area" (P 33).*		
	"Perhaps its an issue of raising their resilience in general and not just focused on flooding that will create long term sustainable interest sustainability" (P43).	*"It comes down to the infrastructure and accessibility of these communication resources to the most vulnerable in particular. With limited technologies as a limitation perhaps the local church notice board is more appropriate" (P 29).*			
		"Community representation is ad-hoc at best" (P27)			
		"There is a gap at the communication level and an understanding of the broader resilience concept" (P30).			
		"There is no formal point of contact between the agencies and the community" (P34).			

[59] Electronic copies of these data outputs are available within the accompanying CD.

Chart 1 Risk	1 Risk Awareness	2 Risk Communication	3 Risk Mitigation	4. Risk Experience	5. Risk Knowledge
Belfast Community Level case-study	*"Yes we knew it had been flooded. We got it cheap because it was flooded". (B4).*	*"They don't listen to us…they do what they want regardless. At best we get a leaflet shoved in the letter box" (B9).*	installation of a SMS-warning strategy	*"I don't see the need now that the flood alleviation measures have been solved now" (B7).*	*"I don't think any flood protection measures could have helped that water stay away, it had such a force…. and after all the work they did on the river I'm happy enough" (B9).*
	"We used not flood but these last few years it's become a real problem. They've started to map it now online its that much of a problem" (B 7).	*"Sure the community doesn't even know we flood down here….you only understand flooding when you've had wet feet yourself" (B11).*	Establishment of the Regional Community Resilience Group (RCRG).		*"I feel like I know what to expect…how to deal with insurerers. I'm better organised" (B10)*
	"I don't think I need any flood protection measures now that they have the river fixed" (B8).	*Agencies were cautious of not 'scare mongering' (B12).*	Developemnt of community emergency plans		
	"I worry now and watch when its heavy rain" (B9). *"I've lived in East Belfast all my life and never knew about flooding in this area" B11).*		No community emergency plan *"You cant stop nature...no point" (B2).*		

Chart 1 Risk	1 Risk Awareness	2 Risk Communication	3 Risk Mitigation	4. Risk Experience	5. Risk Knowledge
Belfast Practioner Level	*"People are not aware how vulnerable they are until they are flooded" (P 45).*	*"It (Belfast matters) is intended to promote debate among communities on issues such as flooding, and represents an opportunity for communities to influence future land use planning and development plans for their area"* (P29).	*"We are addressing planning issues through PPS 15, going forward we are in a better position. But enforcing it is another matter" (P 37).*	*"Given the floods we've had in the past we need a Floods Bill for Northern Ireland but government can only do good things if they have the power that's why we need to give the power to the agencies" (P 29).*	*"Engagement is closely linked to emotion. The experience of being flooded is highly emotive" (P 40).*
	"The responsibility (awareness) lies with the statutory agencies (P49).	Cautious of not *'scare mongering'* (P32)	*"If you build a property in a flood plain you are just building something which has to be protected and that's a nonsense" (P 37).*	*"Some people genuinely believe they wont flood again, they have short memories" (P 52).*	
	"In no uncertain terms have we said the problem is solved (By structural defences) and we believe the residents still need to be alert to the concept of flooding" (P 43).	*"We call these alleviation schemes not defense schemes because there is always a risk, always a residual risk" (P 32).*	*"We strongly advise against building in flood plains. We are only consultee though the legislation lies with planning" (P 37).*	*"What tends to happen is, once the water levels recede so too does flood memory….its a hard job contacting people on a dry summers days asking them about their flood plans…but you can't drop the ball" (P31)*	
	"We call these alleviation schemes not defense schemes because there is always a risk, always a residual risk" (P 32).	*"It's about warning and informing" (P 33).*	*"You cant fully prevent flooding, but we need to reduce the risk , its helping in small ways that together will make a difference (P 48).*		
	"Those that have been flooded are certainly aware. Others not really"(P 32).	*"Communication from agencies to the community have stopped using jargon and this has improved engagement" (P 33).*			
	"We would make it quite clear that the threat of flooding is still there despite our works. No flood alleviation project can offer a guarantee… however the residents also now feel they will never flood again" (P 32).	*"There are gaps in the communication tree, there is too much reliance on one key player" (P 33).*			
	"What tends to happen is, once the water levels recede so too does flood memory….its a hard job contacting people on a dry summers days asking them about their flood plans…but you can't drop the ball" (P40)	*"Community engagement could certainly be better" (P 36).*			
	"Until you are flooded you don't think there is an issue" (P 44).	*"They have no chance to be prepared (Community) … there isn't clarity as to whether they have a responsibility to convey (flood registrar) information to the public" (P 30).*			
	"I don't know how many people even know they live in flood plain or that flood risk maps exist. This needs to be explained at the community level" (P 36).	*"We are still playing catch up with our alert system" (P 38).*			

10.2 Resources and Capacities component

Chart 2 Resources and Capacities	6. Self-organisation	7. Capcity building/ up-skilling	8. Insurance	9. Collaboration	10. Innovation	11. Self-efficacy	12. Flood Responsibility
Fintona Community Level case-study	*"I check the drains myself to make sure they're not blocked. I put my hand in myself. That's the main issue. Remove leaves that kind of thing" (F14)*	*"They (agencies) showed us how to make a sandbag wall properly" (F15)*	91% of residents in both case studies stated they would be willing to carry out flood protection measures to their property.	*"We look after our street and they can look after theirs" (F15).*	"I had my own doors made up and they have worked"(F12).	*"I'd give it a try, it can't hurt" (F16). (Referring to PLP)*	*"We shouldn't have to live with a stinking house for months after raw sewage runs through your house….that's what was happening. It's a disgrace" (P 1).*
	" Talked about using our premises as a shelter after the floods" (F16)	*"They gave a talk in the golf club about what flood doors you can get "(F17)*	*"I've no insurance, cant get it. I'd like to have the peace of mind and have it so yeh I'd try anything" (F17).*	*'We're left to fend for ourselves'* (F16)	"We help a lot pulling cars out of the water and towing them. We'd have the equipment to do that" (F19).	*"I'd consider anything that would help me. I'd do anything"(F26).*	*"Why should I have to pay for flood defences. I've been here 54 years I'm not paying for it now" (P2)*
	"We got the drains all cleared but all we built a ramp out of sandbags out the back where it diverts it away from the main doors. We got a fella to do a survey for us on the manholes and all that, he advised us on some options". (F16)		*"I've no insurance, I'm afraid to look into it"(F19).*	*"I suppose they come, but it's a silent knock on the door. We have to look after ourselves" (F15).*	*"I tried to get a flood door made. I commissioned a blacksmith to make me a door" (F22).*	*"I'm like a flood warden for the street and I help out all the old age pensioners when I get a phone call to say there is a risk of flooding" (F25).*	*"All I want to do is forget about it and get on with life" (P 5).*
	"We'd also knock on some doors and tell people to move their cars before they flooded and blocked the road" (F19).		*"I don't have insurance sure they wouldn't pay out anyway" (F21).*	*"We were trying all night to get someone to come out and help us but nothing happened until 8pm the following day…That's over 30 hours later and its frustrating" (F19).*	*"Lad with a slurry truck unblocking the drains" (F23)*	*" We know who is most at risk so we help them first " (F25).*	*"Less talking and more action. Their (agencies) talking is no use" (P6)*
	"The street was a hive of activity with man, woman and child brushing and mopping….we had to work day and night to get the business back open" (F17).		*"Which would you rather?...your home flooded or an insurance contribution and the hassle that comes with it?" (F28).*	*"The counci lget there but its too late" (F22).*	*"Went round the elderly people…and moved out carpets, sofas and anything wet you know "(F23)*		"*How many unprecedented, once in a lifetime...they call them now, events are we expected to withstand?.....we need to accept the likelihood of it happening more often and get ourselves ready for it. We will flood again, that much I know'* (P7).
	Technical measures (internal changes to the house or business) – Moved light fittings and electrical meters above water level, replace wooden skirting board with plastic, quick release door hinges) and behavioural measures		Described as desirable by both communities, however 38% (Fintona) and 30% (Belfast) of the residents respectively admitted to not having contents or property cover.	*'I'll look after number one next time it happens, no one else is going to help you' (F24).*	*"We even got a blacksmith to make a key so we could open the manholes ourselves ..and let the water away" (F23)*		*Feel it is the responsibility of "the council" "housing executive" (P 7) (Issues of PLP affordability)*
	Behavioural measures (moving furniture and valuables to higher floors in the building, using sandbags and other methods to seal doors and windows, organising a generator and pump, and moving vehicles to higher ground(F15;19;18;25;17),			*"We look after our street and they can look after theirs" (F13).*	*"We have since marked the wall so we will know where they (manholes) are in deep floods" (F26).*		*"It's hardly my fault the river floods, they need to fix it. The council are responsible for this" (P 8).*
					"I had my own doors made up and they have worked "(F20).		*"As I rent I'm not really that interested (in PLP) but would see the benefit from it if the landlord understood the measures (P 12).* *"The powers that be will do what they want anyway" (P 15).*
Resources and Capacity Chart 2	**6. Self-organising**	**7. Capcity building/ up-skilling**	**8. Insurance**	**9. Collaboration**	**10. Innovation**	**11. Self-efficacy**	**12. Flood Responsibility**
Fintona Practitioner Level case-study		*"Hazard Manager is rolled out to the community. They got some initial training on how to operate and navigate the programme also" (P 39).*	"Insurance is fundamental, without it you go through hell" (P 28).	*"Nobody wants to talk about flooding until it happens"(P30).*	*"My perception is that in Northern Ireland community resilience equals having a community emergency plan. Resilience building, cohesion the softer stuff is not understood by agencies" (P 46).*	*"There was the knowledge there but I fear with all the present restructuring valuable knowledge will be lost. I think there is a weakness developing in the knowledge base as a result of these budget cuts in central government level" (P 39).*	*"The community tree doesn't actually name people directly. Where is the accountability, Who is your 'neighbour' the bottom level is weak" (P 46).*
		Resilience building, cohesion the softer stuff is not understood by agencies" (P 38).		*"It's about identifying things that we can do better together" (P30).*		*"They have access to the key to the sandbank store so they feel empowered and engaged that way" (P 38).*	*"It's the responsibility of the government, that's the mentality of the community" (P 45).*
		"There needs to be training on flood maps, get them engaged as most people don't know they are in a flood area" (P 29).		*"Only when flooding is recent will you get engagement" (P38).*			
		"Beyond this (community collaboration and establishment of resilience group) I'm not sure the community has the capacity to pump water etc in terms of safety and expertise. I mean they aren't trained for that" (P 29).		*"Communities have negotiated with the police to be allowed use road closed signs during a flood to stop traffic making waves of water into houses" (P38).*			

Chart 1 Resources and Capacities	6. Self-organisation	7. Capcity building/up-skilling	8. Insurance	9. Collaboration	10. Innovation	11. Self-efficacy	12. Flood Responsibility
Fintona case-study	"We put things (Furniture, white goods) up on breeze blocks that we keep out the back"(B3).	"No we've had no training…they (agencies) are the ones that need the training" (B1)	"We had no insurance so it was an unbelievable stress"(B5).		"I keep my valuables like sentimental photos on a high shelf" (B6).	"We wouldn't know what to do" (B3).	"We were promised new floors, kitchen, doors…we are still waiting for the housing executive to do it" (B5).
	"The builders put the plug sockets higher. I chose furniture on high footings" (B8).		"Some people on the street have no insurance it was so high" (B8).		"The children were going down the road in a canoe to get the sandbags"(B7).	"Water is like a mouse, It'll get in…whatyou can do?" (B12).	"It should be the housing executive (Social housing) that sort that for us. I'm unemployed at the moment and my wife works part-time. We just couldn't afford it"(P15).
	"One neighbour did give out advice about insurance to those who were struggling to get it" (B9).		"Which would you rather?...your home flooded or an insurance contribution and the hassle that comes with it?" (B8).		"The builders put the plug sockets higher. I chose furniture on high footings" (B8).	"If it happens one more time I don't think I could handle it, I'd just move out honestly" (B1).	"I'd consider resilience measures if it lowered premiums and let me get insurance. Might be able to sell my house that way" (B 2).
	"We have the foundations filled in and with the measures they've taken in the river it would take a Noah's ark flood for us to be flooded again" (B 2). "I put plyboard on my air vents too. I think that helped a bit. I also put all my valuables upstairs and no longer keep personal photos and sentimental things downstairs" (B 12).				"I keep my valuables like sentimental photos on a high shelf. I'd just make sure my I had my paperwork in order for the insurance companies" (B8).		"They should pay for our property resilience measures" (B2).
					"One neighbour did give out advice about insurance to those who were struggling to get it" (B9).		"They (government) should pay for our property resilience measures" (B 12).
					"We have the foundations filled in and with the measures they've taken in the river it would take a Noah's ark flood for us to be flooded again" (B 12).		

Chart 2 Resources and Capacities	6. Self-organisation	7. Capacity building/up-skilling	8. Insurance	9. Collaboration	10. Innovation	11. Self-efficacy	12. Flood Responsibility
Belfast Practitioner Level	"How do you incentivize people to sustain engagement, and take action for themselves.. that is the question" (P 37).	"There needs to be legislation and falls down to the statutory agencies which outlines their curriculum and this is the skills training required to deliver these skills"(P 51).	"No one should be left in a situation where they cannot get any (insurance) protection" (P 41).	"Engagement works best when the community feels on a par" (P 40).	"One property owner building a defence wall which actually served to hold the water in if anything" (P 35).	"Knowledge is there, just a matter of building the competence and the drive to act" (P 51).	"There isn't legislation here in Northern Ireland surrounding resilience and civil contingencies, but there should be and we need a real focus and attention from the assembly on this" (P 51). "The community have learnt I'm at risk and I need to do something about it "(P 40).
	"In some cases there's is nothing the community can do (water coming up under floorboards) but they have a part to play…knocking on neighbours door etc. (P37)	"There are hundreds and thousands of skill standards that we use daily but we don't use them for disaster planning…training is needed here" (P 51).	"We can say that a defence has been built to a 1:100 year standard but insurance companies are asking for more than this"(P 31).	"Routinely benchmark in terms of evaluation and how people feel, know and understand and in terms of delivery of how things are carried out. What are the able to do. That is why legislation and training is needed to force people out of their silos and take on board a joined up approach" (P 52).	"Our consultants and ourselves would always consider SUDS in our feasibility studies as opposed to hard engineering defences, piping and culverting solutions" (P 36).		
		"Routinely benchmark in terms of evaluation and how people feel, know and understand and in terms of delivery of how things are carried out. What are the able to do. That is why legislation and training is needed to force people out of their silos and take on board a joined up approach" (P 51).		"It should be better managed now that we are under the one department" (P 30).	"We need more innovative ways to look at drainage through SuDs and sustainable flood management measures" (P 36).		"Lack of ownership ….I pay my rates you should fix this" (P 43).
		"How do you know what needs to be developed if you don't do a skills audit in the area" (P 51).		"Flooding comes from everywhere… it's everyone's problem" (P 32).	"Flood warden scheme has been asked for through a residents association, on the back of engagement" (P 41).		"People are realising that the government doesn't have a wand to make flooding go away" (P 40). "They need to get over the denial of flooding and take action" (P 40).
		"Civil servants are trained to not take on board risk and to turn away from it. They are risk averse…it's an issue to move beyond this" (P 45).		"Until now engagement (between agencies) has been limited, with all the agencies sitting under one umbrella in a flood group maybe things will improve" (P 47).			
		"Government departments don't have the personnel or the links with the community in the case of an emergency" (P 30).		"We are not directly involved at the community level as I say but we felt that the community had a voice and were listened to" (P 30). "Its very rare we would get engagement through organisations or residents groups it tends to be more individual cases of 'my house'" (P 30).			
		"We do disaster training once every 5 years and we include councils in this so they have an idea of what we do and at the end of the day we get paid by the same person" (P 41).					

10.3 Connectedness component

Chart 3 Connectedness	13. Social- Capital	14. Integration of Social networks	15. Sense of belonging	16. Higher-level Trust
Fintona Community Level case-study	*“I’d contact the chair of flood forum, he’s the only one who’s doing anything. He knows who to phone and what to do. But otherwise no formal assistance contacts” (F12).*	*“Local Councillor would help with sand bags, he did all the organising. The council do all that sandbag stuff ”(F21).*	*“Played in the river as a child” (F17)*	*“We are happy to work with them (authorities) and see where this leads. At least they are paying us attention now” (F21).*
	Council come out afterwards when all the work is done…for an assessment (F12)	*“I’d contact the chair of flood forum, he’s the only one who’s doing anything. He knows who to phone and what to do. But otherwise no formal assistance contacts” (F22).*	*“My brother and son live in this row of houses, I’m not going to move” (F 22)*	*“Empty promises. They promise this and that but the road service don’t follow up on it. It’s a bad situation” (F21)*
	“The only help I get is from my neighbour, he’s my standby. He’s been very good to me” (F15)	*"I never hear tell of the council.Theres nobody to help, there’s no coordination or help like that in Fintona. The parish priest would fight for me".(F13)*	*"Everyone played their part, everyone on the street helps each other out. The community can be good like that" (F18)*	*No point in them coming in the good weather, they need to be here in the bad weather when all the leaves are falling (F22).*
	“Sure I rarely leave the house” (F14).	*“There is no such groups that I’m aware of” (F14).*	*“My brother and son live in this row of houses, I’m not going to move” (F22)*	*“I suppose they come, but it’s a silent knock on the door. We have to look after ourselves” (F23).*
	“ You are depending on friends and family you could call upon. It was mostly staff that volunteered” (F19)	*“ Nah not a member of any community groups. When you get to my age you just do what you can to get through the day” (F18).*		*“No coordination or consultation at all with them” (Agencies) (F24).*
	“The chair of the flood forum, he’s the main man, he’d know who needs help” (F19)	*“There does be (are) things going on in the Golf club…if you’re interested in that kind of thing. I just keep to myself really” (F19).*		*“No nobody bothers about you. You have to look after yourself ”(F23)*
	Reliant on son to “See if I’m okay” (F14)			*“There’s no point in them (agencies) putting sandbags down when its flooding ….no point closing the gate when the horse has bolted “ (F24)*
	“*There are no such groups that I’m aware of (Flood Resilience Groups)”(F15)*			*“It’s working okay communicating with the council but they just don’t seem to be working or making decisions very quickly” (F24).*
	“I’d just contact the resilience group. I help chair if I could be I’m usually busy looking after my own house” (P 18).			*“Do nothing apart from sometimes dropping off sandbags” (F24).*
	“We knew she would struggle in a wheelchair so we like to look after her. The community is strong like that” (F22).			*“If they can help us we are happy to do the work needed” (F25).*
	“We look after our street and they can look after theirs” (F23).			*“The fire brigade are very good now at coming and clearing the drains once you ring in” (F27).* *“They just talk mostly and do surveys and reports…its time they built a wall” (F 28)* *“I get no formal assistance and it really annoys me” (F27).*
				“We felt totally let down but the transport NI” (F12). In Fintona (66%) of residents reported not receiving any property level assistance and described their efforts as “Too little to late” (F12).

Chart 3 Connectedness	13. Social- Capital	14. Integration of Social networks	15. Sense of belonging	16. Higher-level Trust
Fintona Practitioner Level case-study	*"Yes community groups may have their insular sub groups but by and large they are engaged with the statutory bodies "(P 40).* *"Community representation is ad-hoc at best" (P45)* *There are very informal support networks where they discuss their problems and how they can cope (P45)* *"There needs to be more of a community focus at the strategic level" (P 45).*	*"You need to put people first. Try and get as much buy in and engagement from the community as possible" (P40)* *"There is some level of contact with agencies but it could be vastly improved. For example they cant directly contact the person" (P30).* *"Getting a sustainable link with authorities such as the council so that they know who to contact in a flood event… that is key" (P 40).* *"Those communities that don't have a community resilience group then they don't get the message. The agencies will get the message but it's a case of how that message gets from the agency to the affected communities themselves. It's not great "(P 40).*	*"Rural communities are communities of place and they tend to be more cohesive in comparison to urban communities. They have a strong desire to protect their place" (P45).*	*"A lady from the council who works very diligently with us but she cant be 15 places at the one time" (P 38).* *"Engaging with the community through agencies is the whole thrust of community development. It would allow you use resources more effectively" (P40).* *Those on the phones are only following protocol …it makes the council look very foolish (P 38).* *"Here the department has taken the idea of community resilience by the scruff of the neck and asked in communities what are the issues. You don't see many other statutory bodies in other countries standing in the firing line like that. What can we do to enable you, to empower you?" (P 40).* *"Historical interaction with agencies-People haven't always had the level of engagement haven't generally been helped during recovery effort and are annoyed and trust lost to suddenly engage with them now" (P30)* *"The RCRG have unified the approach to resilience, there is willingness on the agencies side to fulfill these communities needs" (P 52)*

Chart 3 Connectedness	13. Social- Capital	14. Integration of Social networks	15. Sense of belonging	16. Trust in authorities
Belfast Community Level case-study	*My sisters son is a joiner so he did the flooring for free (B3).*	*"No Community organisations around here….this isn't a poor area" (B9)*	*"We all help each other out, doing one house at a time with the sandbags"(B8).*	*"They gave us sandbags but they were useless" (B3).*
	"Friends and neighbours helped us mostly" (B3).	"The children are in various groups like the girls brigade, cadettes ..and some sporting clubs" (B7).	*"We are very close as a street after the flood" (22)*	*"It was a year after before any of the agencies came in. They came to do and assessment promised this and that but did nothing" (B5).*
	"It was just neighbours and passers by that helped" (B4).	"There are no community groups, centres or anything like that around here. You normally get them in poor neighbourhoods"(B2).	*"This street changes a lot…sure all them houses there are rented you know" (B5)*	*"We feel let down and angry by them (agencies)" (B5).*
	"The neighbours are generally quite elderly here so they couldn't help. Young lads from the other estate and my neighbour helped with the sand bagging"(B6).	*"A group of us meet in the put to watch the football…that's all really" (P22).*	*We had to pay for a neighbours hotel room on the card as they didn't have the money until the insurance came through..that's what communites do!" (B2)*	*"They don't listen to us…they do what they want regardless. At best we get a leaflet shoved in the letter box"* (B9).
	"It's just neighbours helping each other out and keeping an eye out on the elderly" (B7).	"I'm in the house most of the time apart from being driven to bridge by my carer but that's a bit away" (B2).	"The neighbours rallied around and helped" (B11).	*"No one came to help. Politicians came after the event but that's no use" (B6).*
	"There is a residents association and we do meet to discuss insurance and building contractors. The community is very tight after the event" (B8).	"I'm in the footballers supporters club and a fishing club" (B2).	*The sense of community is so strong after the event now because we have this event in common with each other (B3).*	*"You just get through to someone in England (when you ring the agencies). What use is that?" (B2).*
	"The lord mayor and MP's came round. Politicians came after the event too. They helped get my insurance down" (B9).	*"I'm in the footballers supporters club in Glentorin but other than that just my work friends and guys I go drinking with" (B2).*		*"No one (agencies) is organised around here when it comes to flooding"(B11).*
	One elderly neighbour couldn't afford insurance so we rang age concern on her behalf to try and help her" (B8).	*"The kids get involved with sport in the park, that kind of thing. No clubs though just what have you with the school" (B6)*		"Don't trust NI water (the authorities) It shouldn't have happened. Why do we pay rates" (B11).
	"The neighbour gave me his power washer to clean out the garage" (B9).	*"Sure the community doesn't even know we flood down here….you only understand flooding when you've had wet feet yourself"* (B2).		*"The army gave us sandbags from the local barracks" (B12).*
	"We know the neighbours so we'd just go knocking on the doors of the elderly" (B9).			*"I have no confidence in those alleviation works. If they believed in them then why is our insurance still so high" (B12).*
	"Lord mayor and MP's came round which was a nice gesture" (B2).			*Don't trust NI water"(B12).*
	"Friends and neighbours from the surrounding streets helped us. The councillors came around too" (B2).			
	"The army gave us sandbags from the local barracks" (B2).			
	"If I hadn't my daughter to rely on I'd have been in an awful situation" (B2).			
	"No it was just neighbours mainly (that help). A neighbour even offered to find us accommodation the night of the flood" (B2).			
	"They had 2 lifeboats ready for evacuation. The police were about too informing people about the need to possibly evacuate" (B3).			
	No one going to help you hear except friends, neighbours and family. We don't have a residents association here or anything. We just shout out to the street and ask for help (B3).			
	'*I'll look after number one next time it happens, no one else is going to help you'* (B7).			

Chart 3	13. Social- Capital	14. Integration of Social networks	15. Sense of belonging	16. Trust in authorities
Belfast Practitioner Level case-study	*"Disasters bring people together" (P 51).*	*"Here it seems to be the government pushing the community to help themselves.,,we don't have the community structure like they do in England" (P 41).*	*"Urban areas have more of an expectation that a resource will be provided for them whereas rural communities tend to be more resourceful" (P 41).*	*"I feel that the provision in Northern Ireland is totally inadequate and that the statutory agencies are limited by their ability to influence, resource and by the legislation and red tape around policy and practice" (P 51).*
	"The relationships generated (through resilience groups) are priceless" (P 38).	*"We all live and work in the city so we should all get a say" (P 36).*	*"They feel 'part of the team' and engage further a willingness as a result" (P 40).*	*"It is difficult to engage at the statutory level as they believe they are the 'top dogs' and when egos come into the equation they can hamper progress and it can be very frustrating" (P45).*
		"Flooding has no borders, I think we could engage more with other agencies and councils"(P 42).		*"No lessons learned at the engagement level with the community, the departments are not suitable at all" (P 51).*
		"The avenues are there now for people to have their voice heard which wasn't there before" (P 40).		*"Multi agency efforts are strong" (P 40).*
				"It takes a while to engage with the community and show them we are people centred but that resilience actions take time" (P 40). *"Certainly being in direct contact via a personal mobile number and engagement in various meetings has built a relationship and trust" (P 40).*

10.4 Learning component

Chart 4 Learning	17. Problem Definition	18. Critical Reflection	19. Experimentation	20. Transfer of local Knowledge	21. Monitor and Review
Fintona Community Level case-study	Establishment of a flood resilience group in Fintona	*"They (Planners) told us to dig down two metres not to spoil the skyline….that's why we flood" (F14).*	*"I blocked the roads with my van to stop the traffic going into the village" (F17)*	*"Neighbours and members of the flood resilience group help me….They know I'm too old to lift sandbags" (F17).*	*"When I go for a walk with my dog every day, I stick my head over the bridge when I'm passing just to check on it" (F17).*
	"We get onto our Local Councillor and see what he can do"(F15)	*Well they say they are going to fix the problem so if it's (flooding issue) is all solved there's no point investing in measures (F14)*	*"Got a locksmith to make a key to remove the manholes and let the water away" (F17)*	*"The river was at a point I'd never seen water before. I told them that river will flood tonight….and it did" (F17).*	*"We are constantly looking over to the river to see how high the water is at the culvert" (F24).*
		"There's too much water flowing through the same old pipes….the pipes are out-dated"(F24).	*"I asked a blacksmith to make me a flood door" (F27).*	*"Played in the river as a child…I know it well" (F19)*	
		"Have you seen the size of the car park they put in an area that is known to flood?….now you tell me if that was a good idea" (F23)		*"Planning decided to build a supermarket and car park and now there is nowhere for the water to run. It usen't to be like that (F24).*	
				"We knew she would struggle in a wheelchair so we like to look after her. The community is strong like that" (F24)	
				" We know who is most at risk so we help them first " (F24).	

Chart 4 Learning	17. Problem Definition	18. Critical Reflection	19. Experimentation	20. Transfer of local Knowledge	21. Monitor and Review
Fintona Practitioner Level case-study	*"The likes of flood defences are designed to protect against flood events that we have already seen. What happens if we get a flood event beyond what we normally get" (P 30).*	*"Flooding cannot be entirely avoided"* and that all that can be done is *"Manage the risks"* (P41).	*"We could do a lot more but it all depends on the resources (learning). We make do with the resources we have" (P 36).*	*"There is certainly more room for local knowledge" (P 30).*	*"It's about not dropping the ball. We check in on the community even on the dry days. It keeps the flood memory alive" (P40).*
		"Were just staggering along till the next flood...we're no better organised" (P 38).	*"We would restore the property to the same situation as before. We don't use flood doors or anything like that. They are also prohibitively expensive (for social housing) we don't have a budget for that" (P 46).*	*"A member of the resilience group has such an intricate knowledge of the river that he knows exactly where the tipping point threshold of flooding in the river is" (P45).*	
		"I'm fed up ringing the council and getting through to some girl in England who keeps asking me my post code. There has to be a better system".(P38)	*"A lady did put in a concrete step to hold the water back and another man covered his air bricks with ply board" (P45).*	*"They are hyper vigilant worried about the rain yet they don't know about property Level Protection. How is this possible" (P 45).*	
		"We need better organisation on the ground and some accountability" (P29).		*"Flood maps are not really site specific enough and would benefit from local knowledge" (P 30).*	
				"Local knowledge has it place especially when a certain area that floods perhaps hasn't been mapped by Rivers Agency. Local knowledge has its part to play certainly" (P 30).	

Chart 4 Learning	17. Problem definition	18. Critical Reflection	19. Experimentation and innovation	20. Transfer of Konwledge	21. Monitor and Review
Belfast Community level case-study	"The drainage isn't up to standard and they need to monitor that pumping station. They failed us time and again" (B1).	*"Move your car quick is the lesson I learned" (B4).*	*"I blocked the road with my van to stop the cars sending waves of water in the house" (B8)*	*"I knew to watch out for the lady a few houses up who lives by herself". (B11)*	
		"It became dangerous at one point so at a certain point next time I'll stop trying to get sandbags" (B8).	*"I've concreted the floors now" (B12)*	*"I know the lady on the corner has 3 children that are sick so I go and offer her help and ask if there is anything I can do". (B2).*	
		We were trapsing around in sewage and oil looking for sandbags which made no difference and in the end we all got hand foot and mouth and were quite sick. So in future I'd just leave it and let it do its damage and then worry about it (B2).			
		"*We don't need to worry about sandbags anymore, there would need to be a Noah's arch flood for us to flood again after that scheme is finished"* (B9).			
		"There is just so much development, all drives and gardens are paved now too. That can't help" (B12).			

Chart 4 Learning	17. Problem definition	18. Critical Reflection	19. Experimentation and innovation	20. Transfer of local Knowledge	21. Monitor and Review
Belfast Practitioner Level	*"New developments and urban creep the volume in sewers is going to increase by 51% by 2040…we need to be proactive in this regard" (P 29).*	*"If you don't have the architecture there for things to happen then it wont happen…its that simple" (P 41).*	*"The mind shift in government took a while (Community resilience) but it's a model that works and we are becoming more confident with it" (P 52).*	*"Local knowledge has a role in assisting more vulnerable neighbours, acting out a flood plan and lobbying government to meet their need" (P 40).*	"We would like to see a review done by the statutory levels" (P 30).
	"It's really a very real danger in terms of health and safety (for farmers)" (P 49).	*"We've learned the need for a better joined up approach under one minister and will hopefully lead to better policy making" (P 30).*	*"Engineers in NI have their blinkers on, they need to start thinking holisitically about drainage and developments, and their knock on effects on the community"(P 34).*	*"A lot of knowledge has left due to the VES (redundancys) and I fear we are not as effective as we were before" (P 39).*	*"Tackling flooding is a long term issue and that is the response that we need to now put in place for the future" (P 36).*
	"Flooding will happen again and again unless there is a serious commitment from the agencies" (P 37).	*"Community resource is not being utilised, we don't have the resources to encourage this and this needs to change" (P 36).*	*"The community really comes together and helps each other out…they have a lot of personal resources they use" (P 41).*	"The community know their community best….they are the people best placed to highlight where we could implement a good SUDs scheme (P 36)	*"PPS15 should enforce SUDs and change its terminology from 'should' to 'must' " (P 36).*
		"As development arises more houses will be added to the same risk register as they know the pipes are now outdated. How does planning not consult with NI water about this!" (P 29).			*"When you look at the hard facts of how many properties are actually being flooded it s clear we need to stand up and take action" (P 40).*

APPENDIX 11

Appendix 11: Age distribution of interview sample, Cumbria.

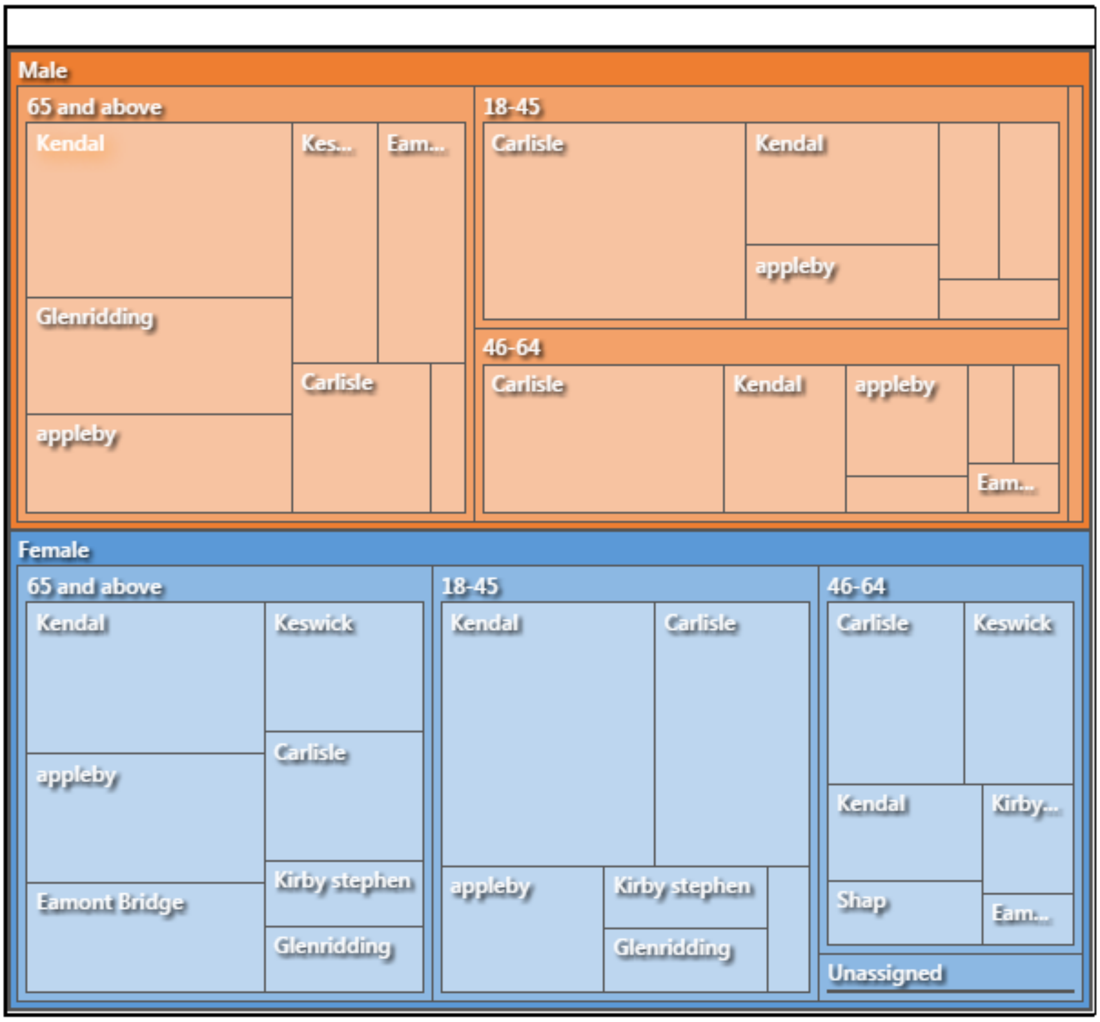

Figure 11.1. NVivo visualisation male/female age sample profile.

APPENDIX 12

Appendix 12: Component indicators sheets, Cumbria

Table 12.1. Risk component indicators

Framework Component	Indicator	Indicator description	Method of assessment	Empirical evidence	Impact on resilience	Scale
Risk (community level)	**1. Risk Awareness**	Awareness of hazard risk information and exposure	_Awareness of whether property lies within a risk zone as indicated on a flood map _Existence of disaster management plan	Semi-structured interview	Positive	Individual, community
	2.Risk Experience	Active flood memory-previous hazard experience leading to mitigative action.	_Knowledge and experience of past flood events	Semi-structured interview	Positive and Negative	Individual, community
	3. Risk Communication	Existence of Early warning system	_Signed up to EA flood alert _River guage	Semi-structured interview	Positive	Individual, community
	4. Risk Understanding	Knowledge and understanding of the extent of risk and cause of flooding	_Monitor and review flood risk _Utilising local knowledge _Critical thinking toward proposing risk solutions	Semi-structured interview	Positive	Individual, community
	5.Risk Acceptance/ Mitigation	Acceptance of risk and adjusting mitigative action appropriately	_Existing and practiced resileince plan _Member of FAG _Implementation of PLP _Current flood risk mapping _Community resileince initiatives _Flood risk maintenance	Semi-structured interview/ Observation	Positive	Individual, community

Table 12.2. ‘Resources and Capacities’ component indicators.

Framework Component	Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
Resources and Capacities	**10.Self efficacy**	Empowerment and self beliefi resileince capabilities	_Membership of Resilience Group/FAG	Semi-structured interview	Positive	Individual, Community
	11. Flood responsibility	Personal flood mitigation actions	_Installing property level protection, insurance, signed up to early warning.	Semi-structured interview	Positive	Individual
	12.Preparedness	Evacuation protocol	_Recognised public buildings as energency centre and shelter _Evacuation protocol _Evacuation 'Grab bag'	Semi-structured interview	Positive	Individual, community
	13. Property	Standard and availabilty of property	_Uptake of property level protection _Provision of alternative accommodation	Semi-structured interview	Positive	Community
	14. Governance	Flexible Governance	_Governance and policy adapting to changes in risk environment _Communitis lobby _Government for change	Semi-structured interview	Positive	Community

Table 12.3. ‘Connectedness’component indicators.

Framework Component	Sub-components	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
Connectedness	**15.Cohesive community**	Sense of belong within a community leading to participative action	_Number of social groups a community resident is a member of _Unwillingness to relocate after a flood __Place attachment (housing tenure) _Volunteer to clean up after a flood (Actively engaged)	Semi-structured interview	Positive and Negative	Individual, community
	16. Multi-scalar interaction	Effective communicatin through multi-scalar channels (bonding, bridging, linking)	_Support from a mix of bonding, bridging and linking sources. _Access to technical Advice (linking) _Colaborative support at local level (bonding) _ Emotional support (bonding) _Number of organisations and clubs in settlement _Membership of FAG	Semi-structured interview	Positive and Negative	Individual, community
	17. Higher-level Trust	Positive relationship with horizontal ties	Inclusion and liaise within Flood action Group activities (linking)	Semi-structured interview	Positive	Individual, community

Table 12.4a. 'Learning' component indicators.

Framework Component	Indicator	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
Learning	**18.Analytical thinking**	Reflective consideration of mitigative options based on past flood experience	_Existence of a Flood Group to allow for reflection _Calibration of risk to community resilience plan	Semi-structured interview	Positive	Individual, community
	19. Integrated development planning	Catchment wide approach to planning and development	_Consultation on planning process _Appropriate land-use planning _Stricter planning approval and enforcement	Semi-structured interview	Positive or negative	Individual, community
	20.Experimentation	Experimental Resileince actions that question the status quo and infomred by lessons learned	_Policy change _Resileince strategies and plans _Soft approaches to flood risk reduction NFM _Build back better	Semi-structured interview/ observation	Positive	Community

Table 12.4b. ‘Learning’ component indicators.

Framework Component	Sub-components	Indicator description	Method of assessment	Empirical evidence	Effect on resilience	Scale
Learning	**21.Knowledge feedback**	Knowledge and information feedback and sharing _Feedback into risk awareness related actions	_Dissemination of results actions across stakeholders _Utilisation of local knowledge _Capacity/structure for feedback to be linked to risk awareness related actions	Semi-structured interview	Positive	Community
	22. Skills and training	Build capacity informed by past experience and integrate new knowledge	_Development of Business Resileince plans _First Aid training _Resileince plan dry run/tabletop exercises _Resilience training offered to Authorities and community leaders	Semi-structured interview and observation	Positive	Community

APPENDIX 13

Appendix 13: Request for information

Department of
the Environment
www.doeni.gov.uk

Local Government Policy Division

Level 4
Causeway Exchange
1-7 Bedford Street
Townparks
BELFAST
BT2 7EG

Telephone: 028 90823375
Facsimile:
Email: Jeff.Glass@doeni.gov.uk

Ms Kate Crinion
Email: Crinion-K@email.ulster.ac.uk

Your reference:
Our reference: DO2-16-95

Date: 24 March 2016

Dear Ms Crinion

Environmental Information Regulations 2004

I am writing to inform you that the Department has now completed its search for the information, regarding the number of flood relief payments received in particular areas across NI, at post code level, which you requested on 8 March 2016.

Some of the information requested cannot be provided as it would potentially identify individuals and therefore falls within the terms of the exception under Regulation 13(1) of the Environmental Information Regulations which prohibits from disclosure information that would breach the Data Protection Principles.

Unfortunately, as some posts codes may be for one property, I cannot give out this information. In rural areas where there is only one house within a postcode the homeowner could be identified. Having checked the information we hold there are a number of postcodes where only one house has received payment and it maybe in a rural area. It would be unfair to the homeowner to release the information.

When considering if we can release this information, we have to consider the reasons for which it was collected. We did so for the purposes of reimbursing the councils for payments made to householders. Those householders supplied their information solely in order that they could receive that payment.

As the personal data was not collected originally for any research purpose it would be 'unfair', and would breach the first Data Protection principle (which states that "personal information must be fairly and lawfully processed") if we disclosed the information.

The department considers that it would not be 'fair' to the individual if we used or processed their information for any other purpose than processing the relevant payments and may cause substantial distress if we disclosed it, as others may become aware that individuals have received the £1,000 payment.

However, I can provide the number of properties within a council area that were flooded and received the £1,000 on more than one occasion.

By Council Area post 1 April 2015

Council Area	Number of Properties Flooded	Number of Properties Flooded Multiple Times
Antrim and Newtownabbey	3	1
Armagh City, Banbridge and Craigavon	1	0
Causeway Coast and Glens	10	0
Derry City and Strabane	35	0
Fermanagh and Omagh	19	3
Lisburn and Castlereagh	1	0
Newry Mourne and Down	3	2
Ards and North Down	1	0

By Council Area pre 1 April 2015

Council Area	Number of Properties Flooded	Number of Properties Flooded Multiple Times
Antrim	219	6
Ards	35	1
Armagh	45	2
Ballymena	195	11
Ballymoney	13	1
Banbridge	106	0
Belfast	1817	296

Carrickfergus	8	0
Castlereagh	833	214
Coleraine	15	1
Cookstown	23	0
Craigavon	146	1
Derry	15	0
Down	169	3
Dungannon	50	12
Fermanagh	9	0
Larne	30	2
Limavady	5	1
Lisburn	490	23
Magherafelt	39	2
Moyle	51	8
Newry and Mourne	103	4
Newtownabbey	163	5
North Down	30	2
Omagh	163	30
Strabane	35	1

I'm sorry I cannot be more helpful at this time.

Under the terms of the legislation, if you are unhappy with this response you have the right to seek a review by the Department in the first instance, within two calendar months of the date of this letter. If you wish to do so, please write to:

Departmental Information Manager
Room 6.20
Department of the Environment
Clarence Court
10-18 Adelaide Street
Town Parks
BELFAST
BT2 8GB

If after such a review you are still unhappy with the response, you have the right to appeal to the Information Commissioner who will undertake an independent review.

If you have any queries about this letter, please contact me. Please remember to quote the reference number above in any future communications.

Jeff Glass

APPENDIX 14

Appendix 14: Dissemination of PhD work

14.1 Publications and conference papers

▪ *Bouncing forward- The development of a theoretical framework to enhance transformational resilience within a post-disaster context.* Institute of Hazard Risk and Dealing with Disasters Conference, Durham, 22 September, 2017.

▪ *Wet Behind the Ears: The Impact of Planning and Development on Flood Resilience. A Case-Study from Cumbria.* UK-Ireland Planning Research Conference (PRC2017), Belfast, 13 September, 2017.

▪ *Findings from a theoretical framework to enhance transformational resilience within a post-flooding context.* SRA-E conference, Lisbon 19-21 June, 2017.

▪ *Community Level Resilience. Perspectives from flood affected communities in Northern Ireland*, Conference and workshop, University of Reykjavik, Iceland, May 2017.

▪ *Unlocking transformational Resilience in the aftermath of a Flood Disaster: A Case Study from Cumbria.* World Academy of Science, Engineering and Technology. International Journal of Geological and Environmental Engineering Vol: 4, No:5, 2017. Amsterdam, May, 2017. (Peer reviewed)

▪ *StreetSpaces from a post-earthquake city, Yushu, China.* StreetSpace exhibition, PLACE, Belfast, April, 2017.

▪ *Bouncing forward after the rain- An Investigation into Perceptions of Community Resilience after the 2015 Winter Floods in Cumbria.* Flood and Coast Conference, Telford, March (2017).

▪ *Disaster Recovery and Reconstruction: Harnessing Capacity and Improving Resilience within Flood Affected Communities.* Research Graduate School, Annual PhD Conference, Ulster University, Belfast, Poster Presentation, March, 2016.

▪ *Facing the future, Octasynthesis as a systems approach to the U.N. Sustainable Development Goals.* Centre for Human Resilience and Environmental Change (CECHR). Delegate contribution (2016).

▪ *Role of urban design and masterplanning in responding to Climate Change.* Institute of Civil Engineers (ICE), Northern Ireland, September, 2016.

14.2 Funding and Awards

▪ Awarded British Council funding to participate in "*Renaturing cities-Theories, strategies and Methodologies"* workshop, Goianaia Brazil, 10-13th July 2017.

▪ Scholarship to present at SRA-Europe Conference; New challenges, new threats: Resilience and adaptation in a risky world. Lisbon, June 2017.

▪ Best paper presentation award: *Findings from a theoretical framework to enhance transformational resilience within a post-flooding context.* SRA-E conference, Lisbon 19-21 June, 2017.

▪ Scholarship to attend workshop on ‘Resilience and crisis management in the context of welfare states’, University of Reykjavik, Iceland, May 2017.

▪ Scholarship to present at *‘Disaster Management’* Conference, Wessex Institute, Amsterdam, May 2017.

▪ Best paper presentation award: “*Unlocking transformational Resilience in the aftermath of a Flood Disaster: A Case Study from Cumbria”.* Disaster Management Conference, Wessex Institute, Amsterdam, May 2017.

▪ Awarded funding to present at ‘Flood and Coast Conference’, Telford, March 2017.

▪ Best Poster award at the Research Graduate School Annual PhD Conference Award, Ulster University, March, 2017.