Coping with drought and flooding: a framework for engendering household and community resilience to water management extremes

Submitted by Kimberly Alicia Bryan to the University of Exeter
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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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ABSTRACT

Achieving resilient outcomes in the water sector is an area of emerging policy and research focus in light of a combination of threats such as climate change, increasing demand, urbanisation, and population growth. Consequences of these threats require that in order to achieve these resilient outcomes, urban water management socio-technical systems require various interventions at different levels. This includes the water user level and highlights the need for greater understanding of households in implementing coping interventions to address extreme system failures of drought and flooding. A combination of methodological approaches, data collection and analytical methods have been used to develop detailed understanding of water service user perceptions and intentions towards drought and flood coping in order to engender action for resilient water management at the household and community levels.

Practitioner interviews have provided insight into core issues of household and community level participatory approaches for addressing drought and flood resilience. These include cross-cutting themes relating to modes of communication and engagement, the influence of past experience, empowerment, and the influence of social networks. Results of a questionnaire survey within the framework of Protection Motivation Theory facilitated understanding of the linkages among threat, consequences, and coping intentions. The most significant indicators of behavioural intentions were the perceived effectiveness of coping response measures, consequences of drought or flooding, and costs. These variables were significant in defining sub-groups at three different decision-stages after Trans-theoretical Model. Households were at early decision stages with regards to flood coping, namely 'Pre-contemplative' and 'Contemplative'. Pre-contemplatives had low behavioural intentions and were driven by low efficacy and low consequences. Contemplatives had low-medium intentions, expected either that cost would be a limiting factor, measures

ineffective, or consequences too low to warrant action. ‘Responsives’, only found in relation to drought coping, had already implemented several coping measures. Despite low drought consequences, cost was not a limiting factor and measures were perceived to be effective, illustrating the potential for increased household drought coping or more sustainable water use practices.

This study provides important baseline data on household perceptions and intentions to cope with droughts and floods not yet widely explored in the UK. The innovative use of cluster analysis to identify and explore decision-stages provides methodological contributions to the literature. Finally, the thesis has led to the development of an assessment and decision framework to promote action towards resilient water management at the household and community levels. This framework is the basis of a toolkit that was co-created with communities and practitioners with the outcome of communities developing action plans to address the consequences of drought and flooding.

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AR Assessment Report.

CA Coping Appraisal.

CCW Consumer Council for Water.

CRR Community Risk Registers.

DCC Devon Country Council.

Defra Department for the Environment, Food and Rural Affairs.

DRY Drought Risk and You.

EA Environment Agency.

ECC Exeter City Council.

EU European Union.

FAZ Flood Area Zones.

FCERM Flood and Coastal Erosion Risk Management.

FRM Flood Risk Management.

FWMA Flood and Water Management Act.

ICE Institution of Civil Engineers.

IPCC Intergovernmental Panel on Climate Change.

LLFA Lead Local Flood Authority.

LoS Level of service.

NERC Natural and Environment Research Council.

NFF National Flood Forum.

Ofwat Economic Regulator of Water Sector in England and Wales.

OLS Ordinary Least Squares.

PMT Protection Motivation Theory.

RMA Risk Management Authorities.

RP Risk Perception.

RQ Research Questions.

SDG Sustainable Development Goals.

SES Social-ecological System.

SPSS Statistical Package for the Social Siences.

SPV Subjects per Variable.

STS Socio-technical System.

SuRe Sustainable and Resilient.

SWW South West Water.

TA Threat Appraisal.

TTM Transtheoretical Model.

UK United Kingdom.

UN United Nations.

UWM Urban water management.

WFD Water Framework Directive.

WHO World Health Organisation.

WP Work Package.

WRMP Water Resources Management Plan.

WSP Water Service Providers.

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Finally, I wish to say thanks to my dear mom, my two brothers, my sister, other family members, and my friends for supporting my decision to leave home to embark on this challenging yet rewarding journey. In addition to Peter and the new friends I have made along the way, I thank you all for providing a never-ending source of love, patience, prayers, friendship, inspiration, and often needed humour.

1 INTRODUCTION

This thesis aims to contribute to the discourse relating to household resilience to water-related infrastructure failures. The thesis does this by undertaking detailed assessments of their perceptions of the consequences of the extremes of drought and flooding and their perceptions and intentions towards implementation of household level interventions. In addition, the thesis seeks to contribute to the development of a framework for operationalising decision making towards resilient strategies for coping with water management extremes both at the household and the community levels. The impetus for this research stems from the realisation that the water sector faces several threats that increasingly compromises capability in the delivery of acceptable services (e.g. adequate water supply, drainage or flood management). Hence, there is renewed focus on the matter of understanding the water user in an effort to better position them towards resilient water management futures.

This chapter provides an introduction to the research by first presenting the research background from both an international and national perspective (Section 1.1). This is followed by the context and rationale for the research (Section 1.2), an outline of the research plan including the objectives, research questions and methods (Section 1.3), an outline of the structure of the thesis (Section 1.4), and the originality and contribution to knowledge (Section 1.5).

1.1 Research background

Critical global challenges for the remainder of this century involves achieving the ever illusive sustainable development, building resilience to disasters, and limiting and living successfully with a changing climate. Within the sphere of global sustainability and resilience, the water sector often emerges as a priority area for action. This is particularly so when the intricate relationship between water and a changing climate present varying implications for society. It was by their first Assessment Report (AR) in 2001 that the Intergovernmental Panel on Climate Change (IPCC) explicitly made this connection by highlighting the vulnerabilities faced by global water resources and the need for increased adaptation and adaptive capacity (Arnell et al., 2001). Since then, all the IPCC ARs have placed specific interest and focus on these issues related to water. In 2009, the World

Health Organisation (WHO) published their Vision 2030 on the need and vision for water supply and sanitation systems to be resilient to climate change (WHO and DFID, 2009). More recently (2015), the United Nations (UN) also highlighted the need for the sustainable management of water and sanitation as part of the sixth Sustainable Development Goals (SDG) (2015-2030), amongst 17 development goals. Under SDG 6, targets for 2030 address issues of water efficiency, water scarcity and participation of local communities in water management. As a result, we are in an era of unprecedented global environmental decision making and cooperation to meet these various challenges as we forge into the Anthropocene.

The water sector in the United Kingdom (UK), like many other nations, is also recognising the need for specific localised focus on water especially as nations come to understand the implications of climate change. Despite the UK water sector's long tradition and experience in managing natural climate variability in the design and operation of Urban water management (UWM), climate change now appears to be one of its greatest threats (Whittle et al., 2010). This is directly linked to the projections of changes in the water cycle due to climate change and variability. Increasing temperatures are expected to change rainfall trends thereby impacting patterns of river flow and groundwater recharge, the availability of water, and the aquatic environment (Prudhomme et al., 2012). The general trend is one of wetter winters and drier summers (Water UK, 2016). Additionally, floods are expected to become increasingly unpredictable and multi-sourced and to occur in areas that have less recent experience of large scale floods (Hulme et al. 2002; Cabinet Office/HM Treasury 2006 in Whittle et al, 2010). The recent UK climate change risk assessment report (Committee on Climate Change, 2017) states that with continued warming and high population growth, the number of households at a significant risk of flooding is projected to increase from 860,000 today to 1.9 million by the 2050s.

Water scarcity is expected to become more common in some parts of the UK in the future due to the combined effects of climate change, urbanisation and population growth (Adaptation Sub-Committee, 2012). Therefore, in addition to climate change, urbanisation and population growth remain prime challenges for the water sector, putting water resources under increasing pressures in areas, such as the south-east of England, where water resources are already scarce. The south west of England, though not likely to experience significant population growth, has been identified as being at risk of facing reduced rainfall by the 2030s (Water UK, 2016). Being reliant on surface water, this situation will prove to be a challenge to the water resources in the south west. Added to this is the increasing demand for water, which although has decreased in recent times continues to be amongst the highest in north-west Europe (Adaptation Sub-Committee, 2012). As the demand for water continues to rise, maintaining supplies to meet these demands is becoming increasingly difficult (Water UK, 2016).

Hence, the water sector in the UK faces several threats, highlighting the increasing risk of failure of UWM systems to meet a required Level of service (LoS). In turn, water service customers will face the consequences of failures of LoS through incidences of flooding, drought or water scarcity, and poor water quality and sanitation. Accordingly, improving the outcomes that water service customers (and the wider society) value, is of mounting priority in a transitioning UK water sector. Achievement of resilient outcomes (e.g. clean and reliable water services, as well as flood protection for residential properties and critical infrastructures) is now part of the remit of both the Environment Agency (EA) (in their flood defence role), and private water companies under the mandate of the economic regulator of the water sector in England and Wales (Ofwat) through the Water Act 2014. Whilst the question of how to achieve such outcomes currently remains the subject of much experimentation (e.g. during the previous water sector price review period), research and debate, it is expected that future strategies will involve the integration of sustainable and resilient management approaches in an effort to minimise and or alleviate consequences for society, economy, and the environment.

In this regard, there is growing interest and focus on the role of water service customers in meeting this challenge of sustainable and resilient outcomes. This thesis places focus on water service customers (as households) to provide detailed understanding of their perceptions of the consequences of LoS failures, their perceptions and intentions towards household level interventions, and to engender sustainable and resilient water management both at the household and the community levels. The Safe and Sustainable and Resilient (SuRe) water management project which is elaborated in the next section, provides further context for this thesis and the various methods employed.

1.2 Research context and rationale

1.2.1 Context

The Safe and SuRe approach, of which this research is a subset of Work Package (WP) 15 in Figure 1.1), proposes a socio-technical intervention framework as a response to the growing threats and uncertainties faced by UWM systems (Figure 1.2). UWM system is framed as a Socio-technical System (STS) (Bell, 2015; Gersonius et al., 2012; Newman et al., 2011; Geels, 2005), a notion that recognises that infrastructure systems function through interactions between people (users), physical systems (technical hardware) and institutions (governance and management arrangements) (Arcari et al., 2011) in order to provide a particular function (Geels, 2005). They consist of water resource systems, water supply and distribution systems, drainage and sewerage infrastructure, river management and flood defence schemes, organisations, institutions and legislation, and finally users and the public with their norms and expectations. UWM systems, therefore, exist within broader social and political contexts defined by interdependencies (Bell, 2015) and complex relationships amongst various networks and actors (Geels, 2005).

The Safe and SuRe approach is based on the premise that UWM systems are traditionally designed to provide reliable (Safe) services, but now in an era of emerging threats, requires new approaches and thinking that will enable the evolution or transition to provide both sustainable and resilient (SuRe) services (Butler et al., 2014, 2017). The framework is therefore based on safety, sustainability, and resilience as system properties or functions (Butler et al., 2014). This means that the system (e.g. flood defence or water supply and distribution infrastructure system) delivers services that are reliable, provides sustainability benefits, and are resilient to specific threats or hazards. Mitigation, adaptation, coping and learning are processes, procedures or actions (interventions) that can be designed or implemented at different interacting levels of the STS to achieve these properties or functions (Figure 1.2) (Butler et al., 2014). Together, these measures aim to minimise the frequency, magnitude and duration of the consequences of threats to UWM systems.

The framework provides scope for analyses from different directions, namely ‘top-down’, ‘bottom-up’, ‘middle-based’ and ‘circular’, depending on the scale of implementation (Figure 1.3) (Butler et al., 2017). Specific to the interaction between the system and a threat is a top-down approach achieved by means

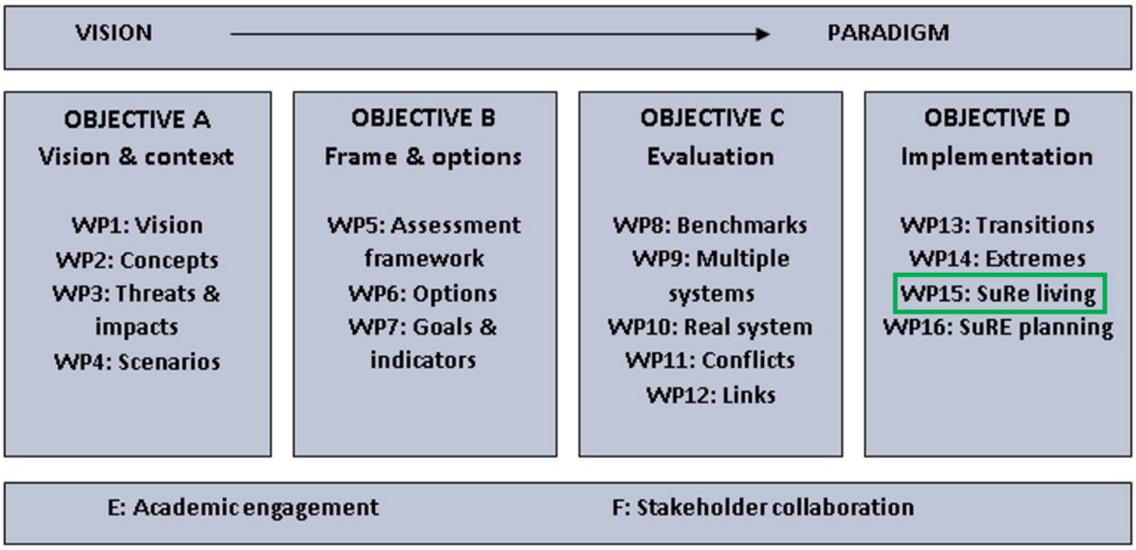


Figure 1.1: Organisation of the Safe and SuRe project. This project is a main outcome of the SuRe living component (WP15)of objective D as highlighted in green.

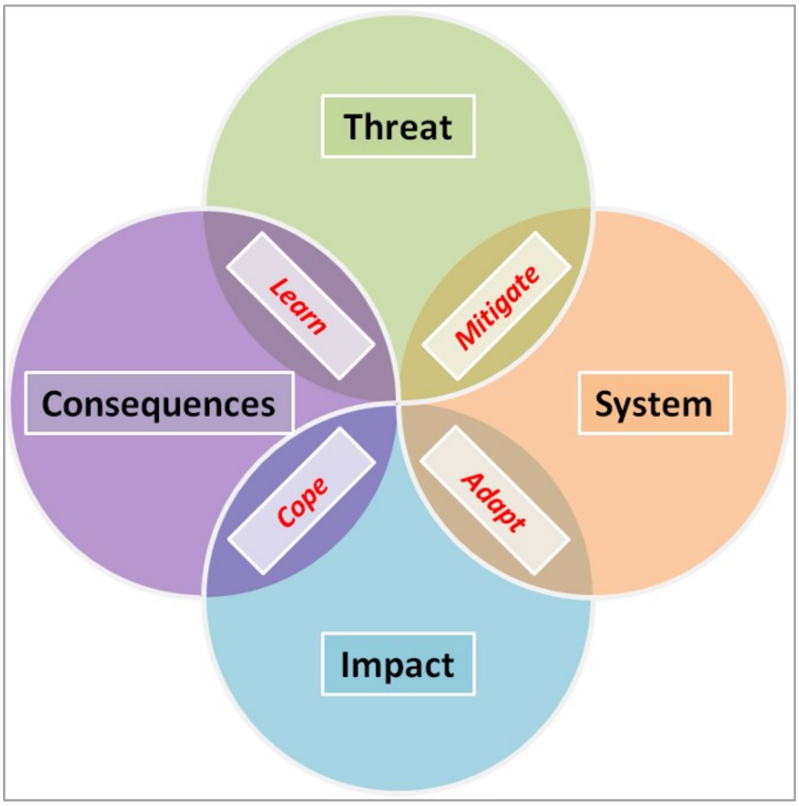


Figure 1.2: The Safe and SuRe framework for urban water management (Source: Butler et al. (2017))

of the intervention of mitigation (Figure 1.3a). Mitigation introduces long-term physical or non-physical actions to reduce the frequency, magnitude or duration

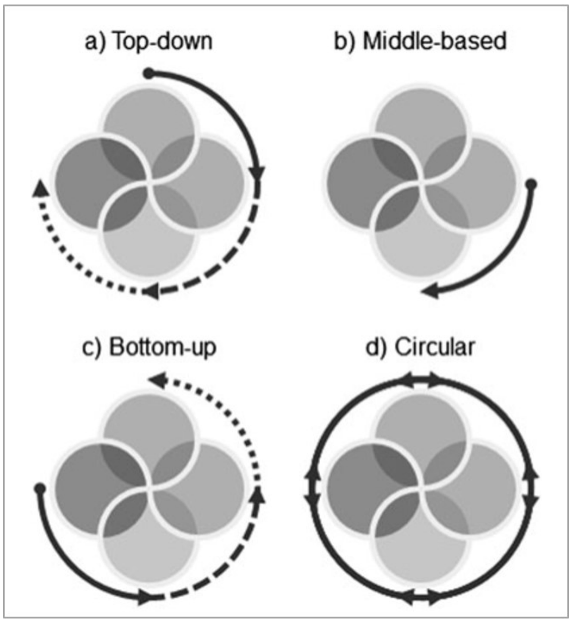


Figure 1.3: Directions of resilience assessments in the Safe and SuRe framework (Source: Butler et al., 2017).

of a threat. A threat is defined as "any event with the potential to reduce the degree to which the system delivers a defined level of service" and is similar to commonly used terms such as hazard, event, perturbation, disturbance, shock, and crisis (Butler et al., 2017). The top-down application of the framework being mitigation focussed and threat based, is representative of the traditional approach to water management (Butler et al., 2017).

Addressing the link between system and impact, the intervention of adaptation encompasses modifications that enhance the capability of maintaining LoS before, during, or after a disruptive event in order to increase reliability, enhance resilience, and/or improve sustainability (Butler et al., 2017). A middle-based approach is applied here (Figure 1.3b). The middle-based approach overcomes the problem of identifying all known and unknown threats (which is a systemic issue with the top-down approach) by focusing its resilience interventions on the identifiable and measurable response to known system failure states (i.e., middle states).

Where impacts and consequences intersect in the STS, the intervention of coping addresses the vulnerability of social, economic and environmental facets through bottom-up approaches (Figure 1.3c). Whilst impacts refer to system failure or non-compliance with a defined LoS, consequences are the more far reaching social, economic or environmental outcomes resulting from system impacts. Coping incorporates the temporary or permanent preparations, actions, etc., that can be implemented by demand side actors (individual, building and neighbourhood scales) of the STS (Butler et al., 2017). Being consequence based and coping focussed, the bottom-up approach can be applied in assessing the vulnerability of water service customers (represented as households and communities) through the identification of potential social, economic, or environmental consequences of LoS non-compliance. Instead of focussing on the threat, the bottom-up approach is concerned with how an individual, household, organisation, or community copes with the consequences of the removal of a critical system or service (Butler et al., 2017).

Under WP15, the 'SuRe living' component considers the role of the water service customer as embedded in the STS of urban water management and is the target outcome of this research. The coping intervention and the bottom-up view point are of most importance to the work and outcomes of this PhD research where focus is placed on the water service customers' perceptions about the consequences of drought and flooding and their behavioural intentions in coping with these extremes.

1.2.2 Rationale for research

The water service user, has expectations of how the system should perform and their roles in the system. These expectations are socially constructed over generations and not only evolve with changing technologies but shape technology changes (Sofoulis, 2005). Furthermore, user expectations and behaviours are shaped by the wider community in which it is situated. Currently water service customers simply pay for the services delivered whether they be water supply or drainage, water quality or flood defence, and little else. In return they expect to receive constant water supply of high quality and be defended from floods.

However, their roles are increasingly being challenged in the transition to sustainable and resilient water management. For instance, public participation is mandated as part of the European Union (EU) Water Framework Directive (WFD) with the aim of enabling behaviour change in water use amongst water users (Page and Bakker, 2005). Similarly, the UK Flood and Coastal Erosion Risk Management (FCERM) strategy (Environment Agency, 2011) incorporates the cooperation of households and communities in Flood Risk Management (FRM). Therefore, users are expected to assume new responsibilities in water management (Domenech and Saur, 2010) in the context of growing threats and the need for transitions to sustainable and resilient systems. However, there is still a lack of understanding of how behavioural intentions to cope with drought and flooding are formed or motivated.

This is where the bottom-up approach of the framework is most applicable. The bottom-up approach being consequence based and coping (and learning) focussed has been applied within this thesis to examine the perceptions and coping behaviours of urban water service customers to the consequences of UWM system failures from extreme events of flooding and drought. Drought and flooding are considered here because they present far reaching consequences for society, economy and the environment and hence require changes in how households and communities respond. With climate change projected to increase the frequency, severity and extent of flooding, as well as posing a threat to water resources (Kovats and Osborn, 2016), UWM systems are increasingly at risk of failure to meet required LoS.

Two recent events that depict extremes of flooding and drought are the 2007 floods and the 2010-2012 drought-flood periods. In 2007, 55,000 properties were flooded and 7,000 persons had to be rescued from the flood waters by the emergency services (Pitt, 2008). In addition, 13 people died and the country experienced the largest loss of essential services since World War II, with almost half a million people without mains water or electricity (Pitt, 2008). The 2010 to 2012 period displayed dramatic and destructive weather patterns. Drought conditions developed (starting in the north-west) through much of 2010, intensified during 2011 and became severe across much of England and Wales by the early spring of 2012 (Marsh et al., 2013). Six months of record rainfall from April to September brought the drought to a rapid conclusion and led to considerable localised flooding. Over 4,500 properties were flooded across England and Wales due to rivers over-topping their banks and defences, and from record surface water (Marsh et al., 2013; Environment Agency, 2012).

Therefore, although flooding and drought represent separate and opposing extremes, their increased frequency and severity pose continued threats to UWM service delivery. If water supply and flood management are not delivered at the required LoS then water service customers and their wider communities should be able to cope with the consequences. To date there have been limited studies that place focus on the two issues together at the household level and as such there is limited information on the perceptions and intentions of households. This study therefore seeks to fill this gap in the research.

The research also tests and refines a model for the development of a decision support framework for prioritising flood and drought resilience measures at the household and community level further emphasising the need for individual and community coping responses.

1.3 The research plan

The research is undertaken using a consultative approach of engagement and enabling knowledge co-production between the researcher, a community group, individual householders, and practitioners. This section presents an outline and justification of the research aim, objectives, and methods for data collection.

1.3.1 Aim and objectives

This research places focus on understanding and developing the coping capacity, and ultimately the resilience, of social units - i.e. water users as households, and their wider communities - to UWM system extremes of drought and flooding. As a result, the aim of the research is to engender household and community resilience to water management extremes through detailed insights of the determinants of household drought and flood coping. The journey towards fulfilling this aim meant that several key research questions had to be investigated. In this regard, this thesis considered five research objectives to be paramount to fulfilling the aim in the context in which the research is set. These objectives are as follows:

Objective 1: To understand the role of the water user in a transitioning water sector

A first step towards achieving the research aim required that the water user history within the context of a socio-technical UWM system be dissected. This was done to provide an overview of: 1) the conditions that have led to the current configurations of the water user with regards to issues such as drought and flood management and; 2) the trajectory of the water user in a future of increased threats.

STSs, such as UWM systems, are subject to transitions which refer to fundamental changes in structures, cultures, and practices of a societal system, that profoundly alters the way they function (van Herk et al., 2015). Transitions are often fuelled by conditions such as tensions (structural or cultural), stressors, pressures (van Herk et al., 2015), and drivers (Brown et al., 2008). In the water sector in the UK, a combination of these conditions have impacted the way water services and flood management are delivered and have shaped the way the water service users are positioned in the STS. This research objective, therefore, draws focus on the transitions that UWM systems have undergone and how these have influenced (and continue to influence) the role of the water service user in drought management and flood management.

This objective is largely examined in Chapters 2 and 4 which ultimately provides an account of how the water user arrived at current framings (in relation to drought and flood management) and why the user now needs to transition to become more resilient. Specific Research Questions (RQ) that were addressed under this objective are:

- Is the water sector transitioning to a more resilient water user?
- What are some of the challenges in promoting drought/flood resilience amongst water users?

Objective 2: To understand resilience and related concepts and how they are applied to social systems

Due to the focus on coping as a resilience intervention, the thesis must also place focus on what resilience actually means and how it is applied across disciplines. Due to the fact that resilience is not a traditional social science concept, the theoretical and epistemological perspectives of resilience must be assessed in order to identify and understand the associated challenges and gaps in its application to social systems such as communities.

Additionally, there are several other concepts that are closely linked with resilience which also have implications for how resilience is applied in social systems. These include adaptation and vulnerability. Their relationships with resilience and coping are examined in a wider context across multiple disciplines in Chapter 2. The following research questions have been investigated under this objective:

- What are the main issues with resilience epistemologies for social systems?
- How are resilience, adaptation, vulnerability and coping related?
- How can water user (household) coping be assessed?

Objective 3: To determine indicators of behavioural intentions in household drought and flood coping

Objective 3 seeks to employ specific methods that will provide detailed insights about the perceptions of households relating to a range of issues such as the consequences of drought and flooding, the implications of climate change on the frequency and intensity of each, and the effectiveness and cost of household coping response measures. Through this objective, it is expected that various statistical techniques can be utilised to identify the indicators of coping behaviours and behavioural intentions.

Objective 3 is addressed in Chapters 5 and 6 through the following research questions:

1. How do households perceive:
   - the severity of drought/flood consequences?
   - the implications of climate change for drought/flood?
   - the efficacy of household drought/flood coping measures as well as self-efficacy and potential costs associated with implementing household measures?
2. Do participants have intentions to implement drought/flood coping measures?
3. What are the key indicators of household drought/flood coping?

Objective 4: To explore the role of indicators in decision-stages for household drought and flood coping

Through this objective, the thesis also set out to explore indicator variables in an effort to determine how such variables shape decision-stages with regards to coping with drought and flooding. This objective is explored to provide insights into the indicators of behavioural intentions in terms of how they might influence decision-stages in coping. Through this exploration, the research is able to further reinforce the critical variables for engendering action at the household and community levels. In light of these expectations the following research questions were investigated:

1. Are there sub-groups of decision-stages for household drought and flood coping?
2. Can the indicators define and explain decision-stages for drought and flood coping?

Objective 5: To develop and test an assessment and decision framework for engendering household and community resilience planning

The final objective of the research sets out to develop a framework which will promote decision-making at the household and community level in fulfilment of the research aim. Development of this framework is expected to stem from the prior detailed analyses of the householder, their behavioural intentions and their decision-stages. Co-creation processes with several stakeholders such as practitioners, academics, and community members are integral to this decision framework. The research questions that were addressed are:

- What are the cross-cutting themes that need to be considered in interventions for community participation?
- How can indicators be incorporated into a framework and toolkit for community planning?

These research objectives are shown in Figure 1.4 below. In this diagram specific research questions under each objective is listed, followed by the methods that have been used to investigate them, and the chapters in which they are further detailed and investigated.

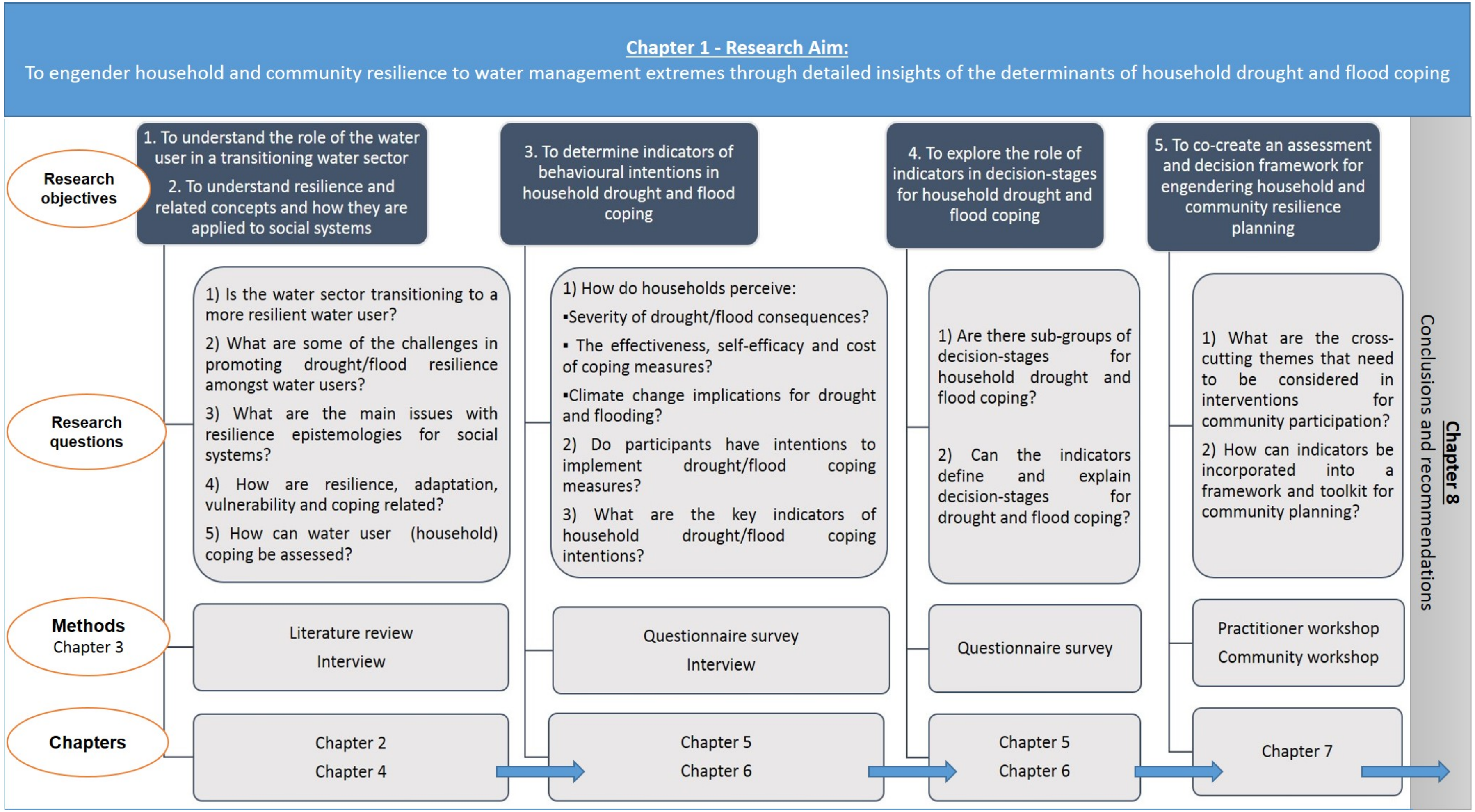


Figure 1.4: Outline of research aim, objectives, questions, methods and chapters of the thesis.

1.3.2 Research perspectives

The nature of this research juxtaposed on the edges of contrasting disciplines dictates that it incorporates some aspects of engineering and sociology. From an engineering perspective, this thesis is grounded on the Safe and SuRe method for urban water management and applies a socio-technical lens in its analyses of recipients of water infrastructure failures. The engineering perspective is therefore concerned with the interface between water infrastructures and its end users at the household scale. It acknowledges that infrastructures will tend to fail in their delivery of an intended LoS resulting in various consequences for the householder who depends on the reliability of said service. Another point of view from the engineering aspect of the research relates to the way the improvements in technology changes the norms, expectations and behaviours of the user. In this regard, the thesis has utilised the literature on technological transitions and water governance to explore these relationships.

Sociological methods that facilitate quantitative and qualitative approaches were applicable to this research. A theoretical framework grounded in psychology formed the basis of the quantitative approach. Application of this theoretical framework provided measurable parameters of interest to the resilience agenda of the Safe and SuRe framework whilst aiming to ensure that the results were replicable and objective. On the other hand, the qualitative approaches facilitated interpretive analyses of specific phenomena from participant experiences.

1.3.3 Research methods

The research has employed mixed-methods to the collection and analysis of data. This means that both quantitative and qualitative methods have been employed for both data collection and analysis. Quantitative data collection was facilitated by means of a questionnaire survey tool which was administered amongst households in two case study areas of Exeter. This survey was developed in the framework of a psychological paradigm, Protection Motivation Theory. Qualitative data collection methods included interviews with survey participants and practitioners involved in the implementation of national projects or policy related to drought and flooding.

The quantitative data were analysed using both descriptive and inferential methods such as regression models and cluster analyses. Techniques used to analyse the qualitative data included thematic analyses of interviews. These are presented in further detail in Chapter 3.

In addition, two small workshops were undertaken. The first workshop was facilitated within the seventh Safe and SuRe project Steering Group meeting and included engineering practitioners and academics. The second workshop, which was more of a focus group, involved members of a community emergency group and community members. These workshops were not used for data collection purposes but rather to co-create the outcomes of the research aim.

1.4 Thesis structure and content

Following this introductory chapter, the thesis is further divided into seven other chapters and each is summarised as follows:

Chapter 2 - The literature review presented in Chapter 2 aims to place the research problem into broader national context as well as to integrate the main theoretical perspectives concerned. The first section of the chapter provides a background review of water management in the UK with specific focus on how changes in the socio-technical regime of drought and flood management have shaped the water user in their current configurations. Current drought and flood management policy are reviewed in this section to place focus on the resilience of the water user as household, communities, and public.

Since coping as a resilience intervention is the focus of the research, the second section of the literature review presents the theoretical perspectives of resilience across disciplines. These are critically reviewed in light of applications in social systems. This includes application of 'community resilience' and the gaps in the research about how community resilience has been conceptualised and understood to date. As there are several concepts closely linked to resilience and coping, this section also prioritises some focus towards better understanding these concepts (e.g. adaptation and vulnerability), how they relate to each other and how they link to this research.

The final part of the literature review places focus on understanding the coping at the water user level. This includes focus on coping from a psychological point of view as well as the coping responses of households. The framework of Protection Motivation Theory which has been applied to understand and determine behavioural intentions for coping is discussed as well as some applications specific to water management issues similar to those of this research, i.e. household drought and flood coping. The chapter also finally introduces the idea of analysing decision-stages to better understand why some households will implement coping measures and why others will not.

Chapter 3 - This chapter explains the research methods in the context of a mixed methods approach utilising both quantitative and qualitative methods. It describes the areas selected as case studies for the research. The quantitative research design discusses the justification and details of a pilot survey, the final instrument, and the sampling and data collection methods. This is followed by discussions of the justification and philosophical underpinnings of the qualitative research design which included interviews and workshops. Both quantitative and qualitative data analysis methods and techniques employed throughout the study are discussed in detail. Finally, the ethical considerations and approval process related to the research approach are discussed.

Chapter 4 - This chapter presents the results of interviews undertaken with practitioners and academics. Firstly, discourses related to drought and water efficiency are presented and discussed. This includes some of the key challenges commonly encountered when engaging with communities on issues of drought. This is followed by the discourses related to flood risk management where key themes are discussed for community flood engagement and participation.

Chapters 5 - This is the second of three results chapters of this thesis. Two objectives underpin the research findings of this chapter: 1) to assess the effect of key indicator variables on household drought coping and; 2) to account for the intention-behaviour gap and decision-stages amongst households. In achieving these objectives, firstly an overview of the socio-demographic characteristics of the sample is presented. The next section then provides an assessment of current behavioural intentions towards household drought coping measures, perceptions of severity of consequences, climate change and issues related to the implementation of coping responses (e.g. perceived efficacy of measures, or cost, etc.). This chapter then examines behavioural intentions in great detail in an effort to determine the variables that are key determinants and hence indicators of coping behavioural intentions. Variables are further explored in an effort to account for how they shape different decision stages within the sample.

Chapter 6 – This chapter provides a twin analysis to that undertaken in Chapter 5 with the objective being to identify the indicator variables for household flood coping and understanding how they account for the decision-stages. It therefore provides an analysis of household flood coping behavioural intentions. This chapter also analyses the perceptions of households about the consequences of flooding (direct and indirect); the influence of climate change on flooding; the efficacy of household flood coping responses; their own self-efficacy; and the costs associated with implementing the measures. This chapter similarly provides detailed analyses and explorations of the determinants of behavioural intentions and decision-stages.

Chapter 7 - In this chapter, the links between threat, consequences and coping are made through the development of an assessment framework and toolkit for engendering participation of households and communities into wider water management issues. The processes leading to the development and testing of the toolkit are discussed within this chapter which precedes discussions on the problem-based approach for sustainable and resilient water management futures. Consideration is also given to the implementation and diffusion of the toolkit in this chapter.

Chapter 8 - This final chapter wraps up the thesis by providing a summary and main conclusions from the research undertaken. This chapter outlines several areas that require further research attention and closes by outlining the key contributions of the research in general terms, as well as part of the wider Safe and SuRe project.

1.5 Originality and contribution to knowledge

This thesis has used multiple regression models and cluster analyses to identify key indicator variables that promote the implementation of coping responses (to drought and flooding) at the household level in the UK. It provides new insights into why some households with high intentions do not actually implement coping responses to increase their resilience as well as why others do not plan to implement such measures. These indicator variables as well as the lessons from community engagement programmes on drought and flooding have been incorporated in the development of both a framework and toolkit for assessing and planning strategies to increase resilience to drought and flood consequences. Unlike the existing generalised frameworks on community resilience, this framework promotes the development of specified resilience (resilience of what to what) through a problem-based approach to addressing the consequences of extreme drought and flooding. This framework can be used to facilitate detailed assessment of consequences of extreme events and has the advantage of incorporating sustainability thinking through the use of the toolkit.

2 LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the literature that contextualises this research. It will be seen that the literature is drawn from a series of intersecting disciplines including engineering, sociology, and psychology, with research streams such as science and technology, complex systems, governance, policy, hazard management and human cognition as outlined in the research perspective in Chapter 1.

The following two research objectives guided the literature review:

1. Objective 1 - To understand the role of the water user in a transitioning water sector
2. Objective 2 - To understand resilience and related concepts and how they are applied to social systems

Section 2.2 of this chapter undertakes an evolutionary overview of the transitions of the water user shaped in the context of changing governance structures, and socio-political and environmental drivers and pressures. Discussions focus on how some of these conditions have led to important transitions in the delivery of water supply and distribution, and flood management, whilst incorporating the changing roles of water user and Water Service Providers (WSP) (also referred to as Water Companies). Current drought and flood management policy are discussed to illustrate the linkages with the framing of the water user and hence implications for their involvement in resilient water management at the household and community level.

If water service users are to become more resilient in an age of emerging threats, then resilience needs to be examined and understood in greater detail to inform how it can be achieved at this level. This is addressed in Section 2.3 where the two main epistemologies of resilience are reviewed followed by the challenges of applying resilience to social systems in light of these epistemological perspectives. This includes the concept and application of community resilience. Following on from this discussion, the thesis then turns to examining current knowledge, issues and gaps surrounding some of the concepts that are commonly related to resilience in social systems. These themes are often interconnected with each other and include vulnerability, adaptation, and coping.

In Section 2.4, the literature review places focus on resilience through coping at the individual level and how this is framed in psychology and hazard management disciplines as well as assessment frameworks for understanding coping intentions and decision-stages. The chapter is summarised in Section 2.5 with discussions on contributions of the reviews undertaken in the chapter and the gaps in research that will be later addressed in the thesis.

2.2 Transitions in water services: the changing nature of water user role

Figure 2.1 below combines the works of Wong and Brown (2009) and Sofoulis and Strengers (2011) to illustrate major historical, current and expected future transition states in the evolution of the water sector in Australia. The general patterns are similar for most modern cities. Socio-technical transitions are characterized as long-term (ca. 50-100 years), transformative change processes that involve many different actors and lead to radical alterations of various (non-) material dimensions (Fünfschilling, 2014). Examples of socio-technical transitions in UWM systems include the transition from surface water to piped water and personal hygiene (1870-1930) where technological innovations, such as piped water infrastructure, soap, toilets, baths, were intertwined with and fuelled cultural, political, economic and behavioural changes (Geels, 2005).

The water sector has over time transitioned to first deliver the fundamental functions of a UWM system such as water supply access and security through supply and distribution networks, then sanitation and public health through sewering and waste water treatment, and finally flood protection through drainage networks and flood defence schemes (Figure 2.1). During the early transitions, rationalist institutional perspectives placed little concern on environmental services, whilst economic development was a chief aim for continued development and expansion of water supply, quality, and flood management (Wong and Brown, 2009).

Each successive transition was influenced by dominant socio-political and environmental drivers, stressors, tensions and pressures e.g. or consumer pressures following droughts and the need to ensure public health protection

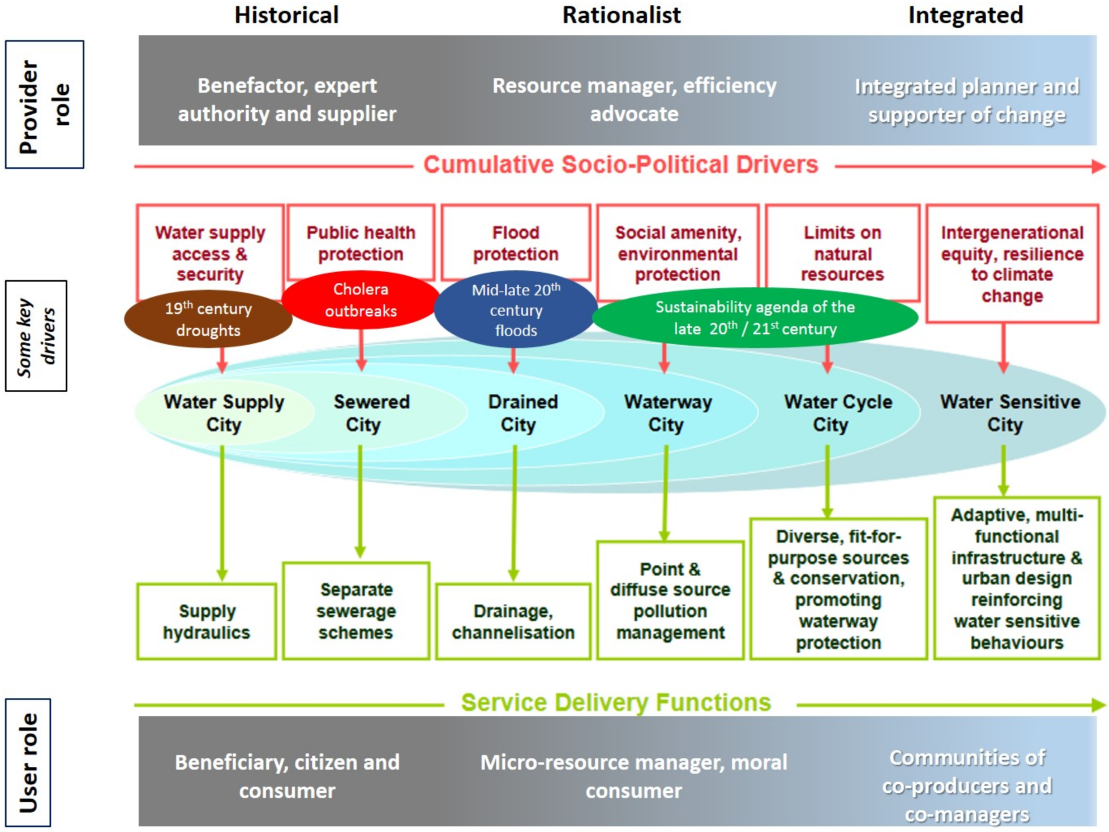


Figure 2.1: Transitions in water services highlighting the changing nature of the water service user (adapted from Wong and Brown, 2009 and Sofoulis, 2011)

following outbreaks of Cholera, both in the Victorian era. The roles of both the supplier and the water service user (WSU) changes as the system evolves and transitions. The three key pillars (i.e. water supply, urban drainage, and flood protection) of UWM systems are now reliably fulfilled in most westernised cities. However, under drivers of sustainability, climate change, and resilience, more integrated approaches are continually being sought as illustrated in Figure 2.1. Values and policy focus become more centred on social amenity, environmental protection, ecosystem services, intergenerational equity, and resilience to climate change (Figure 2.1) (Wong and Brown, 2009). As UWM systems strive to become more integrated to fulfil these environmental and social values and priorities, the user is expected to become more connected and involved. This involvement may be as co-producers and co-managers (Sofoulis and Strengers, 2011) as suggested in Figure 2.1 above, but may also be in the form of participation in water related issues.

Such transitions therefore have implications for resilience of various aspects of the UWM system. It is the transitions in behaviours and roles of the water user (as households) that are of most interest to this thesis. However, in further understanding these behavioural transitions, the transitions that have led to current configurations in UWM systems must be reviewed. Water users behaviours and roles have been directly and indirectly influenced by various transitions in UWM systems.

The ensuing sections will provide more detail on how and why aspects (water supply and flood protection) of the UK water sector has transitioned over time and how these transitions have been influenced by the user as well as the changing user role following major transitions. This sets the scene for understanding the need for household and community level interventions to respond to water management extremes such as drought and flooding. The sections therefore illustrate the linkages between an evolving water sector and the need for a more active role of households and communities in enabling more sustainable and resilient STSs. Since this thesis is concerned with the water supply and flood management aspects of UWM systems, focus is placed largely on these transitions and their implications for the water user.

2.2.1 Evolutions in urban water supply

Water supply, drought and the nineteenth century water user

During the mid-nineteenth century water supply became a dominant feature of the water sector in urban areas of Victorian Britain. By the late nineteenth century major urban centres of England and Wales were connected to water supply networks but water supply could be sparse and intermittent and certainly rural areas were more dependent on rivers and wells (Taylor et al., 2009). As a result customers were vocal in their displeasure with the quantity and quality of water and were quick to mobilise as citizen-consumer for improved services. These complaints led to increasing statutory regulation of water supply and to the development of commercial and domestic water supplies (Taylor et al., 2009). The culture of constant water supply emerged during this period and is reminiscent of the 'system of provision' dominant in the sector today (Medd and Shove, 2007).

The reliability of the water supply city in increasing the quantity and quality of water supply was progressively improved following major droughts of the 19th century such as those of 1826, 1854, 1865, 1887, and the 'Long Drought' of

1890–1909 (Taylor et al., 2009). The Long Drought of the 1890s was the first to affect a major urban area, London, in a new technological and political context of constant supply, organised consumer mobilisation, and pressure for municipal take-over (Taylor et al., 2009). As a response to the drought, the Metropolis Water Act was upgraded in 1899 to require metropolitan companies to improve inter-communication and provide bulk transfers during emergencies (ibid). The drought problem was viewed as a challenge for engineers to resolve for instance by finding new ways of accessing water or making transfers between networks (Medd and Chappells, 2007).

Major nineteenth century droughts, and those that followed, showed that as legislation evolved requiring better services, engineering and infrastructure played a crucial role in shaping the relationship between consumers and water providers (private and public) (Taylor et al, 2009). Through a combination of changes in legislation following major droughts and improvements in technology, this era saw the beginning of the co-relations and co-evolutions between users, providers, and technology. The outcome is what Turton and Meissner (2002) term as a 'hydrosocial contract'. This is best defined by Brown et al. (2008, pg. 848) as:

> *"the pervading values and often implicit agreements between communities, governments and business on how water should be managed. This contract is shaped by the dominant cultural perspective and historically embedded urban water values, expressed through institutional arrangements and regulatory frameworks, and physically represented through water systems infrastructure."*

The hydrosocial contract that emerged at that time was defined by water consumers as citizens within a governed population who were beneficiaries of the state's water provision (Sofoulis and Strengers, 2011). So whilst the user was typically vocal about how the water sector should operate in terms of delivery of water quality and quantity, they were largely passive users consuming a service as a beneficiary of the state. The drive to improve reliability meant that water supply was seen as an engineering challenge and as such the user was not an active participant in any aspect of service delivery. This hydrosocial contract meant that people gradually lost sight of the connections between water as a natural resource and water as for consumption.

Municipal take-over and the twentieth century water user

This section has largely been informed by the work of Taylor et al. (2009) who have provided the most comprehensive review of the municipal period in recent years. With a shift from commercial monopolies to public provision in the twentieth century, water consumer representation declined, resulting in a less polarised water provider/consumer relationship (Taylor et al., 2009). For instance the consumer campaigns of the 1890s were not replicated during the 1921 drought. Civil society had lost some of its autonomy as its organisations, resources and functions became more dependent on the state (Taylor et al., 2009). Citizen rights were now tied firmly to supplier obligations to provide for expanding water consumption (Taylor et al., 2009). This dependence of citizens on the state was a reflection of the governance mechanism of advancing state welfare and planning during this period, and so, the relative decline of self-organised consumer groups paralleled the history of civil society more generally in this era (Taylor et al., 2009). Water authorities therefore continued to expand their networks and exploit water resources in order to manage competing human demands for water, with limited focus on customer participation or protecting the environment (Medd and Chappells, 2007).

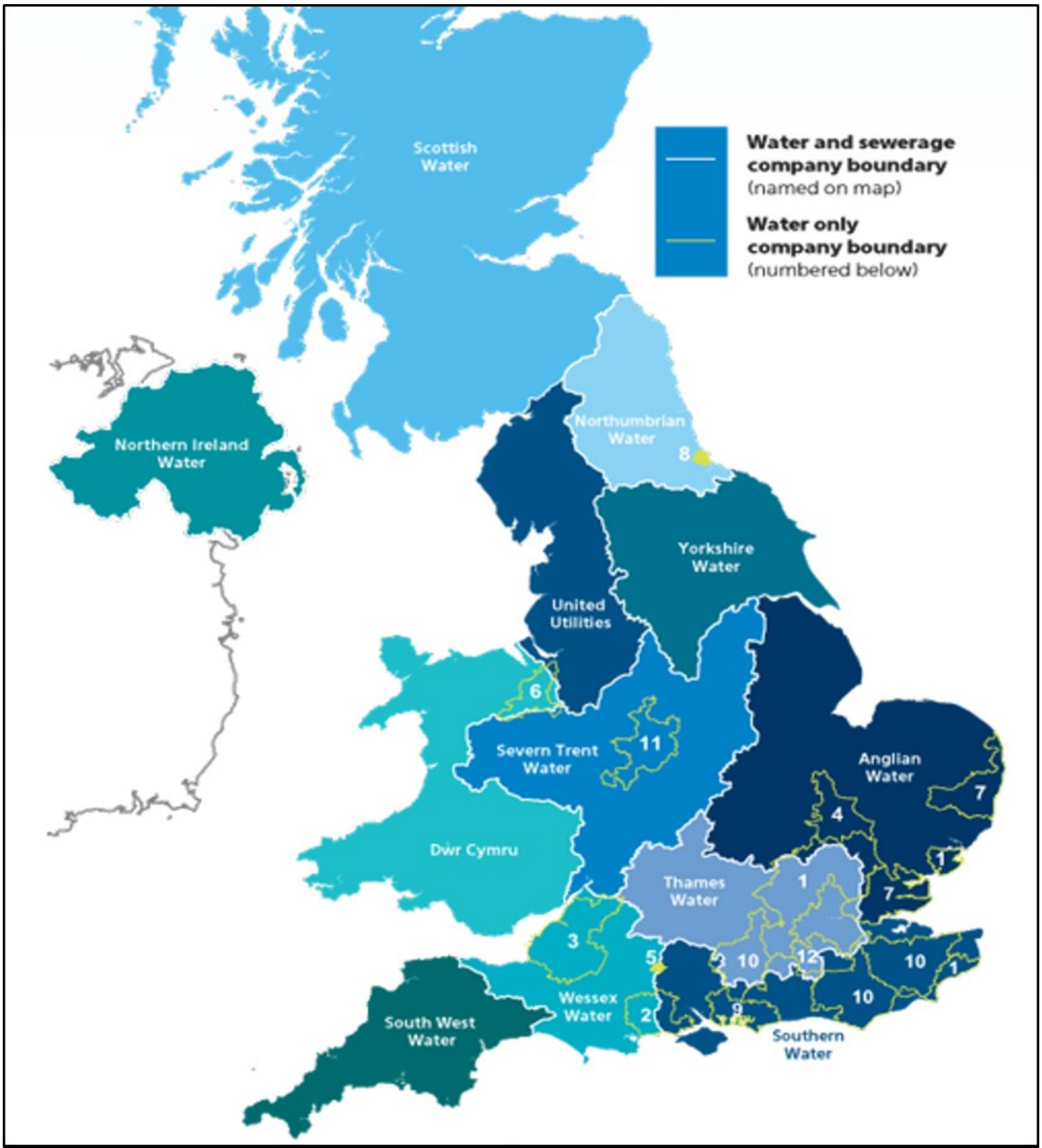
Despite pressure for central planning and regulation in the inter-war and immediate post-war periods, the regulatory framework remained a patchwork of voluntary regional advisory committees alongside direct Ministerial control (Taylor et al., 2009). Transformations in water governance by the 1950s meant that many regions had diverse providers, operated by county and borough councils, joint committees, or private undertakings (Taylor et al., 2009). The consumer voice remained under-represented even after the 1959 drought and up until the 1970s (Taylor et al, 2009).

Nationalisation in 1973, through the formation of ten regional water authorities, established the basis for integrated water resources planning, based on catchment areas rather than administrative boundaries (Taylor et al., 2009; Page and Bakker, 2005). This reorganisation of water services saw the transfer of water management responsibilities from local to central government (Dooling, 2000). Required to operate without government financial assistance, the new authorities began charging customers directly for water services, a move which outraged a British public accustomed to paying water charges as part of local taxes, which Dooling (2000) explained as the beginning of the 'commodification of water services' in Britain. The ethos was still that of engineered control so that during the 1976 drought, despite the use of standpipes, water authorities and national regulators were committed to stretching the supply system to its limits (National Rivers Authority, 1994 in Taylor et al., 2009) by maximising abstractions to meet demands (Medd and Chappells, 2007).

Although the consumer voice was not vocal during nationalisation, nongovernmental pressure groups remained influential during and after nationalisation. However, it is surmised that they had their own agendas for intervening in the policy process such as their ownership of riparian land, water supply networks, or other areas of interest (Page and Bakker, 2005). For other water users, nationalisation was experienced as a loss of community control; water supplies were perceived as having been appropriated by the state and water users became increasingly alienated from the operators of their water supply (Page and Bakker, 2005). Therefore, while elites were able to influence water policy to secure their own self-interests, water users continued to be passive consumers far removed from the system of provision.

Privatisation: commodification, sustainability, and the water user

The water sector was privatised in 1989, and has since undergone significant consolidation so that there are now 16 companies from 39 companies (29 water-only companies and 10 public Regional Water Authorities) in 1989 (Page and Bakker, 2005) (Figure 2.2). Under privatisation of the water sector, water is both a natural resource and a commodity (Pearce et al., 2013). The water user became a 'customer' who pays for their demand of the commodified resource (Pearce et al., 2013) which is in turn matched by a LoS (Sofoulis and Strengers, 2011). Henceforth, shaping the current hydrosocial contract where water service customer relationships 'depend on confidence in the ability of water technocracies to tame and control nature and command human skills to deliver required demand' (Sofoulis and Strengers, 2011). The user has 'rights' to abundant water supply but very few responsibilities besides paying the bill, whilst almost all knowledge of water supplies, infrastructures, and details of consumption patterns rests with WSPs (Sofoulis and Strengers, 2011). These relationships continue to date, with the water sector adopting precautionary approaches to the maintenance of supplies in light of future uncertainty and the sustainability agenda (Taylor et al., 2009).



1.	Affinity Water	7.	Essex & Suffolk Water (Northumbrian)
2.	Bournemouth Water	8.	Hartlepool Water (Anglian)
3.	Bristol Water	9.	Portsmouth Water
4.	Cambridge Water	10.	South East Water
5.	Cholderton and District Water	11.	South Staffs Water
6.	Dee Valley Water	12.	Sutton and East Surrey Water

Figure 2.2: Water company regions in the UK under privatisation

Consumers are formally represented within the regulatory framework for the first time through the Consumer Council for Water (CCW) (Taylor et al., 2009).

However, the consumer has been inevitably distanced from decision making due to the peculiar nature of privatisation, that being that neither private companies nor government regulators are democratically accountable (Page and Bakker, 2005). Public participation of the 1980s represented a different view of the relationship between the individual and the state. Instead of being directly involved in the process by which public policy is made and services delivered, the water user as a consumer, is expected to exercise choice in their consumption of services and to have their rights as a consumer protected by law (Page and Bakker, 2005). As a result, customer complaints and the recourse to legal action remain as the dominant mechanisms through which the public are able to assert their influence rather than through votes, parliamentary lobbying, and participation (Page and Bakker, 2005). The user is therefore more of a consumer of public goods rather than their production (Boaden et al., 1982 in Page and Bakker, 2005) and are hence a far way off from becoming communities of co-producers of an integrated water management system or an adaptive city.

The 1995 drought was the first under a privatised resource, based on economic efficiency, environmental regulation and security of supply (Taylor et al., 2009). The regional impact was uneven revealing disparities in LoS especially because the regions most affected were those with the highest leakage rates (Taylor et al., 2009). It was argued that companies in drought-stricken areas had little incentive to fix leaks because supplying water was relatively cheap. This intensified calls for regulation of individual company performance, and in response, the Economic Regulator of Water Sector in England and Wales (Ofwat) introduced mandatory leakage targets and agreed service levels for consumers (Taylor et al., 2009).

Taylor et al. (2009) note that the 2006 drought offered the opportunity to test the new stringent regulations, and to evaluate whether the private water sector had matured into a more effective provider. Again, public debate focused on network mismanagement and the prioritisation of commercial over public interests (Taylor et al., 2009). Unlike the response to extract ‘every last drop’ in 1976, emphasis was on a phased strategy of communication campaigns, followed by hosepipe bans reflecting the changing valuation of the environment as an equally legitimate user of water (Medd and Chappells, 2007). The user was therefore to assume the role of a micro-resource manager and moral consumer in their use of water. Environmental science and ecological assessments of risk and resilience were introduced into the equation alongside the supply-oriented models of engineers and planners (Medd and Chappells, 2007).

Government hydrologists Kendon et al. (2013) suggest that the 2010-2012 drought, with its severe impact on water resources and agriculture, served to underscore the continuing vulnerability of the UK to sustained periods of rainfall deficits. They note that this highlights the need for innovative river and water management strategies to reconcile the, often competing, demands on a limited resource (Kendon et al., 2013). They surmise that, a combination of factors such as limited development of new reservoirs over the last quarter of a century and an increasing need to better protect the aquatic environment during periods of drought stress, will continue to constitute a considerable challenge. However, they do not mention the need for changing consumer lifestyles and expectations on the design, configuration, use, and maintenance of buildings and technologies as in (Medd and Chappells, 2007), reflecting the continuing focus on a technological approach for water sector challenges. The water service customer continues to receive and pay for their services without much interaction with the resource or the provider.

2.2.2 Current drought policy and management

Under privatisation in England, the main organisations currently responsible for managing water resources during drought are: 1) the EA, with strategic oversight and responsibility for monitoring, reporting, advising and acting to reduce the impact of a drought on the environment and water users; 2) Water Companies, with responsibility for managing water resources and supply for their customers and taking a range of measures (as outlined in required drought and emergency plans) to maintain supplies whilst minimising environmental impact; and 3) Government, with responsibility for policies relating to water resources (Environment Agency, 2015*a*). A number of other organisations and groups also play an important part in managing drought, including Natural England, Canal and River Trust, local councils and representative bodies such as National Farmers Union (NFU), UK Irrigation Association, and environmental charities (Environment Agency, 2015*a*).

Water companies are required to prepare and submit both a drought plan and a Water Resources Management Plans (WRMPs) to the EA every five years under the Water Act 2014. Drought plans set out short-term actions to monitor and manage the impact of drought on customers and the environment, reiterating the sustainability agenda of minimising the impact on the environment and other water users (Cabinet Office, 2015). Actions range from publicity campaigns and changes in normal operations, to customer restrictions and drought permits or orders. In the WRMPs, water companies set out how they will manage supply and demand over the next 25 years every five years (Cabinet Office, 2015). Climate change is now incorporated in water resources planning as it is viewed as a long term challenge.

Drought management practices are based largely on crisis management strategies with little intervention from users (households and businesses) and communities. This is of course due in part to a combination of the low frequency of droughts, privatisation of water resources management to profit driven entities that have invested heavily in infrastructure, and hence a need to maintain the perception that the paid service of constant water supply will continue to persist. Water companies are often restricted and cautious in the way they approach customers on certain issues due to concerns of customer perception about the security of supply and ability to manage supply and demand (Watts et al., 2012). These perceptual risk factors could potentially constrain bottom-up approaches where customers and their various communities could be influential in helping to achieve resilient and sustainable use of water supplies.

Sharp (2006) notes that the water user can take many dimensions depending on how the water company engages them, particularly where demand management is concerned. Some of these roles are illustrated in Figure 2.3 below. Participatory activities that encourage integrated approaches will perhaps best treat the water user as an active citizen with rights and responsibilities and who is part of a community. However, the sector is a far way off from transitioning towards such a hydrosocial contract where users are involved as communities of co-producers and co-managers.

2.2.3 Urban flood management

The literature review now shifts focus from water supply and droughts to flood management and the changing roles of the public, communities and households. Similar to the way water supply and distribution systems have seen major transitions under varying socio-political and environmental contexts, so too have similar drivers influenced flood management. UK flood and coastal risk management has transitioned from a largely technocentric system, to a more ‘socio-technical’ one (Twigger-Ross, 2005; Twigger-Ross and Colbourne, 2009 in Nye et al., 2011).

Passive non-manager: The water-user is a passive recipient of water services.	⟺	**Active manager**: The water-user actively manages own water demand.
Individual consumer: The water-user is an individual consumer of a commodity which they can use as they wish.	⟺	**Community member**: The water-user is part of a community and they have responsibility to help manage society's consumption of water, a communal resource.
Customer: The water-user pays for the commodity of water in a commercial transaction, in return for which they have a right to expect particular levels of service.	⟺	**Citizen**: The political system meets individuals' human rights to water, deciding who should contribute to the costs of providing it according to ability to pay.

Figure 2.3: The varying dimensions and roles of the water user (Source: Sharpe, 2006)

Since the late 1970s there have been two major paradigm shifts in flood management - flood defence and flood risk management (Woodley, 2013; Johnson and Priest, 2008). These shifts have been driven by several factors including changing policy focus. Table 2.1 below illustrates changing policy focus underpinning each of these periods concerned with flood management. There was also an economic rationale for the shift from a technological approach that has not been elaborated in Table 2.1. Each transition is further elaborated below.

Table 2.1: Summary of flood policy evolution post World War II (Source: Johnson et al., 2005)

Belief system	**Land drainage (WWII-1970s)**	**Flood defence (1980s to 1990s**	**Flood risk management**
Nature of humans	Humans have dominion over nature. Land is there for human use.	Humans have dominion over nature (power and right to exercise it)	Humans are part of nature, not superior to it. Nature has intrinsic value
Priority of values	Priority on agricultural productivity and food security within the national economic context	Priority of economic growth, national security and welfare standards	Ecological and environmental values should be viewed on par with economic growth, national security and welfare standards
Fundamental policy position	To improve and protect agricultural lands from flooding	To defend people and property from flooding	To manage flood risk equitably and in accordance with the principles of ecologically sustainable development
Basic policy mechanism	Investment in land drainage and rural flood defence	Investment in urban flood defence and flood alleviation schemes according to national priority criteria and economic appraisal process	A focus on decisions that satisfy social and economic needs whilst maintaining ecosystem enhancement

Flood defence and the householder

The fist paradigm shift in flood management emerged from the local land drainage period in the 1970s to late 1990s. This era was dominated by centralised systems where intensive expenditure was made on infrastructure development and expansion (Woodley, 2013; Newman et al., 2011). Whereas the previous land drainage period focussed on rural areas, the flood defence period was concerned with protection of urban areas through structural/hard engineering (Figure 2.1). During this period, Government was seen as being responsible for protecting people and property (Woodley, 2013; Newman et al., 2011; Johnson et al., 2005).

Although non-structural defence was not the emphasis, there was some progress towards risk and risk communication but this was done through a top-down approach and with much less importance than the structural aspects (Woodley, 2013). Risk transfer through insurance was introduced during this period to transfer the risk of flooding of individuals and businesses from government (Woodley, 2013). The roles of households and communities were not viewed as integral and flood management continued to be seen as solely a matter for government.

As such households, communities, and the general public became accustomed to being protected by outside sources such as the protection provided by engineered defences. Flood management was an engineering challenge (Figure 2.1) and households and communities were not specifically encouraged to become involved in preparedness and flood mitigation activities at the building and neighbourhood scales.

Flood risk management: a shift in policy, practice and participation

The second paradigm shift has been ongoing since the 1990s and represents a shift from flood defence (holding back the water) to FRM (learning to live with floods) (Nye et al., 2011) (Figure 2.1). This shift is supposed to have stemmed from the sustainable development agenda ((Butler and Pidgeon, 2011; Johnson and Priest, 2008; Penning-Rowsell et al., 2006). Additionally, Sayers (2017) explains that the floods of 1998 and 2000 reinforced the need for a basin-wide and strategic approach using a combination of structural and non-structural approaches. The government commissioned report following these events “Learning to Live with Rivers”, concluded that floods cannot be prevented but they can be managed (Fleming et al., 2001 in Sayers, 2017).

The FRM agenda is directed towards minimising adverse effects and at learning to live with floods (Vis et al., 2003). FRM involves a transition towards a more strategic, integrated system of flood management that takes account of the environmental and social impacts of flood hazard management. There is hence a shift from a focus on flood defence to one focused on the combination of: (a) flood abatement, with the aim to prevent peak flows, e.g. by an improvement of water retention capacities throughout a catchment; (b) flood control, aimed at preventing inundation by means of structural measures, e.g. embankments or detention areas; and (c) flood alleviation with the goal of reducing flood impacts by non-structural measures (Tunstall et al., 2009; Thieken et al., 2007). Therefore, FRM focuses directly on flood risk through a range of measures to reduce its frequency, magnitude and duration.

Flood alleviation, which can be classified into preventive, precautionary, and preparative measures (Thieken et al., 2007), is one key aspect of FRM that distinguishes the approach from its predecessors. Prevention is aimed at completely avoiding damage in hazard-prone areas, e.g. by flood-adapted land use regulation or development control. Precaution and preparation help to limit and manage the adverse effects of a catastrophe, and to build up coping capacities by flood-resilient design and construction, development of early warning systems, insurance, awareness campaigns, education, training (Thieken et al., 2007), flood awareness roles of local communities and individuals, and emergency planning (Woodley, 2013). These latter features are philosophically different from the previous flood management regime of flood defence in that they pull humans into the issue of flood management and aims to take it beyond an engineering or technocratic approach.

The Flood and Water Management Act 2014, together with the Flood Risk Regulations (FRR) 2009 and the Civil Contingencies Act 2004, form the overarching framework within which FRM in the UK is governed and implemented (Figure 2.4). Key drivers behind the introduction of these legislation include the crucial “Pitt Review”, the “Foresight Future Flooding” report, the Institution of Civil Engineers (ICE) Ministerial Commission’s “Learning to live with rivers”, government’s “Making space for water”, and the EU Floods Directive (Environment Agency, 2011). All of which followed periods of widespread flooding in the UK and Europe.

Pivotal to the FRM agenda is the National Flood and Coastal Erosion Risk Management (FCERM) strategy, developed jointly between the Department for the Environment, Food and Rural Affairs (Defra) and the EA under the Flood and Water Management Act (FWMA) (Environment Agency, 2011). The FCERM strategy outlines a risk-based management approach comprising collaborations amongst communities, individuals, voluntary groups, and Risk Management Authorities (RMA). RMAs include the EA, a Lead Local Flood Authority (LLFA) (i.e. a county council or a unitary authority), Internal Drainage Board, Highways Authority, and a Water Company. Development and implementation of the FCERM strategy marks the first move in England to bring all types and sources of flooding together as well as to identify and clarify roles of the RMAs Environment Agency (2011). The current FRM structure is outlined in Figure 2.4.

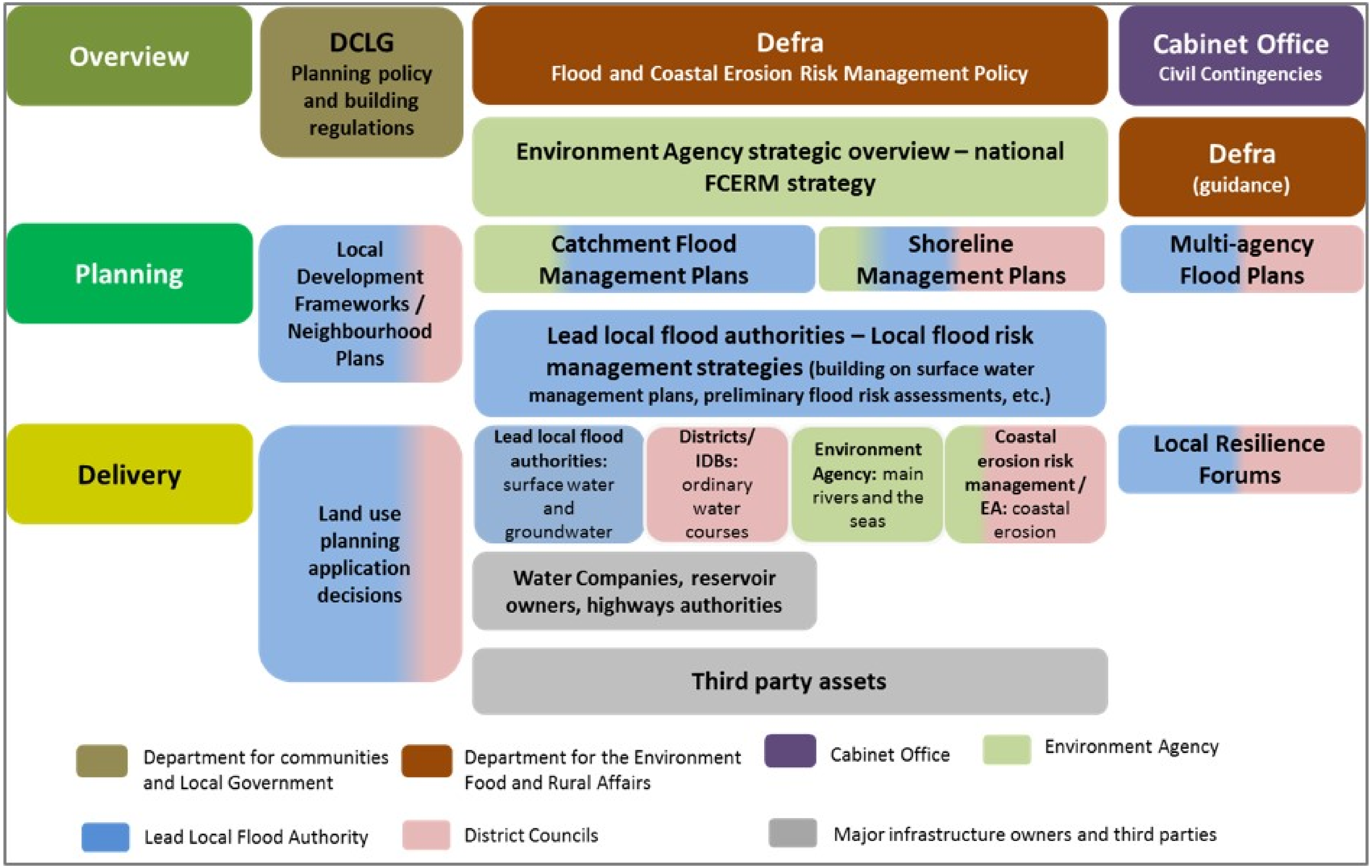


Figure 2.4: Administration and implementation of flood risk management policy in England (Source: Environment Agency, 2011)

As the implementer of the FCERM strategy, the EA receives approximately £750 million of annual grant-in-aid funding from Defra to support a range of activities related to its implementation (ICE, 2010). These include development of catchment flood management plans, shoreline management plans, improved flood forecasting and warning, and awareness raising (Figure 2.4). FCERM also requires the development of a Local Strategy (LS) led by the LLFA in a multi-agency approach with other RMAs. Development of LSs presents the opportunity to initiate a bottom-up approach where businesses, communities and households can become involved in local flood and coastal erosion risk management in line with the national strategy Environment Agency (2011). This includes the development of Community Risk Registerss (CRRs) by Local Resilience Forums. It would seem pertinent to involve communities in the process of CRR development. However, whether or not these CRRs are developed in consultation with the public remains uncertain as review of CRRs did not show evidence of consultation with or participation by the public.

This is against the FRM approach, where the importance of knowledge exchange and participation of stakeholders and individuals are regarded as necessary features in decision-making processes (Woodley, 2013; Johnson and Priest, 2005). Newman et al. (2011) refers to this as a "shift from experts to alliances" where scientific and expert knowledges are not the only recognised forms of knowledge. Local people with their own specific sets of knowledges and expertise should have the opportunity to use and share these knowledges to increase their resilience to flooding. Such a shift allows for more bottom-up involvement in managing and responding to flooding emergencies versus the purely rationalist and technical approaches of the past.

Public participation is now universally considered to be an essential element of FRM and will take an increasing role (Sayers, 2017). Although it is uncertain how the public and communities were involved in the development of CRRs, the Community Pathfinder project which was launched under the FCERM strategy, was an integral approach of Defra and the EA to enhance community flood resilience through a participatory model. Defra launched the Pathfinder project in 2012 to enable and stimulate communities at significant (1 in 75 year / 1.3% annual exceedance) or greater risk of flooding to work with key partners, including local authorities (Twigger-Ross et al., 2014; Defra, 2012). The aim of Pathfinder was to develop innovative local solutions that:

1. enhance flood risk management and preparedness in ways which quantifiably improve the community's overall resilience;
2. demonstrably improve the community's financial resilience in relation to flooding and;
3. deliver sustained improvements which have the potential to be applied in other areas (Defra, 2012).

In their Pathfinder prospectus, Defra (2012) noted that projects should be aligned with the objectives and priorities of Local Flood Risk Management Plans. It was also envisaged that projects should be able to sustain longer term local flood resilience after the pathfinder funding had ceased (Defra, 2012). A total of 13 Pathfinder projects were implemented across England by Local Authorities and the National Flood Forum (NFF), both in partnership and separately depending on the region (Twigger-Ross et al., 2014). Although not stated as an aim, it is uncertain if and how this project has made any transformation in terms of enabling the participation of communities in FRM. Therefore, this thesis has pursued the following research questions in Chapter 4:

1. Is the water sector transitioning to a more resilient water user?
2. What are some of the challenges in promoting drought/flood resilience amongst water users?

Risk transference through flood reinsurance

Another strategy under the FRM agenda is that involving the transference of risk through insurance. Insurance mechanisms provide an effective way of addressing the costs of disasters through the sharing of risks and the distribution of the costs of compensation (Surminski, 2017). Under Section 64 of the Water Act 2014 a new reinsurance pool for flood has now been implemented (Flood Re Ltd, 2017) to do just that. Flood Re Limited (Flood Re) is the Scheme Administrator for the Flood Reinsurance Scheme (Flood Re Scheme) and provides flood peril reinsurance cover within the UK. The Flood Re Scheme is a joint initiative between the UK insurance industry and the UK Government (Flood Re Ltd, 2017).

According to the Water Act 2014, Flood Re's purpose is to promote the availability and affordability of flood insurance for eligible homes, while minimising the costs of doing so (Water Act, 2014). Flood Re is also meant to manage the transition

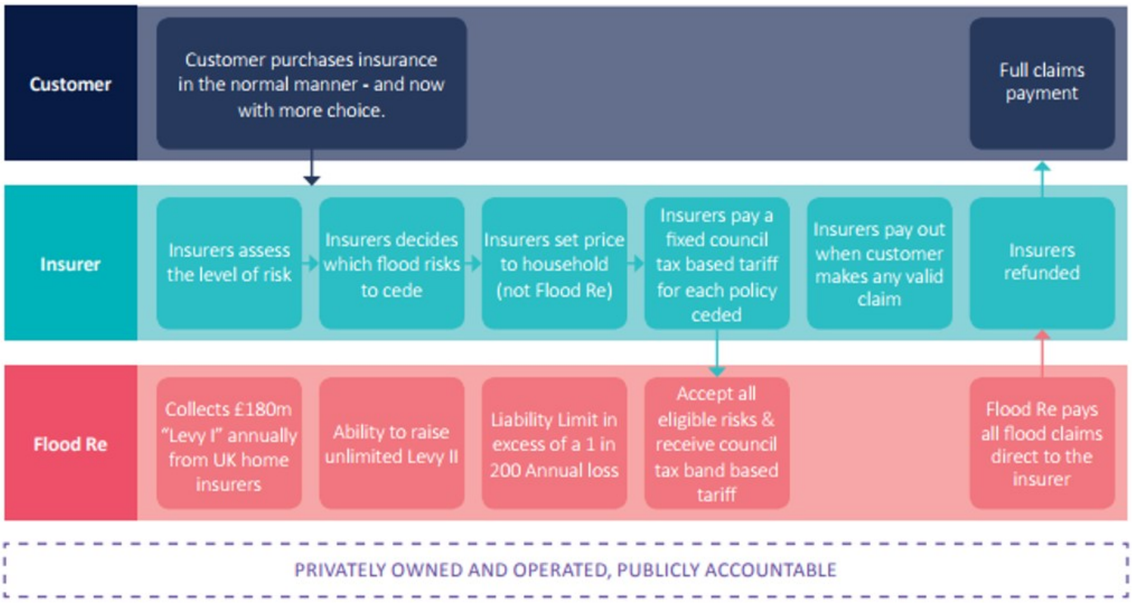


Figure 2.5: An illustration of the operation of Flood Re (Source: Flood Re Ltd, 2017)

to risk reflective pricing for household flood insurance (Flood Re Ltd, 2017; Water Act, 2014), thereby minimising the cost of flood insurance for properties at the highest risk of flooding (1-2% of domestic households) (Flood Re Ltd, 2017).

Whilst significant progress has been made in increasing both the availability and affordability of flood insurance over the first year of Flood Re (Flood Re Ltd, 2017), there are concerns that flood insurance can de-incentivize household resilience (Surminski, 2017). This is because it is speculated that Flood Re's 23 year lifespan might result in householders yet again transitioning to a state of dependency on an outside system versus becoming actively involved in FRM (Surminski, 2017). Béné et al. (2016) found this to be this case in Norway in response to a well-developed government disaster compensation fund. As a result, little if any action is undertaken by households (Bene et al, 2016). Although Flood Re intends to work with the insurance industry, communities at risk of flooding, and government at all levels and society, to ensure that it is no longer needed by 2039 (Flood Re Ltd, 2017), it may yet prove to be another short term strategy to a more systemic problem of building household and community flood resilience.

2.3 Understanding resilience and its implications for the water user

Resilience featured prominently in discussions surrounding the Rio+20 conference on sustainable development in 2012 and was declared as the buzz word of 2013 by Time Magazine (Brown, 2014), displaying its recent prominence. The concept was first applied to complex systems management following Holling's experiments in ecological systems in the 1970s (Cutter et al., 2008). According to Béné et al. (2016), resilience thinking is now becoming a central component in the planning and implementation of interventions in many sectors including humanitarian activities, disaster risk reduction, climate change adaptation, social protection, and food security and nutrition. It is hence quite common to encounter debates in political spheres and policy discussions on the need for resilience (Allmark et al., 2014).

Scholars propose that resilience approaches take account of a 'safe-fail' approach that minimises damage when new risks are revealed (Tyler and Moench, 2012; and Korhonen and Seager 2008 in Park et al., 2011), contrasting the traditional 'fail-safe' approaches applied in engineering. Increasing incidences of failure and hence increasing damage, loss and dislocation resulting from the threat of more frequent, and more severe weather events exposes the vulnerability of the water infrastructure. Consequently, a resilience approach to management of these issues is now gaining prominence over traditional risk based management approaches (e.g. Francis and Bekera, 2014; Park et al., 2011.

2.3.1 Resilience in the water sector

The UK Government has already commenced incorporating resilience into the legislative and planning framework of the water sector. In response to the recommendations of the Pitt Review of the 2007 floods, the UK Government published a Strategic Framework and Policy Statement related to a Critical Infrastructure Resilience Programme (Cabinet Office, 2010). The government also published a Summary of Sector Resilience Plans 2010 and Interim Guidance to the Economic Regulated Sectors (Cabinet Office, 2011). In 2011 the policy document "Keeping the Country Running" was released to provide guidance on infrastructure resilience and risk assessment to natural hazards including flood events (Cabinet Office, 2011).

Furthermore, Ofwat was delegated a new primary duty, *'resilience duty'* through the Water Act 2014 (Water Act, 2014). This new resilience duty is expected to address specific issues relating to the long-term pressures facing the water sector so as to encourage long term outcomes for customers and the environment. Following from this, Ofwat also developed a policy document that sets out future regulatory framework for the water and waste water industry in England and Wales (Ofwat, 2016). According to Ofwat (2016), the new regulatory approach aims to secure a resilient future for water, for the benefit of customers, the environment and wider society. They define resilience as "the ability to cope with, and recover from, disruption, trends and variability in order to maintain services for people and protect the natural environment, now and in the future".

Defra has similarly set out a roadmap of plans to enhance the policy framework, building on discussions with the water industry, regulators, consumer groups and other water users to understand the priorities for reform to meet the resilience agenda (Defra, 2016). The document outlines how Defra will enable water companies to enhance the resilience of the public water supply; support these businesses to manage their *'resilience risks'*; and enable water companies to enhance the resilience of the sewerage network (Defra, 2016).

Resilience is therefore becoming embedded in the water sector as a means of addressing several challenges, but what is it and how can resilience be achieved in the various sub-elements of UWM-STSs such as the social units encompassing water users? This section will present resilience perspectives from two main disciplinary backgrounds and the implications for application in social systems such as households and communities.

Additionally, concepts such as adaptation, vulnerability, and coping often associated with resilience in varied ways throughout the literature, will be further assessed. An understanding of resilience and its relationship with these concepts forms an important basis for developing resilience within STSs and hence the attainment of resilient outcomes for customers.

2.3.2 Resilience framings and applications

Since the influential work of Holling (Holling, 1973), a pioneering resilience researcher in the 1970s, two types of resilience have taken prominence in research (Lorenz, 2013; MacKinnon and Derickson, 2013; Wang and Blackmore, 2009; Webb, 2007; Gunderson and Holling, 2002; Adger, 2000) - engineering resilience and ecological resilience (Lorenz, 2013; Webb, 2007; Folke, 2006). Butler et al. (2014) outlines that engineering resilience essentially focuses on ensuring efficiency of function following failure (system performance) whereas ecological resilience is focused on maintaining existence of function (system integrity). These two framings of resilience are further discussed in Sections 2.3.2 and 2.3.2 below.

Engineering resilience

The concept of engineering resilience refers to resistance to a disturbance or stressor and speed of recovery to stability near an equilibrium-steady state (Pimm, 1984). Ludwig et al. (1997 in Folke, 2006) suggests that this definition applies only to behaviour of linear systems, or to non-linear systems at or near a stable equilibrium which is linear. Since there is only one stable state in this application of resilience, resilience of this nature is based on efficiency, control, constancy and predictability (Gunderson and Holling, 2002; Folke, 2006). As such, these systems are typical of a 'fail-safe' mode of design based on optimal performance but low uncertainty (Gunderson and Holling, 2002).

The works of Wang and Blackmore, 2009; Bruneau and Reinhorn, 2006 and Hashimoto et al., 1982 also place focus on time to recovery in their conceptualisations of resilience. Butler et al. (2014) suggest that frequency and duration of disturbances are factors inherent to system resilience. Engineering resilience therefore strives to meet the objective of providing a desirable service (a level of service or LoS) to society through rapid recovery of the system (Wang and Blackmore, 2009) so as to return to its initial value or to normal as soon as possible. Figure 2.6 illustrates that following disturbance a community may: A - exceed the original state because of effective recovery planning, substantial inflow of disaster assistance, or taking advantage of opportunities by fixing pre-existing problems within the community; B - return to its original state ; C - suffer some permanent loss and equilibrate below the original state or; D - suffer almost total destruction and rebuilding is deemed unviable (Wang and Blackmore, 2009).

With its strong focus on the time to recovery of the system to initial conditions (value), this type of resilience may not be easily transferable to social systems like households and communities because they are complex, unstable and non-linear systems. As such recovery in social systems can extend over a protracted period of time, be disjointed and be experienced in different ways by different people

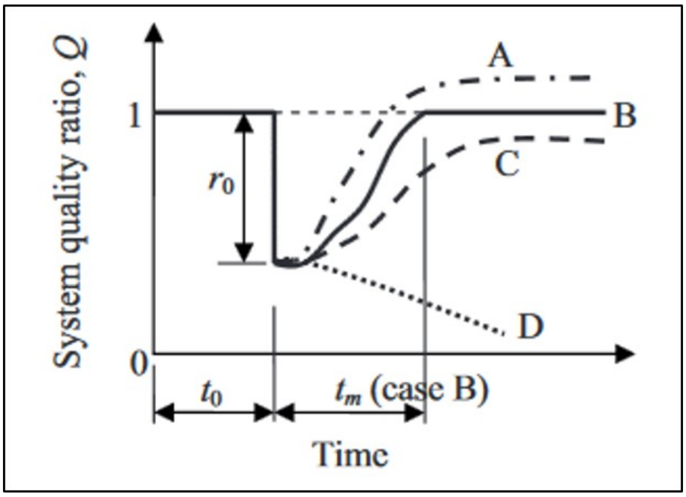


Figure 2.6: Recovery trajectory for a resilient system (Source: Wang and Blackmore, 2009)

and communities (Medd et al., 2015) as opposed to the recovery experienced in engineering systems. Medd et al. (2015) suggest that recovery may not constitute a 'return to normal' as as illustrated by B in Figure 2.14. This was illustrated in the findings of a long term study of flood victims of an extreme flood event in the city of Hull in 2007 by Whittle et al. (2010). Figure 2.7 below shows the non-linear recovery trajectories of two of these flood victims from the study and demonstrates the multi-faceted nature of recovery in an individual. Whittle et al. (2010) hence characterize flood recovery as a long and difficult process with no clear beginning or end point. The recovery aspect of resilience at the individual scale is hence often not as linear as obtains in engineered systems, making it difficult to apply the concept to human systems.

In addition to the fact that recovery in social systems is non-linear, the conceptualisation of a return to the same state after disturbance, makes some scholars question the usefulness of resilience as a community or social science application (e.g. Allmark et al., 2014; MacKinnon and Derickson, 2013). A general argument amongst these scholars is that resilience neglects politics and power relations (Brown, 2014). In their paper on resilience, MacKinnon and Derickson (2013) present three arguments against resilience of social systems. Firstly, they argue that resilience embodies a system that can maintain stability even after it faces a major disturbance and as such when applied to social systems may tend to privilege existing/incumbent regimes. If the regime is characterised by unequal power relations and injustice, then resilience will only allow these undesirable situations to persist despite disturbances (MacKinnon

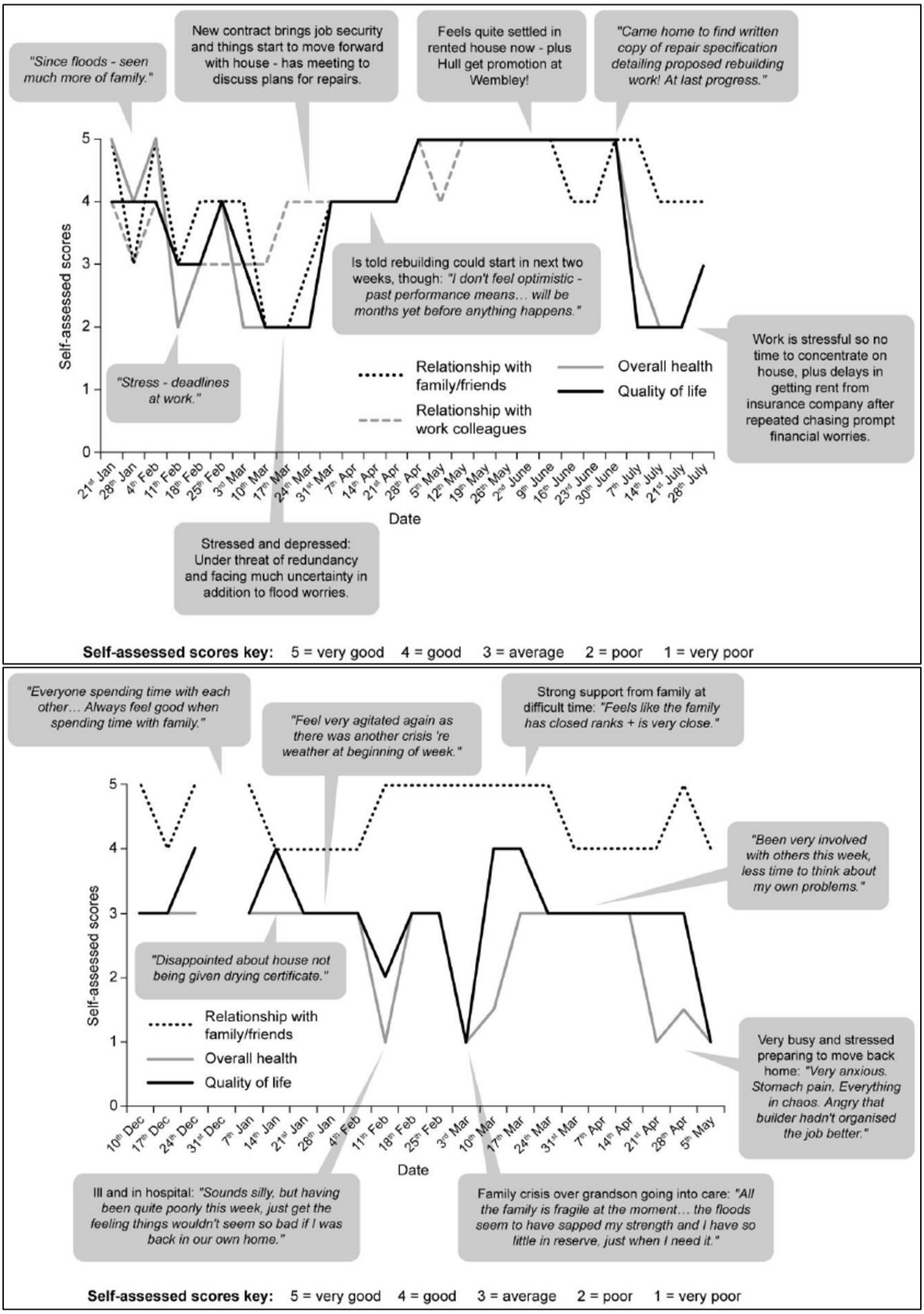


Figure 2.7: Recovery trajectories as recorded by two flood victims in the city of Hull leading up to one year after the flood. (Source: Whittle et al., 2010)

and Derickson, 2013).

Their second argument against resilience is that it is framed from a top-down perspective (i.e. state agencies and experts) which perpetuates wider social and spatial turbulence and inequality (MacKinnon and Derickson, 2013). In their third point they discuss how resilience of places is misconceived in terms of spatial scale (national, regional, urban, local) where the source of resilience apparently must lie within that particular scale (MacKinnon and Derickson, 2013). Therefore, resilience of communities will transfer responsibility from the state unto the individual/community representing a situation of 'responsibility without power' which in itself has its own problems and can persist with each tragedy (MacKinnon and Derickson, 2013).

Although these issues of power and equality are critical within a social unit, they may well be sustainability challenges rather than resilience issues. Nonetheless, ecological resilience, another branch of resilience applications, may prove to be more useful in applications of social systems such as communities and households and will be discussed below.

Ecological resilience

Ecological resilience, the second paradigm of resilience, is a measure of the magnitude of disturbance that a system can absorb before it changes structure (Gunderson and Holling, 2002) or crosses a threshold (Wang and Blackmore, 2009). This type of resilience is focused on the capacity to absorb shocks and still maintain function (Gunderson and Holling, 2002; Carpenter et al., 2001). The conditions are far from any equilibrium steady state and instabilities can flip the system into another regime or behaviour i.e. another stability domain, or multi-stable states (Gunderson and Holling, 2002). Resilience is hence based on maintenance of function or performance (e.g. in the delivery of a LoS).

Building on this multi-stable view of resilience, yet another dimension of resilience has evolved with further understanding of complex adaptive systems (CAS) (Webb, 2007). In this version of resilience, performance is maintained but system structure may not necessarily be maintained (Martin-Breen and Anderies, 2011). Resilience in CASs therefore, involves the capacity for renewal, re-organization, flexibility, learning and development based on adaptive management (Berkes and Ross, 2013; Tyler and Moench, 2012; Cutter et al., 2008; Folke, 2006; Adger, 2006; Gunderson and Holling, 2002). This conceptualisation of resilience is commonly applied to interdisciplinary discourses concerned with the interactions between people and nature (Carpenter et al., 2001), e.g. in Social-ecological Systems (SESs) (Berkes and Ross, 2013; Adger, 2006; Folke et al., 2002; Gunderson and Holling, 2002). SESs act as strongly coupled, complex and evolving integrated systems with non-linear relationships (Cutter et al., 2008).

Closely linked to this is also a body of thought around resilience and the 'adaptive cycle'- a metaphor for the dynamics of ecosystems later extended to the social aspects and SESs - referring to the concept of panarchy or cross-scale dynamics and interplay between nested adaptive cycles (Folke, 2006; Gunderson and Holling, 2002). Adaptive cycle considers dynamical systems such as ecosystems, societies, corporations, economies, nations, and SESs that are not defined by stable or equilibrium states (Carpenter et al., 2001). Resilience changes throughout the adaptive cycle, and different aspects of resilience assume prominence at particular phases of the cycle (Carpenter et al., 2001). It is theorised that they pass through four characteristic phases (Figure 2.8) outlined as follows:

1. Collapse or release (creative destruction - Ω) which is a period of rapidly collapsing dynamics following a major perturbation during which some components and attributes of the system may be lost (e.g. memory);
2. Renewal or reorganization (α) then follows whereby novelty can often arise in the system (e.g. new institutions, new ideas and policies, new industries).
3. Rapid growth and exploitation (r) in which the system settles into a new trajectory in a well-defined basin of attraction then follows a;
4. Finally a long, slow progression sees the system moving from rapid growth (r) to conservation (K) where the likelihood that any further novelty will arise reduces, although the system may become more complex as new connections are solidified.

These principles are especially applicable to social systems as they are non-linear, unstable, and exist within an environment with a given history and with set expectations for the future (Lorenz, 2013). As a result, they are able to learn and act forward looking in anticipation of desired future states (Lorenz, 2013) and will therefore not likely return to a stable state after recovery from a shock or threat. This conceptualisation of resilience holds particular appeal for social systems as the idea of people being able to endure shocks and stressors and bounce back provides an opportunity to better understand the links between

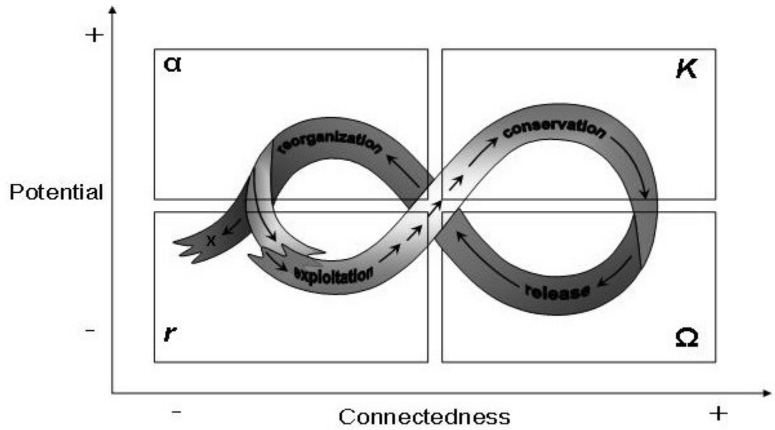


Figure 2.8: An illustration of the concept of panarchy (Source: Gunderson and Holling, 2002)

shocks, responses and development outcomes (Constas et al., 2014 in Béné et al., 2016) in social systems. The resilience of social systems will vary from system to system with each having their different forms or sources of resilience (Lorenz, 2013).

However, whilst these ideas of resilience seem particularly applicable to social systems, the question of whose resilience is being met still remains an issue for some social scientists (Leach, 2008). It is argued that the focus on management of ecosystem services for human well-being and development, means that ecological resilience studies have not adequately considered whose needs are being met and the politics of their distribution and management (Brown, 2014). These arguments highlight that resilience ideas have developed in isolation from critical social science literature. For instance, Adger (2000) asserts that although resilience of ecological systems threatened by human intervention/disruption has been studied, the concept of resilience as applied to a community or society has yet to cross the disciplinary divide. Community resilience is hence still at an early stage of theoretical development as will be seen in the next section.

2.3.3 Achieving community resilience

In his 2008 paper, Chaskin (2008) observed that the previous two decades had seen *"a resurgence in attention to community as a critical arena for addressing a range of social problems and promoting a range of social benefits"*. Community would reform our understanding and inform our responses to such issues as poverty, crime, health, youth development, and child abuse, among others and as he put it had *"become a kind of 'modern elixir' for society's ills"* (Chaskin, 2008). Community resilience is now one of these 'ills'.However, complexity in the definition of community (Chaskin, 2008) challenge the very notion of community resilience as, in addition to resilience, it is yet another highly contested term (Coates, 2010) with varying conceptualisations.

Therefore, the varying conceptualisations of community have implications for how resilience can be applied within a community context. For instance, community as context versus community as an agent of change, can impact the way resilience is contextualised (Chaskin, 2008). Resilience in the former would be more concerned with community as a local environment with a set of risk and protective factors. On the other hand, in the latter, the focus would be in understanding the aspects of community that promote or inhibit, enhance or diminish resilience and well-being within communities (e.g. among individuals, families, children and youth) (Chaskin, 2008). As such, the disparities of community adds further contention to the problem of operationalising community resilience.

Further complicating the operationalisation of community resilience is the challenge of defining resilience. The term community resilience has also taken on some of the same characteristics as that of resilience in general. In their review on community resilience, Patel et al. (2017) identifies three general types of definitions of community resilience used throughout the hazards literature. These are categorised as: 1) process definitions; 2) outcome of functional stability definitions; and 3) range of attributes definitions. Table 2.2 below provides some examples of these definitions. Although there are three categories, community resilience is generally seen as either a set of attributes or a specific performance (outcome) as illustrated by the various definitions in Table 2.2. The challenge with this is that the processes of becoming more resilient remain unknown. Despite the so-called process definitions in Table 2.2, the process of community resilience is unclear in the literature. Without an understanding of the processes involved, it is seemingly difficult to understand how community resilience can be achieved to a specific threat or hazard.

Whilst there is agreement in the literature that community resilience involves complex processes of dynamic interactions between people, community, society, and the environment to overcome adversity, there is still limited development in terms of understanding of these processes. Several scholars have proposed different conceptual frameworks to both measure and assess community

Table 2.2: Typologies of community resilience definition in the literature (Source: Patel et al, 2017)

No.	Definition type	Examples
1	Process definitions (community resilience as an ongoing process of change and adaptation)	1. A process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a disturbance (Norris et al 2008, p. 131); 2. A capability (or process) of a community adapting and functioning in the face of disturbance (Castleden et al, 2011, p.370)."
2	Outcome of functional stability definitions (community resilience as an ability to maintain stable functioning)	1. “resilience is not a process, it is not a management system standard, nor is it a consulting product. Resilience is a demonstrable outcome of an organisations’ capability to cope with uncertainty and change in an often volatile environment. Resilience is thus a product of an organisation’s capabilities interacting with its environment” (Gibson, 2010, p.246); 2. “Maintain relatively stable, healthy levels of psychological and physical functioning (Bonnano, 2004, p.20).”
3	Range of attributes definitions (community resilience as a broad collection of response related abilities)	1. “communities and individuals harnessing local resources and expertise to help themselves in an emergency, in a way that complements the response of the emergency services” (UK Cabinet Office, p. 11) 2. “a multidimensional attribute that in its different forms contributes in various but equally important ways to disaster recovery (Coles and Buckle, p. 6).”

resilience (e.g. Berkes and Ross, 2013; Cutter et al, 2008; and Norris et al, 2008). Generally, these frameworks conceptualize community resilience to include a set of characteristics or community capitals that are necessary for resilient communities (e.g. Berkes and Ross, 2013; Buikstra et al., 2010; Cutter et al., 2008; Norris et al., 2008). Some of these include people-place connections, values and beliefs, social networks, leadership, and positive outlook, all attributes of a resilient community. There is usually no focus on the actual processes involved in achieving or enhancing community resilience.

From the perspective of this thesis, these attributes are desirable for any community, and as such, they more so define community development attributes that are essential for the reliable performance of a community. These characteristics therefore define the 'community' aspect of community resilience and embody the resources and properties needed to leverage general resilience but not necessarily to perform or achieve resilience to a specific threat. These characteristics are similar to those often encountered in the psychological resilience literature where there was traditionally a focus on strengths of the individual to overcome some form of adversity. For example features such as self-efficacy, positive outlook, self-esteem, and happiness were usually associated with resilient adults who had endured adversity or displayed risk factors to certain threats as children (Richardson, 2002). These strengths protect individuals from the negative appraisal of stressors (Fletcher and Sarkar, 2013). However, as discussed in Richardson (2002), studies involving psychological resilience at the individual level have progressively shifted from simply identifying these positive attributes towards understanding the processes involved in deriving them. Such a shift has yet to take place in the research area of community resilience. There is still limited development about the processes that drive community resilience to a specific threat.

Furthermore, studies on community resilience fail to specify what system state is being considered (resilience of what) and what perturbations are of interest (resilience to what), two critical aspects of operationalising resilience as proposed by Carpenter et al. (2001). Across the various frameworks on community resilience, the characteristics of a resilient community as listed above do not provide a means of operationalising resilience to specific threats and so they do not directly contribute towards answering the question 'resilience of what to what?' For instance Cutter et al. (2008) propose an excellent model for assessing resilience of place (Figure 2.9). However, this model is not instructive in terms of how to actually achieve resilience to a specific threat.

Where resilience to a specific threat is recognised as important, a community must embrace a problem-focussed approach that involves a process that eventually leads to the development of strategies and plans. To date the literature has not presented a community resilience framework that operationalises the performance of resilience towards specific threats at the community scale in a process oriented framework. Therefore, this thesis sets out to develop such a framework to operationalise resilience to drought and flooding within households

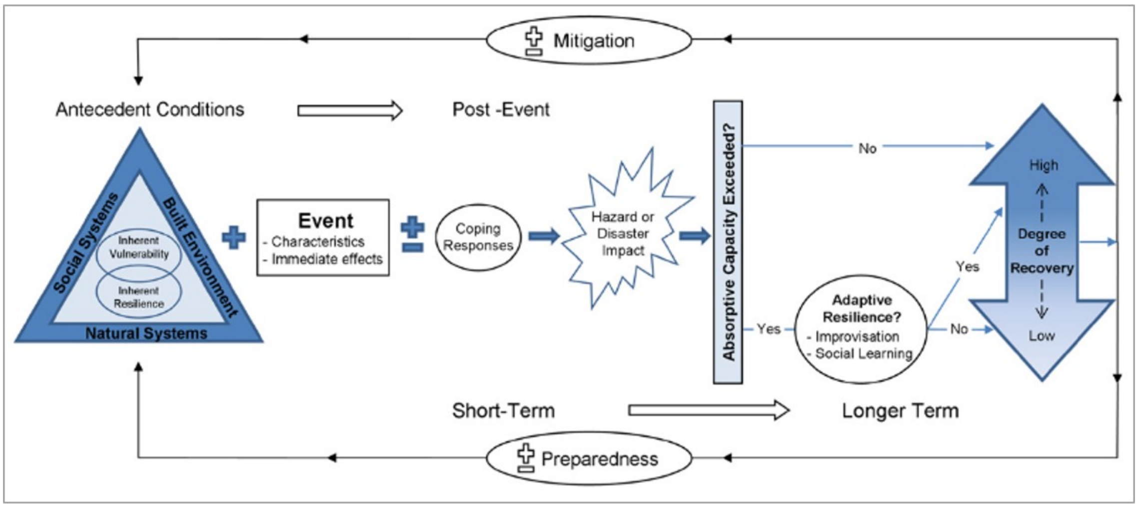


Figure 2.9: Schematic representation of the disaster resilience of place (DROP model) developed by Cutter et al., 2008. (Source: Cutter et al., 2008)

and communities.

2.3.4 Resilience and related concepts

Research and policy related to building resilience typically include the concepts of adaptation, coping, and vulnerability, implying that these concepts are related. As to how the concepts are related remains the subject of much debate. Some of these arguments are reviewed in the sections below.

Resilience and adaptation

Resilience and adaptation are relevant in both biophysical applications as well as in social systems albeit with varying focus and meaning (Gallopín, 2006). Adaptation has many meanings throughout the various disciplinary literatures (Carpenter et al, 2001). In a global change context specific to human systems, where it is most commonly applied, adaptation has been defined by Smit and Wandel (2006) as “a process, action, or outcome in a system (household, community, group, sector, region, etc.) in order for the system to better cope with, manage, or adjust to some changing condition, stress, hazard, risk or opportunity”. At the local level, impacts of these threats or hazards can be modulated by state interventions as well as through actions by communities, individuals, non-government organisations (NGOs), and the private sector (Lemos et al., 2007).

According to Nelson et al. (2007), adaptation involves change and is not about returning to a prior state, since all social and natural systems evolve, and in some senses co-evolve with each other over time (Tompkins and Adger, 2003). It encompasses the building of adaptive capacity, thereby increasing the ability of individuals, groups or organisations to adapt to changes, as well as implementing adaptation decisions, i.e. transforming that capacity into action (Nelson et al, 2007, and Adger et al, 2005). Adaptations may have social and temporal dimensions for instance they can be administrative or private and they can be proactive or reactive (Grothmann and Reusswig, 2006). Adaptive capacity is viewed by some researchers as a component of resilience that reflects the learning aspect of system behaviour in response to disturbance (Bruneau et al, 2003; and Carpenter et al, 2001).

Both adaptation and adaptive capacity are often linked with resilience in political ecology and global environmental change research (Cutter et al., 2008; Lemos et al., 2007). However, as deduced by Cutter at al. (2008), associations between adaptation and resilience are less prevalent in the hazards research perspective. Instead, the term mitigation (any action taken to reduce or avoid risk or damage from hazard events) is more commonly applied in natural hazards (Godschalk, 2002; and Mileti, 1999 in Cutter et al., 2008), whilst mitigation has a completely different connotation in global environmental change arenas. From a hazard management perspective, both principles, i.e. mitigation and adaptation, are concerned with increasing a system's or society's resilience to hazards (Bruneau et al., 2003; Cutter et al., 2008). In addition to the term coping, all of these principles are incorporated in the Safe and SuRe framework as distinct interventions to be applied at different levels of the STS when considering a systems based approach to resilience. Although this thesis uses the term coping in the context of the Safe and SuRe approach, it should be highlighted that both adaptation and mitigation, as used in climate and disaster risk management research respectively, are similar concepts to coping but used in different contexts. Throughout the literature, adaptation and adaptive capacity are seen as precursors towards achieving resilience as seen in Figure 2.10 C and E. However, vulnerability is also often involved in the equation where discussions on resilience and adaptation are concerned.

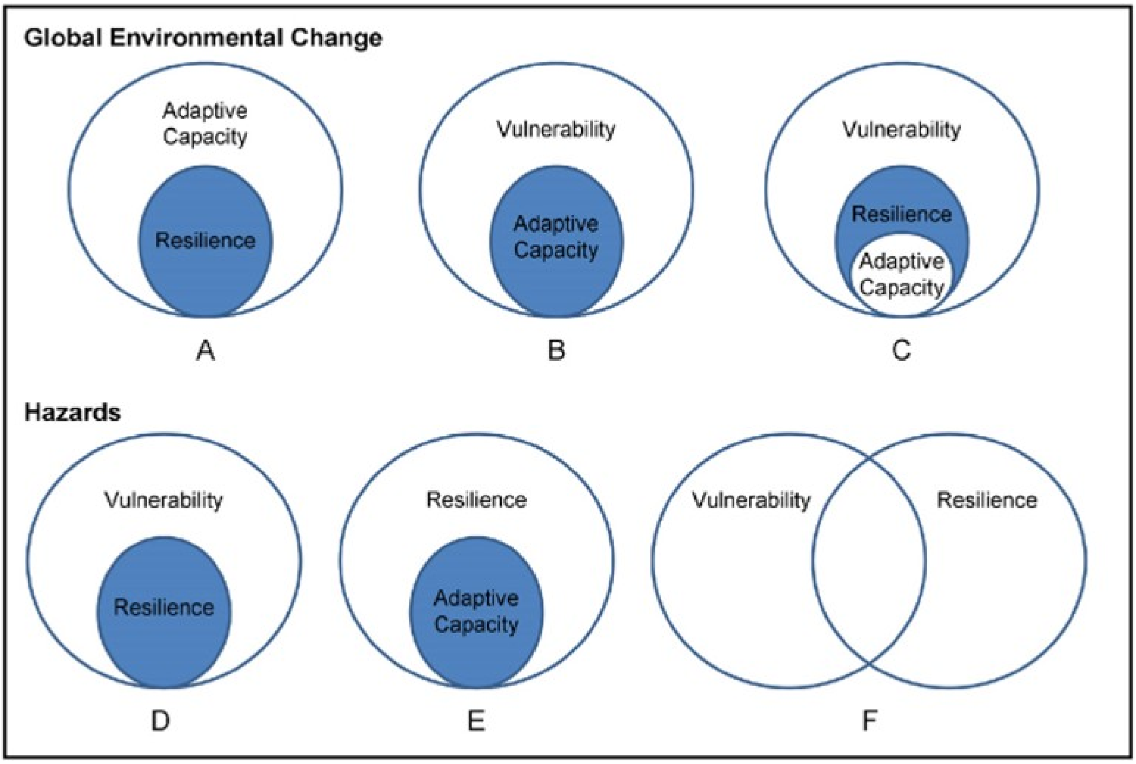


Figure 2.10: Varying conceptualisations of the relationship between resilience, adaptation and vulnerability (Source: Cutter et al, 2008)

Adaptation and vulnerability

Like adaptation and resilience, adaptation and vulnerability are also seen as being inextricably linked (Luers et al, 2003 and O'Brien et al, 2004 in Grothmann and Patt (2005)) although the direct relationship between the two remains uncertain (Gallopín, 2006). This is partly because there is still no universal consensus on what vulnerability is or is not (Gallopin, 2006). Vulnerability, like resilience, is generally viewed as being specific to perturbations that impinge on the system; in other words, a system can be vulnerable to certain disturbances and not to others (Gallopin, 2006). Although the concept of vulnerability has been used in different and sometimes incompatible ways across varying intellectual traditions (Gallopin, 2006), it is generally in the human-environment arenas where it tends to find common meaning (Adger, 2006). Some of these commonalities include vulnerability being conceptualized as comprising exposure and sensitivity to perturbations or external stresses, and the capacity to adapt (Adger, 2006). Exposure in this regard usually refers to the nature and degree to which a system experiences environmental or socio-political stress (Adger, 2006). Characteristics of the stresses include their magnitude, frequency, duration, and the areal extent of the hazard or threat (Adger, 2006). The related term, sensitivity, is the degree

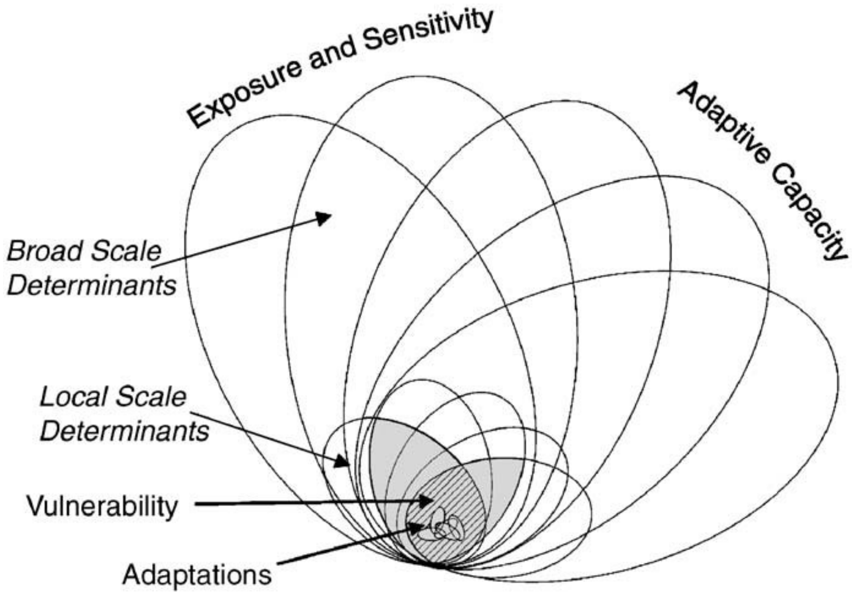


Figure 2.11: A nested model of vulnerability (Source: Smit and Wandel, 2006)

to which a system is modified or affected by the stresses or perturbations (Adger, 2006). Whilst these characteristics have generally been attributed to vulnerability in human-environment or social-ecological studies, there are varying debates on how they relate to each other (Figure 2.10) and whether they form a process or result in an outcome; the outcome being vulnerability of the system.

The nested model of vulnerability in Figure 2.11, proposed by Smit and Wandel (2006), posits that broad stresses and forces (large outer rings) experienced by a system determines its exposure and sensitivity. Stresses and forces include the interaction of environmental and social factors. These in turn determine exposures and sensitivities, as well adaptive capacities at the local or community level (smaller embedded rings). Therefore, the processes responsible for levels of exposure, sensitivity and adaptive capacity are frequently interdependent (Smit and Wandel, 2006). Research in social systems indicate that these processes are often linked to demographic and socio-economic indicators. Finer scale interaction of exposure and sensitivity represents local vulnerability, whilst adaptations are particular expressions of the inherent adaptive capacity (Figure 2.11). As a result, the vulnerability of a system (e.g. a community) that is both exposed and sensitive to a climate stimulus, condition, or hazard (threat), may be largely dependent upon its adaptive capacity Smit and Wandel (2006) (Figure 2.11). This is more generally illustrated in Figure 2.10B.

Resilience and vulnerability

As seen in Figure 2.10, the relationship between resilience and vulnerability is also an important feature of the resilience debate in both global environmental change and hazards research arenas. After reviewing several key literatures in these research spheres, it is understood that the relationship between vulnerability, resilience, and adaptive capacity is still not well articulated as shown in Figure 2.10. In some spheres, resilience is seen as the more constructive opposite of vulnerability, whilst others use the terms interchangeably at times (Gallopín, 2006). Both Carpenter et al. (2001) and Cutter et al. (2008) explain that some researchers (e.g. Nelson et al., 2007; Adger, 2006; Folke, 2006) view resilience as an integral part of adaptive capacity (Figure 2.10A). On the other hand, others such as Burton et al., 2002, O'Brien et al., 2004, and Smit et al., 1999 (in Cutter et al., 2008) view adaptive capacity as a main component of vulnerability (Figure 2.10B). A third perspective sees adaptive capacity and resilience as nested concepts within an overall vulnerability structure (Figure 2.10C) (Gallopin, 2006; Turner et al., 2003 in Cutter et al., 2008). Cutter et al. (2008) propose that vulnerability encompasses the inherent pre-event characteristics of the social system unlike resilience which they view as an ability of the social system during and post-event.

Although it remains uncertain from the literature whether vulnerability is in fact the opposite of resilience or if a reduction in vulnerability will lead to increased resilience, vulnerability research has provided important insights about the dynamics of the human subsystem. There has been particular focus on the role of economic globalisation and entitlements (e.g. Adger, 2003; O'Brien and Leichenko, 2000; and Young et al., 2005 in Turner, 2010). Vulnerability in social science applications is concerned with the likelihood and degree of harm and determining and understanding the conditions that influence social vulnerability (Cutter et al., 2008). Research findings on social vulnerability generally indicate that the economically marginal and the politically un-empowered tend to be most vulnerable. This vulnerability is a manifestation of demographic and socio-economic factors such as income, age, gender, race and ethnicity, etc. (Cutter et al., 2008). Consequently, the economically marginal and politically un-empowered presumably have low coping capacity in addition to high exposure and sensitivity to hazards (Turner et al, 2010). They are also viewed as less resilient to threats due to these risk factors.

Nonetheless, some researchers argue that social vulnerability research limited to socio-demographic indicators provide limited usefulness for vulnerability reduction (e.g. Werg et al., 2013). This is because socio-demographic characteristics are inherent and static features of an individual or group and hence cannot be modified in the short to medium term to reduce vulnerability (Werg et al, 2013). A useful example by Werg et al. (2013) is that whilst increasing poor people's income is essential to reduce their vulnerability, it is but a long-term challenge in vulnerability reduction. Contrastingly, it is also noted that some people choose to live in vulnerable locations as a trade-off with benefits that may range from aesthetic and environmental values to portraying a certain social status. This is often evident in many western countries where people reside in expensive riverside and seaside properties where they have both increased their exposure and potential sensitivity to the threat of coastal or riverine flooding. Others reside in wildfire hotspots due to the nature and aesthetic values of such areas. For instance, Johnny Galecki, a star of the American TV show Big Bang Theory, responded to a recent (June 2017) wildfire in California which destroyed his vacation home as follows:

> *"My heart goes out to all in the area who are experiencing loss from this vicious fire, the threat of which we live with constantly, which may seem crazy to some but we do so because living in our beautiful, rural area makes it worthwhile."*

(http://www.bbc.com/news/entertainment-arts-40428288).

In the fashion of United Nations Office for Disaster Risk Reduction (UNISDR, 2009), it would seem that vulnerability also reflects the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Vulnerability hence arises due to a combination of physical, social, economic, and environmental factors (UNISDR, 2009). Therefore, both the economically disadvantaged and the more privileged may be placed in positions of vulnerability to natural hazards, albeit in perhaps different ways and with quicker recovery for the latter. The question then becomes how to make people more resilient to a specific threat or hazard? A simple answer is that they can increase their resilience by adapting so that they are better able to cope with the implications of their circumstances. However, this may not be as easily achieved as it sounds due to the complexities involved in human decision-making, and of course the long term issues surrounding poverty reduction. The literature review therefore now places focus on coping and the relevant research to date in order to enable understanding of not only the potential household coping measures but how best to assess coping as a basis towards the development of a framework for enabling resilience from a bottom-up scale.

2.4 Individual resilience and coping

As mentioned in Section 2.3.3 above, research on individual resilience has now shifted from identifying the individual and environmental protective factors underlying resilient behaviour, to understanding the protective process of resilient coping (Sinclair and Wallston, 2004; Richardson, 2002). Knowledge about the resilient coping process is of great interest to researchers because this process is associated with a variety of positive psychological and physical outcomes (Benard, 1999; and Hechtman, 1991 in Sinclair and Wallston, 2004). Some of the processes are explored below.

2.4.1 Understanding resilience and coping

Some researchers suggest that resilient qualities (e.g. positive outlook and self-esteem) in individuals are attained through a law of disruption and reintegration. Richardson (2002) propose that this process involves passing through stages of biopsychospiritual homeostasis, interactions with life prompts, disruption, readiness for reintegration and the choice to reintegrate resiliently, back to homeostasis, or with loss. According to (Jacelon, 1997), Rutter (1985) proposed a continuum from vulnerability to resilience as a means to conceptualise an individual's response to adversity. Characteristics or experiences of the individual function as protective factors and mediate the response to stress. Another theory on the resilience process in psychology include Fine's (1991) work which identified resilience as a two-stage process: an acute phase and a reintegration phase (Jacelon, 1997).

Common to these theories of the processes involved in psychological resilience is that, is biological entities, humans are capable of displaying basic properties of animal self-regulation (Carver and Connor-Smith, 2010). Three of these properties of most relevance here include: the tendency to approach desirable objects and situations (e.g. the quality of life and aesthetics attributed with living on the sea front or river side); the tendency to avoid dangerous objects and situations (e.g. predators); and the capacity to regulate the approach and avoidance tendencies. Humans can therefore make decisions by applying approach and avoidance systems, together with a supervisory system in an effort to reorder the priorities they pursue. These actions thereby illustrate the core of a biological model of human nature (Carver and Connor-Smith, 2010).

In addition to inherent biological models, resilient behaviours can be developed utilising goal-based models. Such models propose that motivational processes are in part accountable for an individual either approaching a goal or avoiding a threat. Goal-based models usually incorporate an 'expectancy' construct: a sense of confidence or doubt that a given outcome will be attained successfully (Carver and Connor-Smith, 2010). This forms a link to the expectancy-value tradition in motivational theory. Expectancy value theories provide frameworks that have been used to explore relationships between people's attitudes and their choice and adoption of environmental behaviour (Rogers, 1975). Some of these models include Health Belief Model (HBM) (Becker, 1974), the Theory of Planned Behaviour (TPB) (Ajzen, 1991), and Protection Motivation Theory (PMT) (Rogers, 1975). These are social cognition models which refer to a group of similar theories, each of which specifies a small number of cognitive and affective factors ('beliefs and attitudes') as the proximal determinants of behaviour (Sutton, 2001). These models do not deny that behaviour is influenced by many other factors (e.g. social structural, cultural, and personality factors), but they assume that the effects of such distal factors are largely or completely mediated by the proximal factors specified by the model. Unlike the distal factors, the proximal factors are assumed to be amenable to change, for example by provision of relevant information (Sutton, 2001).

PMT is set apart from most social cognition models based on 'expectancy value' (e.g. TBP above) in that it is designed within a framework aimed at understanding and assessing how people develop intentions towards a (coping) decision in the context of a threat and their capability of implementing the decision. Therefore, PMT combines threats, coping, intentions, and deicisions towards resilient applications making its application most appealing to the current research agenda as will be explored below.

2.4.2 Protection motivation theory (PMT)

Developed more than 40 years ago, Protection Motivation Theory (PMT) (Rogers, 1975) is amongst the most validated theories for psychological research on health behaviour (Grothmann and Patt, 2005). In addition, it has proven to be a functional tool in explaining human decision-making and behaviour under conditions of risk and uncertainty, through broad application across several other disciplinary arenas such as natural and technological hazards. Examples include Chenoweth et al. (2009) in their application to protective technologies, Martin et al. (2007) for application to preparedness for wild fires in California, and Mulilis and Lippa (1990) who applied PMT in their study on earthquake preparedness in California. More recently, PMT has seen further cross-disciplinary application in areas such as climate change and water management (e.g. Dittrich et al., 2016; Mankad et al., 2013; Bubeck et al., 2013; Grothmann and Reusswig, 2006).

PMT proposes that an individuals' decision to implement a protective or coping response is reflective of their perceptions of: 1) the probability and severity of the consequences of a threat; 2) the efficacy and cost of the coping response measure(s) and; 3) their ability to implement the measure (Dittrich et al., 2016). In doing this, PMT combines two major cognitive mediating variables - Threat Appraisal (TA) and Coping Appraisal (CA) (Rogers, 1975). According to Grothmann and Patt (2005), the TA must reach a critical threshold level for individuals to start a CA. Combined, the TA and CA typically lead to the formation of a behavioural intention to respond to a threat. Behavioural intention indicates the degree to which someone is willing to perform behaviour (Grothmann and Patt, 2005) (e.g. to enact a flood protection measure at the household scale). The more intense is the behavioural intention, the higher the probability an individual will adopt the behaviour Chenoweth et al. (2009). If intentions to respond are not formed this leads to non-coping (maladaptive) responses such as denial, fatalism and wishful thinking (Grothmann and Reusswig, 2006).

In sum, PMT assumes that protection motivation is maximised when: (i) the threat is severe; (ii) the individual feels vulnerable; (iii) the adaptive response is believed to be an effective means for averting the threat; (iv) the person is confident in his or her abilities to complete successfully the adaptive response; (v) the rewards associated with the maladaptive behaviour are small; and (vi) the costs associated with the adaptive response are small (Prentice-Dunn and Rogers, 1986). Such factors produce protection motivation and, subsequently, the enactment of the adaptive, or coping response (Prentice-Dunn and Rogers, 1986) (Figure 2.12).

This approach has therefore been applied in this thesis as it provides a framework

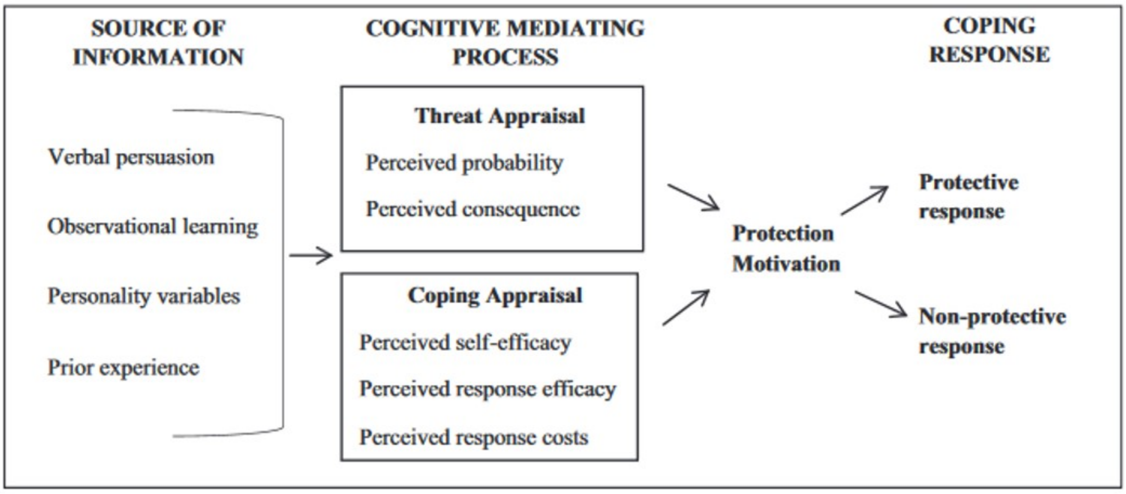


Figure 2.12: A schematic overview of Protection Motivation Theory (PMT). (Source: Bubeck et al., 2012).

for investigating how decision-making for implementing a coping response is influenced by perceptions of the benefits and costs (of implementing a coping response measure) in the context of the consequences of the threat. Each of the mediating processes are discussed below along with the related themes of risk and coping on which they are based.

Threat appraisal, risk and risk perception

In PMT, the threat appraisal (Figure 2.12) is focused on the individual's perception about the likelihood that the threat would affect them and the resulting consequences of such a threat (Dittrich et al., 2016). The ultimate outcome of the TA is to provide an assessment of risk perception through the perception of the probability or likelihood of being affected or experiencing a threat, and the severity of potential consequences. Slovic (1987) explains RP as follows:

> *"Whereas technologically sophisticated analysts employ risk assessment to evaluate hazards, the majority of citizens rely on intuitive risk judgements, typically called 'risk perceptions'."*

The study of Risk Perception (RP) is however, a complex issue due to the nature of human cognition which can be influenced by a combination of psychological, social and cultural components (Slovic, 1992). As a result, research on RP have attempted to develop techniques for assessing the complex and subtle opinions that people have about risk (Slovic, 1987). These techniques have been used by researchers in providing greater understanding of what people mean when they say that something is (or is not) “risky”, and to determine what factors underlie those perceptions (Slovic, 1987). RP is increasingly viewed as an important aspect of risk and coping because because risk area residents often have inaccurate beliefs about a given hazard agent and its impacts, are unaware of the available adjustments to cope with the hazard, and may have erroneous beliefs about the advantages and disadvantages of adjustments they do know about (Lindell and Perry, 1993). Therefore those who promote and regulate health and safety, or risk management, need to understand the ways in which people think about and respond to risk (Slovic, 1987), the outcome being to develop interventions to help people reduce risk to various threats or hazards.

Risk is considered both as a way of expressing uncertainty, and as a collection of perceptions by Raaijmakers et al. (2008). This means that risk should be considered to be a judgement rather than a fact according to Slovic (1992). Slovic (1992) posits that risk does not exist “out there”, independent of our minds and cultures, waiting to be measured but that human beings have invented the concept risk to help them understand and cope with the dangers and uncertainties of life. He proposes that there is no such thing as “real risk” or “objective risk” (Slovic, 1992 pg. 5). For instance, theoretical and statistical models, whose structure is subjective and assumption laden, and whose inputs are dependent upon judgement (Slovic, 1992), are used by engineers and hydrologists in their determination of the frequency of floods (Kates, 1963). Non-scientists have their own models, assumptions, and subjective assessment techniques (intuitive risk assessments), which are sometimes very different from the scientist’s methods.

Two main theories of RP have been proposed from different disciplines (Reynaud et al., 2013). The first, the ‘psychometric paradigm’ proposed by Slovic (1987), linked to psychology and decision sciences, purports that cognitive factors have a major influence on individuals’ perception of risk. This approach assumes that risk is subjectively defined by individuals who may be influenced by several psychological and cognitive factors, thereby offering insights into why people perceive or react to risks differently. The second theory, ‘cultural theory’ by Douglas and Wildavsky (1982 in Reynaud et al., 2013), presents anthropological and sociological perspectives on RP as the result of social and cultural influences. This theory proposes that because individuals belong to different social structures, then social context shape values or attitudes.

Therefore, the most important predictors of behavioural intentions are the socially shared world views in relation to the "culture" individuals belong to (Reynaud et al., 2013). More recent work on RP, specifically in flooding, have found that socio-demographic characteristics, knowledge about hazards, trust in institutions, earlier disaster experiences, feelings and emotions all appear to influence RP in varying ways.

In addition to RP, other variables have been incorporated in or found to be associated with the TA. Grothmann and Reusswig (2006), included in their PMT model past experience and reliance on public administration which are particularly relevant where natural hazards such as flooding and drought are concerned. Several research findings since the 1980s to date have shown strong relationships between the severity of consequences from past events and behavioural intentions to implement a coping response measure. Experience has sometimes been measured as the amount or occurrence of damage and/or physical injuries caused by a disaster; the number of problems resulting from a specific threat; the occurrence or extent to which people experience affect resulting from a disaster; or a comparison is made between "experience" and "no experience" (Zaalberg et al., 2009). Where reliance is concerned, households may be less inclined to undertake precautionary actions if public authorities are successfully implementing flood prevention programmes or flood management policies (Grothmann and Reusswig, 2006).

Coping appraisal and coping mechanisms

Once a person begins to own a risk, they then need knowledge of the solution, resources to implement it, and a belief that the solution is effective and beneficial in order to prepare for its consequences (Lamond and Proverbs, 2009). These considerations are very well placed within the framing of the coping appraisal, the second construct of PMT. Coping appraisal (CA) evaluates perceived ability to cope with and avert harm by a threat in an effective way (Grothmann and Patt, 2005). PMT defines three constructs of CA, namely response efficacy (the extent to which something is perceived as effective for reducing a threat), self-efficacy (the level of confidence in one's ability to undertake the recommended preventive behaviour), and response costs (assumed cost of taking the preventive behaviour) (Grothmann and Patt, 2005). The inclusion of CA distinguishes PMT from other similar models on behavioural intentions (Grothmann and Patt, 2005) and highlights its usefulness over other methods for this type of research on understanding household resilience to droughts and floods.

People respond to perceptions of threat, harm, and loss in diverse ways, many of which receive the label “coping” (Carver and Connor-Smith, 2010). Coping is often defined as efforts to prevent or diminish threat, harm, and loss, or to reduce associated distress. Some prefer to limit the concept of coping to voluntary responses, while others include automatic and involuntary responses within the coping construct (Carver and Connor-Smith, 2010). The boundary between these can often times be a grey area, reflecting the complexities involved in coping. Some of the most important distinctions that have been made concerning coping have been identified and discussed by Carver and Connor-Smith (2010) as follows:

1. Problem versus emotion focussed coping: The distinction that launched modern examination of coping was that between problem-focused and emotion-focused coping. Problem-focused coping is directed at the stressor of threat itself and involves taking steps to remove or to evade it, or to diminish its impact (consequences) if it cannot be evaded. On the other hand, emotion-focused coping is aimed at minimizing distress triggered by stressors. Emotion-focused coping includes a wide range of responses, ranging from self-soothing (e.g., relaxation, seeking emotional support), to expression of negative emotion (e.g., yelling, crying), to a focus on negative thoughts (e.g., rumination), to attempts to escape stressful situations (e.g., avoidance, denial, wishful thinking). Carver and Connor-Smith (2010) explain that both types of coping may also facilitate each other as effective problem-focused coping diminishes the threat, whilst also diminishing the distress generated by that threat and vice versa. The two are hence interrelated and complementary coping functions rather than two fully distinct and independent coping categories.

2. Engagement versus disengagement coping: These relate to how an individual might handle a stressor or related emotions. Engagement coping includes problem-focused coping and some forms of emotion-focused coping. Examples include support seeking, emotion regulation, acceptance, and cognitive restructuring. Disengagement coping includes responses such as avoidance, denial, and wishful thinking. Disengagement coping is often emotion-focused, and involves an attempt to escape feelings of distress ar to act as though the stressor does not exist. Wishful thinking

and fantasy temporarily distances the person from the stressor/threat, and denial creates a boundary between reality and the person's experience. Despite this aim of escaping distress, disengagement coping is generally ineffective in reducing distress over the long term, as it does not remove the existence of the threat and its eventual consequences.

3. Proactive coping: Although most discussions of coping emphasize responses to threat and harm, some coping may occur proactively before the occurrence of any stressor. Proactive coping is nearly always problem-focused, involving accumulation of resources that will be useful if a threat arises and anticipating the signs that a threat may be building. If the beginning of a threat is perceived, the person can engage strategies that will avoid or reduce the consequences.

Some of these categorisations of coping (e.g. problem-focused and engagement coping) lend well to the research at hand where coping is meant to reduce the consequences of a threat. Furthermore, PMT makes it clear that one is coping with and avoiding a noxious event rather than escaping from an unpleasant emotional state of fear (Rogers, 1975). As such problem-focussed, engagement and proactive coping are of most relevance to the work presented in this thesis.

In later studies refining PMT, Maddux and Rogers (1983) found that even amongst people who did not believe they would be exposed to a threat, there was willingness to adopt the recommended behaviour if they believed (a) they could perform the coping response and (b) the coping response was highly effective. Individuals seemed to be thinking "Why take a chance?" and thus followed a *precaution strategy* or heuristic rather than a strictly *rational strategy* (Maddux and Rogers, 1983). On the other hand, they also found that if people believed they would be exposed to danger, then their intentions were stronger if they believed either (a) they could perform the coping response or (b) the coping response could effectively avert the danger. These findings highlight the strengths of CA to PMT very early on in its research application. Since then, the CA aspect of PMT has proven to be a significant contribution to behavioural intentions throughout the various fields in which PMT has been applied, further validating its importance. This thesis therefore considers the CA aspects as central to the data collection and analysis.

PMT applications in water management studies

Due to growing uncertainty and mounting threats in the water sector, renewed focus on water users as households have led to several studies that aim to better understand the motivations and intentions of households to implement coping responses to water management issue such as flooding and drought. Over at least the last decade, researchers have increasingly applied PMT as a framework for gaining insights into the users intentions. Some of the peer reviewed research findings utilising this framework are summarised in Table 2.3 below.

Table 2.3: Summary of the application of PMT in water research

Aim of paper	Data collection and analytical methods	Results/Outcomes	Country	Author(s) and year
To gain insights into the influence of the three individual components of flood-coping appraisal on precautionary behaviour.	Questionnaire survey (752 households); logistic regression models	The results of the study indicate that both self-efficacy and response efficacy considerably influence flood mitigation behaviour. On the basis of these results, it can be concluded that policies to stimulate precautionary behaviour should emphasize that flood mitigation measures at the household level can effectively prevent or reduce flood damage.	Germany	Bubeck, Botzen, Kreibich and Aerts (2013)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
To use insights from PMT to explore whether Flood Action Groups have a direct impact on uptake and on people's perceptions of the effectiveness of measures and their confidence in implementing them.	Questionnaire survey (124 households); logistic regression models and path analysis	Flood action groups may increase the uptake of precautionary measures in particular by providing specific information. Given limited resources of local authorities, the promotion of well-designed flood action groups might provide a cost-effective way of increasing household resilience to flooding in Scotland and elsewhere.	Scotland	Dittrich, R., Wreford, A., Butler, A. and Moran, D. (2016)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
To determine the usefulness of a perceptual approach in assessing flood vulnerability and to identify those factors most important in prompting precautionary action to avoid flood damage in private properties.	Questionnaire survey (157 households); binary logistic regression models	Simply influencing the people's risk perception may be insufficient to cause them to behave proactively, taking their share of responsibility for their own protection against natural hazards. Instead, it may also be important to address issues of concrete action, barriers to self-protecting behaviour, and the social settings and environments that allow people to take their share of protection responsibility. Communication should address not only the risk of flooding and potential consequences, but also the possibility, effectiveness and costs of private precautionary measures.	Germany	Grothmann, T. and Reusswig, F. (2006)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
This paper aims to understand protection-based motivational factors that vary among residents who do not install a rainwater tank on their property and their related intentions to do so.	Questionnaire survey (406 households); factorial analysis and multiple linear regression models (ordinary least squares)	Perceptions of threat and perceived effectiveness and costs of protective behaviours accounted for a significant proportion of explanatory power in participants' intentions to engage in adaptive behaviour. Recommendations emerging from this research suggest that education and information should target personal threat perceptions through greater water cycle knowledge, increasing awareness of the functionality and utility of decentralised systems.	Australia	Mankad, A., Greenhill, M., Tucker, D., and Tapsuwan, S. (2013)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
The aim of this paper is to offer insights into individual flood preparedness decisions for flood risk management policy in France.	Questionnaire survey (885 households); multiple linear regression models (ordinary least squares)	The overall findings show that threat appraisals have a small effect on mitigation behaviour, while coping appraisals have a more important influence. Several variables that have been added to the PMT framework appear to be influential in households' preparedness decisions, such as: flood experience; local flood risk management policies and incentives; and the social network.	France	Poussin, J.K., Wouter Botzen, W.J., and Aerts, J. (2014)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
This paper aims to: 1. analyse mean differences for subjective experiences, appraisals, and coping responses as a function of exposure level (victims vs. non-victims) and; 2. analyse the mediating processes, in terms of subjective experiences and appraisals, explaining the relationships between exposure levels and coping responses.	Questionnaire survey (516 households); confirmatory factor analysis and path analysis	Subjective experiences (i.e., negative affect and social support) not only predict adaptation via cognitive appraisals, but form an indispensable part of the mediating process explaining mean differences in behavioural intentions and threat denial between victims and non-victims. More research is needed to clarify the roles of past, anticipatory, and anticipated emotions in the decision-making process. Interventions should be aimed at influencing threat and coping appraisals as important determinants of coping actions.	Netherlands	Zaalberg, R., Midden, R., Meijnders, A.,and McCalley, T. (2009)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
The aim of this paper is to provide an assessment of the determinants of flood risk perception for Vietnamese households	Questionnaire survey (448 households); ; multiple linear regression models (ordinary least squares)	Threat appraisal, reliance on non-individual flood protection and, to a much lesser extent, threat experience appraisal processes were the most significant determinants of flood protective behaviours. In particular, some variables measuring threat appraisal (perception of flood probabilities and flood damage) are significant to explain flood protective behaviours.	Vietnam	Reynaud, A., Aubert, C. and Nguyen, MH. (2013)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
This paper aims to explore how the factors that negatively influence flood risk preparedness can be addressed to foster a shift towards greater levels of mitigation behaviour.	Focus groups (6 meetings, 19 participants); thematic analysis	A high perception of risk is in itself insufficient to motivate people to prepare for a prospective flooding event. Participants tend to favour non-protective responses despite an acute awareness that they are at substantial risk of flooding and the scale of damages that would arise from such an event. The findings indicate that participants were unwilling to take protective action based on perceived low efficacy of preparedness measures available to them and their own personal capacity to implement them. The 'levee effect' also influences perception and intentions.	Ireland	Fox-Rogers, L., Devitt, C., O'Neill, E., Brereton, F., Clinch, J.P. (2016)

Table 2.3 – *Continued from previous page*

Aim	Data collection method/s	Results/Outcomes	Country	Author/s and year
This paper aims to: 1. explore current adaptation behaviour of coastal households to flood risk and; 2. identify drivers of this behaviour by exploring variables that are likely to influence adaptation behaviour.	Questionnaire survey (491 households); descriptive and correlational analyses	Cognitive variables were found to be more important than socio-economic and housing variables for predicting adaptation behaviour. Risk communication should therefore target cognitive characteristics and particularly promote household-level adaptation as a feasible and cost-effective way to respond to flood risk.	Greece	Koerth, J., Jones, N., Vafeidis, A.T., Dimitrakopoulos, P.G., Melliou, A., Chatzidimitriou, E., and Koukoulas, S. (2013)

As noted from Table 2.3, the water management research has largely applied PMT to flooding with the exception of the study by Mankad et al. (2013) which is concerned with water scarcity. This is reflective of the limited studies that have been undertaken on household drought management. The studies typically provide a range of flood coping measures that are encouraged by policy makers in the given country or region. Participants, which are largely households, provide their perceptions about the threat in combination with the recommended coping measures. Therefore both the TA and CA are included. In addition to the studies undertaken in other sectors, those in water management generally find that the CA is the most significant predictor of intentions to implement flood and drought coping responses. This is sometimes more so than the TA itself.

2.4.3 Analysing behavioural intention

Rogers (1975) proposed that the predictive power of PMT could be improved by the process of finding regression coefficients for the proposed variables incorporated into the model. To date, a majority of researchers applying PMT in various disciplines have undertaken some form of correlational analysis to better understand the determinants of behavioural intentions. Most applications of PMT in water related literature have been quantitative (through use of questionnaire surveys) thereby allowing for development of these models. The work by Fox-Rogers et al. (2016) in Table 2.3 is one of the few studies that applies the theory qualitatively.

In their assessment of protection motivation, previous studies provide detailed understanding of the factors that motivate behavioural intentions to respond to a threat or hazard. However, these studies, with their rich sources of information, do not offer any specific insights into different groups of people that might exist within the population. This is because the protection motivation variables that shape behavioural intentions towards coping, may combine to impact people in different ways, thereby positioning them in different decision-stages. In other words, their behaviour change may unfold over various stages led by the interactions of certain variables. Understanding the characteristics and driving forces behind these decision-stages is critical in developing appropriately targeted interventions. Stage theories, such as the Transtheoretical Model (TTM) (Prochaska et al., 1994), provide a framework for investigating these potential decision stages amongst households.

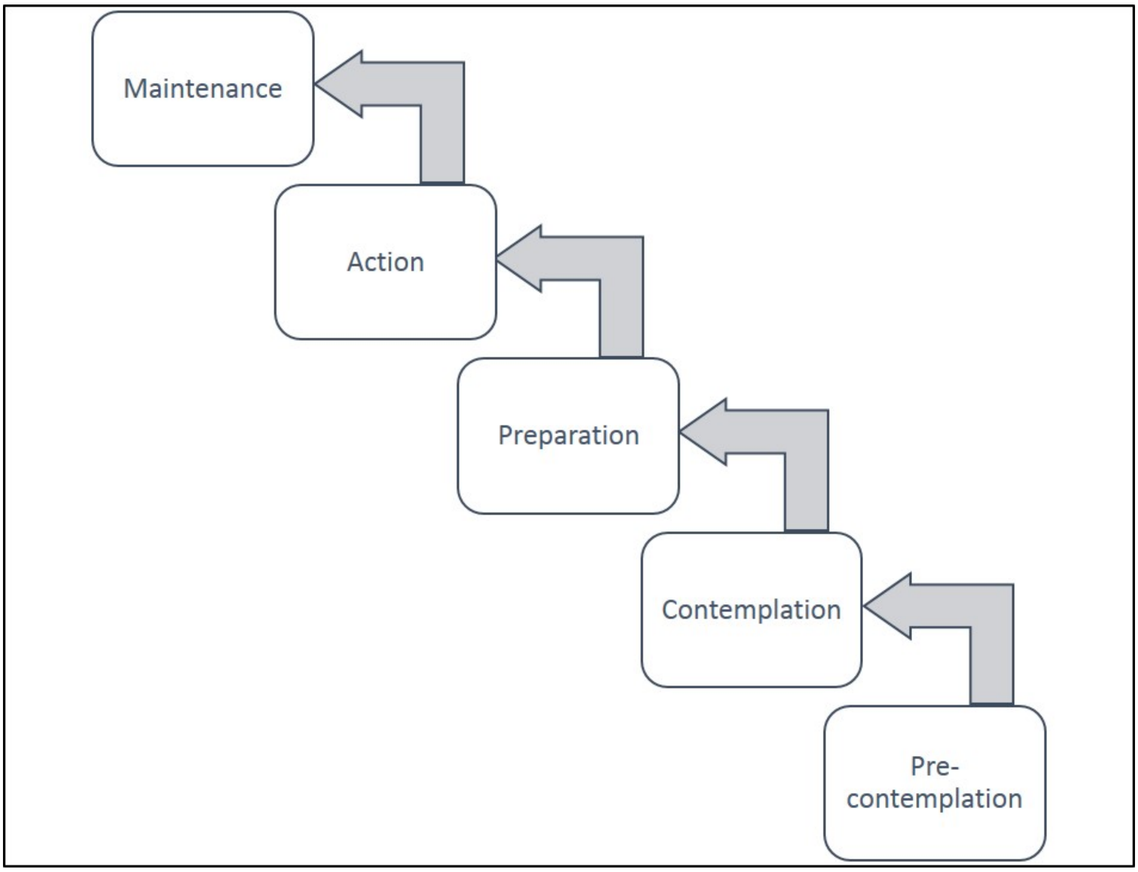


Figure 2.13: The stages of the transtheoretical model on decision making. (Source: Prochaska et al, 1994)

Stage theories specify an ordered set of categories into which people can be classified. The basic premise is that people can be distinguished based on those who have not yet decided to change their behaviour, those who have decided to change, and those already performing the coping behaviour Martin et al. (2007). TTM construes change as a process involving progress through a series of six stages that an individual faces when exposed to a threat (Prochaska et al., 1994). These are identified as pre-contemplation, contemplation, preparation, action, maintenance, and termination (Prochaska et al., 1994) (Figure 2.13).

Based on Prochaska et al. (1994), these six stages are outlined as follows:

1. The 'pre-contemplative' stage is where people have no intention to implement a certain measure in response to a threat.
2. The next stage is the stage of 'contemplation' where there is intention to implement a change. They are aware of the benefits of implementing the measure but are driven by a combination of variables that limit their

motivation to actually do so.

3. The third stage of ‘preparation’ is where an individual is intending to take action in the immediate future.
4. The fourth stage, ‘action’, is where the individual has actually implemented the recommended measure to respond to the threat.
5. In TTM, the next stage of ‘maintenance’ sees individuals who are confident that they can continue with the changes they have made.
6. The final stage of ‘termination’ is where the individual is committed to consistently maintaining the actions implemented to cope with the threat. In a health related sense they completely terminate the unhealthy behaviours such as smoking (Prochaska et al., 1994).

Martin et al. (2007) has applied this theory to wildfire risk in America and found only the first four decision-stages for such a threat. Indeed Prochaska et al. (1994) acknowledges that not all these stages are usually found even in health related research. This thesis will seek to explore the implications of the key predictors of behavioural intentions on forming sub-groups at different decision-stages. This is not so much to develop targeted approaches based on typology as seen in some research arenas such as waste management, but rather to identify and better understand indicators of drought and flood coping behavioural intentions. In this way more meaningful approaches may be developed to stimulate change from the bottom-up end of the UWM-STS through participation at the community level.

2.4.4 Household coping with drought and flooding

There are several mechanisms that can be implemented at the household level to respond to the consequences of drought and flooding. The principles surrounding their use are discussed below.

Drought coping

Where household drought management is concerned, demand management is a critical factor. Lawrence and McMANUS (2008) and Allon and Sofoulis (2006) succinctly explain that the capacity of households to reduce water consumption is limited by expectations and conventions of water supply shaped by existing water infrastructure and ‘saver-unfriendly’ household water fittings. This chapter has already explored how this situation emerged in the water sector. To overcome this situation, the key challenge ahead involves the evolution of the water user to a more efficient user that embraces fit-for-purpose water usage and has the appropriate household configuration to make this aspiration successful (Medd and Chappells, 2007).

The 2006 drought renewed debates about the need to build resilience in demand, including its management through cooperation between providers and user groups (Medd and Chappells, 2007). One aspect of this debate has centred on the need to build adaptive capacity through constructing water efficient homes and retrofitting existing properties. Water efficiency technology regarded as key to mitigating future water scarcity is that of rainwater collection via water butts (Medd and Chappells, 2007). Water butts are now promoted by water companies as part of their campaigns for water efficiency (Medd and Chappells, 2007). However, the promotion of these measures are not without criticism about the commitment of government and water companies in increasing water efficiency (Medd and Chappells, 2007). The challenge of enabling household drought coping through water efficiency remains an important management issue in the water sector. As such, this thesis is interested in further understanding how users perceive and respond to drought and drought coping so as to develop a framework that will engender resilience to drought from a bottom-up level of the UWM-STS.

Flood coping

In countries where extremes are perhaps more frequently experienced, households and communities tend to employ a range of coping responses to both buffer the consequences of an event and reduce recovery efforts. Few (2003) cites two examples of these: 1) in the valleys of northern Pakistan, ropes are tied across fast-flowing rivers with bells attached to provide flash flood warning when flood waters break the rope and; 2) houses are raised on stilts in flood-prone regions of Malaysia. In contrast, as seen earlier in this chapter, in developed countries, such responsibility lies with government and those agencies involved in implementing flood management policy. Households and communities, therefore, do not have strong traditions of developing long term coping strategies.

However, as UWM systems continue to face increasing threats (e.g. climate change, urbanisation, etc.), the potential for failure remains a challenge for the water sector despite the advancement and investment made to date. As a result, where flooding is concerned, the value and prominence of non-structural measures has seen emergence (Few, 2003). Non-structural strategies are deployed both at macro and micro scales. At a macro-scale these include formal flood warning systems and evacuation programmes, land use controls on flood-prone sites, building regulations to prevent incursion of flood waters, and insurance schemes (Few, 2003). Micro-scale strategies focus on adjustments and actions (both traditional and new) at the community and household level (Few, 2003) which is representative of the actions taken in the Pathfinder project mentioned in Section 2.2.4. These micro-scale coping actions are relatively new to most communities in countries like the UK.

Poussin et al. (2015) explain that recent studies (e.g. Bubeck et al, 2012, and Kreibich and Thieken, 2009) have shown that adequate implementation of household flood coping measures, with the aim of flood-proofing individual buildings, can decrease the costs of floods. Examples of such measures include the installation of flood barriers, anti-backflow valves, and elevation of the ground floor. Some examples are illustrated below in Figure 2.14). Avoided damage can be as much as 35-50% as found in studies of the 1990s Meuse (Wind et al., 1999 in Poussin et al., 2015) and Rhine floods (Bubeck et al., 2012), as well as several later floods (2002, 2005, and 2006) along the Elbe river in Germany (Kreibich et al., 2005, 2011, 2012; Olfert and Schanze, 2008; Kreibich and Thieken, 2009 in Poussin et al, 2015). Although they found much variation in the cost-efficiency of household flood coping measures in their study of 506 households across three regions in France, Poussin et al. (2015) provided empirical insights that some mitigation measures (coping measures in the context of this thesis) can substantially reduce flood damage.

Despite these findings, and a spike of extreme flood events over the last decade, the uptake of household flood protection in the UK remains low (Joseph et al., 2015). This thesis is therefore interested in undertaking detailed analyses of flood risk households to further understand why households in flood risk areas may or may not implement recommended household flood coping measures in order to engender household and community resilience to flooding.

2.5 Chapter summary

The first section of this chapter provided a review of water sector transitions and their impacts on the water user. It explains how current hydrosocial contracts in water management have emerged and the areas of policy that aim to change

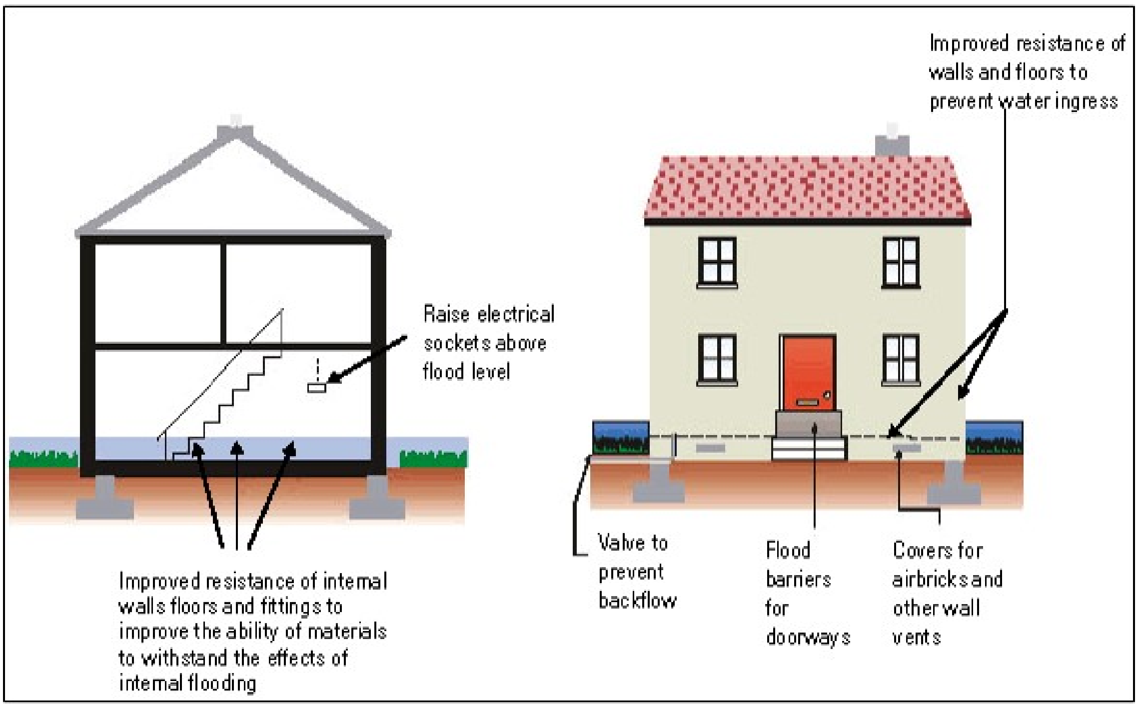


Figure 2.14: Household flood protection measures (left: flood resilience measures; right: flood resistance measures) (Source: Scottish Government, 2004 in Djordjević et al., 2011)

some of these contracts such as greater household and community participation in FRM.

The recognition of the need for more resilient UWM systems led to discussions on resilience from its main disciplinary underpinnings. The literature review shows that conceptualising resilience is not a straight forward matter, thereby challenging the enhancement of resilience at various scales of UWM-STSs. One of the main challenges with resilience relates to its conceptualisation as either a process which links with several properties of a system, or as an outcome and hence the performance of the system. In some cases it is about maintaining structure whilst in other cases it is about maintaining function. This therefore means that understanding what is important for achieving resilience becomes more problematic when applied to the complex nature of social systems.

Whether resilience is a property or performance (function), it is generally agreed that it results in recovery from adversity and is generally positive. However, some social scientists question the applicability of resilience to social systems. This is because resilience can be seen as a means of maintaining undesirable characteristics within the system so that power relations that result in inequalities continue to be apparent in the system after recovery from disturbance. Nonetheless, resilience is also associated with processes such as adaptation, self-organisation and learning, which together may address issues of power and inequality in social systems.

Community resilience has its own challenges stemming from the conceptual issues of resilience as well as community. Conceptions of community resilience typically place focus on various community capitals but rarely focus on the 'resilience of what to what' that is needed to actually enhance resilience. There is hence need for a framework that will operationalise an action oriented and problem focussed approach to community resilience in response to the threats of drought and flooding.

Although several step have recently been taken to incorporate the water users, as households and communities, into a more active role in water management, a co-management approach to demand management and household and community flood management remains illusive. Several gaps currently remain in the research where the water user is concerned. These include:

1. the challenges in promoting drought/flood resilience amongst water users
2. identifying and understanding the indicators of behavioural intentions in household drought and flood coping
3. understanding how these indicators form sub-groups of decision-stages to implement a coping response
4. the cross-cutting themes that need to be considered in interventions for community participation
5. how to achieve resilience to water management stresses such as drought and flooding at a community level.

The next chapter will detail the research methods used in investigating these gaps in the research.

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

As extreme weather events increase, both in frequency and intensity, it is expected that water service users will face increased failures for instance in terms of water supply and distribution or in terms of flood management. In some respects, their involvement in more resilient futures will depend on how their roles are framed and how they use their collective agency at the community level. This research project intends to better understand the water user in terms of how they think of the consequences of drought and flooding as well as their perceptions and intentions to cope with these consequences. In doing so, the research aims to promote resilient water management at the household and community level. The purpose of this chapter is therefore to provide a description of the methodological approaches employed in fulfilling the aims and objectives of this thesis.

The remainder of this chapter is divided as follows:

- Project study area in Section 3.2 further details the selection of case study locations.
- Research plan in Section 3.3 reiterates the research objectives from Chapter 1 and provides justification of the methods utilised to investigate and or achieve them as well as the advantages and limitations of the methods used.
- Quantitative research design in Section 3.4 further details the pilot study undertaken as well as the considerations involved in administering the principal study.
- Qualitative research design in Section 3.5 discusses the interviews and workshops.
- Data analysis and interpretation in Section 3.6 explains how both the quantitative and qualitative data were analysed.
- Ethical considerations in Section 3.7 explains the ethics approval process and the various factors of concern for the research.

- A summary of the research methods is presented at the end of the chapter in Section 3.8.

3.2 The project area

The city of Exeter located in Devon, a county in the south west of England, has been selected as the study region for this research. It is not an area that floods frequently but has varying levels of flood risk from rivers and seas in different sections of the city and its surrounding communities. There is also a risk of surface water flooding due to the city's growth exceeding that of the current drainage capacity.

The Exe catchment has suffered a long history of extreme flood events since as early as 1286 (HM Government, 2016). Exeter's vulnerability to flooding is largely defined by the river Exe which flows through the city particularly during prolonged periods of rainfall when the ground is already saturated (Environment Agency, 2012). The river Exe originates on the open wet moorland of Exmoor. Several tributaries join it before flowing through steep sided wooded valleys that respond rapidly to rainfall down to a floodplain that widens through gently undulating landscape in Exeter (Environment Agency, 2012).

Wide floodplains of the lower reaches of the Exe naturally provide considerable floodwater storage that attenuates and reduces peak flows. However, floodplain development in Exeter has reduced this area of attenuation (Environment Agency, 2012). In total, approximately 11,000 properties (10% of properties) in the Exe catchment are at risk from a 1% annual probability flood, representing 10% of all properties in the Exe catchment, including key community assets such as schools, care homes, ambulance, police and fire stations, health centres and a hospital. The river Exe eventually flows into the Exe estuary immediately to the south of Exeter. Communities around the estuary face a risk of significant tidal flooding associated with tide locking of the tributary streams (Environment Agency, 2012). The greatest number of people and property at risk of flooding from the River Exe are located in Exeter and Tiverton, and the towns around the Exe estuary. The locations of these towns an the number of properties at risk are illustrated in Figure 3.1 and Table 3.1 below.

Exeter and the south west region are also not drought risk areas but due to the dependence of the region on surface water sources (Exeter City Council,

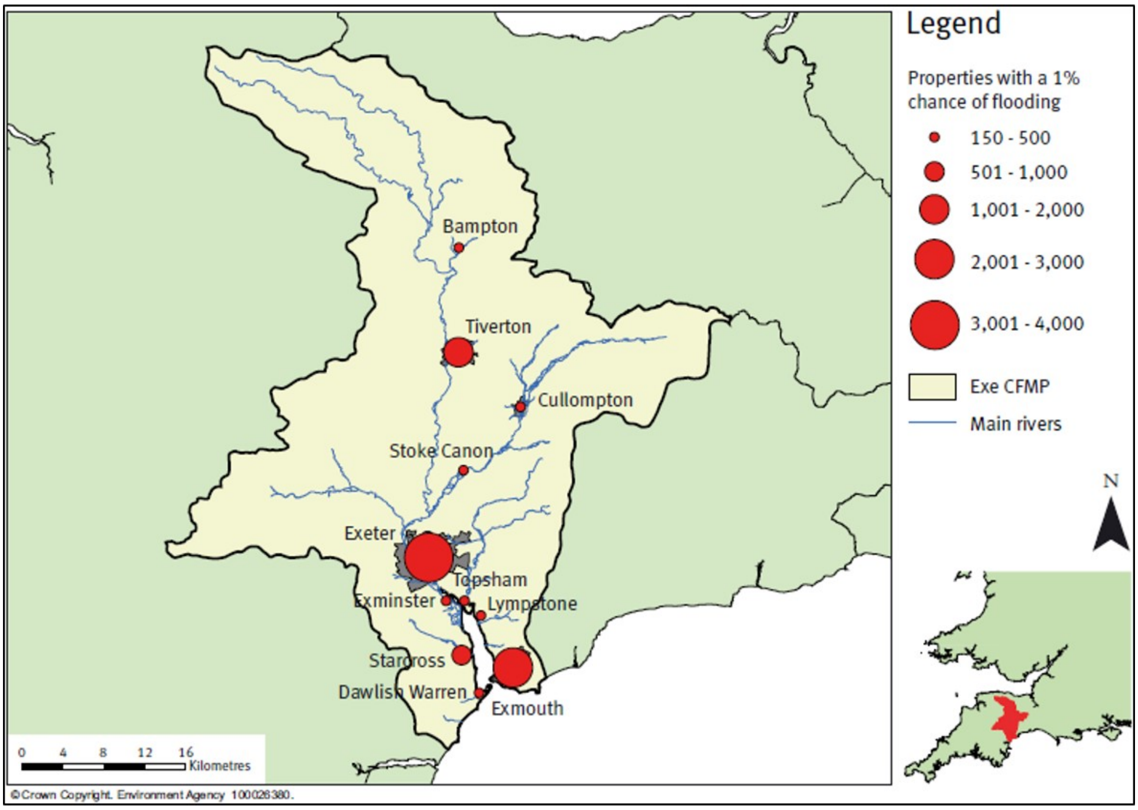


Figure 3.1: Flood risk to property in a 1% annual probability river flood, taking into account current flood defences (Source: Environment Agency, 2012)

2008*a*), twinned with projected changes in precipitation as a result of climate change (Exeter City Council, 2008*b*), the region presents a useful situation to study perceptions of drought.

Two contrasting communities in the city of Exeter have been selected to study both drought and flood perceptions and intentions. The rationale for the selection of these two Exeter communities is presented in the discussions that follow.

3.2.1 Case study 1 – St. Thomas

Significant flooding of urban and commercial areas in Exeter occurred in 1800, 1917, 1920, 1950, and 1960 (Environment Agency, 2012). The urban area of the city of Exeter was affected by serious flooding six times within 50 years between 1910 and 1960. Two extreme flood events in October and December 1960 saw over 1000 properties in the low-lying lands of St. Thomas, an administrative ward of Exeter, severely flooded. As a response to the growing threat of severe flooding, major flood defences were constructed and completed in 1978 (HM Government, 2016) (Figure A.1 in Appendix A). Since then, there has not been

Table 3.1: Locations of towns and villages with 100 or more properties at risk in a 1% annual probability river flood (Source: Environment Agency, 2012)

Number of properties at risk	**Locations**
2,000 to 5,000	Exeter, Exmouth
1,000 to 2,000	Tiverton
500 to 1,000	Starcross
250 to 500	Dawlish Warren, Cullompton
100 to 250	Stoke Canon and Cowley, Bampton, Dawlish, Exminster, Lympstone, Topsham

significant flooding in the St. Thomas area. With the Exeter, Tiverton, and Exmouth defences in place, estimated annual average damages for the towns are reduced to less than a third of what they would be without defences (Environment Agency, 2012).

However, the vulnerability of the adjacent floodplain areas to flooding has been highlighted through a number of events such as: (1. minor flooding of several riverside properties in St Thomas and in Countess Wear over recent years (EA, 2014); (2. damage to the railway line at Cowley Bridge (a vital link into the south west) several times; and (3. rising of river levels to within 1 m of the top of the existing flood defences during two flood events in 2000 and three times again in 2012 (Environment Agency, 2015*b*). In addition to the risk posed to the main rail line to the south west region, critical facilities such as the main water and waste water treatment works are at risk from flooding (Environment Agency, 2015*b*). So too are critical community assets such as schools, care homes, ambulance, police and fire stations, health centres and a hospital. Therefore, the consequences of a major flood could devastate the local economy as well as severely affect households within this area (Environment Agency, 2015*b*).

In response to this situation the EA and the Exeter City Council (ECC) have secured funding for upgrades of the flood defences. The city's flood defences are now in the second phase of upgrades to provide protection for a 1 in 100 year flood (1% annual probability) up from a 1 in 40 year flood (2.5% annual probability). Without these upgrades between 500 and 3500 homes and businesses are at risk of being flooded (Environment Agency, 2015*b*). The EA estimates that over the life of the improved flood defences the economic benefit to Exeter through the avoidance of flood damage will be in excess of £260 million (Environment Agency, 2015*b*).

Although the river Exe poses the greatest threat of flooding to a large number of households and businesses, there is also a risk of surface water flooding in sections of St. Thomas (Environment Agency, 2015*b*) (Appendix A, Figure A.3). This further exacerbates the potential for flooding of households given that much of the flood management plans are developed with the aim of reducing flooding from the river versus from pluvial sources. Therefore, in the event of a major rainfall event, even if the upgraded flood schemes do not fail, some properties remain at risk of flooding from surface water run-off sources. As such, there is further incentive for residents in this area to implement flood coping measures.

St. Thomas was therefore selected for study because: 1) much of it is currently at medium risk for flooding under a 100 year return storm with the existing flood defences (Figure A.2 in Appendix A), and 2) there is a risk of surface water flooding which has not yet been addressed at the scale of the riverine flood risk.

Where drought is concerned, the risk of drought in the region of South West Water (SWW) (within which the case study sites are located) may not appear as imminent. However, the south west of England being dependent on surface water supplies has a hydrological sensitivity to drought (Phillips and McGregor, 1998). Ground-water does not form a major contribution to public water supply and accounts for less than 10% of the region's available water resources. Phillips and McGregor (1998) further explain that the region experiences great seasonal variation in water demand, which can double in some seaside resorts during the summer holiday period, incidentally the region's driest season. Despite these physical and social conditions, the region does have high rain fall rates (ranging from between 800-1300 mm mean annual rainfall) making the issue of drought less topical compared with flooding. Furthermore the south west was identified as having increasing risk of drought under future climate scenarios (Water UK, 2016). Therefore it was viewed as pertinent to also investigate perceptions and intentions on the basis of drought. Since drought is not generally site specific, the flood area zone (FAZ) which encompasses both riverine and surface water flooding, was used as the stratification for random sampling within St. Thomas.

3.2.2 Case study 2 – Topsham

Topsham, located on the Exe estuary, is also at risk of flooding from the river but largely from the high tides and the influence of prevailing winds. Figure A.6 in Appendix A shows the flood zone in this community. Sections of the community were flooded during the winter 2013-2014 floods which involved a combination of high tides with a high pressure system that changed wind directions. The flood event was the first since the 1990s and affected areas adjacent the estuary (The quayside, Ferry Road and the Strand). Unlike St. Thomas, this community was not protected by large flood defences and as such several properties were severely flooded. The flooding here is tidal and hence recedes within a few hours providing another interesting contrast to the riverine and surface water flooding risk in St. Thomas. This community being an administrative ward of Exeter, has the same drought risk as the remainder of the city.

3.3 Research design

3.3.1 Objectives and methods

Consultative and participatory approaches of engagement with individual households, community groups, and practitioners facilitated the process of fulfilling the research aims and objectives. Both quantitative and qualitative methods have been incorporated to produce a mixed methods research design. Data collection methods therefore included the administration of a questionnaire survey amongst householders, as well as interviews with householders and practitioners (and academics), and small workshops with practitioners and community members to test the tools developed. The researcher also attended community emergency group meetings and a community flood simulation activity to interact with the members and learn more about how they were planning and preparing for emergencies (mostly centred on flooding, fires, and acts of terrorism) at the community level.

The research objectives and the methods used to investigate them are presented in Table 3.2 below. Each aspect of the methods and approaches applied in this research are presented and discussed further in this chapter.

Table 3.2: Research objectives mapped against specific methods that were used in their assessment

No.	Objectives	Literature review	Questionnaire survey	Interview	Workshop
1.	To understand the role of the water user in a transitioning water sector	x		x	
2.	To understand resilience and related concepts and how they are applied to social systems	x		x	
3.	To determine indicators of behavioural intentions in household drought and flood coping		x		
4.	To explore the role of indicators in decision-stages for household drought and flood coping		x		
5.	To co-create an assessment and decision framework for engendering household and community resilience planning			x	x

3.3.2 Use of a mixed-methods approach

The use of a mixed methods approach to data gathering was established as a fundamental component of this research due to the complex and interdisciplinary nature of the research questions. Mixed methods is a term increasingly used in social science to describe:

> *"the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study"* (Johnson and Onwuegbuzie, 2004, pg. 17).

In other words, mixed methods refers to research where the researcher collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry (Tashakkori and Creswell, 2007). Generally, the logic of inquiry of mixed methods research includes the use of induction (or discovery of patterns), deduction (testing of theories and hypotheses), and abduction (uncovering and relying on the best of a set of explanations for understanding one's results) (Johnson and Onwuegbuzie, 2004).

Johnson and Onwuegbuzie (2004) propose that, philosophically, mixed methods research is the "third wave" or third research movement following a research tradition divided on the one hand by quantitative purists with their positivist approaches, and on the other hand, qualitative purists with their constructivist and interpretivist approaches. Recent developments in the philosophy of science have argued that the two traditions should not have a separate-but-equal status, but should instead interact (Olsen, 2004). Therefore, the epistemological rationale for mixed methods research dictates that the two paradigms (qualitative and quantitative) co-exist into a single study under under a new paradigm based on the philosophy of pragmatism (Symonds et al., 2008).

In a mixed methods study, qualitative methods can be used to complement the data provided in surveys, thereby proving to be crucial for triangulating and validating data (Robson, 2002). If findings are corroborated across different approaches, then greater confidence can be held in the singular conclusion (Johnson and Onwuegbuzie, 2004). However, it is recognised that using a combination of both methods may sometimes add further uncertainty and conflicting results that need interpretation in answering research questions (Robson, 2002). Nonetheless, Johnson and Onwuegbuzie (2004) proposes that conflicting findings present the researcher with greater knowledge so that they can modify interpretations and conclusions accordingly. They (Johnson and Onwuegbuzie, 2004) further assert that, in many cases, the goal of mixing is not to search for corroboration but rather to expand one's understanding.

However, the use of mixed methods is not without its challenges and criticisms. Tashakkori and Creswell (2007), proponents of mixed methods, purport that the method is still developing and will do so for years to come. As such, there are important unresolved issues, and unexplored aspects that need to be better understood. Some of these issues include how to conduct a mixed methods study, the philosophical underpinnings of mixed methods, where in the research process does mixing of paradigms occur (e.g. at the research question stage, or data collection stage), and how it should be done Tashakkori and Creswell (2007).

Furthermore, as the methods (qualitative and quantitative) are not without their limitations, Johnson and Onwuegbuzie (2004) suggests that an understanding of both the strengths and weaknesses of the methods, puts the researcher in the position to mix and combine strategies to produce the best outcomes from a mixed methods study. The researcher should therefore collect multiple data using different strategies, approaches, and methods in such a way that the resulting mixture or combination is likely to result in complementary strengths and non-overlapping weaknesses Johnson and Onwuegbuzie (2004).

Whilst quantitative methods have the advantage of focusing on the macro-scale, qualitative methods focus on micro-scale issues (Robson, 2002). Therefore, rather than aiming to generalize about large populations, the purpose of qualitative studies is to offer a window-like or a mirror-like view on the specific situation or phenomenon being studied. Combining the two can help to integrate findings on both levels of social life (Robson, 2002).

A disadvantage of quantitative methods is that they are generally recognised as representing the researcher's pre-existing knowledge and perspective, therefore reflecting bias on the part of the researcher (Robson, 2002). Conversely, qualitative methods which are aligned to the participants' perspective, can also introduce bias (Robson, 2002). For instance, the use of interviews as a research method allows the researcher to probe the experiences and perceptions of the participants thereby positioning the research towards the participants' perspective (Robson, 2002). Nonetheless, the qualitative interview allows respondents to raise issues that the interviewer may not have anticipated in relation to the research questions, thereby giving insight into what the participant sees as relevant (Bryman, 2004).

Employing a mix of these methods provided the best approach to investigate the research objectives and associated questions which included different facets leading to the research aim. For instance Objective 1 which is concerned with understanding the role of the water service user in a transitioning UWM-STS, required qualitative methods such as interviews with practitioners in order to facilitate detailed inductive exploration on specific aspects of research and policy implementation. This highlights the exploratory value of qualitative research methods Sayer (2000). However, objective 3 (Table 3.2) required theory testing (PMT) through use of a questionnaire for standardised data collection which would then be used for establishing general patterns within the population, and undertaking statistical analyses that would allow for more in-depth understanding of behavioural intentions (Johnson and Onwuegbuzie, 2004; Sayer, 2000). Therefore, the main rationale for the use of a mixed methods approach was to integrate both the representative and explanatory results in order to promote or engender action towards resilient water management at household and community levels.

3.4 Quantitative research design

As seen in the previous chapter, testing of PMT has generally been undertaken by quantitative research design. Quantitative research aims to test an existing theory by examining the relationships amongst variables (Creswell, 2013). Therefore, in this type of research, the researcher decides what to study by asking specific narrow questions which are collected in a quantifiable way (Creswell, 2013). Quantitative methods involve the process of collecting, and analysing data, and presenting the results. Data collection is usually by means of pre-determined instruments such as surveys which allow for a large number of participants to be included. The resulting data can then be analysed numerically usually through various statistical analyses.

Previous research on PMT in water management have generally employed the use of cross-sectional surveys in their data collection. Cross-sectional surveys involve the collection of data at a single point in time from a sample drawn from a specified population (Visser et al., 2002). This design is most often used to document the prevalence of particular characteristics in a population and to make associations between variables. Visser et al. (2002) defines population as "the complete group of elements to which one wishes to generalize findings obtained from a sample" (pg. 230).

A cross-sectional questionnaire survey was selected as the main approach for quantitative data collection in this study for the following reasons:

1. Use of surveys provide a quick method of collecting large amounts of data which can be used to make quantitative inferences about the populations being studied in the context of a given framework such as PMT.
2. Surveys are well suited to be administered to a representative sample (depending on the sampling method) thereby allowing for generalisations to be made about the population of interest.
3. Some of these generalisations might include the associations between variables and the causal processes that give rise to those associations, as well as differences between subgroups in a population (Visser et al., 2002).
4. The data collected by use of a survey provides a standardised measure of the variables represented. Therefore, survey data are generally more favoured by policy makers in decision making processes due to their quantitative nature.

As the main quantitative tool for assessing the theoretical framework of PMT, a pilot questionnaire was developed before the final study was launched. This was done in an effort to improve the reliability and validity of the final data collection tool.

3.4.1 The pilot survey

A pilot study was conducted in December 2014, with the following objectives at hand: 1) to test the clarity and flow of the questionnaire; 2) to ensure that appropriate questions are included to test each variable of interest; 3) to examine if the measurement of each variable is suitable to facilitate advanced statistical analyses; 4) to assess the appropriateness of the language used (e.g. technical terms, or areas that are ambiguous or difficult to comprehend or interpret); 5) to assess the feasibility of simultaneously studying two extremes of urban water management system failures i.e. flooding and drought; and 6) to determine the areas that would require further research expansion for instance by qualitative means and thereby justifying the need for a mixed methods approach.

Design and sampling

Questions were constructed around some of the main sub-variables of PMT and included likelihood of experiencing the event, severity of consequence, response efficacy, self-efficacy, response costs, behavioural intentions, and coping behaviours. These variables were examined within the context of flooding and drought as the result of infrastructure failures. Overall, the small pilot study allowed for exploration of these ideas in a preliminary fashion in order to inform future investigations and allow for detailed statistical analyses. The questionnaire was developed in the Survey Monkey (SurveyMonkey Inc.) online platform (www.surveymonkey.com) and converted to a printable version for distribution (see Appendix A).

The pilot questionnaire survey targeted 30 residents of St. Thomas using a face-to-face purposive non-probability sampling method. As the pilot phase is an exploratory stage of the research, this method allowed for the researcher to deliberately but non-randomly target households within a specific population in order to facilitate distribution and receipt of responses within a given time-frame. Since statistical representation was not the aim at this stage, this approach was deemed suitable and reduced the time that might be required for a random postal survey (Robson, 2002). The area selected covered three of the EA defined Flood Area Zones (FAZ) of St. Thomas. A total of 11 people eventually completed the survey, an uptake of just less than 40%. Most of the people approached were simply not interested in talking about flooding which they believed was not a problem for their community due to the flood defence schemes.

Results and conclusions

Following a descriptive analysis the following results and conclusions were extracted from the pilot phase:

Threat appraisal - The concept of risk, which includes likelihood (probability) and consequence, is not easy to communicate and hence measuring or assessing risk perception through the use of threat appraisal further augments an already complex problem. When likelihood and consequence are considered together, the resulting flood and drought risk perception of the sample appeared to be low which may be reflective of the population. However, it is noted that this could also have been attributed to the way probability was communicated in the questionnaire survey. The questionnaire applied the use of return periods (Figure 3.2) which appeared to have been poorly understood by the majority of respondents who indicated either uncertain or low for all options.

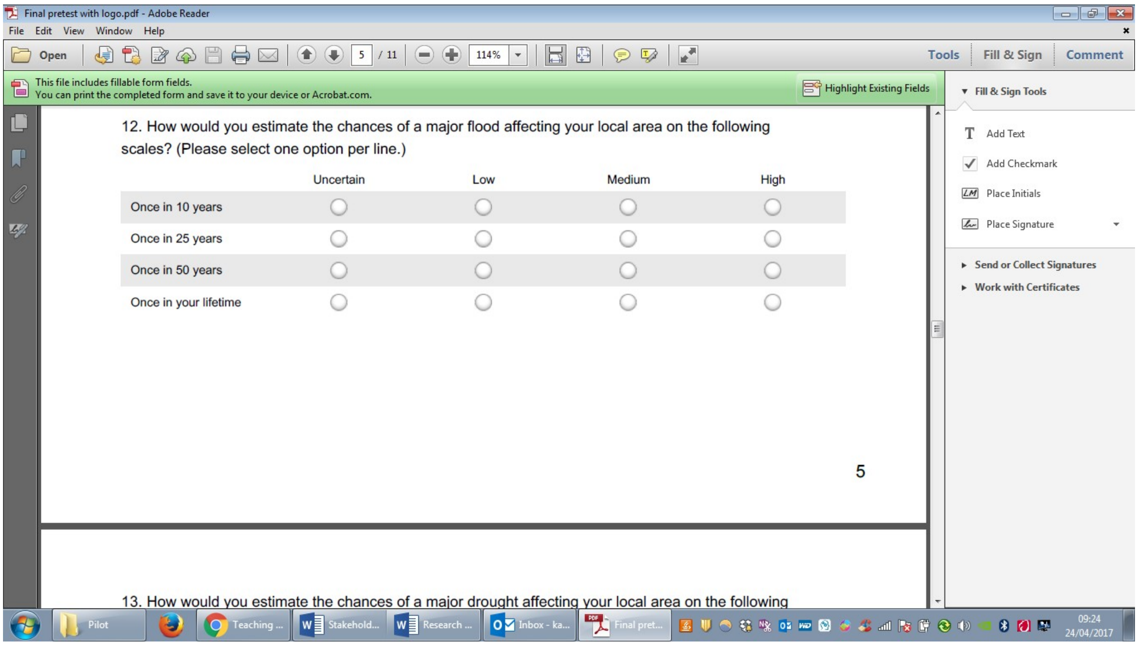


Figure 3.2: Screen shot of the flood probability question used in the pilot survey.

Tunstall et al. (1990) and Green et al. (1991) found that the likelihood of flooding is typically analysed by the public in causal terms, as opposed to the probabilistic conception of likelihood used by engineers and decision-makers (Tunstall et al., 1990). If a flood occurs, this is often interpreted by households and communities as the result of some human cause and if floods have not happened recently it is because something has been done e.g. flood defence schemes constructed (Green et al., 1991). Therefore, since the two appear to be speaking separate languages in the same conversation, it is not always useful to discuss probability or likelihood. In fact the EA agrees that discussions on probability should be limited in future engagements with the public due to the lack of unified understanding and interpretations between experts and lay persons (Defra, 2015). Similar rationale pertains where drought probability or likelihood are concerned (Dessai and Sims, 2010).

Additionally, several variables apart from the likelihood and consequence of a threat also appear to construct or at least influence risk perception e.g. previous experience. Socio-technical changes such as upgrading of public flood defence schemes, proved an important factor in how flood risk is perceived within the community. Existing flood defence systems were viewed as being able to withstand any flood event with little regard for residual flood risk. These add to the complexity of understanding and measuring risk perception and should also be further investigated in the final study.

Coping intentions and behaviours - Although most participants were of the opinion that as individuals, families and communities they have a role in flood risk management, they were not willing to implement flood coping responses and indicated that they could be motivated by government incentives. Of the 11 participants, only one had actually taken any action to become more flood and drought resilient with a completely retrofitted house to provide a more resilient and sustainable lifestyle (e.g. by raising the height of the ground floor, and through use of flood resilience measures throughout the ground floor - Pilot participant). Whilst drought consequences were only expected to be low-medium, intentions to implement drought coping responses received greater receptivity than flood coping measures. Participants were not as unwilling to take household level measures for drought coping as they were where flooding was concerned. This result prompted the need to further investigate intentions towards additional drought coping measures in the principal/final study.

Question construction - Other findings related to the way questions were constructed. This included areas that needed to be modified in order to improve user understanding and interpretation, as well as to enable the utility of advanced statistical techniques. Examples included the use of terms or words that were not be easily recognised or understood such as 'No-return valve' or 'consequence' which needed some explanation. Socio-demographic variables which were placed at the beginning might be better near the end due to the potential sensitivity of this personal information which might deter further completion.

Conclusions - Results of the pilot study showed that it is exceptionally challenging explaining probability to the public. It is not an easily understood concept amongst households and communities and as such it was decided that it would not be assessed in detail in the principal study. Furthermore, coping intervention strategies at a household and community level should not need to focus on probability especially where low probability-high consequence scenarios are to be planned for. Implications of interpretation of probabilities often manifests in the limited planning and preparedness of households and communities to exposed threats. Therefore, its limited relevance for potential intervention strategies, combined with its complexity, justified future exclusion from analysis.

In addition, since the probability of major flooding or major drought in Exeter is low (for example a 1 in 100 year event or worse), it is assumed that this is already a major deterrent in minimising implementation of household coping responses and hence it might be more informative to focus on the severity of flood/drought consequences.

3.4.2 Design of the final survey

Following the lessons learnt from the pilot study, the survey was revised to provide a more comprehensive tool for data collection and analysis. Questions and their rating scales were revised with the aims of improving reader comprehension and assuring validity and reliability. Also additional questions were included to gauge perceptions on issues such as climate change, recovery and flood insurance. The final survey consisted of a total of 47 questions as seen in Appendix A.

Thekey target variables that were measured are summarised in Table 3.3 and further discussed below.

Table 3.3: Variables that were measured using the questionnaire survey.

Measured variable	**Question typology**	**Questionnaire survey #**	**Rating scale**
Past experience	Flood experience - current and previous address	Q.1-3	0-never; 1-once, 2-twice; 3-three or more times
	Drought experience - current address and or previous address	Q.9-11	
Perceived consequences	Perceived level of flooding within property	Q.6	1-My property will not flood; 2-yard and gardens only; 3-up to ground floor only; 4-up to first floor; 5-up to roof
	Perceived severity or extent of consequences of a flood event	Q. 4,5,7,8	1-very low; 2-low; 3-medium; 4-high; 5-very high
	Perceived severity or extent of consequences of a drought event	Q.13-15	1-very low; 2-low; 3-medium; 4-high; 5-very high
Response efficacy	Household's perception of the effectiveness of coping measures: Resilience measures; Resistance measures; Household drought measures	Q.20 & Q.26	0=uncertain; 1-very ineffective; 2-ineffective; 3-somewhat effective; 4-effective; 5-very effective

Table 3.3 – *Continued from previous page*

Measured variable	**Question typology**	**Questionnaire survey #**	**Rating scale**
Response costs	Perception of financial or other costs to implement flood and drought coping measures	Q.21 and Q27	1-strongly disagree; 2-disagree; 3-neither agree nor disagree; 4-agree; 5 strongly agree
Self-efficacy	Perception that the household has the capability to implement flood and drought coping measures	Q.21 and Q27	1-strongly disagree; 2-disagree; 3-neither agree nor disagree; 4-agree; 5 strongly agree
Reliance	Belief that there is adequate flood protection from outside sources	Q.39	1-strongly disagree; 2-disagree; 3-neither agree nor disagree; 4-agree; 5 strongly agree
Trust	Trust in the organisations involved in FRM and drought management	Q.34-35	1-not at all confident; 2-not confident; 3-somewhat confident; 4-confident; 5 very confident
Postponement	Flood and drought coping measures would only be implemented under certain critical future conditions/events	Q.37 - Q.38	1-strongly disagree; 2-disagree; 3-neither agree nor disagree; 4-agree; 5 strongly agree
Behavioural intentions	Household intentions to implement suggested coping responses: Resilience measures; Resistance measures; Household drought measures	Q.18, Q.19; Q.25	1=would not do; 2=uncertain; 3=plan to do; 4=already doing

The ‘what if’ scenario

Since probability would not be a major focus, it was expected that more value could be ascertained by use of a ‘what if’ scenario using a modelled storm or an example of a flood or drought that has occurred in the recent past. Such an approach provided the necessary context of the severity of the event being labelled as a major event.

Images from the EA flood simulation of Exeter under a 100 year storm were presented as a major flood for St. Thomas (https://www.youtube.com/watch?v=0QL0hYIURyk). As there are several FAZs in St. Thomas, different images from the visualisation, paired with photos of past floods, where available, were used to illustrate the flood extent based on the sample location. For e.g. the famous photo of the flooding of the Royal Oak pub and houses along Okehampton Street is paired with an imagery of that area from the flood visualisation (Figure 3.3). In the absence of no similar visualisation for Topsham, images were used from the recent 2013-2014 winter floods in the main FAZ.

Figure 3.3: Examples of the images used in the final survey for St. Thomas.

The drought scenario presented was one similar in extent to the 1976 drought and provided imagery of the consequences of that drought.

Severity of consequences

Flooding consequences are wide and varying and certainly more visible than those for drought. They can be both direct (e.g. loss of life, damage to property, infrastructure, and natural environments) and indirect (e.g. dislocation, disruption of livelihoods, health and well-being, etcetera). For these reasons there were more questions related to flooding consequences than those for drought consequences. Questions were on a five point scale and included consequence to family, property, local area, livelihoods, and natural environments, among others (Table 3.3).

Response efficacy

Questions used to gauge response efficacy proposed several examples of household measures for coping with the consequences of flooding and largely included property-level flood protection (PLFP) measures. PLFP concerns the installation and deployment of a range of flood resistance and flood resilience measures (Environment Agency, 2014). This typology of household flood coping strategies has been promoted by the EA since 2009 (Environment Agency, 2014) and consists of resistance and resilience measures. Resistance measures (dry proofing) such as door barriers are aimed at preventing water from entering individual properties, while resilience measures, such as waterproof plaster, aim to limit the damage caused once flood waters have entered (wet proofing) (Environment Agency, 2014). In addition, the survey included a minor focus on flood insurance coverage. Their efficacy in minimising flooding as well as in minimising flood consequences were examined.

Where drought coping response strategies were concerned, water efficiency measures for minimizing water usage (e.g. hose pipe bans and water saving devices) and encouraging fit-for-purpose water usage (grey waters for gardening and toilet flushing) were included. These were: 1) water conservation measures; 2) use of alternative water; and 3) water storage. All of these measures have the advantage of lowering use of potable mains water, thereby maintaining reservoir levels for the times when supply will be under pressure.

In addition to a five point effectiveness scale, participants were also given the opportunity to select whether they were uncertain about a specific option for their own property in line with ethical considerations if the participant is genuinely uncertain (Table 3.3).

Self-efficacy

In this assessment, self-efficacy was measured through participants' level of agreement about awareness, knowledge, and abilities that these factors would limit their implementation of coping responses (Table 3.3). These variables were reverse coded to facilitate relational analyses such as correlations and regression models. This is because they are presented as levels of agreement about limiting factors with the result that a high level of agreement would suggest high self-efficacy, but is in fact a measure of low self-efficacy. Self-efficacy was not measured for each specific measure but rather as an overall perception of the measures presented.

Response cost

Perceptions of response costs associated with coping responses were measured through agreement that money and time and effort were limitations (Table 3.3). In hindsight, time and effort could have been measured separately to provide a more comprehensive measurement of response cost since the two could be considered as being different and separate. Like self-efficacy, the perceived costs of each coping measure was not assessed, as done in the pilot, but rather a general overview of how costs would affect intentions and behaviours was assessed. However, it is recognised that each coping measure may have been viewed differently by participants in terms of cost limitations.

Behavioural intentions and responses

Each coping response measure (resistance and resilience for flooding and water conservation, alternative water and storage for drought) was given a rating from 1 (would not do) to 4 (already done) to gauge participants' intentions and behaviours towards implementation (Table 3.3). This scale was selected over a willingness scale due to its ability to allow for both willingness and actual behaviour to be captured without the need to include two additional questions thereby further lengthening an already long instrument.

Reliance, trust and postponement

Grothmann and Reusswig (2006) introduced reliance into the PMT model and found a significant negative correlation with protective/coping responses. This research also includes reliance on public flood defence systems as well as trust in FRM and water management organizations. Reliance was derived based on perceptions of personal roles in both FRM and drought management (Table 3.3). Participants rated their level of trust amongst the key agencies responsible for flooding and drought in their local area. Postponement was measured through participants' level of agreement to several actions that would influence them to implement household drought or flood coping responses.

Past experience

The variable that determines past experience combines two questions about drought and flood experience at the current address and at previous location. The questions framed as "have you ever experienced a drought/flood since living in the current address" and "how many times have you experienced a drought/flood whilst living at a previous location" were rated on a scale from 0 = never to 3 = three or more times (Table 3.3).

3.4.3 Sampling and sample frame

Sampling method

Once a survey design has been specified, the next step in a survey investigation is selecting a sampling method (Visser et al., 2002). There are two general classes of sampling methods: non-probability and probability sampling (Visser et al., 2002). Non-probability sampling refers to selection procedures in which elements are not randomly selected from the population or some elements have unknown probabilities of being selected (Visser et al., 2002). Probability sampling refers to selection procedures in which elements are randomly selected from the sampling frame and each element has a known, non-zero chance of being selected. Selection of each element must be independent of the selection of every other element (Visser et al., 2002). This research has undertaken a probability sampling technique in determining the sample size due to its two main advantages. The first being that it facilitates a representative of the larger population from which it was drawn thereby allowing generalisations to be made.

The second advantage of probability sampling is that it permits researchers to precisely estimate the amount of variance present in a given data set that is due to sampling error (Visser et al., 2002).

The probability sampling method used was a stratified random approach. With this method, the sampling frame is divided into subgroups (i.e., strata), and the sampling process is executed separately on each stratum where all elements in each stratum have the same chance of being selected (Visser et al., 2002). Although the survey included questions related to both flooding and drought risk, it was on the basis of flooding that the sample areas were defined. As drought is not a geographically defined phenomenon, flooding served as a suitable defining criterion for targeting sample populations that can relate to both threats. Therefore, FAZs in both communities were stratified as the sample area since flooding (mainly from river and seas) would largely be experienced in these areas.

In Topsham as there were only approximately 200 houses in the FAZ, it was intended that all the residential properties would be included in the sample in a census. However, some of the 200 properties in the FAZ were not suitable as some were commercial (e.g. restaurants, pubs, etc.) and others small resort/holiday type properties as well as empty properties used for vacation. These properties were hence excluded from the sample. In addition, several properties e.g. large secured apartment blocks, that were inaccessible or had limited access, were excluded from the sample. Eventually a total of 97 properties in the FAZ were found suitable as well as accessible for the sample and an additional two persons residing outside of the FAZ opted to participate in the survey after hearing about it from the researcher at a community event.

The FAZs in St. Thomas were randomly sampled using a traditional set of processes due to the large size of the population. These processes included:

1. Developing a sampling frame;
2. Determining the sample size, *n*; and
3. Randomly selecting *n* samples from the sample frame.

Sampling frame

The sampling frame is a list of units or elements from which the sample is selected (Israel, 1992*b*). The ideal frame lists every element separately, once and only once, and nothing else appears on the list (Kish, 1965 in Israel, 1992*b*). Sections of St. Thomas in the flood zone were divided into six blocks (Figure 3.4), based on the EA FAZs to better manage the way the sampling frame was developed as well as the actual distribution of the surveys.

In developing the sampling frame, a combination of street addresses from google maps and reconnaissance of each FAZ was undertaken to determine if there were characteristics that would disqualify certain properties from being included. During the pilot study, it was noted that there were many properties that were ineligible for inclusion in the sampling frame. For instance areas with apartment buildings and blocks of houses divided into apartments were not deemed appropriate for sampling largely due to issues concerning access. Residential properties with for sale or for letting signs were also excluded since these were likely to be unoccupied and being renovated as frequently noted by the researcher. Additionally, houses with signs noting they did not want unsolicited mail with specifics about surveys were excluded. Non-residential zones within the FAZs were also screened out from the sample as far as possible. Together these processes helped to determine the sampling frame, and hence the population from which to draw the sample. Residential properties that were deemed suitable in each FAZ were noted and included in the sample frame which eventually amounted to 996 eligible properties.

Sample size and margin of error

In determining an appropriate sample size that will result in a representative sample, Israel (1992) suggests that this should be influenced by population size, sampling error, the desired confidence level, the degree of variability, time, and cost. Confidence interval refers to probability that the sample will accurately represent the attitudes of the population and, good statistical guidance dictates that this should be at least 95% (Howell, 2016). A number of approaches can be taken to determine the appropriate sample size and typically include using a census for small populations (as done for Topsham), using published tables, adopting sample sizes from similar studies, and using a sample formula (Israel, 1992*a*).

In the case of the St. Thomas community, given its size of close to 1000 eligible properties, it was necessary to calculate an appropriate sample size. A representative sample from the population was found to be 211 assuming a confidence level of 95%. This sample size does not necessarily account

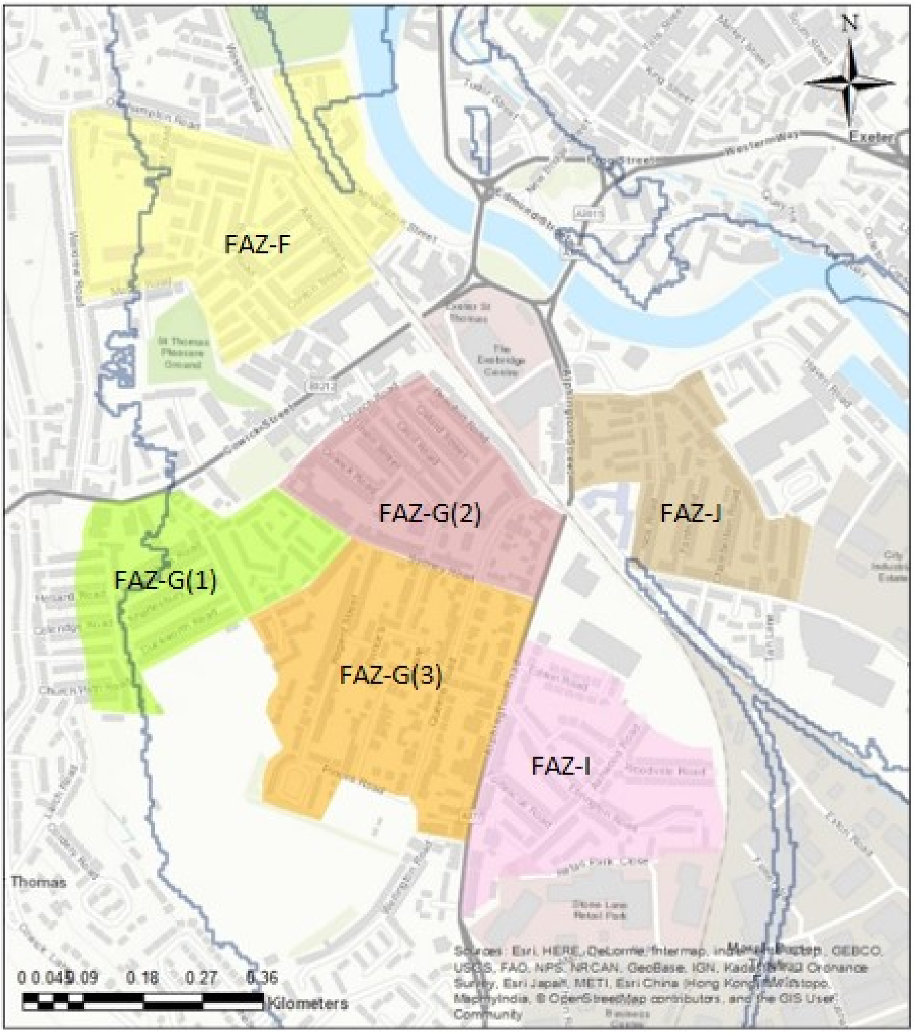


Figure 3.4: Flood area zones used in developing the sample frame in St. Thomas. (Source: author created)

for non-response, but due to the low level of participation in the pilot study it was thought that further calculations to increase the sample size would not necessarily guarantee greater participation. This is because there is little interest in discussing flooding in the community which was further exacerbated by the commencement of upgrades to the existing flood defence schemes. Therefore, the researcher assigned an upper limit of 250 as the final sample size which would be in keeping with the representative sample as well as be manageable for the undertaking of face-to-face contact and follow-up where possible. Each FAZ was allocated a proportion of this sample size based on its size to ensure adequate coverage in all the zones. Table 3.4 below shows the designated sample size for each FAZ.

Table 3.4: Sample areas within the St. Thomas FAZs

FAZ	Boundaries	Number of houses	Sampled houses
F	Northwest – Okehampton Street; North, north west – Flower Pot Lane; East – river Exe	157	40
G-1	West – midpoint of streets from Churchill Road to Church Path Rd; East Chieftain Avenue; North – Cowick Street; South playing field	222	54
G-2	West – Chieftain avenue; North east – Beaufort Road; South east – Alphington Rd; South, southwest – Sydney Rd	106	28
G-3	North – Sydney Rd; East – Alphington Rd; South – Princes Rd	283	70
I	North – Aldi and allotments; West – Alphington Rd; South – Retail Park Close; East – Railway line	120	30
J	North – Haven Rd; North east – industrial zone; West – Alphington Street; South, south west – Willey's Avenue	108	28
Total		**996**	**250**

Distribution and follow-up

The surveys were hand delivered where possible and others left in the mail box. Each envelope included a signed covering letter explaining the purpose of the research, a consent form and a copy of the survey. The covering letter served the purpose of legitimising the research as being from the University of Exeter as well as to explain why the research could be useful for both flood and drought management at a household and community level. Participants were given the option of completing the printed form and posting it back (or arranging collection with the researcher), or that of using the online survey facility. Some of the surveys were also completed face-to-face with those who preferred that method. Both the URL link and a password were included in the covering letter in the two communities. The researcher spent two to three days per week in the communities going door to door to speak with people or doing post box drops for those who were not in.

Within two weeks of distributing the first set of questionnaires, reminder letters were sent to ask those who had not yet responded to complete and return the form. Another reminder was sent out close to the end of the response period noted on the form (December 2016). The researcher also attended two community events in Topsham in 2016 to increase uptake by interested residents within the FAZ. This led to a further 16 completed questionnaires (two of which were completed by residents just outside of the FAZ who expressed interest in the study).

Participants were given the option for inclusion in a prize draw for a shopping voucher; the receipt of research findings; and for further research. The contact details of those who opted for the prize draw were entered into an excel file to which a randomisation was applied to select a winner in each community. All participants who entered were notified to thank them for their participation and that a winner of a specific gender and postcode was selected in their community. The two winners were thanked and presented with their preferred shopping vouchers.

Response rate

In relation to St. Thomas, a total of 73 responses were returned, but only 55 of them were fit for analyses due to several issues. The first issue was that of incomplete responses; 13 questionnaires had more than 60% missing variables and as such these were discarded as they were unusable for statistical tests. The remaining five questionnaires were returned with no responses with two stating the reason for non-response (newly settled in area and short term rental). The questionnaire survey therefore had a response rate was 22% representing 55 completed surveys out of a sample of 250 households (Table 3.5). Of the accepted 55 questionnaires, the completion rate was quite high with most cases having completed more than 85% of questions, specifically those needed to analyse the theoretical framework.

In Topsham, although 39 surveys were returned from 97, only 36 were completed, giving a response rate of 37% (Table 3.5). All had explanations for non-participation as follows: it was not relevant to them; another had just moved into the community; and the other stated they were not able to participate at this time but thought the research was useful and relevant.

Generally, both communities saw a greater uptake of paper based surveys versus online versions, possibly a reflection of the preference of older groups to use paper-based surveys versus online versions.

Table 3.5: Completion rate of the survey research of this study.

Community	No. of surveys distributed	No. of surveys returned	Number of surveys completed	Completion rate %
Topsham	97	39	36	37
St. Thomas	250	73	55	22
Total	347	112	91	26

3.5 Qualitative research design

Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem (Creswell, 2013). Qualitative methodologies consist of the philosophical perspectives, assumptions, postulates, and approaches that researchers employ to render their work open to analysis, critique, replication, repetition, and/or adaptation and to choose research methods (Vaismoradi et al., 2013). According to Holloway and Todres (2003), qualitative approaches share a broad philosophy such as person-centeredness, and a certain open-ended starting point.

Qualitative methodologies refer to research approaches as the tools with which researchers design their studies, and collect and analyse their data (Given, 2008 in Vaismoradi et al., 2013). Therefore, qualitative methodologies are not a single research approach, but different epistemological perspectives with a range of "approaches" such as grounded theory, phenomenology, ethnography, action research, narrative analysis, and discourse analysis (Vaismoradi et al., 2013). Qualitative approaches seek to arrive at an understanding of a particular phenomenon from the perspective of those experiencing it. As such, the researcher needs to determine which research approach can best answer their research questions (Vaismoradi et al., 2013).

The purpose of the qualitative aspects of the research were: 1.) to facilitate the collection of detailed information and perspectives of key elements of the research that could not be elicited in-depth through the survey; 2.) to provide a point of view of those in the field of whether or not the water sector was enabling a more resilient water user and; 3) to better understand some of the challenges associated with community level engagements and participation. As such a phenomenological approach was applied to the research. The goal of phenomenology is to describe, interpret and understand the meanings of experiences at both a general and unique level (Holloway and Todres, 2003). In other words, it focuses on the subjective experiences of the individuals being studied and is the philosophical basis for interpretive research strategies (Robson, 2002).

In line with this phenomenological approach, the qualitative method for data collection involved the use of interviews by means of individual interviews, and two small workshops. Qualitative studies may use several types of interviews, the most popular being semi-structured, in-depth, individual interviews and focus groups (Giacomini et al., 2000). Individual in-depth interviews were undertaken using a semi-structured open-ended format, to provide details from an insider's perspective. Semi-structured interviews were facilitated by the use of an interview guide with a list of questions under specific themes (see below) as recommended by experts in this field (e.g. Bryman and Cramer, 2011; Robson, 2002). Interviews were undertaken with practitioners and academics as well as householders. Household interviews involved survey participants who indicated a willingness to be considered for interviews and further research. Workshops and focus groups involved a mix of community groups, practitioners and academics.

3.5.1 Practitioner interviews

A total of 11 practitioners and academics were interviewed in this research, to better understand if and how the water sector is working to make the water user more resilient as well as the challenges for engagement and participation in drought and flood resilience. All interviews were semi-structured and face to face, with the exception of three that were done via teleconference. A semi-structured interaction facilitated more open discussions on the research questions, and beyond, rather than being restricted only to the researchers' interests and perspectives.

Sampling

Instead of employing a random sampling method, characteristics of suitable individuals were sampled through a purposive sampling approach. Purposive sampling aims to represent typical cases, unusual cases, critical cases, politically important cases, or cases with connections to other cases (i.e. snowball sampling) (Giacomini et al., 2000). Some participants were initially identified based on the researchers previous knowledge of their work and experiences. Upon interviewing these participants a snowball sample method was used to allow the researcher to further identify specific individual/s in the various target organizations, agencies, and projects. Snowballing operates whereby the first interview participants serve as informants to identify other members of the population (in this case experts who are knowledgeable and experienced in the subject areas and the case study region), who are themselves used as informants about other potential participants (Robson, 2002).

Interviews were conducted with representatives from Devon Country Council (DCC) who are the LLFA, ECC, the EA, South West Water (regional water company), the NFF, as well as a community flood engagement consultant (Table 3.6). Representatives from the Natural and Environment Research Council (NERC) funded UK Droughts and Water Scarcity Programme were also consulted; these included the Drought Risk and You (DRY) project and the Historical droughts project (Table 3.6).

The above mentioned organizations were selected due to their relative importance and differing roles in the FRM and drought management frameworks in the UK and the expert knowledge of those engaged in the national drought projects. Due to the exploratory nature of qualitative studies, the study population or sample was not pre-specified in a strict sense in an effort to avoid overlooking any critical or key participants that could otherwise be missed (Leech, 2002).

Interview guides

Each semi-structured interview was guided by the use of an interview guide. The interview guide was developed at the outset of the interview process and modified where necessary after the first two interviews in order to capture the breadth of topics and questions that would be useful in future interviews. The guide included some guiding questions (Appendix A). This guiding questions were developed to achieve comprehensive insights into the organizations' or projects' activities as well as experiences and perspectives on household and community perceptions, intentions and actions.

Table 3.6: List of organisations involved in the qualitative interviews of the research.

No.	Agency/Group	Topic discussed	Number interviewed
1	Exeter City Council	Flooding	1
2	National Flood Forum	Flooding	1
3	Environment Agency	Drought	1
		Flooding	2
4	DRY Project	Drought	1
5	Historical Droughts Project	Drought	1
5	Devon County Council (DCC; LLFA)	Flooding	2
6	Community Flood Engagement Consultant - Mary Dhonau and Associates	Flooding	1
8	South West Water	Drought	1
9	**Total**		**11**

Recording interviews

Interviews were voice recorded with the permission of each participant in order to ensure accuracy of the discussions. Yin (2003) explains that the recording of interviews provides the most accurate rendition of an interview than any other method. Of the 11 informants, only one declined to be recorded and quoted. Careful notes were hence taken from this meeting and these were in turn sent for confirmation of contents to the participant. One participant gave permission to be quoted by name although this was not done in the final report of the interviews. Each interviewee was assigned a number from Interviewee 01 to Interviewee 011, in no specific order, to provide confidentiality. Chapter 4 provides some background information about each of these participants.

3.5.2 Survey participant interviews

Of the total number of participants who opted to be contacted for further research (seven from St. Thomas and four from Topsham), a total of five participants were eventually interviewed. In addition the owner of a small enterprise in St. Thomas was also interviewed upon the recommendation of one of the practitioners who was interviewed. These interviews included discussions about probability and consequence of floods, the role of households and communities as well as that of government and other agencies (e.g. City Council, Highways Authority) and water companies. However, it was decided not to include the analyses from these interviews in this study due to the small number of interviews undertaken.

3.5.3 Practitioner and community workshops

The researcher had the opportunity to host two events where a community decision framework was reviewed and assessed on different bases by different audiences. The first was with the Safe and SuRe project steering group, at a meeting held in November 2016 where five groups (average five participants) of academics and practitioners reviewed and discussed the framework. This activity allowed for the researcher to identify several weaknesses and threats before undertaking testing with an actual community.

A community meeting with members of the Topsham Community Emergency Group and other community members facilitated the second review of the framework. This was attended by 10 participants who reside within the local area (specifically in the FAZ). The discussions and findings are presented in Chapter 4.

3.6 Data analysis and interpretation

This section provides a description of the quantitative and qualitative data analyses used to provide results in the remainder of the thesis.

3.6.1 Quantitative analyses

The quantitative data generated from the questionnaire survey were subject to several analytical techniques, using a combination of statistical packages: Statistical Package for the Social Siences (SPSS) (IBM Corp., 2016) and R, a free software environment for statistical computing and graphics (R Core Team, 2015). Both software are widely used in the analysis of social science research offering a range of statistical analyses and graphical outputs. The breadth of statistical analyses range from descriptive (univariate and bivariate) analyses to inferential and relational analyses.

Descriptive statistics form the first set of analyses and provide an overview of the sample and its general characteristics. These analyses were facilitated by means of univariate and bivariate methods. Univariate analyses (frequency distribution, mean, standard deviation, etc.) were applied to determine how individuals are distributed across a given variable. Bivariate tests were used in order to establish whether responses within one data set were different to the other and the significance of these differences. This included use of the Mann Whitney U Test and the Wilcoxon sum rank tests. These tests were used where normality was not assumed. Analyses in determining associations included cross-tabulation and correlation using Spearman's rho for data assumed not to be normally distributed.

Following this descriptive analysis, linear regression models (using Ordinary Least Squares (OLS)) and various clustering algorithms were used to test the determinants of behavioural intentions and the presence and characteristics of decision-stages. In order to develop these models, the many variables used to measure the various PMT constructs needed to be aggregated to represent each construct. This was done by aggregating the variables through their arithmetic means. However, prior to conducting this aggregation, factorial analyses or dimension reduction was undertaken to validate certain latent variables (discussed in Section 3.6.2) in order to ensure that they measure the same intended construct and hence can be aggregated together. A five stage process was utilised in the data analysis protocol as illustrated in Figure 3.5 below and explained in the sections that follow.

3.6.2 Step 1: Testing the validity and reliability of variables

This section discusses how certain variables from Table 1 above were validated before being averaged into aggregate scores and used in regression models and cluster analyses. Each of these variables is made up of three or more questions or sub-questions that need to be aggregated to derive the variable. Some survey questions that were used to measure the variables are considered as *'latent variables'*. Definitions of a latent variable appear implicitly and explicitly across

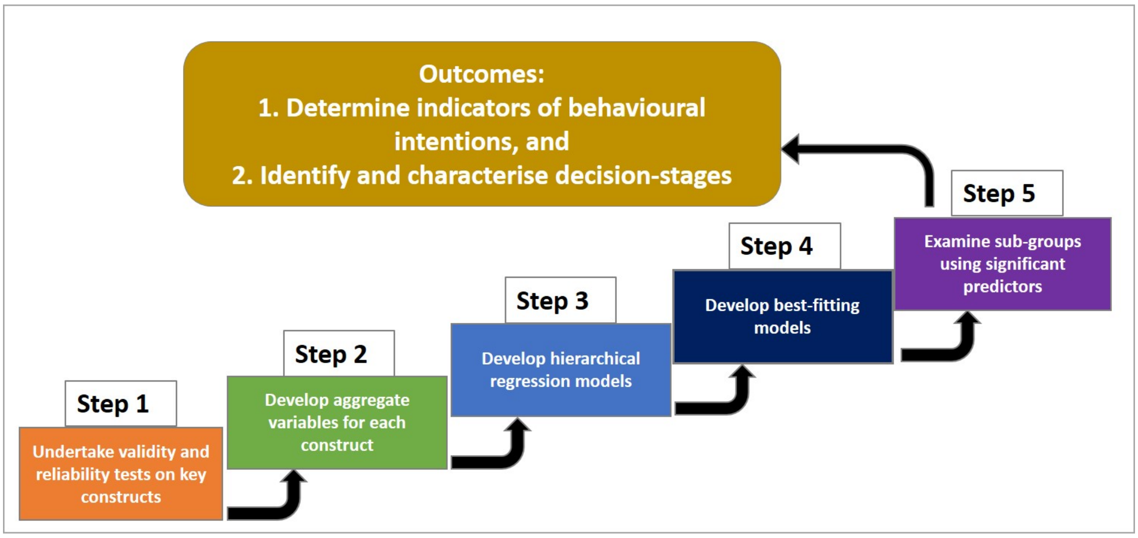


Figure 3.5: The five step analytical protocol for quantitative analyses of data.

disciplines making it challenging to define them (Bollen, 2002). In this research they refer to variables that infer the measure a particular phenomenon/construct, for example several questions were used to measure self-efficacy (the construct) such as abilities, knowledge and awareness and are viewed as latent variables. These variables were factor analysed to ensure that they are valid measures of the underlying construct i.e. if they actually measure the same variable, self-efficacy. If so then they should load together under the same factor. In other words each question is measured for its validity towards the aggregated scale that accounts for that variable.

The reliability of factors from a factor analysis will depend on the size of the sample (Bryman and Cramer, 2011) more so than on the 'variables to cases ratio' (Field, 2013). This is because test parameters tend to be stable regardless of the cases-to-variables ratio (Kass and Tinsley, 1979 in Field, 2013). Although it is traditionally advised that it is best to have 300 or more samples, Field (2013) presents several reasons why this is not always necessarily applicable. The first reason relates to factor loadings which range from -1 to 1 and refer to the degree to which a factor explains a variable. Guadagnoli and Velicer (1988) (in Field, 2013) found that if a factor has four or more loadings greater than 0.6, then it is reliable regardless of sample size.

The second argument against small sample size in factor analyses are the communalities; as they become lower the importance of sample size increases (Field, 2013). A communality refers to the variance that a variable shares with all other variables in the same factor (Bryman and Cramer, 2011). With all communalities above 0.6, relatively small samples (less than 100) can be deemed adequate (MacCallum, Wildman, Zhang, and Hong, 1999 in Field, 2013). When communalities are in the 0.5 range, samples between 100 and 200 are acceptable provided there are relatively few factors each with only a small number of indicator variables. For a worst case scenario, when communalities are well below 0.5 with a large number of underlying factors, a sample size greater than 500 is recommended.

Another argument made by Field is that measures of sampling adequacy such as the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970 in Field, 2013) should be used by researchers as a guide. KMO measure represents the ratio of the squared correlation between variables to the squared partial correlation between variables. The KMO statistic varies between 0 and 1. A value close to 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations (hence, factor analysis is likely to be inappropriate). A value closer to 1 indicates that patterns of correlation are relatively compact and so factor analysis should yield distinct and reliable factors. Finally, Field discusses the determinant which must be greater than 0.

As this research has small sample size, these guidelines were deemed important in validating latent variables that would be used in further analyses and interpretations. Based on the above account, several assumptions were developed by the researcher to guide each stage leading to the development of indicator variables that would be used to test PMT. These rules were as follows:

1. Variables with communalities <0.5 pose a problem and should be further checked as below
2. Variables with communalities <0.5 and factor loading < 0.5 will be removed except if the factor has four or more loadings greater than 0.6
3. Variables that load unto more than one factor add complexity and will be removed
4. Variables that load alone on one factor will be removed.

Remaining variables were then tested for their internal reliability of measuring the underlying factor or construct, e.g. consequence, using Cronbach's alpha. Internal reliability of multiple-item scales is important in that it seeks to examine whether each scale is measuring the single idea and hence whether the items that make up the scale are internally consistent. The rule of thumb is that an acceptable Cronbach's alpha should be 0.7 (Bryman and Cramer, 2011). Large samples will tend to have higher Cronbach's alpha than smaller samples (Field, 2013) and so some flexibility is allowed with this value for smaller samples. Any variable that reduces the reliability of a factor or construct below 0.6 were removed to improve its reliability. Results of the factor analysis and reliability tests are presented and discussed in Chapters 5 and 6.

3.6.3 Step 2: Develop aggregate variables

Variables found to be valid (i.e. they meet the statistical assumptions) were then aggregated to form index values representing the appropriate construct/variable. The average of each factor was calculated to form new aggregate variables/indices which were then used in the development of regression models and further in clustering of the data. The 'compute new variable' feature of the 'analyse' menu in SPSS was used to develop these mean values representing each variable of interest.

3.6.4 Step 3: Develop hierarchical regression model

OLS regression, in its various forms (correlation, multiple regression, ANOVA), is the most common linear model analysis in the social sciences (Pohlman and Leitner, 2003). This is because OLS models the relationship between a dependent variable and a collection of independent variables which is most suitable when testing theories. The value of a dependent variable is defined as a linear combination of the independent variables plus an error term (Pohlman and Leitner, 2003) and is expressed as follows:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} ... + \beta_n X_{ni} + \epsilon \tag{3.1}$$

where Y is the dependent variable, the β (Beta) values are the regression coefficients, the Xs are column vectors for the independent variables, subscript *i* refers to the *i*th individual or unit in the population, and ϵ (Epsilon) is a vector of errors of prediction. The model is linear in the β parameters, but may be used to fit non-linear relationships between the Xs and Y. The regression coefficients are interpreted as the change in the expected value of Y associated with a one-unit increase in an independent variable, with the other independent variables held constant (Pohlman and Leitner, 2003). The errors are assumed to be normally distributed with an expected value of zero and a common variance.

Where multiple regression models are concerned, the estimate of R (correlation) is dependent on the number of predictors (*n*) and the sample size (*k*), and hence the question of how many independent predictor/explanatory variables are required to reliably estimate regression coefficients is an important yet contested issue. This is because it is possible that the model can be overfitted depending on the number of variables relative to the sample size. Overfitting of regression models arises when a regression model includes more predictor variables or incorporates more analytic steps (e.g., univariate pre-screening of variables, stepwise selection of variables, searching for non-linear transformations and statistical interactions) than are warranted by the amount of data available (Austin and Steyerberg, 2015). To avoid the case of overfitting a model, common rules of thumb include 10 or 15 Subjects per Variable (SPV), i.e. 10 or 15 cases of data for each explanatory variable in the model. However, as explained by Field (2013), these rules over simplify the issue. This is in-part related to the size of the effect being measured and the statistical power we want to detect (Field, 2013). In the previous studies where PMT is tested in water management, typical R^2 values range from 0.19 to 0.45 which represent moderate to good effect for psychological research due to the difficulties in measurement of human perceptions (Grothmann and Reusswig, 2006). In more recent research, Austin and Steyerberg (2015) confirm that it is acceptable to allow for two SPV to permit accurate estimation of regression coefficients in a linear regression model estimated using OLS. Although this minimum of two SPV is acceptable in order to guarantee unbiased estimation of coefficients and adjusted R square, they note that higher SPVs allow for greater statistical power (Austin and Steyerberg, 2015). These guidances were taken into account in deciding the number of variables that would be used to develop the regression models due to the small sample size.

In relation to variance, it is recommended that smaller samples make use of the adjusted R^2 versus conventional R^2 for explaining the proportion of variance explained by a model (Austin and Steyerberg, 2015). This rationale is because small samples tend to inflate the R^2 (Austin and Steyerberg, 2015). R^2 represents the loss of predictive power or shrinkage of the model and is one means of cross-validating a regression model as per Field (2013). Adjusted R^2 therefore tells us how much variance in Y would be accounted for if the model had been derived from the population from which the sample was taken (Field, 2013). Austin and Steyerberg (2015) found minimal bias throughout their entire data range for adjusted R^2 versus conventional R^2 which conveyed substantial bias when the number of SPV is low. Due to the small sample size of less than 100 valid cases in this research, the adjusted R^2 value was used as the final measure in the predictive power of the models. The option of cross-validation which includes splitting the data was not viable considering the sample size.

Hierarchical regression models were developed to give the researcher the opportunity to use pre-existing results from the literature to guide the development of the models (as per Field, 2013). It is proposed by PMT that both the threat appraisal and coping appraisal will determine how intentions are formed by an individual exposed to a given threat. Therefore, use of the hierarchical method allowed for these variables to be input in a preferred order versus a stepwise method where mathematical criteria of the software decides the order of variables in the model.

Socio-demographic variables were controlled for by entering them into the first block. The second block included the PMT variables of interest to this research (consequence, efficacy, self-efficacy and response cost) along with the expanded elements that link to the socio-technical system (e.g. past experience, reliance, postponement).

3.6.5 Step 4: Develop best-fitting model

After examining the results of this model, a best-fitting model was developed. This best-fitting model included only those variables that were significant in the hierarchical model. Significant variables of the best-fit model were taken as the indicators of behavioural intentions and used in cluster analyses to determine the existence and characteristics of sub-groups.

The following assumptions were assessed to ensure the best-fitting regression model was suitable:

1. Multicollinearity - was checked by reviewing the correlation coefficients of the variables in the model. Variables with coefficients of 0.8 and over are said to show multicollinearity (Field, 2013). Additionally SPSS produces a variance inflation factor (VIF) and its reciprocal, the tolerance statistic, which were also reviewed for multicollinearity.

2. Homoscedasticity - residuals at each level of the predictor should have the same variance. This was checked by calculating the Cook's distance, average leverage and the related Mahalanobis' distance and reviewing their ranges.

3. Normality of residuals - through histogram and normal probability plots of the outcome residuals as well as partial plots of residuals of the predictors versus the outcome regressed against the remaining predictors.

3.6.6 Step 5: Examine sub-groups

In addition to regression models, cluster analyses were undertaken to aid in the identification of different decision stages that might exist within the sample. Cluster analysis was hence applied to: 1) determine the presence of different groups, 2) identify decision-stages (as discussed in Section 2.4.5 of Chapter 2) of these sub-groups and; 3) explore the interaction effects of indicator variables on behavioural intentions of the different sub-groups.

Cluster analysis is the organization of a collection of patterns (usually represented as a vector of measurements, or a point in a multidimensional space) into clusters based on similarity (Jain et al., 1999). Patterns within a valid cluster are more similar to each other than they are to a pattern belonging to a different cluster (Jain et al., 1999). In this research, cluster analysis has been combined with concepts from the research stream on decision stage theories to examine decision-stages and the intention-behaviour gap. Output clustering can be hard (a partition of the data into groups) or fuzzy (where each pattern has a variable degree of membership in each of the output clusters) (Jain et al., 1999).

Despite its usefulness in several exploratory pattern-analysis, grouping, decision-making, and machine-learning situations (Jain et al., 1999), cluster analysis is not without its challenges. The first major challenge is that all clustering algorithms will produce clusters from a given dataset regardless of whether or not there are clusters (Jain et al., 1999). If the data does contain clusters, some clustering algorithms may obtain 'better' clusters than others but Jain et al. (1999) suggests that this is not necessarily due to the algorithm alone, but also the input data. Therefore a fundamental challenge relates to the input variables which is then linked to finding the optimal cluster solution and validating it. Each of these are discussed below in relation to the current research.

Deciding on input variables

Cluster analysis requires a group of input variables (also known as the input variate) which are specified by the researcher. Therefore, in order to obtain valid results, good researcher judgement is required to specify the input variate as this ultimately determines cluster characteristics (Jain et al., 1999). Jain et al. (1999) advise that it is often valuable to isolate only the most descriptive and discriminatory features in the input set. By developing the regression models in the previous step, this was already mostly achieved with the identification of predictor variables. However, it was necessary to explore other variables that were related to behavioural intentions from the literature to ensure that the optimal solution could be ascertained.

Determining the optimal number of clusters

Fraley and Raftery (1998) identified the determination of the number of clusters as a fundamental challenge of cluster analysis. This is because most clustering algorithms require that this be specified. In specifying the number of clusters, various different cluster solutions can be derived from most algorithms thereby making it difficult to determine the correct number of clusters that most adequately recovers the underlying cluster structure i.e. presents the optimal cluster solution (Krzanowski and Lai, 1988 in Yan, 2005). Whilst several methods have been proposed to address this issue (Yan, 2005), there is no one definitive solution. To overcome this challenge, two types of clustering techniques were used in this research to explore the data to determine the optimal clustering solution.

Firstly, a hierarchical clustering method was employed to estimate the number of clusters that can reasonably be expected. Hierarchical methods proceed by stages producing a sequence of partitions, each corresponding to a different number of clusters (Fraley and Raftery, 1998). Clusters can be either agglomerative, with fewer clusters at the higher level (by fusing clusters generated at the lower level), or divisive, which separate the *n* objects into more and finer groups in sequential steps (Yan, 2005). Here an agglomerative partitioning method was used where groups were merged. This method explores all cases by forming individual clusters with each case and then clustering each case with the nearest case with the most similarities (Gilg and Barr, 2006). This is done through a succession of iterations and fusions until there is finally one cluster that includes all cases (Gilg and Barr, 2006). At each stage of hierarchical clustering, agglomerative merging is used to optimize some criterion e.g. sum of squares (Fraley and Raftery, 1998). One commonly used method, Ward's method, uses an analysis of variance technique to compare clusters with the aim of minimising the sum of squares of each potential cluster (Everitt and Dunn, 2001). A combination of Ward's method and euclidean distance measure (straight line measure of association or similarity) were used in this analysis to determine cluster centres.

Although subjective, this approach presents an estimate of the potential cluster solutions that can be explored with more optimal techniques that require specification of the number of clusters (*k* clusters). One such method is that which employs a *k*-means clustering algorithm and was the second type of clustering applied to the data. The *k*-means clustering method optimises the clustering of cases more robustly than the hierarchical cluster technique by means of an iterative relocation algorithm (Fraley and Raftery, 1998). In each iteration, the algorithm allows cases to be moved around so they can be clustered in the optimum position by reducing the within-group sums of squares versus being locked in with the first similar case as in hierarchical clustering (Everitt and Dunn, 2001). This is the common shortcoming of hierarchical algorithms - divisions or fusions once made are irrevocable therefore cases cannot move around after fusion or division (Everitt, 2001) as opposed to the *k*-means algorithms.

The *k*-means clustering method has become one of the most popular methods because it is computationally easy to implement and it is generally accessible in most statistical software and clustering packages (Yan, 2005). A major disadvantage of k-means algorithms is that the results can sometimes depend on the order of the objects in the input file (Kaufman and Rousseeuw, 1990 in Yan, 2005). Additionally, by defining the number of clusters, a researcher will obtain different local optima of the *k*-means algorithm (Yan, 2005). The researcher tested a range of cluster solutions, taking the maximum clusters from the results of the hierarchical clustering as a guide for developing best-fitting models.

Validating cluster solution

The output of a clustering procedure can be validated using specific criterion of optimality. However, these criteria are usually arrived at subjectively and there are various methods. Statistical methods are often employed to test hypotheses (Jain et al., 1999).

Due to its flexibility and power, the statistical programme R (R Core Team, 2016) was used to undertake cluster analyses. Validation of cluster solutions was the final step to ensure the optimal solution is derived. Since there are several methods for testing cluster validity, the NbClust package in R was used as it is capable of running 30 different indices to determine the optimal cluster solution. The results of these analyses are discussed in Chapters 5 and 6.

3.6.7 Qualitative analyses

In line with a phenomenological approach, a thematic analysis method was employed in the analysis of the qualitative data. Thematic analysis is "a method for identifying, analysing and reporting patterns (themes) within data" (Braun and Clarke, 2006, pg. 79). This is done by analytically examining narrative materials from life stories by breaking the text into relatively small units of content and submitting them to descriptive treatment (Sparker, 2005 in Vaismoradi et al., 2013). In this way, thematic analysis provides a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex, account of data (Braun and Clarke, 2006). Whilst thematic analysis is widely used, there is no clear guideline on how it should be conducted and it is not typically listed as a qualitative analytic method the way other methods, such as content analysis, are usually listed (Braun and Clarke, 2006).

From a philosophical point of view, thematic analysis can be an essentialist or realist method, reporting experiences, meanings and the reality of participants (Braun and Clarke, 2006). It can also be a constructionist method, examining the ways in which events, realities, meanings, experiences and so on are the effects of a range of discourses operating within society (Braun and Clarke, 2006). This research has used a mix of both the realist and constructionist methods to better understand how the water user is involved in coping and resilience efforts for drought and flooding.

Data analysis and interpretation were undertaken through the use of the NVivo software version 11 (QSR International Pty. Ltd., 2015). Recorded interviews were first transcribed. Each transcription was reviewed against the recordings to ensure accuracy and representativeness by ensuring they provide a 'verbatim' account of all verbal (and sometimes nonverbal, e.g. coughs) utterances (Braun and Clarke, 2006).

Interview transcripts and recordings were imported into the NVivo platform. Drought centric interviews were imported into a separate project to those related to flooding to ensure that the analyses were independent. The analytic process involved coding of the data to derive transferable themes. Coding is a “mechanism for thinking about the meaning of your data and for reducing a vast amount of data that you are facing” (Bryman, 2004, pg. 409).

Coding and thematic analysis

Coding of the data was undertaken to conceptualize, classify, categorize, and identify themes. Within NVivo, there is facility to code the data according to the research questions and expected outcomes using a sophisticated system of nodes. The codes were pre-developed to correspond closely with the question typology that was developed before the interviews were undertaken. All transcripts were reviewed in detail to ensure that they were adequately coded and all data extracts were collated together under specific codes. Use of NVivo allowed for this to be done efficiently. The initial coding served to systematically highlight interesting features across the data sets that appeared to have a repeated pattern in all or most transcripts. Some examples of initial codes are shown in Figure 3.6 below.

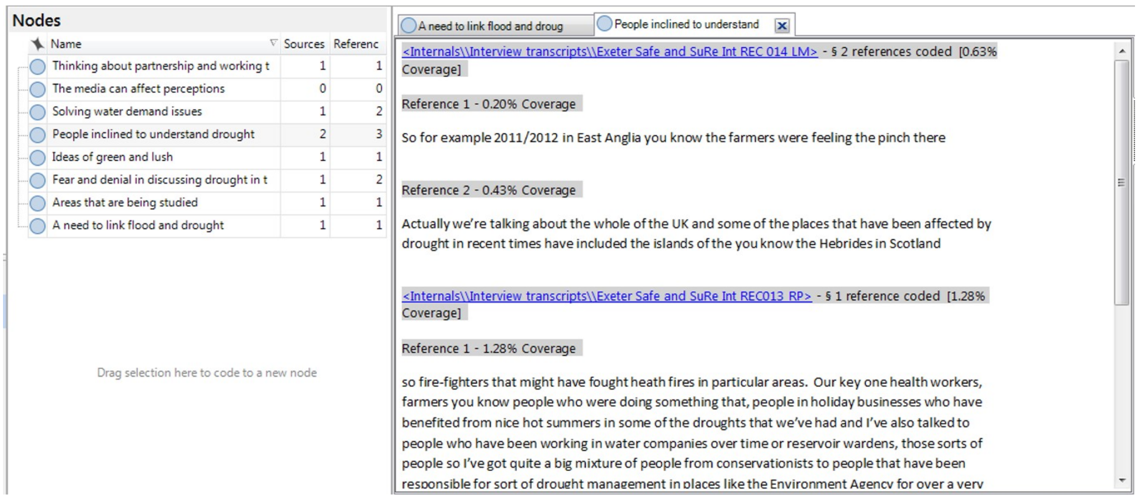


Figure 3.6: Examples of some initial codes that were developed with respect to the drought related interviews.

The initial codes were then collated into broader themes by reviewing all the relevant data for each potential theme. A theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set (Braun and Clarke, 2006). The themes that were developed were done so based on analysing the data in an interpretive way by considering how different codes can be combined into a meaningful theme that would address the research questions. The relationships between different themes were also considered in this stage.

In reviewing the themes that were developed, it was then essential to decide whether or not all themes were relevant to the research. Extracts that did not seem to match themes were discarded as were those themes that did not present useful findings. Sub-themes were also identified within themes to provide more in-depth understanding of the narratives. Each theme was given a title and detailed analyses were undertaken to define their meaning and interpretation. Again it was important to understand the relationships amongst the themes in an effort to address the research questions.

In preparing the final report of the thematic analysis, each theme was presented with sufficient extracts to illustrate the main ideas that they convey. This is where the extracts are presented in an analytic narrative in relation to the research questions. These themes are discussed in Chapter 4.

3.7 Ethical considerations

In line with requirements set out by the University of Exeter, this work was subject to ethical approval due to the nature of human interactions involved. In order to fulfil ethical responsibilities in relation to teaching, research and other activities, each college has designated personnel responsible for the management of ethical procedures. Initially the application was placed through the College of Engineering, Mathematics and Physical Sciences where the researcher is based. However, the responsible parties suggested that the application be placed with the School of Geography within the College of Life and Environmental Sciences as they are regarded as being more experienced with this type of application.

Ethical issues regarding the research were not considered to be significant and involved consent, confidentiality, and the use of incentives. These issues were discussed with supervisors prior to completing and submitting the forms to the Geography E-Ethics approval application process http://geography.exeter.ac.uk/media/universityofexeter/schoolofgeography/pdfs/E-Ethics_Guidance.pdf. Each of these aspects were identified and mitigations presented as follows:

1. Consent - All participants were presented with a consent form which provided information on what the study is about. The consent form allowed them to indicate their consent after all the information about the study was presented. Interview and focus group participants were asked for their consent to be voice recorded before the interview proceeded. Participants were also advised that their participation is voluntary and that they could withdraw from the study at any time and for any reason. This would not impact their participation in future research or possibility to win incentives being offered.
2. Confidentiality - Consent forms indicated that all responses will be treated with confidentiality. This would be assured by storing personal information separately from the associated data and maintaining the anonymity of each participant in any reports or publications. Participants who gave their contact details for specific reasons would not be contacted for anything other than that reason e.g. to receive a report of the findings.
3. Use of incentives - Survey participants were offered the option to be entered into a randomly selected prize draw (£75 gift card). However, the use of incentives in research is still a grey area as one major argument is that it may be deemed as a means of coercing the sampled population in the case study regions to participate in the research. To mitigate this, firstly entry into the prize draw was optional. Secondly, only one prize was made available in each of the two study regions and hence the chance is reduced for each participant to be awarded the prize draw; therefore their participation occurs under the knowledge that they may not necessarily be compensated. Additionally, participants who do not complete the questionnaire in entirety will not be disqualified from entry.

Other ethical issues included providing participants with the option of ‘uncertain’ as a response to questions where they perhaps have no prior experience or knowledge such as use of household flood coping responses and how effective they may be. As research on flooding can sometimes cause anxiety, participants were provided with the researcher’s contact details in case they wish to hold further discussions or have any concerns.

A risk assessment was also required along with the ethics application form.

This risk assessment presented the potential risks that undertaking the research could present along with mitigation plans that the researcher might implement or consider.

3.8 Chapter summary

This chapter provided detailed discussions about the case study areas, the research approach and methodologies, the research methods, and the analytical techniques employed. Additionally the chapter discusses some of the methodological issues and ethical considerations required to ensure that the research meets the standards for academic rigour and validity.

Quantitative and qualitative approaches both have advantages and disadvantages associated with their development, use and interpretation. A mixed methods approach to data collection and analysis has been utilised to provide a detailed data collection and analyses of the research objectives towards the development of an approach for engendering greater resilience to water management extremes at the household and community levels.

4 BUILDING HOUSEHOLD AND COMMUNITY RESILIENCE: A PRACTITIONER POINT-OF-VIEW

> *"So you know there have been times when people have thought God we are really going to run out and we don't know what to do and probably as much emphasis should go on planning for droughts as planning for flooding."* (Interviewee 009 - academic with community engagement expertise)

4.1 Introduction

The quote above highlights that there is a disparity in drought planning and management versus the case of flood management. In Chapter 2 it was explained that current FRM policy embodies community and individual participation (albeit there are challenges in implementing this) but that there is no similar strategic drive for such levels of participation with respect to drought management. This chapter aims to explore how the sector is working to make households more resilient to both the threat of drought and flooding as well as to explore the challenges involved in these efforts through practitioner discourses. As such this chapter explores objective 1 which posits the following research questions:

1. Is the water sector transitioning to a more resilient water user?
2. What are some of the challenges in promoting drought/flood resilience amongst water users?

The perceptions, opinions and experiences of practitioners and academics involved in implementing key drought and flood management policy and/or major national research projects at the household and community levels are analysed to better understand how the water user is positioned with relation to drought and flood resilience. By undertaking this overview of the discourse, it provides an opportunity to explore the cross-cutting themes that must be considered in the development of programmes and tools for enabling participation in drought and flood management in the UK.

The remainder of the chapter is as follows: Section 4.2 presents the participant profile of those who were involved in the interviews. Section 4.3 presents the discourses related to drought management and households whilst Section 4.4 presents those related to flood management and community approaches. Finally Section 4.5 provides a summary of the key themes as well as some conclusions that will lead into the next chapter.

4.2 Participant profile

A total of 11 practitioners and academics were interviewed. The practitioners were of various academic backgrounds and professionals thereby providing a range of perspectives, experiences, and opinions. Of these 11 interview participants, four were experts in water resources planning, and environmental social science, public engagement and participation with respect to drought management. These participants included a mix of academic researchers and industry practitioners. The remaining seven interview participants with whom flood related issues were discussed included a mix of engineers, environmental scientists, and environmental social scientists.

To maintain confidentiality, interview participants whose quotes are presented in this chapter are referred to according to a randomised number. An example of one interview transcript is presented in Appendix B. Table 4.1 below outlines each of the participants and their core areas of expertise.

4.3 Community drought discourses

The aim of the interviews related to drought was to provide an overview of some of the current approaches being embarked upon to incorporate the water service user, as households and communities, as active participants in a more resilient sector. There were three broad themes that resonated in the drought related interviews. These are presented as follows:

1. Challenges for drought engagement - starting discussions about drought in the UK can be daunting in some places due to limited experiences in recent times and a well managed and regulated private water sector. Some of the challenges with such discussions include fear of ridicule, perceptions of a green, wet country, the signal of the hosepipe ban, as well as issues related to cost, comfort and cleanliness which are the key sub-themes identified under this theme.

Table 4.1: Interview participant profiles.

Number	Subject consulted on	Area of expertise
001	Drought	Environmental planning and management in the south west
002	Flooding	Engineering management in Exeter
003	Flooding	Community flood resilience in Devon
004	Flooding	Water engineering in Exeter
005	Drought	Water resource strategist in the south west region
006	Drought	Academic with expertise in drought and flood memories
007	Flooding	Community flood resilience in the UK
008	Flooding	Community flood resilience in the UK
009	Drought	Academic with expertise in drought management and community engagement
010	Flooding	FRM expert in Devon
011	Flooding	Community flood resilience in Devon

2. Drought communication under privatisation - This theme discusses specific challenges related to drought communication in light of the water sector being privatised are transfer of blame to the water company or regulator, media influence in this and perceptions that the service agreement should always be satisfied.

3. The influence of past drought experience - in their discourses, interview participants tend to find that the way past droughts are experienced often influences perceptions about future droughts and may or may not lead to improved water management at the household level.

4.3.1 Challenges for drought engagement

Fear, ridicule and psychological distancing

Although drought and its consequences are not new to England (Taylor et al., 2009), modern droughts no longer affect users or disrupt their practices and comforts on protracted scales of the past, or as recently experienced in some countries (e.g. Australia, Namibia, and the United States). Additionally, the risk of drought is lower in some parts of the country compared to others. Some regions such as the south east of England are more prone to drought and water scarcity than other parts of the country further complicating public engagements and participation relating to drought and household/community drought resilience. There is hence some fear of being met with ridicule and sarcasm when talking to people about drought and in some areas. The following quotes reflect some of the participants experiences and perceptions in broaching the subject of drought with Water Companies and communities:

> *"actually even starting conversations about drought in certain settings is really quite problematic. If you use the 'D' word with Water Companies for example, they've, you know that's seen as, it's fairly politicised and it's synonymous with failure [laughs]....getting conversation with the public about drought and water scarcity it really isn't on people's radar"* (Interviewee 006)

> *"of course we rarely talk about drought now, we talk about water supply situations and restrictions and shortages and the value of it and all sorts of other rubbish you know people are quite scared to say the word drought....people start laughing at them when they do .... You've always got some smart Alec that says oh yes but you know look at all these other places around the world that have got far less water and you can see why people don't want to talk about it. Because you know they just become a laughing stock don't they."* (Interviewee 009)

It can therefore be very difficult to bring up the topic of drought with certain audiences including Water Companies, households and communities. For the Water Company drought is closely interlinked with their ideals of service provision on a continuous basis. For households and communities there is limited knowledge of and experience with drought:

> *"so there's a sort of unpredictability of their character and their impact that means that [the] public and for some organisations like the Water*

Authorities, indeed the public, they may see that drought is a failure you know" (Interviewee 009)

"I think it's...completely out of sight, out of mind I think flooding is as an issue is so much more vivid and people have seen and unfortunately some people have sort of felt the effects, you know recently, whereas with drought there hasn't really even 76 which was a bad drought there are actually only very few communities that were directly involved by standpipes, very few so even though it was very bad it still wasn't as bad as it could have been." (Interviewee 001)

Discussions about drought also reflect some amount of 'psychological distance'. Psychological distance is a subjective experience that something is close or far away from the self, here, and now (Trope and Liberman, 2010). Perception of issues such as drought and climate change often reflect psychological distance as found by Taylor et al. (2014). Some of the participants noted that people will often reference 'Africa' as a place where drought happens as opposed to the UK. Drought is certainly not on the minds of many households in the UK and peoples' decisions and actions about implementing coping responses can be guided by thoughts of the future, the past, remote locations, another person's perspective, and counterfactual alternatives (now popularly termed 'alternative facts') (Trope and Liberman, 2010).

The 'green and wet effect'

Another factor that challenges drought engagements is the perception that the UK is generally a wet country. This perception has implications for community engagement related to drought or water resources. Interview participants have found that the perception of the green, wet landscape throughout the UK is often distracting to discourses on drought, thereby further adding to the challenge of engaging with communities on the topic:

"I mean part of the problem of talking about drought is that people see the UK as a wet country you know I think there's quite a big, one of the barriers we've identified is that sort of understanding of green and lush you know certainly in Wales you know they make a big play about rain but you know we tend to talk about the weather a lot in the UK it's just perceived as a wet country" (Interviewee 006).

Similar sentiments were echoed by Interviewee 009 who explained that:

> *"it's harder for people to connect. What are you going on about drought, you know there's plenty, the country's wet you know....In their mind it's always raining you know and so it is a very difficult one."* (Interviewee 009)

There is also agreement with this matter in the literature where the perception of a 'wet London' was identified as a limiting factor in drought communication and comprehension by Bell (2009). In fact, this belief of London being a rainy city cultivated debates that drought must be the result of mismanagement of water resources rather than that of a natural phenomenon (Bell, 2009). So the discussion often leads to a blame game situation where the accountability of profit based Water Companies comes into question and their mismanagement is often cited as the reason for experiencing a drought. This situation undermines the goal of pursuing solutions to the real issues such as the necessity for a re-configuration of water relationships which is a long term process of transformation.

The 'hosepipe ban effect'

In addition to the green and wet effect, is the way the presence of a drought seems to be signalled by a hosepipe ban which has its own effect on how people relate to drought and its consequences. The decree of the hosepipe ban has become somewhat of a signature for householders and communities that a drought is underway:

> *"if people are talking to me about, I don't know, say the 1959 drought or maybe 1976...they are very well versed in hosepipe bans and I would say that the number one trigger in people's mind if there's a drought or not is not, they don't look at weather forecasts and go oh yes there's a drought or they don't hear a communication that says this is you know this is a drought warning, but the first thing they tend to know about...is when there's a hosepipe ban."* (Interviewee 009).

Therefore, the hosepipe ban being the main consequence faced by households from a drought, removes the incentive for action towards coping and adapting now in preparation for potential future water stress. This is because whilst a hosepipe ban is in effect, water supply services are usually still being met. As a result, Interviewee 009 explains that even with a hosepipe ban in effect, households can often remain in denial about the fact that there is a drought:

> *"In their minds if there isn't a hosepipe ban there isn't a water shortage and if there is a hosepipe ban very often they will then go 'well is it really a drought' and they need to, people often need to feel and see proof so they want to see crops dying, cracked earth, that kind of stuff before they'll really acknowledge that there's a problem....it's like 'well prove it to me you know because water's still coming through the tap'."*

This is very closely intertwined with the perception that rain and hence water are never in short supply, resulting in a general disconnect where drought in the UK is concerned. According to the account of Interviewee 006, it is mainly those people or professionals engaged with water from certain perspectives (e.g. through farming, gardening) who tend to acknowledge that there is a possibility that they could be affected by a drought. Although most people might adhere to the ban (e.g. Chappells et al., 2011), it may not necessarily resonate with them that there could potentially be water supply issues, or that the environment is perhaps under pressure and experiencing low flows in an effort to serve competing users.

In response to the challenges presented by such debates and perceptions, Interviewee 006 suggests that it is through discussions on wider relationships with water that drought engagement, and indeed demand management, might meet most success. Consequently, new approaches must be sought and taken to help promote engagement on water management issues at the household and community levels.

Cost, comfort, and cleanliness

The interview participants had similar views on the barriers towards household implementation of more resilient and sustainable measures and practices. It was found that simple water efficiency measures were always the easiest for a household to implement and in general households are often willing to implement them. However, when it came to implementing more sophisticated and long-term measures, they tend to find that there is less willingness by individuals to implement them largely because of cost and long payback:

"you know the sort of water saving measures that householders can take over and include things like putting in the water saving devices or putting in a water butt or you know tending not to use a hosepipe....Not to leave the tap running, flush the toilet less, not wash the car maybe....When you move on to the kind of next level efficiency measures like you know grey water reuse or rainwater harvesting off the roof you're talking serious money you know and then the payback is a very difficult thing...if someone said oh I'm going to put in a rainwater harvesting system, it's going to cost ten thousand pounds, what's the payback period?" (Interviewee 001)

In their study of public engagement in water supply in London, Doron et al. (2011) found that similar small or simple water-use behaviour change were not uncommon amongst participants but when it came to making major financial investments in certain water saving measures, cost was definitely a barrier to implementation. The matter of cost is not one with a simple solution but it certainly warrants greater discussion in the sector in order to find new ways to promote and incentivise the uptake of more long term water efficiency measures.

Longer term solutions such as rain water harvesting or grey water reuse have the potential to make real savings in demand (Domenech and Saur, 2010), and therefore they feature very well into debates about climate change adaptation at the household and community scale. In encouraging more water efficient lifestyles and getting around the matter of cost, some practitioners suggest that talks about the impacts of climate change must permeate the discourse for promoting household level coping:

"I think it's important that we get across to people...that there are risks of increased periods of drought in the future and the importance of people making plans and I think it you know and part of that is you know bolsters you know our long-standing aim to encourage people to be more, to use water more efficiently...if and when we do get these periods of dry weather people have got these sort of plans in place you know and use is that more efficient." (Interviewee 001)

"you know the climate change predictions are all about that we're going to be wetter winters, drier summers so you know this is not

a problem that's going to go away and it'll be a lot, as you know with flooding it's much easier to engage people after you've had a big event but the challenge for us I think is to try and make people aware before there is a big event so people have a better awareness of how they can adapt and things they can do in terms of their water practices to make themselves more resilient." (Interviewee 006)

However, this approach is not without its challenges what with the way climate change is viewed by the public with distrust. This further adds to the complicated challenge of climate communication. Recent research into climate change consensus has found that whilst there is strong consensus amongst scientists that anthropogenic climate change is real (as evidenced by agreement amongst peer-reviewed scientific publications spanning 1991 to 2011) (Cook et al., 2013), there was still much confusion and uncertainty amongst the public about this consensus (Pew Centre for Research, 2012). As such the public can become demotivated if they are confused on the position of the actual scientists.

In addition to a climate change approach, others believed that a complete social change is needed to change people's relationship with water. Despite there being less incidences of extreme drought in the UK, lifestyle changes today are expected to provide a buffer for future generations who might encounter these extremes more frequently. In other words if we adopt more sustainable practices now, then future drought periods may not affect the population as potentially severely. Some of these changes might include households learning to live with only a fraction of the water they now use per day as well as more fit-for-purpose water usage. An overall reduction in water demand is required:

"what's acceptable to people could change quite dramatically and they do need to learn that but while we keep protecting them from shortages they will not learn it, it doesn't matter how much you talk to them they have to experience it and that's really important, it's really important that they learn that it might be OK to wear the same clothes more than once you know because it's ridiculous we are wasting so much water and we could really make ourselves a lot more resilient just by you know learning a few home truths about how often do you really need to wash, about introducing better building regulations that determine the situation in terms of where pipes are in a property." (Interviewee 009)

Whilst the above statement has much truth in it, the fact still remains that water is a service which customers pay for and as the sector continues to improve its service outcomes, they therefore expect to continually receive this service despite rainfall shortages. Additionally, societal conventions of cleanliness, comfort, and convenience continue to hold true. To this end, hygiene and sanitation practices remain as part of daily routines and clean water is expected to be available for every activity throughout the day. These conventions are not easy to change and changing them can present many challenges associated with how our society has framed these three conventions. According to Interviewee 009 the notion of fit-for-purpose use has not yet infiltrated the market in many countries including the UK, and the few who are aiming towards this lifestyle change often find different challenges along the way. The following quote presents a practical example of some of these challenges:

> *"There's one woman in Bristol we spoke to who was actually quite embarrassed by the fact that she was water cycling in the house to a scale that probably she felt might be seen as odd so I think she was using grey water to flush toilets and things like that"* (Interviewee 009).

This person was embarrassed that their household was utilising a fit-for-purpose mode of operation because it is not the usual 'water in water out' remit of the average household (Allon and Sofoulis, 2006). People undertaking such practices can often be viewed as inferior and unclean and sometimes receive 'expressions of disgust' (Drechsel et al., 2015) from family, friends, and neighbours. An Australian study on the reuse of household grey waters by Hamilton and Greenfield (1991 in Po et al., 2003) indicated that those who perceived potable reuse as 'filthy and unclean' accounted for the majority of respondents who rejected the reuse scheme. From the perception of filthy and unclean, the disgust reaction was generated and served to tip the balance, motivating people to stay away from using recycled water in order to prevent illness and disease (Po et al., 2003). Hence, people who may want to make the change to embody this lifestyle might not bother to do so out of fear of being perceived negatively.

Russell and Lux (2009) suggests that to counter some of these issues of digest and the so-called 'yuck factor', fruitful explanations and effective public engagement both require a shift to a more sociological and cultural approach, that examines users' practices around the STSs of providing water and handling waste. These ideas can be applied more generally to water issues and aligns very well with addressing household participation towards greater resilience.

4.3.2 Drought communication under privatisation

The above issues (e.g. perceptions of a wet country) further reinforces the need for more comprehensive drought communication strategies that go beyond an ongoing drought episode. However, the water sector has yet to transition beyond episodic response to drought. Interviewee 005 explains that before a drought is declared there is usually intense monitoring by the regulators and Water Companies. This is then followed by media campaigns on water efficiency when it is agreed that a drought is indeed underway, and if the drought conditions worsen then usually a hosepipe ban is put into effect. Therefore the only role of the customer is to reduce their demand for outdoor water usage during the drought. Although Water Companies are now making greater efforts to engage customers on various issues, they are still cautious in how they approach demand management talks perhaps out of fear of how they will be perceived both by the customer and Ofwat, in addition to the impact of a more efficient water user to the economics of their commodified resource. As Interviewee 006 explains:

> *"a lot of the drought risk communication if you look at organisations like the Environment Agency...a lot of their concerns are about how you actually communicate during drought rather than necessarily thinking how you actually normalise discussions about drought in periods when there isn't drought...if you can't actually have dialogue about this, then how can you expect people to prepare and adapt?"*

This situation of drought communication with the public only occurring during a drought, continues to be the case as validated by Interviewee 001 who describes the regulatory response to a recent drought as follows:

> *"I suppose the freshest memory would be between 2010 and 2012 and we declared a drought...when we declare drought then that is when the message that we're going to a dry period goes externally. Before then we are kind of in a heightened state of awareness ... but externally when we start engaging with people back then it wasn't really until we were ready to declare a drought and it is at that point that we need to make sure that we are providing very carefully crafted information to communities"*

The EA and Water Companies are still mainly communicating with the public in a time of potential crisis rather than developing programmes that allow for greater engagement and debates around water as a resource. Discussions on drought have therefore not evolved beyond the reactive response during an actual drought. It is the opinion of some of the interview participants that drought and water management conversations need to be ongoing. The value of ongoing discussion about drought and scarcity is highlighted by Interviewee 006 below:

> *"whereas floods are quite site specific droughts are actually much more regional and pervasive and so you know in a sense everybody would be affected by drought particularly if it gets down to socio-economic drought and so actually having those conversations with people early I think is important and...I think the idea that drought can continue over many years or several you know a series of years and in California you know people's awareness of that, people might see it as being something that doesn't affect us here but actually some of the principles and the stresses we can learn from I think."* (Interviewee 006)

Communicating issues of water supply and drought are quite complex especially when positioned in a regulated privatised industry where water is both a commodity and a resource (Pearce et al., 2013). There is a tendency to transfer all blame and responsibility to the Water Company reflecting the hydrosocial contract where the Water Company is the technocrat with control over nature and users as customers. Therefore when issues of water supply arise there is always need to point the finger at the service providers:

> *"they'll say well ... are the water companies doing something wrong or are the Environment Agency not doing enough ... I think that there can be a tendency for people to want to blame maybe or that there could be someone at fault."* (Interviewee 001)

Further complicating drought communication in a privatised industry, is the role of the media whose framing of communication surrounding drought and water scarcity can impact the way people respond and behave as examined by Bell (2009). Whilst the media are useful for relaying and promoting messages and for providing information, they sometimes frame the narrative in which natural disasters come to be understood by the general public through various persuasive mechanisms. In the case of the London-Sydney comparison by Bell (2009), morality was expressed or implied in the reporting of drought in both cities. Throughout the London press, moral outrage was levied at the private Water Company for poor maintenance records and a drive for profit-making; on the other hand the Sydney press focused on the wastefulness of private householders, particularly in comparison to the hardships experienced by their rural counterparts (Bell, 2009).

Instead of promoting a safe-to-fail ideology (Butler et al., 2014) which places focus on long term strategies for change, as seen in Australia, the drought narrative in the UK is often concerned with getting through the current ongoing drought (Bell, 2009), whilst placing blame on the industry. The idea of a profit-making water company telling people to restrict their water use continues to be a problem for water users often affecting how they respond in a drought:

> *"the more they pay for water or the more they see water companies being successful and creating profit the less inclined they are to do anything other than the bare minimum because they feel it is a service that is supplied to them that they pay for and they should have the luxury of it."* (Interviewee 009)

Interviewee 006 acknowledges these experiences with community engagements turning into a blame game and proposes more targeted and empowering discussions around water and resilience:

> *"I think there's still you know in terms of bringing decision making around water resilience down to the local level there's still quite a lot to be done in terms of how you work with communities, how you empower communities, how you get you know around the emotional resilience side of things .... if you're going to work with community and the public and communities as part of the resilience process which is really essential then you need to be able to work with them in ways that integrate knowledge sort of I suppose support emotional intelligence you know the ability to be able to engage in a non-combatant way."* (Interviewee 006)

The current configuration of the water user as a customer of a commodified resource in a privatised industry makes it very challenging to enable resilience to drought at the household and community level. There is hence much work that needs to be done to re-configure the water user as part of an active community of co-managers.

4.3.3 The influence of past experience on household drought coping

In their interactions with households and communities, some of the practitioners found that past experience can affect perceptions of drought as well as drought coping intentions and behaviours of households. Those who have experienced drought before may sometimes be more willing to embrace a change in their lifestyle especially if the drought affected their way of life in a negative sense or in a way that made them rethink how they might use water in the future. For instance Interviewee 009 suggests that:

> *"If you had to live on you know a very small quantity of water a day you'd learn about efficiency"*.

This statement was further referenced by the following discussion:

> *"we went to the Fife Show in Scotland last May and there was a woman I spoke to whose house was reliant on a spring, it was a rural setting and you know she had gone for quite a period of time with her family without water and she said how it had changed their water relations you know how they you know people were bringing water bottles back home from school but they weren't tipping it down the sink you know they were keeping water, they'd changed their water practices and I think the critical thing then is...it's about people's water practices and how you change those."* (Interviewee 001)

Therefore, sometimes having experienced the negative consequences of drought can indeed sway people to become more proactive in their own household coping. However, whilst experience can influence a change in behaviour and increase willingness to implement coping responses, so too can experience lead to low levels of willingness. Modern droughts in the UK have largely had minimal consequences for households and also consistently and conveniently ended following periods of heavy rainfall. This familiarity of experience creates the expectation that each drought will follow a similar pattern even in an age of increasing climate variability. Therefore households and other water users (e.g. farmers) may not display high willingness to pay attention to future drought events and their consequences as reflected in the following quotes:

> *"1976 was severe but it only lasted for eighteen months or so you know ... it ceased quite quickly after heavy rainfall in the autumn and there's a lot of perception amongst people in the UK and farmers that droughts always end with extreme rainfall....because it's happened a few times that way certainly that was something that was mentioned up in Scotland you know that actually every drought finishes. Well what we're seeing with the millennium drought and the Californian drought is actually droughts can persist over several years and actually in the public psyche in the UK I don't think that's on their radar. What happens if you actually have if we had a situation where drought continued over more than two summers what would be the implications of that?"* (Interviewee 006)

> *"every time we've got to that crunch point so far miraculously and I really mean miraculously we've had rain and going back through all the records that I've looked at that's what happens, we get to the very last point where you know things are really going to go badly wrong and somehow we get an amazingly huge amount of rain but there's nothing to say that we wouldn't at some point."* (Interviewee 009)

As a result of this 'pattern of experience', people tend to think that a drought will only last up to certain period by which time systems will easily recover. However, the reality is that droughts are uncertain making it difficult to tell how the next one might affect a given area, for how long, and to what extent. Additionally there still remains much uncertainty about how climate change may affect drought patterns. This thereby complicates how practitioners working with drought and behaviour change might engage with communities to enable greater coping responses.

4.3.4 Section summary

A wide range of issues therefore complicates the landscape of drought discourse in the UK. These range from the impact of privatisation which has successfully provided the investments needed to reform water supply and distribution, to water users' perceptions about roles (theirs, those of the Water Companies, etc.), expectations and relationships with water, to the impact of past experiences with drought and water scarcity and the effects of fear and ridicule that often arise when discussing the subject of droughts in the UK.

4.4 Experiences and lessons learnt from community flood engagement and participation

The chapter now turns to flood management. In this section, the thesis draws upon practitioner knowledge and experiences with public and community engagement and participation in flood prone areas in Devon and across the UK. Some interview participants were involved in the Defra community Pathfinder project outlined in Chapter 2, and/or have responsibility for implementing flood policy through various means (e.g. community engagement, engineering planning and design)at a local level. The themes that emerged from analyses of the interviews with these FRM participants are defined as follows:

1. the value of social networks in community engagements and participatory activities - this theme highlights how the presence of strong social networks within a community can either enhance or impede the engagement process. Additionally, the idea of community resilience is now becoming topical in many community groups and as such flood resilience can be an interest to many of these groups.
2. lessons for engaging different types of communities - is a theme which is linked to the previous theme, explores the lessons learnt about how to and how not to engage with communities of different sizes and structures.
3. Communicating flood risk - under this theme two critical sub-themes for community flood resilience engagements included the challenges and approaches of communicating and discussing flood probability and residual risk, as well as the merits of approaches such as peer-to-peer engagement that allows people to share their memories, and stories.

4. strategies for empowering communities - is a theme concerned with airing the lessons learnt from empowering communities by various means whether it be through training, facilitation, or providing financial assistance to implement flood resilience measures for households as well as within communities.
5. the influence of past experience - this theme explores how past experience can influence individuals and communities

4.4.1 The value of social networks

Based on practitioner accounts, community engagement strategies used during the Pathfinder project were fairly similar amongst the projects and usually began with initiating a dialogue with individuals or groups who see the benefit of developing community flood resilience programmes. Less responsive communities were engaged through various avenues such as the Parish Council, Fire Services, Police, and other community groups such as the Women's Institute, the Rotary District, or the Lion's Club, amongst others. These groups are usually active within the community and as such are familiar with key community members such as those who are proactive and interested in being involved in various community activities. Interviewee 011 notes that this approach is particularly useful in communities that are still traditionally organised and structured such as more rural communities. Therefore, the use of existing social networks can prove instrumental to community engagements on FRM.

Nonetheless, it was found by some practitioners that not all social networks are strong, closely linked, and cooperative. Interviewee 011 for example, divulged her experiences with community feuds:

> *"you can have anything from if you have local feuds and people who don't get on. We had to work with residents' flood group and town council separately because they couldn't work together, we tried everything and they couldn't get along."*

She notes that these long standing issues within some communities cannot easily be overcome by even the most empowering approaches and as such must always be broached with caution and sensitivity.

Throughout the Pathfinder project it was discovered that many of the community organizations were already discussing community resilience (though not necessarily flood resilience) and how this could be achieved (Interviewee 003). As such their partnerships with the implementing agencies were beneficial in introducing their ideas about approaches towards more resilient communities. Pathfinder engagement strategies provided an avenue to enable effective collaborations between communities and various agencies and partners on their path towards greater flood resilience. A methodology for this facilitation process is viewed by some interview participants as a key outcome of the community pathfinder project on reducing flood risk through preparation and recovery. Project implementing agencies believed this aspect of their engagement was fairly successful and could be utilised in future.

4.4.2 Lessons for engaging different types of communities

Large urban versus small rural communities

In addition to community features such as social networks, the size and type of community may also influence how they engage with flood resilience issues. For instance, flooding in a small community is perceived differently to flooding in perhaps a small section of a larger community as explained by in this example by Interviewee 011:

> *"if you have ten houses flooded in small community it's a huge impact, it's a big thing and the community is fired up and want to do something about it because it had a huge impact on their community. If ten houses are flooded in a larger town then it is much harder to engage with the community as they don't see it as their problem."*

Interviewee 011 illuminates that the implementers of pathfinder projects in England similarly concluded in their progress reports, that in large towns there is more of an expectation and reliance on Local Authorities to ensure the resilience of their communities. On the other hand, in smaller towns, especially isolated or very rural ones, people have come to rely on themselves, neighbours and the wider community. This observation was validated by in discussions with other participants:

> *"in rural locations where there's regular floods...people are far more*

proactive about taking responsibility and doing something about it and preparing for it....So people that particularly where there's a sense of community, smaller communities where flooding is a high risk I think people do take their responsibility and resilience to flooding very seriously." (Interviewee 003)

As a response to this issue some interview participants believed that a lesson from the Pathfinder project for the national FRM agenda is to get across to communities the understanding that these services may not be able to provide help to a specific community when needed. This is because they may be called to another area in greater need or have difficulty accessing their local area depending on the circumstances. Therefore, larger urban communities may require a more rigorous approach to capture their attention and ultimate participation.

Finding appropriate communication tools

Rural and urban communities may sometimes respond to different forms of engagement and communication approaches. For instance at the beginning of Pathfinder project in Devon, the Local Authority had initially planned on developing flood simulations but soon realised that some communities were not interested in this type of communication. In small rural communities where some 30 or less properties were affected, the perception was that they would perhaps not benefit from visualizations as perhaps a larger urban community where the consequences could be enormous. In the case of large urban communities, flood visualisations were perceived as effective and beneficial for engaging with the wider community. Such visualisations were used in Exeter and:

> *"they prompted some really good discussions about flood risk because people were going oh gosh that's my house ... it really made them think about actually we need to prepare and we need to put in our own you know flood protection measures or whatever"* (Interviewee 003)

Some participants postulate that in cities and large towns where people were less connected compared to smaller semi-rural areas where people typically know each other, engagements are most successful when undertaken on the ground, through the use of champions who have the ability and connections to take the message out to the community. It was also found that in some urban areas use of traditional ways of communicating with households such as news bulletins, parish newsletters, etc. were sometimes successful. The research experiences leading to this thesis have shown that engaging with urban communities on the matter of flooding can certainly be more challenging than a small village but each has their unique challenges. For instance in small villages, residents are likely to be much older and find the matter of flooding to be too stressful to worry about whereas in large towns there is some measure of flood denial and or reliance on infrastructure.

4.4.3 Communicating flood risk

Communicating probability and residual risk

It is agreed by practitioners that when they engage with communities it is difficult to communicate flood risk particularly in terms of the probability aspect of risk. As noted by one practitioner

> *"the sort of one percent in any one chance in any one year...people don't quite get what that means"* (Interviewee 008).

Although no one seemed to have a direct solution to this age old problem, it was agreed that new approaches were needed where engagement and communication on flood risk in communities was concerned. One such approach was the concept of communicating residual risk which some believe is beneficial to engagements about flood risk. As explained by Interviewee 011 communities sometimes forget that flood defences can potentially fail and when they do their families and properties could face several consequences. The following examples highlight the need to ensure that residual risk is discussed with communities, particularly those with flood defence schemes:

> *"I'll give you a very good example, in Braunton [north Devon] their flood defences overtopped and it was a total shock. They didn't think that could happen....They realised they were not entirely safe. It's always trying to convey that issue of risk, it registers a risk of this might happen, might still happen."* (Interviewee 011)

"Carlisle hadn't flooded for forty years and when Carlisle flooded in 2005 well over a thousand properties were flooded and they were taken completely unprepared...and they all thought because they hadn't flooded since the 1960s they'd never flood again...flood defences reduce your risk, they do not take it away." (Interviewee 007)

In addition, it is not possible to defend and protect everywhere, and people and property will still be at risk from severe, exceptional floods that are beyond the design standards of flood defences (Djordjevic et al, 2014). In recognition and acceptance of this reality and a drive away from flood defence towards FRM, the concept of residual risk is now permeating the discourse on community flood risk and appears to be useful in improving understanding that the threat of flooding remains despite engineered defences. Interviewee 003 who works with communities along the river Exe believes that their awareness of flood risk has improved with more discussions on residual risk:

"even though they have got...good kind of flood alleviation schemes in place they still I think they still kind of understand that there is that small residual risk that if they're you know there was an extreme event that those defences could overtop." (Interviewee 003).

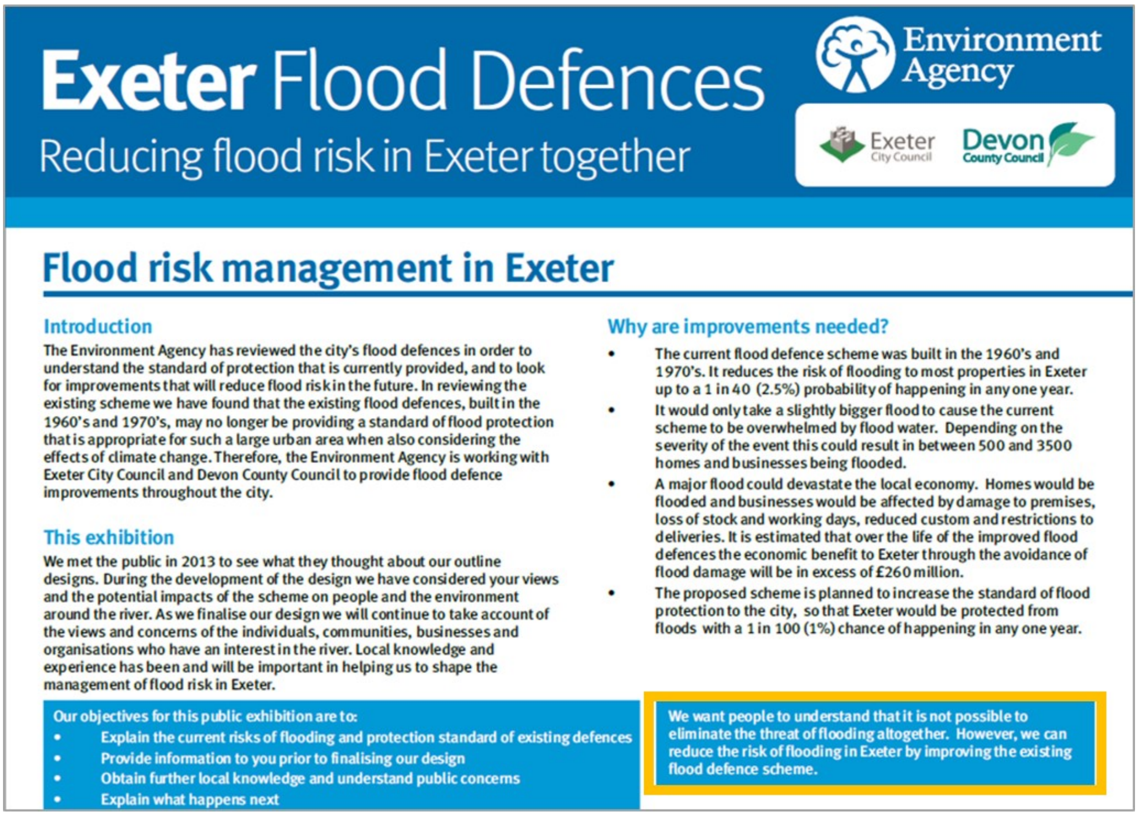
Where in the past the EA would not have mentioned the concept of residual risk with a community out of fear of negative perceptions, this appears to be more readily done in today's FRM landscape (Interviewee 008). Based on the account of Interviewee 008, the EA seems to be getting better at reminding communities that even though flood defences have been constructed to reduce their risk of flooding, they do not totally remove that risk.

"I think they're getting better at saying it now, they didn't used to say it at all and I actually started lobbying them, I went straight to the top and said in the light of what's happened recently we've got to stop, we've got to tell people at the celebrations of a flood defence we've got to remind them that even though they might not want to be reminded because it's a happy day that their flood defences reduce their risk, they don't take it away."

This claim was validated by one of the EA participants who agreed that this type of message is important in their communication and engagement with communities and residents as they believe it can be especially useful in helping them to make informed decisions:

> *"we need them to know that there is a residual risk, that there is a risk of flooding even though they have got defences so we're trying to do that in a number of ways."* (Interviewee 003).

The EA are therefore now using different methods to communicate the idea of residual risk to households, businesses and communities. Evidence of such communication of residual risk by the EA was noted in one of their flyers used in a 2014 consultation which was held to discuss the planned upgrades of the flood defense schemes along the river Exe in the community of St. Thomas (Figure 4.1).



Exeter Flood Defences

Reducing flood risk in Exeter together

Environment Agency

Exeter City Council

Devon County Council

Flood risk management in Exeter

Introduction

The Environment Agency has reviewed the city's flood defences in order to understand the standard of protection that is currently provided, and to look for improvements that will reduce flood risk in the future. In reviewing the existing scheme we have found that the existing flood defences, built in the 1960's and 1970's, may no longer be providing a standard of flood protection that is appropriate for such a large urban area when also considering the effects of climate change. Therefore, the Environment Agency is working with Exeter City Council and Devon County Council to provide flood defence improvements throughout the city.

This exhibition

We met the public in 2013 to see what they thought about our outline designs. During the development of the design we have considered your views and the potential impacts of the scheme on people and the environment around the river. As we finalise our design we will continue to take account of the views and concerns of the individuals, communities, businesses and organisations who have an interest in the river. Local knowledge and experience has been and will be important in helping us to shape the management of flood risk in Exeter.

Why are improvements needed?

- The current flood defence scheme was built in the 1960's and 1970's. It reduces the risk of flooding to most properties in Exeter up to a 1 in 40 (2.5%) probability of happening in any one year.
- It would only take a slightly bigger flood to cause the current scheme to be overwhelmed by flood water. Depending on the severity of the event this could result in between 500 and 3500 homes and businesses being flooded.
- A major flood could devastate the local economy. Homes would be flooded and businesses would be affected by damage to premises, loss of stock and working days, reduced custom and restrictions to deliveries. It is estimated that over the life of the improved flood defences the economic benefit to Exeter through the avoidance of flood damage will be in excess of £260 million.
- The proposed scheme is planned to increase the standard of flood protection to the city, so that Exeter would be protected from floods with a 1 in 100 (1%) chance of happening in any one year.

Our objectives for this public exhibition are to:

- Explain the current risks of flooding and protection standard of existing defences
- Provide information to you prior to finalising our design
- Obtain further local knowledge and understand public concerns
- Explain what happens next

We want people to understand that it is not possible to eliminate the threat of flooding altogether. However, we can reduce the risk of flooding in Exeter by improving the existing flood defence scheme.

Figure 4.1: An example of the change in EA communication to remind communities that engineering features do not remove flood risk entirely (Source: Environment Agency (2015*b*)).

Using flood memories and experiences

Another potentially effective approach to community engagement and participation found by those participants involved in Pathfinder was the use of a model of peer-to-peer experience. This is where those who have been affected by flooding in the past recall their experiences and explain how what coping mechanisms and measures they have since employed and whether or not these have been beneficial. Interviewee 008 who works extensively with communities further explained this method that she has used:

> *"Me going in or other people that have been flooded, other communities working within communities at risk I think is far more powerful and has a far greater effect with those at risk than those that manage flood risk doing so ... when we had our feedback forms it was the fact that they found that most useful, practical help and support from flood survivors and people that are helping themselves .... you immediately can empathise, you are looked on as an equal, you don't look on as if you're telling them what to do you are just speaking out of experience .... I'm not telling them what to do, I'm sharing my experience."* (Interviewee 008)

She further notes that this approach proved successful even in communities where the initiation of engagement activities was difficult :

> *"to be honest it was an uphill struggle but once I'd spoken to them about what it's like to flood and how a little bit of planning and preparation in advance could reduce the misery of people and I talked through my own experiences we found that we managed to turn round people."* (Interviewee 008)

Interestingly this approach is being more widely applied in community engagement in various forms. For instance interviewee 008 has been contracted by various LLFAs, engineering consultancies, and the EA to undertake this peer-to-peer engagement with communities. Barr and Woodley (2013) used the sharing of memories as a means of facilitating discussions and knowledge co-production about flooding in Dulverton (Devon) between community members and experts. A similar approach of collecting memories and stories is being used to help build local, historical knowledge about drought impacts, experiences and adaptation (coping) through the DRY project which is the first of its kind in the UK. Experience sharing and building of memories therefore appears to be an emergent approach in community engagement and knowledge co-production in an era characterised by attainment of sustainability goals and resilient outcomes as a response to a growing climate change dilemma.

4.4.4 Shifting the blame game and empowering communities

There was general consensus that households and communities continue to be highly reliant upon government and infrastructure even under the current FRM agenda. Flooding is often attributed to the fault of an outside force such as the government. Some direct quotes reflecting these discussions are as follows:

> *"I think until recently there was the expectation that local committee/government,...would do something for them and you know the immediate reaction after a flood event is that that should never have happened; you should have done something to prevent that from happening. So I think shifting that perception is taking a long time"* (Interviewee 011)

> *"there is an expectation that an authority be it Environment Agency or the water company or the local authority or government is meant to deliver"* (Interviewee 007)

> *"I think we worked with about 18-20 properties and none of them had done anything about it since 2012, they were still expecting for the government to sort it out...it's still a long way to go...It's expecting the government to control the weather....you can blame a lot of reasons for why flooding takes place ...obviously it's easier to blame the government, the town planning."* (Interviewee 011)

The interview participants strongly agreed that this transference of blame and lack of acceptance of shared responsibility was an imperative issue where engagement and communication efforts regarding flooding and flood risk are concerned. It is believed that this can be reversed by empowering communities in various ways. According to Interviewee 007:

"you have to give them the confidence and the skills and the power to be able to work with the relevant authorities, being able to work out what their flood risk issues are and to work collaboratively to address them."

He further goes on to explain that when a community feels empowered and are given the opportunity to work together,

"communities are quite willing when they know what and how and where and when."

In empowering communities interviewee 011 specified that

"you need to provide skills, a bit of resources, advice and guidance and also provide a bit of a broker you know a facilitating role with e.g. partners."

Therefore there are several avenues through which a community can be empowered to take action and these will vary from one community to another according to their needs. Those involved in the Pathfinder project explained that throughout the project, they did not approach communities as flood resilience experts. Since the essence of the project was to engender a community approach to flood resilience, communities were able to define how, and by what means, household and community resilience could be achieved based on their own local situation. The point of view was that a community flood resilience programme really had to come from the community and gradually implemented by the community and their social networks with the help of various partners. Interviewee 011 believed that power was granted to the people through this empowering approach versus from the point of view of experts with a strict set of activities that they want to impose on the community to *"make them resilient."* As an alternative, implementing agencies provided support and resources to enable the communities to develop their own plans. Hence enabling a shift from *experts to alliances* (Newman et al., 2011). The following quote illustrates this notion:

"We came to the communities by saying we can help you with for example either doing a flood plan or community emergency

plan...flooding was the starting point with most communities involved. We say we can help you with that and we had facilitators helping, they were writing the plans themselves....we would get people around the table, build scenarios; they could test it, identify gaps in the plan, build confidence so they feel that their plan is working." (Interviewee 011)

Financial empowerment

Furthermore, grants awarded to communities under the Pathfinder project were expended at the liberty of the community. They were able to purchase material and equipment that they felt would help them to activate their flood plan e.g. signs, sandbags, shovels, radios, gloves, etc. (Interviewee 011). Additionally project implementers were also assisting community groups in identifying sources of funding that could aid in not only the implementation of their plan but also for expanding the plan and ensuring its longevity. The following example illustrates a case where the community was assisted with funding and technologies to execute elements of their community flood resilience plan:

> *"we were working mainly with what we call a rapid response catchment so that means these are communities that are prone to flash flooding....Sometimes the Environment Agency flood warning systems are on the main rivers, bigger river where the river will respond very slowly so that was not very helpful to these areas. We put some money into offering communities to have flood warning systems, very simple technologies. River pressure level gauges, rain gauges that they could put at the top of the catchments they could receive alerts when it's at critical thresholds and they could also respond to it by communicating and cascading down into the rest of the community."* (Interviewee 011)

Nonetheless, access to funding remains a major challenge for communities, particularly those with less social capital and hence weaker social networks. Empowerment in community flood engagement includes the enabling of mechanisms and environments for providing financial resources for communities. This is especially helpful in building household resilience in communities that may not be part of any structured project or programme such as Pathfinder. It was the experience of some practitioners that in addition to the targeted high risk communities, there were other communities that were also keen to participate in Pathfinder projects despite not being amongst the target communities. This prioritising of financial resources becomes even more relevant when there exists many communities at varying levels of risk that do not qualify for capital expenditure projects but might want to implement household and community resilience initiatives. Such communities might want to make a change but find themselves in the position of being financially disempowered. Some of these examples are reflected in the quotes below:

> *"we had all those new communities that were coming along and keen to participate in the project and although they weren't part of the original communities that we were targeting we didn't want to push them away. We'll help you as much as we can, but for the grant we can't give you a grant because we don't have enough in our budget. We worked with other organisations such as the Devon Community Foundation and they were happy to provide some grants."* (Interviewee 011);

> *"they kind of had an idea of what they wanted to do and they had the people ready to do the works like local farmers and landowners but they just needed the money and that was great we were able to just give them the money and help you know just they basically got on with it....successful scheme to divert a bit of water off their road and reduce the risk of property flooding."* (Interviewee 010);

> *"and a fine case study for you would be the Bodenham Flood Protection Group....they were flooded in 2007 and that's when fifty-seven thousand other properties were flooded, they realised they were at the bottom of the pecking order for help so I suggested that they actually did it themselves. So they actually got a working group together, got into the ditches, went on training courses...so as a result of them being proactive they got property level flood protection grants from the Environment Agency and DEFRA....they managed to get a free telemetry system to warn them that the local streams were rising rapidly as a gift for being so proactive"* (Interviewee 004)

These situations illustrate that, in addition to asking the public to become more involved in household and community flood resilience, government and its policy implementing agencies must continue to prioritise resources that will advance this agenda successfully because *"they are a very important part of the flood risk management solutions"* as acknowledged by Interviewee 004. Therefore, they need to have various sources of support that will aid in empowering them in different ways. This includes balancing investment priorities between competing interests such as capital investments for engineering projects and adequately funding Local Authorities so that they can continue to invest in people and communities. According to Interviewee 011,

> *"we need to do more of resilience work, we can't just go back to our old ways and forget about this two years project. We decided that this is very important and that's the way forward. So it's dividing our technical and infrastructure issues as well as advising resilience issues so they come hand in hand."*

Past experience of flooding

As discussed elsewhere in this thesis, past experience may serve as either a driver or a barrier towards the implementation flood coping responses. The following two examples illustrate where a previous flood has either quelled a community into complacency or driven them in the pursuit of a resilience agenda:

Interviewee 007 elaborates on the latter point in her experiences with a Worcester (Worcestershire) community that has experienced surface water flooding in the past but were not prepared to make any changes:

> *"but people that have been flooded just once think it's just a one-off and they don't think that they remain at risk they think it might be a fluke thunderstorm or something like that particularly an urban flood risk where there's no tangible river or the sea or the coast in front of their door but the whole housing estate is paved over and there's nowhere else for the water to go, they don't get flood risk and just think they've been flooded once that's not going to happen again and it's really from my experience of working with people."* (Interviewee 007)

The impact o past experience can indeed be conditional as Interviewee 011 explained the opposite for a community she worked with that was flooded in the 2012/2013 period:

> *"in 2012 and 2013 this wasn't just now a combination of a bit of tidal surge, it was water everywhere; running down the streets; culverts blocked; lot of properties getting flooded that normally wouldn't flood. So it probably was a bit of a wakeup call, outside of their comfort zone. This is not like it used to be. The town council decided that this is something that the Town Council should be tackling so when we approached them there was already that frame of mind saying yes we need this, we think it's important. And there it was the town council that led it not the community, but it was a bigger sort of community and took in a wider population. So you see it can go the other way"*.

4.4.5 Section summary

The recent implementation of flood policy at the local level through projects such as Pathfinder, has introduced community coping measures at a scale not seen before in the UK. This is therefore already a major accomplishment. However, many challenges remain with regards to engaging with communities and involving them in a more participatory role. The perceptions of the threat of flooding itself is perhaps the greatest challenge as these are convoluted by ideas of probability, likelihood and past experiences. Practitioners have found that communities need empowerment in different forms to keep them engaged and involved with issues of flood risk and to support the transition from a state of reliance on outside sources to one of co-managers in a process.

4.5 Chapter summary and conclusions

The above discussions highlight the many challenges and obstacles that both practitioners and communities tend to face when trying to implement community projects and provides useful insights towards the aim of the thesis. Engagements with regard to community drought and flood resilience can become fraught with various cross-cutting issues. Some of the most critical of these include the need for empowerment through the provision of resources to build capacity and provide fiscal freedom; the moderating effect of past experience on future behaviours which can either lead to behaviours that engender greater resilience or no result in change in behaviour; the value of sharing memories and stories of extreme events; and the many facets involved in communicating the issues of drought or flooding.

Privatisation of water supply services and the central role of flood defence in flood management have framed water service users as passive customers who rely on the service contract and the state to provide protection. However, the increased frequency and intensity of extremes means that this hydrosocial contract must be re-framed to ensure that households and communities are more resilient to the consequences. Several efforts are clearly now underway to counter these existing hydrosocial contracts as seen from the discourse in this chapter. This thesis aims to contribute towards the shifting of these contracts and to contributing to more resilient and sustainable management of water at the household and community levels. To this end, the ensuing chapters will seek to better understand the water service user as households with the intent of developing an action-oriented intervention.

5 EXPLORING HOUSEHOLD PERCEPTIONS AND INTENTIONS TOWARDS DROUGHT COPING

5.1 Introduction

As a response to the various threats, and their potential consequences, to the water sector, it is increasingly being proposed that a whole-cycle planning and management approach be pursued to achieve sustainable and resilient outcomes. Such an approach should encompass all components of the socio-technical system including household and neighbourhood actors. A combination of top-down and bottom-up approaches must therefore combine with technical and social strategies. Whilst engineering solutions are being sought to address the resilience of water management systems, so too are solutions being sought to better understand how water service users can reduce their demand. This thesis is most concerned with understanding the perceptions of water service users and understanding what drives their intentions and behaviours in response to the threat and consequences of drought. Illuminating these issues is expected to contribute towards the development of a bottom-up strategy within the socio-technical system with a focus on flooding and drought as extremes of UWM system failures.

Already there is a recognition that responsibility of households and communities are critical to the FRM agenda and the policy framework is addressing this as seen in the policy review in Chapter 2. However, with regards to drought management, since households and businesses have been scripted as solely customers paying for a service that must be delivered at a certain standard (LoS), no similar expectation of responsibility exists. Drought management is therefore still largely technocratic which is in itself a barrier to the rationale for the development and implementation of bottom-up roles and approaches.

In an effort to further contribute to this bottom-up strategy the objective of this chapter is to characterise and explore the nature of key drivers and barriers of household drought coping.

Table 5.1 below outlines the objectives and research questions addressed in this chapter.

Table 5.1: List of objectives and research questions to be addressed in this chapter

Objective 3: To determine indicators of behavioural intentions in household drought coping	**Objective 4:** To explore the role of indicators in decision-stages for household drought coping
1. How do households perceive: • severity of drought consequences? • the effectiveness, self-efficacy and cost of coping measures? • Climate change implications for drought? 2. Do participants have intentions to implement drought coping measures? 3. What are the key indicators of household drought coping intentions?	1. Are there sub-groups of decision-stages for household drought coping? 2. Can the indicators define and explain decision-stages for drought coping?

The quantitative methods and approaches described in Chapter 3 were utilised to collect and analyse data in attempt to answer these questions. Analysis of the results of the cross-sectional survey, as well as interviews, undertaken as a part of this research has compiled much of the appropriate data to expedite these analyses. This is the first of two consecutive chapters that will comprise these results. In this chapter the focus will be on drought risk perception and coping behavioural intentions under low probability high consequence scenarios.

The remainder of this chapter is divided as follows. Section 5.2 presents an overview of some basic elements of the socio-demographic composition of the sample. This is followed by Section 5.3 which analyses and discusses the socio-technical variables of reliance, trust, and past experience. Then Section 5.4 describe behaviours and behavioural intentions towards drought coping measures. Section 5.5 provides an appraisal of the threat of drought (including perceptions of the likelihood and consequences of drought) and perceptions of climate change and its influence on extremes of drought. An appraisal of drought coping is provided in Section 5.6 which presents perceptions of the efficacy of drought coping response measures, and perceptions of self-efficacy and response costs associated with drought coping. The results of drought coping indicators and analysis of drought coping decision-stages are discussed in Section 5.7. Finally, the chapter closes with a summary whereby the results are re-contextualised alongside the theoretical framework of PMT, as introduced in Chapter 2, underpinning this aspect of the research. The summary highlights the key messages of the chapter, including conclusions about the research questions, and implications for the ensuing chapter.

5.2 Community socio-demographic profile

Age distribution was skewed towards older age groups with the majority of participants being 55 years and older (Figure 5.1). Much of this skewness could be accounted for in the Topsham community which had more than 50% of its participants being 65 years and older. In fact the 75 plus age group was the largest in Topsham (28%). A majority of female participants in St. Thomas were represented in the over 55 age group whilst in Topsham the males were mainly 55 and over. Whereas more females (63%) completed the survey in St. Thomas, the reverse of majority male completed the survey in Topsham (56%).

Houses were predominantly (60%) occupied by one and two persons in both communities represented by mostly older groups of households. This is consistent with the 2011 census for both communities (Office for National Statistics, 2011). These were the older age groups and hence likely the retired population with adult children away on their own. Younger households in St. Thomas comprised an average of three occupants perhaps indicating families with children and shared households. Participants were living in the communities for various numbers of years ranging from less than one year to over 50 years with the mean period being 20 years. Some 15% of participants had lived in the communities for at least 30 years. As expected older participants have, on average, been living longest in the communities although some older participants had moved into the communities in recent years.

In terms of education and home ownership, the communities displayed similar patterns. Within both communities up to 60% of participants in each had a combination of undergraduate and postgraduate education qualifications (or

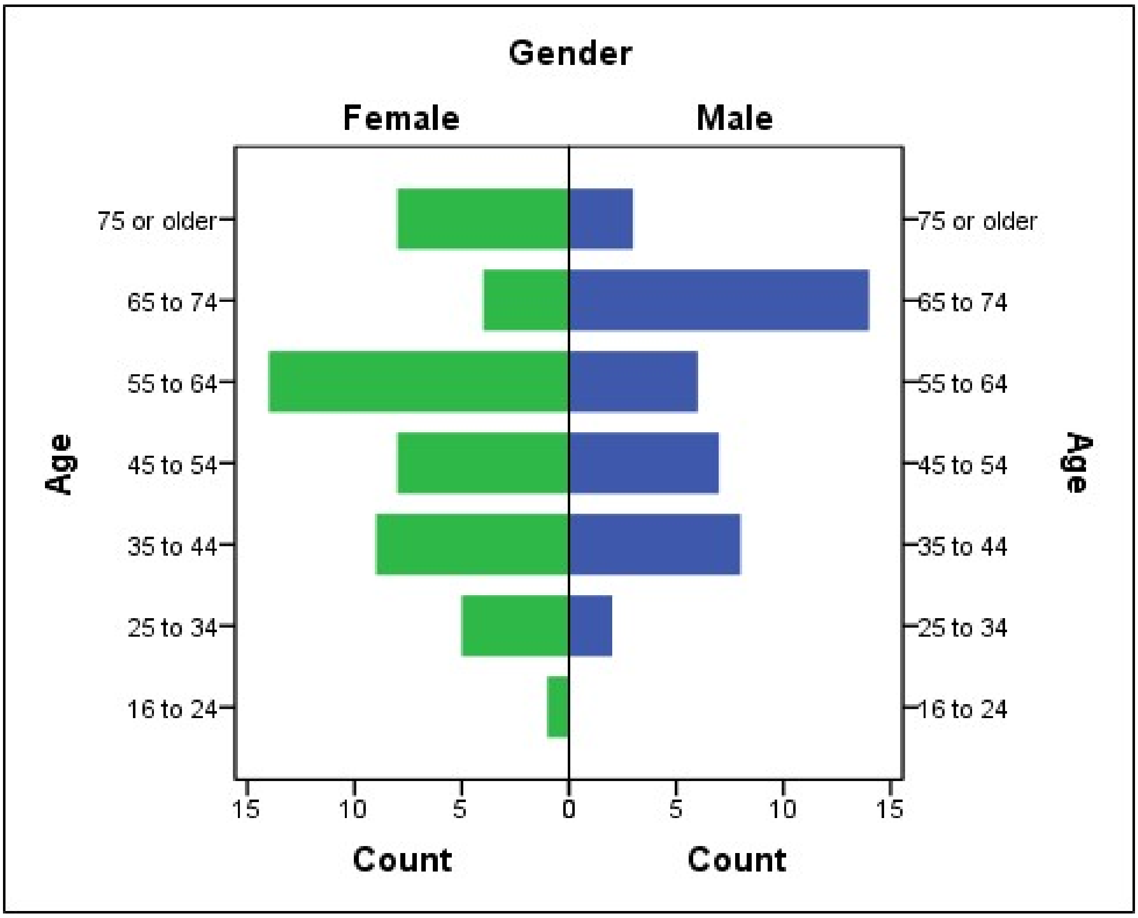


Figure 5.1: Distribution of participant age versus gender across both communities (n=91).

their equivalents). The majority of the remainder had a mix of majority secondary school level (GCSE and A Levels), and a minority with vocational level qualifications or no formal qualifications. Generally, participants in younger age groups had higher levels of educational qualifications compared to older participants and appeared to be female. Where home ownership was concerned the majority (>70%) of participants owned their home. In Topsham, some 83% of the participants were owner-occupiers, 11% private renters and the remainder had missing data, whilst in St. Thomas 73% were owner occupiers with the rest being private tenants. Home ownership increased with age in both areas.

Where income was concerned, Topsham appears to be a higher income community compared to St. Thomas, with over 30% indicating that their annual household income ranged from £35,000 and upwards. However, some 20% of the participants from Topsham opted not to reveal their income categories. Amongst the St. Thomas participants their incomes ranged from low income (<£15,000) to high income with the highest proportion (35%) being medium income earners. Close to half (44%) of participants preferred not to indicate what their annual household income category was, presenting a major limitation to the validity of testing the influence of income on behavioural intentions.

5.3 Reliance, trust, and past experience

Complex factors and feedback processes that are financial, social and environmental in nature often combine to control the way people respond to a threat (Bubeck et al., 2012). Some of these social factors connect with the wider socio-technical system of provision. This is particularly so if the systems are defined by high levels of reliability, are technically driven, and strictly regulated as obtains in the UK water sector.

5.3.1 Reliance

Drought is often viewed as a failure as discussed in Chapter 4 and hence is not expected and/or have low public acceptance. As such, household users become reliant on water supply systems resulting in limited planning to respond to potential failures. This study found that 22% of all participants accepted no loss of service in water supply even during a drought whilst 60% expected losses of only a few days up to one week. There was no significant difference in perception between the two communities (U=924.00, z=-0.41, ns).

Postponement variables which included reasons that would further encourage households to implement coping response measures in future were viewed similarly amongst participants from the two communities. It was found that the majority of participants (>60%) would be more willing to prepare for a drought if: 1) they received an incentive; 2) it became a legal requirement; 3) they were to be severely affected by a drought in the future. They were less inclined to implement drought coping measures if their neighbours were doing the same.

In most case, it appears that household responses would need to be prompted by some change in the STS such as an incentive in order to increase their uptake of certain drought coping response measures. This is against the finding of high agreement by a majority of participants (>60%) that in addition to water companies and government they too had a role in drought management.

5.3.2 Trust

Where trust was concerned, participants displayed mixed perceptions in how they perceived some agencies and organizations involved in local planning and management. Devon County Council and Exeter City Council received the lowest confidence ratings. The EA and South West Water were better rated with less than 15% of participants selecting the lower confidence scales (1-2). On the other hand over 30% of participants selected the lower scales for the city and county councils. Generally, neither the city council nor the county council have a history of managing droughts and hence this fact may strongly account for why they were both rated with very low confidence for drought risk management. As discussed in Chapter 2, drought management and planning takes place at a more centralised level involving largely the EA and Water Companies. As seen in Table 5.2 below, there is no significant difference in perceptions of trust between the two communities.

Table 5.2: Mann-Whitney U test of the differences in perceptions of trust between the two communities.

	Environment Agency	**Exeter City Council**	**Devon County Council**	**South West Water**
Mann-Whitney U	940.50	782.50	848.50	852.00
Wilcoxon W	2480.50	2322.50	2388.50	2392.00
Z	-.46	-1.59	-1.02	-.97
Asymp. Sig. (2-tailed)	.65	.11	.31	.33

5.3.3 Past experience

The only study to date that has assessed household drought coping intentions in a developing world context, Mankad et al., 2013, has not assessed the influence of past experience on behavioural intentions. In Exeter, close to 70% of the participants from both communities had never experienced a drought since living at their current address. Naturally, those who had experienced a drought, were the ones who had lived in the areas longest.

In St. Thomas, 60% of participants who had experienced a drought perceived the past droughts to have been of low or very low severity, while the remaining 40% perceived them to be of medium severity. All the past droughts experienced by Topsham participants were perceived as very low severity. In addition to the droughts experienced at their current addresses, some 32% of participants from both communities indicated that they had experienced a drought whilst living at a previous location. As only a minority of participants had experienced a drought in their current address, it is noted that the communities both have little experience or history of drought, but particularly Topsham. By extension, experience of preparing or planning for a major drought is equally low.

5.4 Drought coping intentions and behaviours

This section explores behavioural intentions towards household drought response measures. A series of water efficiency measures were presented to participants in the survey instrument (see survey in Appendix A) to gauge their behavioural intentions towards drought coping. These measures have been grouped as water conservation measures, alternative water use, and water storage. Results are presented and discussed below. Basic statistics about the intentions towards these measures are presented in Table 5.3 below.

Table 5.3: Statistics of behavioural intentions towards drought coping response measures (N=91)

	Use Water Butt	**Store water**	**Reuse household grey waters**	**Use SWW recycled water**	**Take shorter showers**	**Install water saving devices**	**Adhere to hosepipe ban**
Mean	3.08	2.66	2.58	2.24	3.21	3.04	3.39
Median	3.0	3.0	3.0	2.0	3.0	3.0	3.0
Std. Deviation	0.95	1.1	1.04	0.68	1.0	0.86	0.66
Variance	0.89	1.21	1.09	.46	1.0	0.73	0.44
25^{th} percentile	3.0	2.0	2.0	2.0	3.0	2.0	3.0
50^{th} percentile	3.0	3.0	3.0	2.0	3.0	3.0	3.0
75^{th} percentile	4.0	4.0	3.0	3.0	4.0	4.0	4.0

5.4.1 Water conservation measures

Water conservation measures included in the survey were: 1) taking shorter showers; 2) installing water saving devices; and 3) adhering to a hosepipe ban. These measures are typical drought protection measures used in the UK and other developed countries. Some of these measures were reported to be amongst the most low-cost, efficient, and successful demand-side strategies in response to the Australian Millennium drought (Turner et al., 2016).

In terms of minimising water usage, it was reported than 50% of participants from St. Thomas and Topsham were already taking shorter showers. This is a practice that may be linked to a need for lower water bills in a region where the water rate per capita is amongst the highest in the UK. According to Ofwat's report on affordability (Ofwat, 2011), water and sewage charges in 2011-2012 ranged from £311 for Severn Trent Water customers to £517 for customers in the South West Water area. The largest proportion of South West Water customers spend above 3% and 5% of their income on water and sewerage bills respectively (compared to the England and Wales average of 1.6%) (Ofwat, 2011) and hence it is possible that the need for lower water and sewerage bills is the driver for shorter showers amongst participants.

An average of 35% of the participants between the two communities, had already installed water saving devices, and an average of 37% indicated that they plan to do so. South West Water in collaboration with Savewater.co.uk currently offers a free water saving kit to each household in the region (http://www.southwestwater.co.uk/freewatersavingkit) and so it is to be expected that some households have benefited from these offers. Still approximately 24% overall were undecided about the use of water saving devices, more so in Topsham. At least 30% of the participants from Topsham were uncertain if they would install water saving devices compared to 18% from St. Thomas. Only less than 5% of participants from either community did not plan to install water saving devices.

Adherence to a hosepipe ban as a water company drought response measure received favourable response from participants in both communities and is the main consequence faced by households in response to drought (Bell, 2009). There were 46% and 61% of participants from St. Thomas and Topsham who indicated that they were already adhering to a hosepipe ban. They perhaps meant that they have adhered to hosepipe bans in the past, with the last one being issued in the region in the 1990s . Unwillingness to adhere to hosepipe bans was reflected by 2% of St. Thomas participants compared to Topsham where no one selected this option. However, 11% of the Topsham participants were undecided as opposed to just 4% from St. Thomas who were undecided. It is not surprising that most participants would indicate a willingness to adhere to a hosepipe ban as this is usually the response most associated with a drought as found in Chapter 4.

Whilst decisions about water use efficiency can often be centred around financial matters, there are also social and environmental variables that drive such behaviours. An important social aspect relates to the sociology of water use (Shove, 2003) which embodies the perceptions of personal hygiene and comfort, both of which impact the way people use water, often resulting in actions such as long showers or daily baths. Allon and Sofoulis (2006) argue that effective management of water demand cannot ignore the social and cultural differences associated with different habits, expectations, meanings and practices of water use. The socialisation around these conventions still remains as an important aspect of sustainability as does the improvement in technological innovations for improved efficiency (Shove and Walker, 2010). Therefore, despite the efforts made by water companies in encouraging water saving behaviours through technological innovations, the embedded social conventions around water use will continue to challenge these expected behaviours.

In addition to financial considerations and conventions of personal hygiene as major factors influencing personal water use, customers can have different values. For instance, customers identified as 'socially-conscientious customers' in a CCW commissioned report by YouGov (YouGov, 2013), are motivated by their concerns about the environment and the implications of their actions. Similar actors were also identified by Dessai and Sims (2010) and Gilg and Barr (2006). Although not directly linked, the current research found that 42% of those who were already taking shorter showers and 29% who had installed water saving devices agreed that sustainable water use practices were important.

Behavioural intentions towards the implementation of water conservation practices were the highest amongst water efficiency measures (Figure 5.2). There was no significant difference in behavioural intentions between communities as seen in Table 5.4 below.

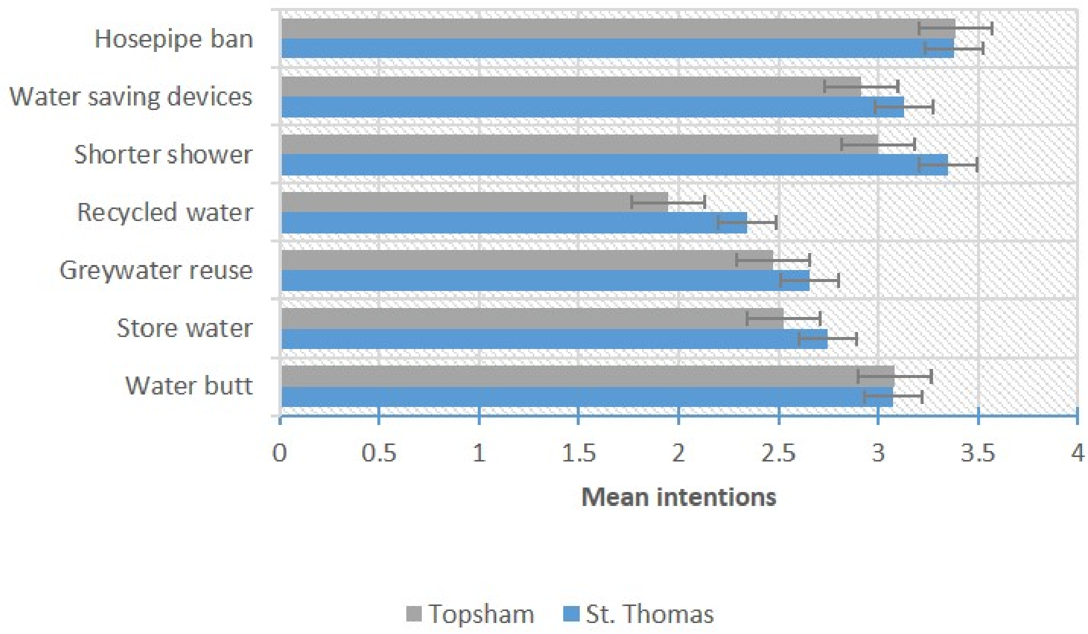


Figure 5.2: Mean behavioural intentions towards personal drought coping measures. (n=91)

Table 5.4: Significance tests of difference in intention towards implementation of water conservation measures

	Taking shorter showers	Installing water saving devices	Adhering to a hose pipe ban
Mann-Whitney U	889.00	850.50	976.00
Wilcoxon W	1555.00	1516.50	2516.00
Z	-0.90	-1.20	-0.13
Asymp. Sig. (2-tailed)	.37	.23	.90

5.4.2 Alternative water use

The supply of recycled water and reuse of grey water are important alternative sources of water that increase efficiency during a major prolonged drought as seen in the Australian Millennium drought (Turner et al., 2016). Intentions towards implementation of these two types of alternate waters was assessed in this research. These are not traditional sources of water for the UK but are slowly gaining importance as measures of scale towards drought resilience. Although there can be quite sophisticated configurations for grey water reuse systems, here more crude systems of collection in buckets are considered for simple uses such as gardening.

Perceptions on the reuse of grey water from showers and laundry were similar between the two communities. However, the number of participants from Topsham who selected “plan to do” for this option was far less than those from St. Thomas (25% compared to 40% respectively) and was the main area where the two differed. Some 20% of participants from both areas were already using this type of water possibly for gardening purposes. This finding was surprising for several reasons. One reason being that access to grey waters is often restricted by the inflexible nature of existing infrastructure and would possibly require labour and effort as found by Hurlimann (2011). Another reason is that of social acceptance. Since this is not a traditional source of household water (at least not up to this point in time) complex social issues, including fear of being perceived negatively, can often determine willingness to use this alternative as illustrated in the previous chapter. Hurlimann (2011) also found that tenants perceived their inability to adapt their household infrastructure due to their housing tenure status as a barrier to the use of alternative water sources. However, this study did not find any significant difference in intentions between homeowners and tenants (U=514.50, z=-0.61, ns).

Even though recycled water is not currently a source of water that is supplied by Water Companies in the UK, this was included as a means of responding to a major drought as it was one of the measures implemented by state governments during the Australian millennium drought (Turner et al, 2016). The use of recycled water was unsurprisingly the measure with most uncertainty amongst participants from either community (47% St. Thomas and 53% Topsham). There are many issues with recycled water (e.g. sanitation and aesthetics) that the average householder is not likely be aware of or comprehend which does warrant some measure of uncertainty with regards to its usage. Whereas 21% of the participants from Topsham indicated that they would not use recycled water, only 9% of those from St. Thomas stated likewise. Some 44% of St. Thomas participants plan to use this source of water if supplied in a major drought compared with 27% from Topsham.

Participants had the lowest intentions towards the implementation of these two measures (Figure 5.2). There was no significant difference in intentions between communities for grey water reuse (U=890.50, z=-0.84, *ns*) or use of recycled water (U=728.50, **z**=-1.92, *ns*).

5.4.3 Water storage

For water storage, the survey examined perceptions towards storing water at home and storage of water for non-potable uses by means of a water butt. Compared with alternative water, there were higher intentions by participants to implement these measures (Figure 5.2).

Storing of water at home was one of the most implemented measures with 33% and 28% of the participants from St. Thomas and Topsham respective already using this measures. Less than 20% from both communities had no intentions to store water while a majority (42%) from Topsham were undecided. Twice as many people from St. Thomas (27%) had intentions to store water compared with Topsham (14%). Combined, both communities had 38% of participants who indicated that they were already using water butts for non-potable uses. There was also a high rate of participants who plan to use water butts in future (44% St. Thomas and 36% Topsham). Twice as many participants from St. Thomas (13%) had no intentions to install a water butt compared to Topsham (6%). There were no significant differences in intentions towards storing water at home (U=877.50, z=-0.95, *ns*) and use of water butts (U=975.50, z=-0.13, *ns*).

5.5 Threat appraisal of drought

The threat appraisal of drought within the study areas included perceptions of likelihood and consequence, the results of which are presented in this section.

5.5.1 Likelihood and consequences

Perceived likelihood of drought

The two communities were quite similar in terms of their perceptions about the likelihood of a major drought (U=952.50, z=-0.01, *ns*). It was generally perceived by $>$70% of participants in both communities that a major drought would have a low to very low likelihood of affecting their local areas as seen in Table 5.5. Only a minority of participants believed that a major drought had medium (18%) and high likelihood (5.6%). Mankad et al. (2013) similarly found that despite the recent millennium drought, participants in South-east Queensland, Australia, did not perceive the likelihood of a drought or water shortage to be high. In both cases, this perception of low drought probability in countries where drought is historically ‘normal’, is perhaps linked to the reliability of water services in these countries where there has been significant economic and technological investment in securing and maintaining the ‘water supply’ city.

However, despite these advancements, it is noted by Taylor et al. (2009) that water stress is becoming a permanent feature of life in Britain and other developed societies, thereby prompting changes in ‘consumer behaviour’ to meet sustainability goals. This drive in consumer behaviour has more recently been extended towards the achievement of resilient outcomes. With the many threats facing the water sector, it is expected that the water future of the UK may face greater risk of supply shortfalls and more severe consequences for the economy and customers (Water UK, 2016).

Table 5.5: Perceptions of drought likelihood amongst participants of St. Thomas and Topsham, Exeter.

Community	**Drought likelihood in local area**	**Percent**
St. Thomas	Very low	30%
	Low	47%
	Medium	19%
	High	4%
	Very high	-
Topsham	Very low	33%
	Low	42%
	Medium	17%
	High	8%
	Very high	-

Perceived drought consequences

Consequences associated with drought were perceived to range from very low to medium in both communities (Figure 5.3). The highest consequences were viewed as those to the local area (medium = 35%, high = 7%), as well as to health (medium = 35%, high = 5%). Consequences to property and family were expected to be low and very low by over 70% of participants from both communities.

Companies have a responsibility to secure resilient supplies, and both Ofwat and the Secretary of State have a duty to further the resilience objective in England and Wales (Water UK, 2016). Therefore, it is not surprising that there is low expectation amongst most water customers that a major drought would impact them.

In their study, Mankad et al (2013) investigated motivational indicators of protective responses for water shortages and found significant relationships between behavioural intentions and threat appraisal (measured as the product of likelihood and consequences). Whilst this current study did not measure threat appraisal in a similar manner, it was found that there was a significant correlation between perceived drought consequences and behavioural intentions (to implement drought coping measures), thereby illustrating that this is potentially a determinant of behavioural intentions. This relationship will be further investigated in Section 5.7.

5.5.2 Perceptions of the linkage between climate change and drought

Climate change was assessed as a threat that might impact future extremes and weather-related conditions (e.g. increasing temperatures) in the local areas under investigation. Nearly all participants from both communities indicated that they had heard of the term climate change. Combined, only less than 10% of participants from both communities did not think that climate change would impact them or their local area. Where implications of climate change were concerned, the two communities were quite similar in how they perceived the various impacts of climate change on drought risk. Agreement that drought likelihood and consequences could be impacted by climate change was low amongst participants. It was found that at least one third of participants from both communities neither disagreed nor agreed about climate change affecting drought perhaps indicating limited engagement with drought related issues. Figure 5.4 below illustrates the low level of agreement about drought issues.

There could be several reasons for this disconnect where drought and climate change are concerned. Firstly, water service customers in the UK generally do not think drought is a problem for them, let alone linking it with climate change. This has been found to be the case by a Consumer Council for Water (CCW)

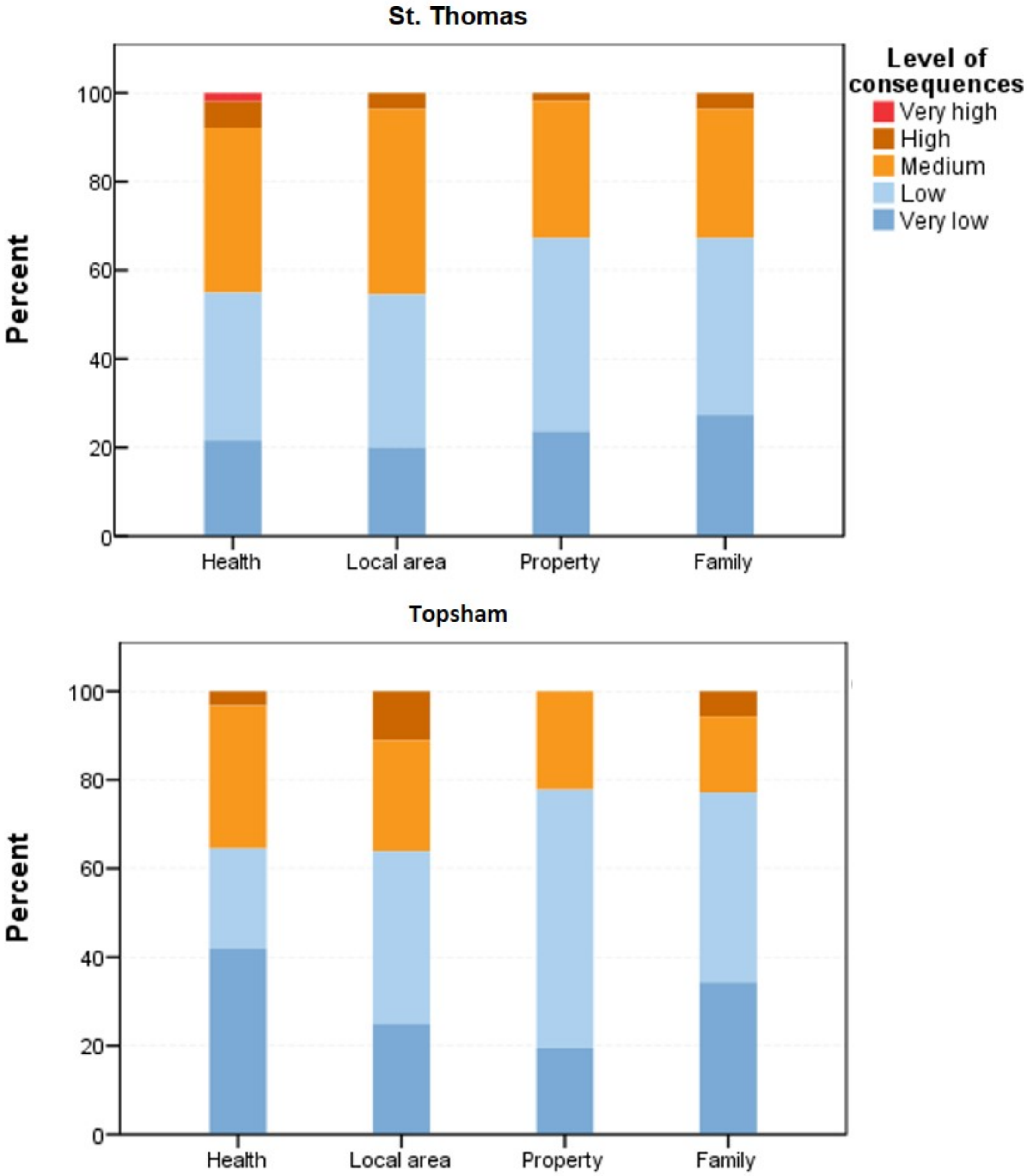


Figure 5.3: Participants' perceived extent of drought consequences to their health, family, property and local area.

commissioned report (YouGov, 2013) of customers who experienced the 2012 drought as well as by Dessai and Sims (2010) amongst south-east England residents. The YouGov report explained that water users in the UK tended to associate droughts with other countries such as the Sudan and Australia rather than the UK (YouGov, 2013). Taylor et al. (2014) explains that this suggests that there is some measure of psychological distancing where drought is concerned.

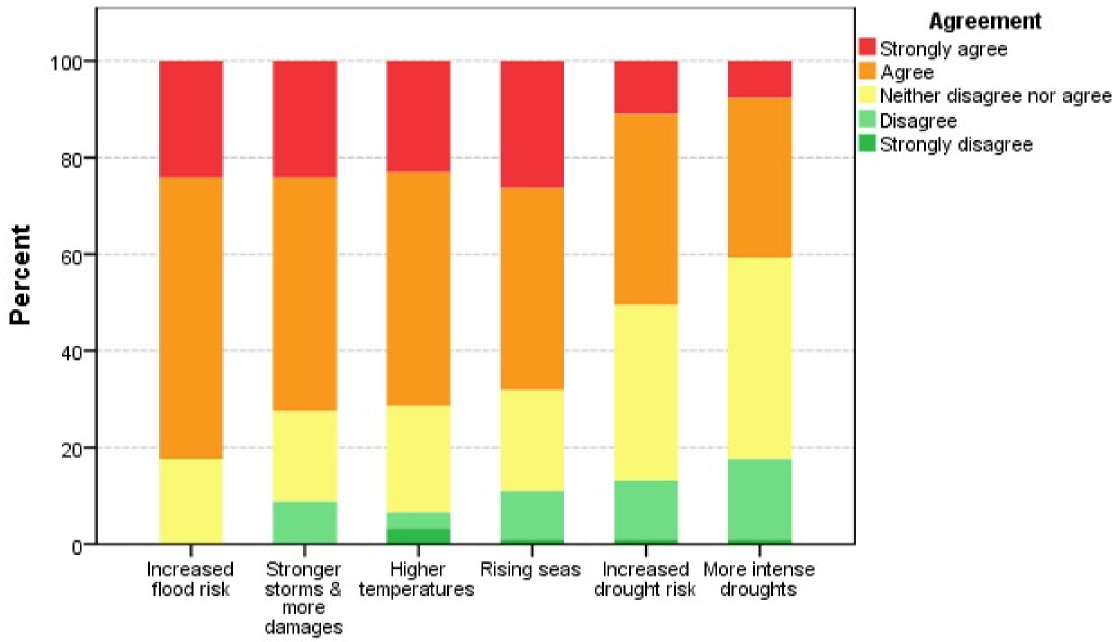


Figure 5.4: Perception of climate change implications for both case study communities.

Customers preferred the terms water shortage or low water levels than drought which often made them suspicious of water company motives (YouGov, 2013). Some customers classified as service-motivated customers (focussed on water bill and service provision by profit-based water companies) believed drought to be a term used to infringe on their freedom of water usage. These customers perceived drought only in the grand scheme of water management and cited privatization, leaks, and management failure as the cause of drought similar to the case of Londoners in Bell (2009) as discussed in Chapter 4. This is not to say that all customers have limited understanding of the reasons for drought. Factors such as lower than average rainfall, water-intensive lifestyles, population growth and increasing housing developments were cited by some customers in the south-east of England as some of the main reasons for the 2004-2006 drought period (Dessai and Sims, 2010).

Another reason for the disconnect may be due to the situation where droughts are experienced by most urban customers through hosepipe bans, making it incomprehensible for the average household to relate drought to wider environmental and economic implications e.g. rising food prices due to reduced agricultural yields. Indeed most droughts faced in the UK of recent time have not led to severe socio-economic and environmental consequences as perhaps those of California and Australia. Droughts were seen by south-east England residents as more of an inconvenience than as a serious problem (Dessai and Sims, 2010). The YouGov report (2013) found that those customers classified as socially-conscientious (engaged with environmental issues and need for reduced water demand) were able to ally drought with environmental issues such as climate change. Participants of the current study also appear to have both sets of customers - that is those disconnected with droughts and the fact that climate change is projected to affect drought frequency and intensity, and those who are engaged with water related and wider environmental issues.

No significant correlations were found between climate change perceptions about drought and behavioural intentions, indicating that climate change was not necessarily a driver in their behaviours or intentions.

5.6 Drought coping appraisal

This section presents discussions on perceptions of the efficacy of drought coping response measures as well as perceptions of self-efficacy and response cost in responding to or coping with drought at a household level.

5.6.1 Efficacy of drought coping responses

Overall, the proposed drought coping measures as household response to dry spells or water supply shortfalls, were perceived as largely effective by a majority of participants from both communities (Figure 5.5). Of the measures, water butts were perceived as the most effective measure to cope with a drought, with over 80% of participants from both communities rating their effectiveness as ranging from the middle to the upper end of the scale (somewhat effective to very effective) (Figure 5.5).

Adhering to a hosepipe ban and storing water at home were perceived as the second most effective drought coping measures by all participants. A majority of the participants with high intentions regarding hose pipe bans correspondingly considered it an effective drought response measure as see in Table **??**. Other measures such as installing water saving devices, taking shorter showers, storing water at home and reusing grey waters were all similarly perceived as ranging from somewhat effective to very effective by a majority of participants in both communities (80%). Perceptions of efficacy of water company recycled water was the lowest between both communities though St. Thomas participants had a

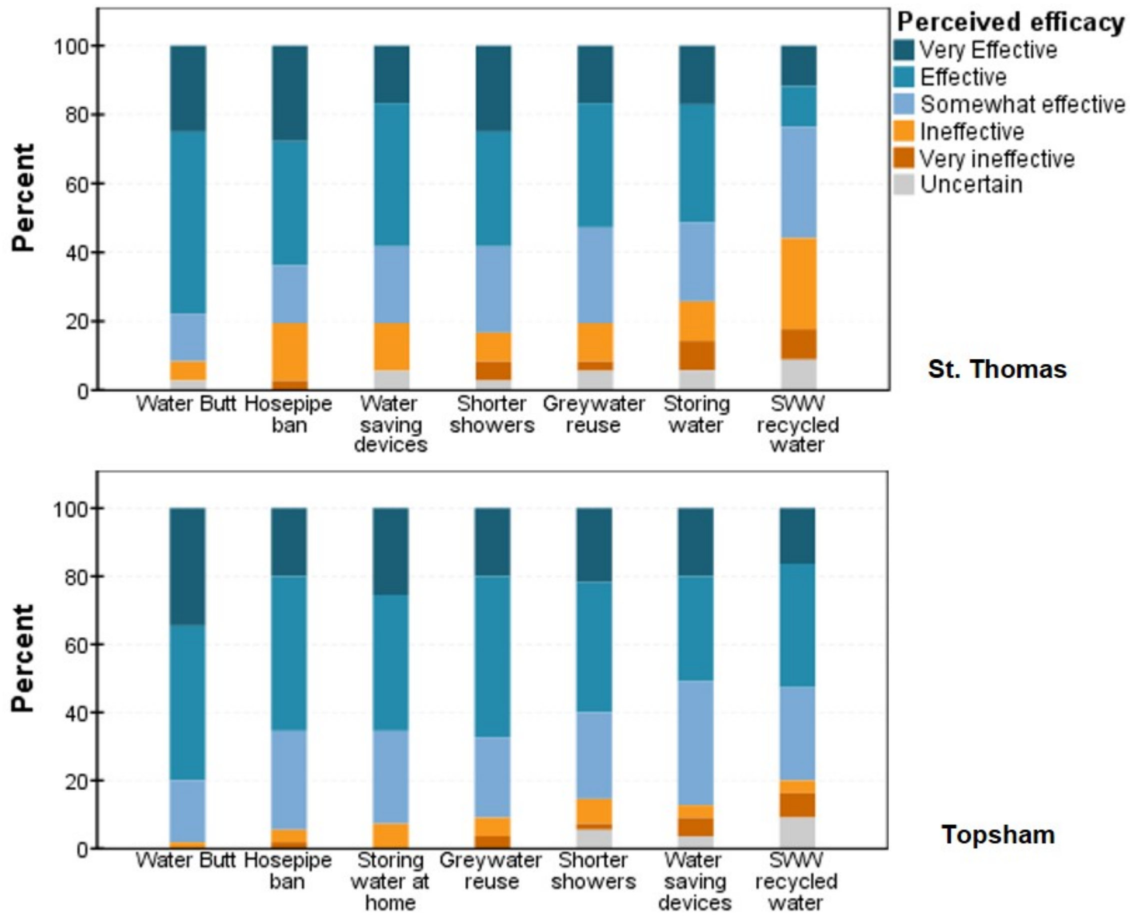


Figure 5.5: Perceived efficacy of drought coping measures by community.

lower perception of efficacy than Topsham participants as seen in Figure 5.5. This is the only measure across which there was a significant difference in perceived efficacy (U=668.00, z=-2.31, p$<$.05) between the two communities.

With the exception of the installation of water saving devices and adherence to hose pipe bans, the perceived effectiveness of all drought coping measures displayed significant positive correlations with behavioural intentions (Table 5.6). This finding illustrates the importance of perceived efficacy in motivating decision making and will be further investigated in Section 5.7.

5.6.2 Self-efficacy towards drought coping

Self-efficacy assessment consisted of perceptions of being limited to implement drought coping responses by lack of abilities, knowledge and awareness. Perceptions of self-efficacy were generally higher for St. Thomas participants as they had lower agreement about being limited by the above factors compared

Table 5.6: Correlation matrix showing the relationship between intentions to implement drought coping responses and perceived efficacy of the measures

Behavioural intentions	1	2	3	4	5	6	7
1. Use water butt	**.41****	-	-	-	-	-	-
2. Store water	.24*	**.48****	-	-	-	-	-
3. Reuse greywater	.09	.25*	**.48****	-	-	-	-
4. Use recycled water	.12	.30**	.43**	**.58****	-	-	-
5. Take shorter showers	-.05	-.06	-.00	.27*	**.25***	-	-
6. Install water saving devices	.10	.06	.17	.20	.02	.20	-
7. Adhere to hose pipe ban	.10	.12	-.08	-.09	-.02	.03	.03

** Correlation is significant at the 0.05 level (2-tailed)*

*** Correlation is significant at the 0.01 level (2-tailed)*

to those from Topsham. Lack of awareness was regarded as the most limiting factor for participants from both communities but more so amongst those in St. Thomas with more than 60% agreeing. Perceptions of knowledge and awareness as limiting factors had similar patterns across the two communities. There was high agreement ($>$60%) about both being limiting factors. All three measures of self-efficacy were significantly different between the two communities (Table 5.7). Although several of the key studies applying PMT to household coping (Chapter 2) find significant relationships between self-efficacy and behavioural intentions, this research finds no significant relationships between them.

Table 5.7: Results of significance tests for self-efficacy and response cost variables (n=91).

	Abilities	**Knowledge**	**Awareness**	**Money**	**Time and effort**
Mann Whitney-U	593.50	723.00	708.00	851.00	882.00
z	-3.35	-2.32	-2.31	-1.16	-0.90
Assymp. Sig (2-tailed)	.00	.02	.02	.25	.37

5.6.3 Response cost of drought coping measures

Response costs were assessed based on whether or not money and time and effort were considered limitations to implementing drought coping measures. There were mixed perceptions about response costs throughout the sample. It was inconclusive whether money was a limiting factor for the St. Thomas participants as 34% and 33% disagreed and agreed respectively, with the remaining 33% indicating they neither disagree nor agree. The picture was clearer amongst the Topsham participants where 50% of them disagreed that money was a limiting factor versus the 39% who agreed. As discussed above, both communities are very different in their income distributions (Topsham falling into medium-high income zone despite large proportions of missing data and St. Thomas being low-medium), which could account for this finding.

They both had similar levels of agreement about time and effort being limiting factors (49% St. Thomas and 41% Topsham) but with less disagreement from Topsham and more neutrality from St. Thomas participants (26% compared with 19%). As a result, there was no significant difference between the two communities where response cost variables were concerned.

Amongst both sets of participants, there is generally a negative relationship between response cost and behavioural intentions indicating that as the expectation of costs (financial, time and effort) associated with implementing the measures increases, participants were less likely to implement these measures. Mankad et al. (2013) also found a negative correlation between response cost and behavioural intentions indicating that as financial cost, property space and time increased there was less uptake of drought coping responses. Cost, whatever the nature, can tend to be a limiting factor to implementing personal responses regardless of the nature of the threat. The influence of cost on behavioural intentions will be assessed further in Section 5.7 below.

5.7 Understanding drought coping behaviours and intentions

This section provides the results from hierarchical multiple regression analyses undertaken to better understand the influence of key socio-psychological variables on behavioural intentions to implement household drought coping measures.

5.7.1 Assure validity and reliability

As discussed in Chapter 3, the first step in determining the indicator variables was to undertake validity and reliability tests for certain variables, i.e. latent variables. These latent variables (in this case were self-efficacy, consequence, and postponement) were validated by means of principal components factor analyses. This process is useful in confirming the degree to which the questions measure the intended variables. As such those variables that form consistent factors that meet the assumptions are known to be valid in measuring the given construct. The Dimension Reduction feature of SPSS enabled these analyses to be undertaken. It was important to indicate both an extraction and a rotation method, as well as calculation of the determinant and KMO (Keiser-Meyer-Olkin measure of sampling adequacy). In this case the extraction method used was principal axis factoring combined with varimax rotation. Scree plots were also generated to assist in the interpretation of factorial results.

Results of these validity tests and their associated reliability tests are shown in Table 5.8. It is noted that, with the exception of the consequence construct, the remaining latent variables did not prove to be valid or reliable measures of their respective constructs, i.e. self-efficacy and postponement. Where self-efficacy was concerned, one explanation may relate to the nature of the questions posed. It is likely that they needed to be more detailed to allow participants the opportunity for greater reflection on an issue that is out of sight and mind. Because of the low likelihood of a drought affecting them, it is possible that most participants had probably not thought of drought and its consequences before, thereby resulting in a varied pattern throughout the sample. Another reason for low validity may have resulted from self-efficacy measures not being assessed against each specific drought coping measure. This problem has not been highlighted in the literature on PMT research but it has been seen that researchers have measured self-efficacy in a similar way as done in this research but also as directly linked to each response measure. The former approach perhaps ensures greater validity of the results achieved. Regardless of this situation, the variable of self-efficacy was used in the forthcoming analyses due to its importance to the PMT framework of analysis.

Table 5.8: Validity and reliability of drought latent variables.

Factor	**Measured variable**	**Variance (eigenvalue)**	**% Variance**	**Cronbach's alpha**
Consequences	Severity to property Severity to family Severity to health Severity to local area	2.25	17.28	0.81
Self-efficacy	Lack of abilities Lack of knowledge Lack of awareness	1.2	9.26	0.50
Postponement	I would implement drought protection if neighbours were doing I would implement drought protection if incentive I would implement drought protection if legal requirement I would implement drought protection if affected in future	0.94	7.19	0.46

5.7.2 Developing regression models to determine indicators of flood coping intentions

Prior to undertaking the regression models, aggregate values were calculated for all variables including the latent variables. Aggregate values were derived by calculating the arithmetic mean of all key variables that are needed in the regression models. This method was preferred over the use of the sum as they were more readily relatable to the original scales on which items were measured. The variables that were aggregated included:

1. consequence
2. self-efficacy
3. perceived efficacy
4. behavioural intentions

Regression models were developed using two stages of modelling. The first stage was based on a hierarchical sequence with guidance from the literature. The hierarchy of steps were as follows:

1. Block 1: socio-demographic variables only as it is expected that these are the variables that affect whether or not a household will implement a coping measure. The variables are highly linked to vulnerability (e.g.Grothmann and Reusswig, 2006) and hence offer a good starting point for understanding the determinants of behavioural intentions.

2. Block 2: socio-demographic variables in block 1 plus a second block of PMT determinants. As discussed in Chapter 2, several studies have found that PMT variables are strong determinants of behavioural intentions and hence these are included in a second block to test their effects. Additionally, variables that are linked with the STS such as past experience with drought/water supply shortfall are included in this block to test whether or not they further influence behavioural intentions.

Each block resulted in a different predictive model as explained below. Hence two models were developed using this hierarchical method. In stage two, the significant predictors from the hierarchical model were used as inputs to develop a best-fitting model. Results of the best-fitting model provided the indicators of behavioural intentions.

Results of the hierarchical model

Model 1: Socio-demographic variables

Results of the regression model with socio-demographic variables (education, housing status, and age) as explanatory variables showed no significant relationships with behavioural intentions (Table 5.9). In their study which investigated motivational indicators of protective responses for water shortages, Mankad et al. (2013) similarly found that socio-demographic variables were non-significant explanatory variables where drought coping responses and intentions were concerned.

Socio-demographic variables appear to have little or no effect on coping behaviour at least not where droughts are of infrequent occurrence with often un-noticed consequences. This is further exacerbated by the fact that the water supply and distribution services are still technocratically driven with limited roles for households. Hence, there is somewhat a level playing field for all. It is possible that in cases with more frequent and severe drought scenarios, socio-demographic factors could become a mediator of coping behaviour. Additionally, socio-demographic variables such as education and income of participants were fairly homogeneous and would certainly yield insignificant results compared to a situation where the study areas are defined by large inequalities.

Model 2: PMT and socio-technical variables

Although there was a significant correlation between consequence and drought coping intentions ($r=0.21$, $p=0.02$), Model 2 in Table 5.9 shows that consequence had limited explanatory power on drought coping intentions. Such findings can be placed into wider context of water supply and distribution systems in the UK. As mentioned elsewhere in this thesis, supply and distribution of water is highly regulated to ensure resilient outcomes for customers and as such it is usually under extreme conditions that a region falls into a period of drought. Therefore, experience with drought and its resultant consequences tend be quite low, thereby limiting perceptions of the severity of consequences particularly as a hosepipe ban is usually the worst thing that a household will experience during a drought. Nonetheless, there may be variations in perceptions of drought consequences that lead to the formation of sub-groups as will be explored later in this chapter.

Table 5.9: Coefficients for drought coping hierarchical regression models.

Model		Unstandardised Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.90	0.40		7.24	.000
	Education	0.04	0.06	.07	0.59	.559
	Housing status	-0.02	0.17	-.02	-0.13	.896
	Age	-0.04	0.05	-.10	-0.82	.416
2	(Constant)	2.20	0.58		3.79	.000
	Education	0.01	0.06	.02	0.14	.886
	Housing status	-0.09	0.16	-.07	-0.60	.553
	Age	-0.01	0.04	-.02	-0.14	.892
	drought_cons	0.06	0.09	.08	0.73	.741
	drought_eff	**0.27**	**0.07**	**.38**	**3.64**	**.000**
	drought_selfeff	0.01	0.06	.02	0.23	.820
	drought_rescost	**-0.12**	**0.06**	**-.21**	**-2.01**	**.048**

Model 1 R^2=.022, $\triangle R^2$ for Model 2=.24 (R^2=0.26 and R^2 (adj) = 0.20) ($p<.001$)

Variables that contributed significantly towards behavioural intentions were those of response efficacy and response cost (financial, time and effort). These two variables were the only significant contributors to the hierarchical model and accounted for 20% of the variance in behavioural intentions when socio-demographic variables are controlled for (see R^2 (adj) in Model 2 Table 5.9). Perceptions of the efficacy of drought response measures had a significant positive effect on behavioural intentions, and was the strongest contributor to model 2 (Table 5.9). Response cost had a significant negative association with behavioural intentions.

Results of the best-fitting model

Using the significant variables from the hierarchical model, response cost and perceived response efficacy were entered into a best-fitting linear model:

$$Dci = b_0 + b_1CRE_1 + b_2RC_2 + \epsilon \quad (5.1)$$

Where:

- b = the coefficients
- Dci = Drought coping intentions
- CRE = Coping response efficacy
- RC = Response cost
- e = the independent error term

Both variables were significant predictors of behavioural intentions for drought coping measures as seen in Table 5.10. The model shows that together, these two variables significantly account for 23.3% of the variance in behavioural intentions. The difference between R square and adjusted R square is now reduced by only 3.8 percentage points, illustrating a more stable model. The assumptions highlighted in Section 3.6.5 were all reviewed as per Appendix C. These included checking for multicollinearity amongst predictor variables and assessing predictor residuals for homoscedasticity and normality.

Table 5.10: Summary of the best-fitting model for drought coping intentions.

Variables	**Unstandardized Coefficients**		**Standardized Coefficients**
	B	***Std. Error***	***Beta***
(Constant)	2.14	0.31	
drought_respeff	0.29	0.07	.41*
drought_respcost	-0.12	0.05	-.21***
R2 (adj.)=0.23 (p<0.001), *p<0.05, ***p<0.001			

As the aim of implementing a household coping measure would be to alleviate or minimise some specific consequence(s), then the effectiveness of a measure would seem a plausible potential driver of intentions. Hence a household would be encouraged to implement a measure that is expected or proven to be effective in an effort to reduce the magnitude and/or duration of consequences. As proposed by Maddux and Rogers (1983), even if the perceived probability of the threat is low, a high perceived efficacy can prompt action towards coping. In this regard, perceived efficacy will act as a driver in most cases. However, just as there are drivers, there are likely to be barriers, all of which are embedded into different situational contexts of the UWM-STS. In the case study areas, these might include limited recent experience of the consequences of drought added to living in a region of high average rainfall and large reservoirs.

Another barrier might be the perceived cost of a potential response. In contrast to the significant positive effect of response efficacy, response cost had a significant negative effect on behavioural intentions ($b=-0.12$, $t=-2.03$, $p<0.05$). Cost, whatever the nature, can tend to be a limiting and often times deciding factor in making decisions about implementing a household response regardless of the nature of a threat. As seen in Section 5.6.2 above some participants were concerned with financial costs whilst others more so with the non-material costs such as the time and effort needed to commit to planning and implementing a household coping measure. Higher costs will result in less willingness to implement measures that minimise a threat that is not imminent, as in the case of a major drought.

Unlike the case of response efficacy and cost, this research finds no significant relationship between self-efficacy and behavioural intentions (Table 5.9). This finding could be related to the nature of the questions measuring perceived self-efficacy which did not form a strong one factor variable. However, it may also be that self-efficacy is not an especially important variable where drought response is concerned. Already most participants do not expect to be impacted by any major droughts, which may have impacted the way different participants responded to these questions.

From the above account, it has been demonstrated that PMT provides a useful framework for assessing the relative importance of some of the psychological processes that may mediate household response to the threat of a drought. Variables that were significant predictors appear to be indicators of intentions. In the next section these variables as well as others were explored to examine their roles or potential in defining behaviours and decision-stages of sub-groups within the population. That is, are they actually indicators of behavioural intentions?

5.7.3 Assessing decision-stages for household drought coping

In this section, the research was concerned with investigating if there are sub-groups of decision-stages for household drought coping and the influence of indicator variables in forming these sub-groups. This was done by applying various clustering algorithms to explore the characteristics of sub-groups.

Results of cluster analyses

The R statistical software was used for cluster analysis due to its powerful statistical capabilities for cluster analysis compared with SPSS. As discussed in Chapter 3, both hierarchical and *k*-means cluster analyses were undertaken consecutively. Results of the hierarchical cluster analysis were analysed to determine a range of clusters to guide further explorations using the more robust *k*-means method. This process helps the researcher to identify a realistic number of clusters particularly given the size of the sample.

However, interpreting the results of the hierarchical cluster model is indeed a subjective decision making process as different researchers may interpret the results differently that they derive different number of clusters even with the same data, e.g. one researcher might interpret seven clusters versus three clusters by another. In this case, a five cluster solution was selected because it appeared to provide the best segmentation of the data. These five cluster are illustrated in the dendrogram in Figure 5.6 below.

Using the NbClust package in R, a range from two to five clusters was assessed using 26 out of 30 indices. The results proposed that the optimal number of clusters was two instead of five. Although seven of the indices calculated a five cluster solution this was expected to be too large and would produce very fuzzy results where the groups overlap too much in several indicator variables. The result in the output from R note that among all indices:

- 2 proposed 0 as the best number of clusters
- 12 proposed 2 as the best number of clusters
- 4 proposed 3 as the best number of clusters
- 1 proposed 4 as the best number of clusters
- 7 proposed 5 as the best number of clusters

These two clusters were distinguished on the basis of perceived efficacy, cost

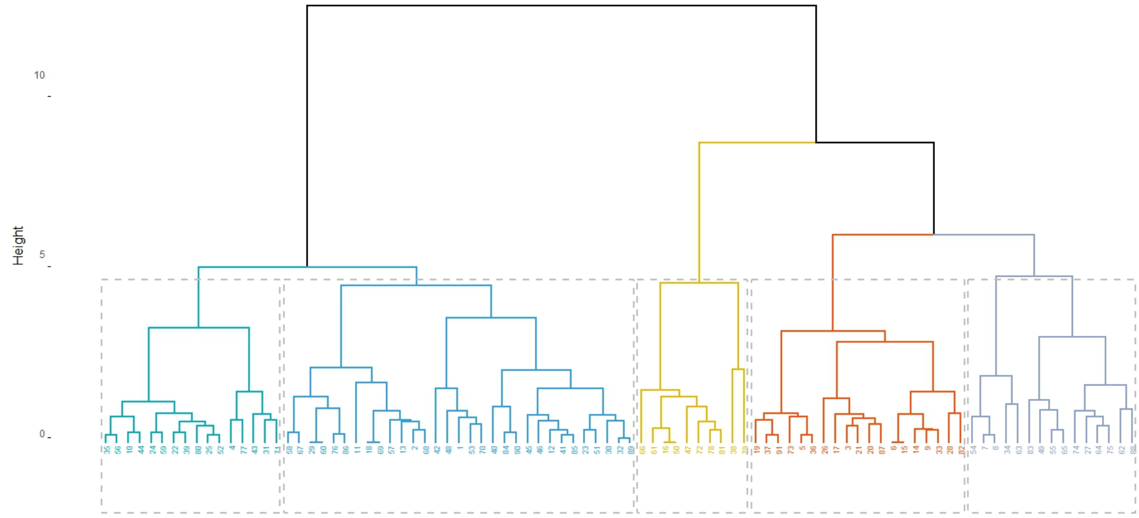


Figure 5.6: Hierarchical clustering illustrating a five cluster solution. The dashed grey lines partition the dendrogram into five clusters represented by different colours.

and consequences (Figure 5.7). The two cluster solution shows two distinct sets of actors based on significant differences in these three indicator variables as illustrated in Table 5.11. They therefore also differed significantly in their behavioural intentions. These two clusters are the Contemplatives and the Responsive actors. Although the TTM proposes Preparation and Action as the stages following Contemplative, this research has identified a stage similar to both which was hence renamed as 'Responsive' actors. These clusters are further presented and discussed in the sections below.

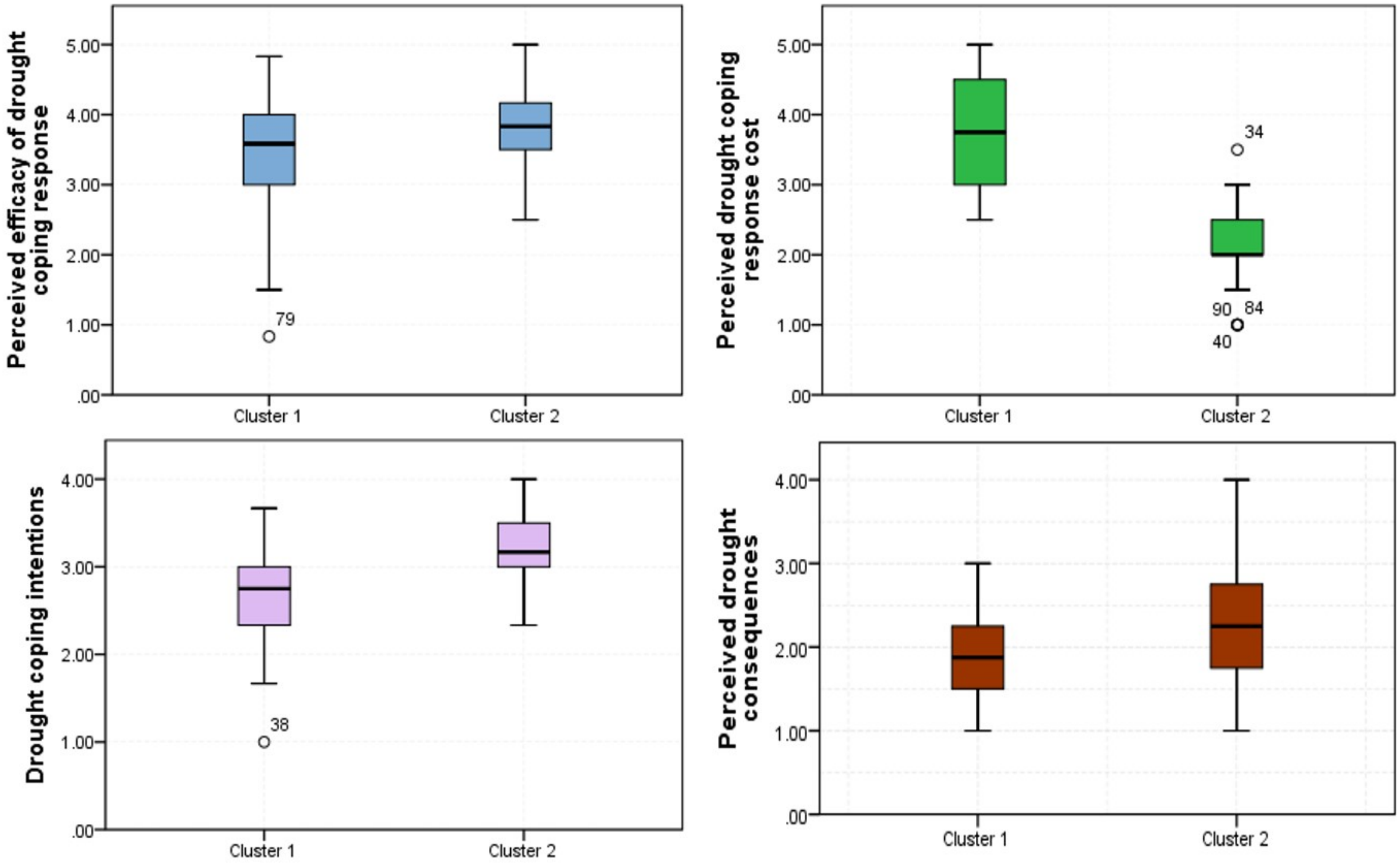


Figure 5.7: Distribution of variables across the two drought decision stages of cluster 1 and cluster 2.

Table 5.11: Results of significance tests of cluster 1 and cluster 2 (n=91).

	Consequences	Efficacy	Self-efficacy	Response cost	Past experience	Intentions
Mann-Whitney U	693.50	639.00	980.50	111.50	861.50	349.50
Wilcoxon W	1434.50	1380.00	1721.50	1542.50	1602.50	1090.50
Z	-2.54	-2.98	-0.22	-7.31	-1.28	-5.31
Asymp. Sig. (2-tailed)	0.01	0.00	0.83	0.00	0.20	0.00

Cluster 1: Contemplative actors

The contemplative actors of cluster 1 was the smaller of the two groups consisting of 38 participants (42%). Despite already implementing just a few of the measures, contemplatives were both unwilling and uncertain if they would implement the majority of the measures to cope with a future drought. They were characterised by low perceived drought consequences, moderate efficacy, and high response cost (Figure 5.8).

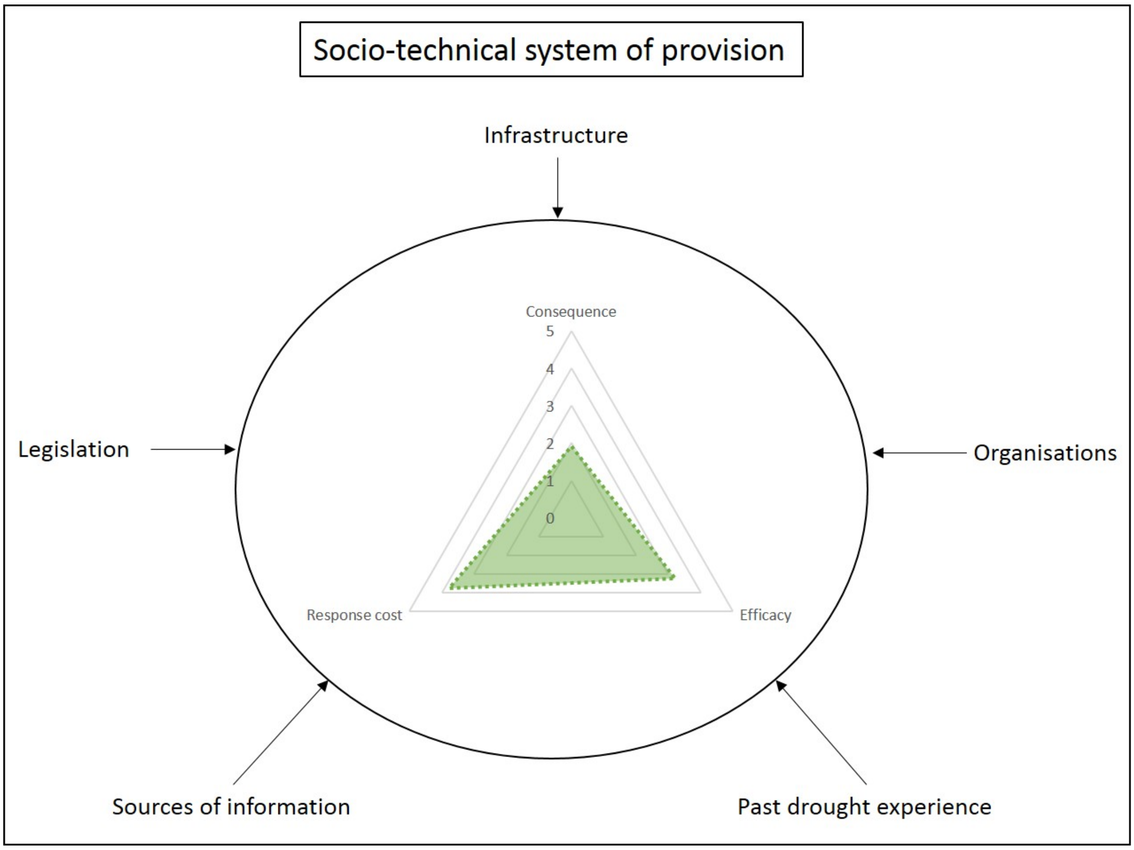


Figure 5.8: Defining characteristics of the contemplatives (cluster 1).

They perceived drought likelihood in their local area to be low and very low but were not significantly different from cluster 2. Like the responsives, they believed the consequences of a drought would be low and very low ($\bar{X} = 1.72$). In addition, this group perceived high response cost for implementation of most measures. There was a mix of experienced and inexperienced people within this group but overall they had less drought experience compared to those of cluster 2. Whilst self-efficacy was not an issue for this group and they believed response measures to be at least moderately effective. The combination of low expected drought likelihood, low consequences and high cost were perhaps important barriers towards their implementation of drought coping responses.

Contemplative actors did not necessarily agree or disagree that they would implement more coping responses based on any socio-technical changes. They were also similar to the responsive actors in their perceptions that climate change impact on drought would perhaps be limited.

Cluster 2: Responsive actors

The group identified as 'responsive actors' consisted of 53 participants or 58% of the sample (n=91). They were characterised by high perceived efficacy, low response costs and low perceived consequences (Figure 5.9) and were significantly different from the other group on the basis of these indicator variables (Table 5.11). With a larger sample, it is expected that responsive actors could be configured in other ways for instance they may perceive consequences of a drought to be high combined with low cost and high efficacy of response measures.

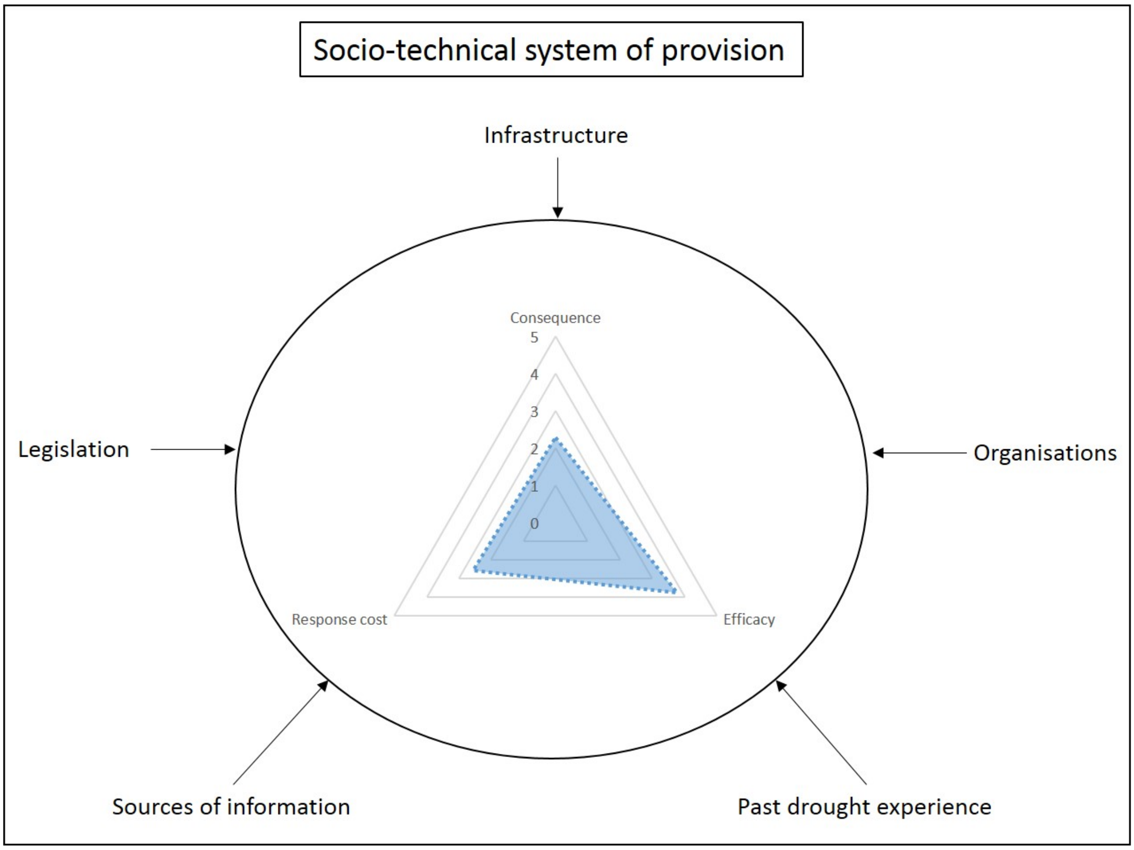


Figure 5.9: Defining characteristics of the responsive actors (Cluster 2).

The members of this group had high behavioural intentions, hence their label as responsive actors. A majority of the 'Responsives' were already implementing several (four or more) of the proposed household drought coping responses or they indicated that they plan to implement them. It might be possible that this, to some extent, is linked to their past experience. More than half of this group had experienced at least one drought in the past, making them the more experienced of the two groups. They also had the higher mean perception of drought likelihood ($\bar{X} = 2.16$) of the two groups, although the standard deviation was higher indicating greater variation in their perceptions.

Perceived efficacy of the responses were generally rated from the medium to the high end of the scale in the 50th and 75th percentiles indicating higher perceived response efficacy from the majority of the participants. Although they had similar mean perceptions of efficacy to the contemplatives of cluster 1, the 75th percentile perceived high efficacy compared with medium efficacy of the contemplatives. Therefore they had significantly higher perception of the efficacy of the measures compared with cluster 1.

The members of this cluster did not expect response cost to be a limiting factor to drought coping implementation, both in terms of the financial costs and the time and effort needed to implement the measures. Despite low perceptions of drought consequences throughout the sample, this group expected consequences to be low-medium as reflected up to the 75th percentile and were significantly different to the contemplatives in this respect. Members of this cluster were not significantly different from cluster 1 in their majority perception that climate change would have limited influence on increasing the frequency and intensity of drought in their local area. Neither were there any significant differences between the two with regards to self-efficacy.

5.8 Chapter summary

At the beginning of this chapter several questions were posed in order to fulfil the objective. The researcher administered a questionnaire survey to provide data in the framework of aspects of PMT. Therefore several analytical techniques were applied to the data to provide answers to these questions.

In relation to the question of perceived drought consequences, these were generally perceived to be of low severity. Although not assessed in detail, the likelihood of a major drought was correspondingly perceived as low. Participants though were aware of climate change and expected some local level implications (e.g. higher temperatures, rising seas, more frequent and intense storms). However, drought and its consequences were not readily identified as implications by the majority of participants throughout the study areas. This is synonymous with the findings of other studies on climate change adaptation research of UK residents.

Where household drought coping measures were concerned, these were largely perceived as ranging from moderate to high effectiveness in minimizing drought consequences. Of the several water efficiency measures proposed for drought coping, alternative waters such as grey water reuse had the lowest perceived efficacy while water conservation strategies, including hosepipe bans, were perceived to be the most effective. Participants agreed that lack of abilities, knowledge and awareness could be limiting factors towards implementation of proposed drought coping measures. That financial costs as well as time and effort were limiting factors varied throughout the sample. There was overall a high level of implementation and willingness to implement potential drought coping measures. Participants were already implementing some of the proposed household drought coping measures.

There were no significant relationships between socio-demographic variables and behavioural intentions. Past experiences with drought was low in both communities, though it appeared that more participants in St. Thomas had some experience with minor droughts compared with those in Topsham. Significant predictors of behavioural intentions were perceived efficacy of proposed measures and their associated costs. Hence both were found to be indicators of drought coping intentions. Detailed exploration through cluster analysis indicate that the sample is divided into two main groups - responsive actors and contemplatives - each at their own decision stage. Their decision stages were significantly defined by perceptions of response efficacy and response cost, as well as perceptions of drought consequences, with influence from past experience with a drought.

PMT provided a framework within which to analyse and interpret the results of this study. The variables proposed by PMT appear to be more instructive than socio-demographics in explaining some measure of variance in people's intentions to respond to threats such as drought. Results indicate that variables such as consequence, efficacy and costs can be influential in determining how and when people respond to a given threat. Intervention strategies for household and community levels should consider use of these variables to improve the outcomes for more drought resilient households. A recommended intervention strategy will be the subject of the penultimate chapter of this thesis.

6 EXPLORING HOUSEHOLD PERCEPTIONS AND INTENTIONS TOWARDS FLOOD COPING

6.1 Introduction

The preceding chapter provided some key insights into the key indicators of household drought coping intentions and their influence on behaviours and intentions. This chapter provides a similar analysis concerning household flood coping. The objectives of this chapter and the key research questions underpinning these objectives are presented in Table 6.1 below.

Table 6.1: List of objectives and research questions to be addressed in this chapter

Objective 3: To determine indicators of behavioural intentions in household flood coping	**Objective 4:** To explore the role of indicators in decision-stages for household flood coping
1. How do households perceive: • severity of flood consequences? • the effectiveness, self-efficacy and cost of coping measures? • Climate change implications for flooding? 2. Do participants have intentions to implement flood coping measures? 3. What are the key indicators of household flood coping intentions?	1. Are there sub-groups of decision-stages for household flood coping? 2. Can the indicators define and explain decision-stages for drought and flood coping?

The remainder of this chapter is outlined as follows:

1. Section 6.2 - This section provides discussions on flood coping intentions and behaviours by presenting results of flood resistance and flood resilience measures employed at the household level.
2. Section 6.3 - Variables related to the wider STS such as reliance, trust, postponement and past experience are discussed in this section.
3. Section 6.4 - Participants' perceptions of various consequences of floods are presented and discussed here along with climate change linkages with flooding.
4. Section 6.5 - The perceptions of the efficacy of household flood coping measures and their costs are presented and discussed in this section as well as perceived self-efficacy to implement the measures.
5. Section 6.6 - In this section the results of validity and reliability tests are discussed. Additionally the regression models that were developed are presented and results discussed.
6. Section 6.7 - The cluster analyses for flood coping are presented here along with the clusters that were derived.
7. Section 6.8 - A summary of the main findings of this chapter is undertaken in this section.

6.2 Flood coping intentions and behaviours

This section explores patterns in behavioural intentions and behaviours in relation to flood coping response measures at the household level. Flood resistance and resilience measures were presented to participants to gauge their behavioural intentions. Flood resistance or dry proofing measures are encouraged for use by households due to their potential in minimising or alleviating water entry, whereas flood resilience measures involve use of wet proofing techniques to minimise damages and recovery efforts if flooded.

6.2.1 Flood resistance measures

Implementation rates of flood resistance measures was overall low amongst the participants from both communities. However, there were more participants implementing the measures in Topsham compared with St. Thomas. The use of flood barriers was the most prominent flood resistance measure amongst Topsham participants with 53% indicating they had implemented these already. The flood walls/boards were funded through an EA grant following the 2013-2014 winter floods. Some 30 properties throughout the flood area zone (FAZ) in Topsham can be seen with flood board frames and mounted flood boards on gates, front doors and garage doors. Figure 6.1 shows one of these properties. Not all residents who were flooded or who are living in the FAZ opted to take the grants for these protective measures. Therefore some properties at risk remain unprotected. It is not known how the unprotected houses might be affected in a future flood, particularly those located amidst several houses with flood barriers. For instance in a future flood is it possible that the pressures created by the barriers from a set of houses could be exerted unto an unprotected property next door, thereby increasing the expected level of flooding for the unprotected property? These are some aspects of property level flood protection still untested due to their relatively recent usage in the UK combined with infrequent flooding.

Use of flood barriers was less accepted in St. Thomas with just over 40% of participants indicating that they would not implement flood barriers and 36% being undecided. A mere 2% indicated they already had flood barriers though these were not obvious on any of the properties included in the sample. It is possible that they have used temporary barriers following past flood warnings in the area and still have these ready for future deployment.

The measure of raising floor levels above expected flood heights was a measure that 70% of participants from both communities indicated that they would not do. Some properties already had elevated floor levels as could be seen in the sampling exercise. Most of these would have been done in the construction of the houses as part of the planning process rather than as a conscious decision of the homeowner and is a typical feature on some streets that were previously

Figure 6.1: Topsham resident installing flood boards during community flood simulation activity (September 2015) (Source: the author).

flooded such as along Okehampton Road in St. Thomas and some sections of Ferry Road in Topsham.

It is also recognised that raising floor heights and certain retrofits can often require planning approval which might become challenging. One participant provided further details about their proposal to raise the floor height as a flood resistance measure:

> *"We wanted to raise floor levels as advised by the Environmental Agency (as an unlisted home on the Strand) but the planners would not allow us to adjust ceiling height to compensate. We were totally rebuilding these properties and not allowed to protect ourselves."* (Survey participant #63)

Since they were not willing to do one without the other, this household did not raise the floor height to respond to future flooding because of this planning bottleneck. Another householder residing in St. Thomas, and who took part in the pilot, but not the final study, also reiterated these planning challenges encountered in attempting to include flood protection measures in home retrofitting projects. Furthermore, the raising of floors can be considered a major retrofitting job for the average household and so in most cases, unless there are other upgrades being done to the property, it is an unlikely measure for a household to undertake. This is particularly so when individuals believe that there is low likelihood of flooding and that their local area is well protected by public flood defences.

Use of sandbags was one measure for which a majority of participants from St. Thomas (53%) indicated willingness to undertake compared to only 15% from Topsham. Close to 40% of Topsham participants indicated that they would not use sandbags whilst 32% indicated they were already using sand bags. This is opposed to 13% of participants from St. Thomas who do not plan to use sand bags and 2% already using them. It is assumed that these participants have stockpiled sand bags for future use. As noted in Figure 6.2, sandbags were the most favoured household flood resistance measure amongst St. Thomas participants.

Airbrick vents can allow water ingress into houses during a flood and as such it is encouraged that covers designed for flood proofing be attached to them to reduce

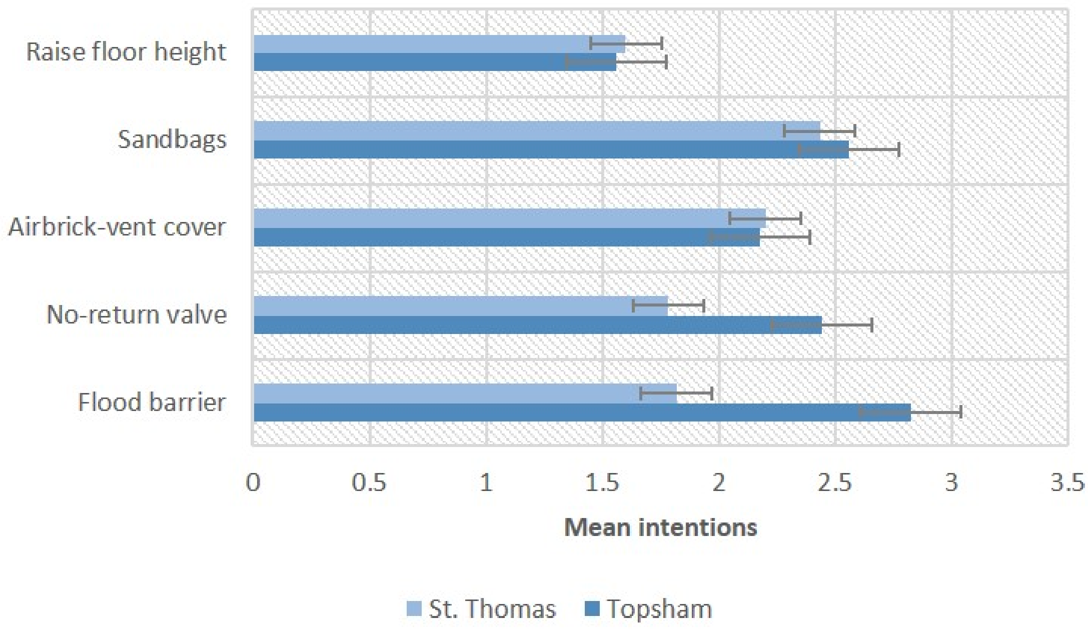


Figure 6.2: Mean behavioural intentions towards flood resistance measures.

this potential source of ingress. Despite their role in reducing ingress, air brick vent covers have low uptake in the UK as found by Joseph et al. (2015), where only 16% of Yorkshire and west Midlands households that were flooded in 2007 had installed them eight years later in 2015. The Exeter sample, particularly the St. Thomas group, displayed high uncertainty regarding this measure (St. Thomas participants 40%; Topsham participants 27%). Nonetheless, 21% of Topsham participants already have airbrick vent covers compared to 7% of St. Thomas participants. Similarly, twice as many participants from Topsham than St. Thomas (29% compared to 15%) indicated that they 'plan to use' them. Regardless of these differences, both communities had similar mean values (Figure 6.2) in their behavioural intentions towards this measure.

The final resistance measure was the use of "no-return valves" which is especially useful for surface water flooding, to which both communities are vulnerable. St. Thomas participants were not keen on the use of no-return valves as 36% indicated that they would not take this measure and 51% were undecided. Only 2% had already implemented this measure and the remaining 12% indicated they planned to install them. Intentions of Topsham participants were higher with 15% planning to do and 29% already doing. The remainder either did not plan to install the valves (29%) or were undecided (27%). A probable explanation for the low intentions and high uncertainty towards this measure could be due to a lack of understanding of how it functions and hence its benefits in flood prevention and minimization under certain circumstances.

In addition to completing the measured elements of this survey question, some participants provided the quotes below in the open-ended section of this question to further reflect their perceptions:

> *"Not considered measures as do not consider it an interest for me"* (Survey participant #4)

> *"Would only take measures if risk of flood increased or after flood events."* (Survey participant #10)

> *"In rented accommodation so would only be able to do superficial fixes if needed and not prevention maintenance."* (Survey participant #12)

> *"My perceived risk of flooding is low hence I'm not planning any of the measures listed."* (Participant #42).

> *"Would do more if situation changed dramatically in next few years."* (Participant #70)

Both communities were only significantly different in their behavioural intentions towards two flood resistance measures, namely flood barriers ($U=545.00$, $z=-3.44$, $p=.001$) and use of no-return valves ($U=664.00$, $z=-2.43$, $p<.01$). Certainly the difference in the use and intentions towards flood barriers is best explained by recent experience of flooding in Topsham which has seen a community wide effort of implementing this measure to reduce flooding of properties. On the other hand St. Thomas has not been flooded and is protected by a flood defence scheme in its second phase of upgrades (to annual exceedance value of 0.01%). Figure 6.3 below illustrates some of the recent (summer 2017) construction works along the river Exe in St. Thomas. There is hence less incentive for these residents to invest in property level flood protection such as flood barriers.

6.2.2 Flood resilience measures

Flood resilience measures included in the study were: 1) flood adapted interior fittings; 2) use of pumps to remove flood waters quickly; 3) raise the level of

Figure 6.3: Construction of a new wall that will prevent flooding of houses and businesses in a 100 year storm in the St. Thomas area of Exeter. (Source: the author).

electrical fixtures; 4) concrete or tiled floors and; 5) store valuable in upper floors. Intentions for uptake of flood resilience measures amongst participants in both communities were even lower than those for flood resistance measures.

The lowest intentions were towards the installation of flood adapted interior fittings and use of pumps to remove flood waters. Over 50% of participants, from both communities combined, indicated that they would not use either of these measures. These two measures were also the ones that participants were most undecided about implementing (at least 30% in both communities). Less than 10% from St. Thomas and 20% from Topsham were already using these measures or planned to use them in the future.

Raising the level of electrical fixtures was also amongst those measures participants indicated low willingness to adopt with higher mean intentions in Topsham (Figure 6.4). Whereas only 4% of St. Thomas participants and 12% from Topsham had already raised the level of electrical fixtures, it is found that 54% from St. Thomas and 32% from Topsham did not plan to undertake this measure. Both had 30% who were undecided about making such a change, whilst 27% of participants from Topsham indicated that they planned to undertake this measure as opposed to less than half this amount (11%) of St. Thomas participants.

At least 20% of participants in either community had already changed traditional wooden floors to concrete or tiled flooring, a measure which allows a flooded property to be quickly restored. However, 47% and 32% of participants from St.

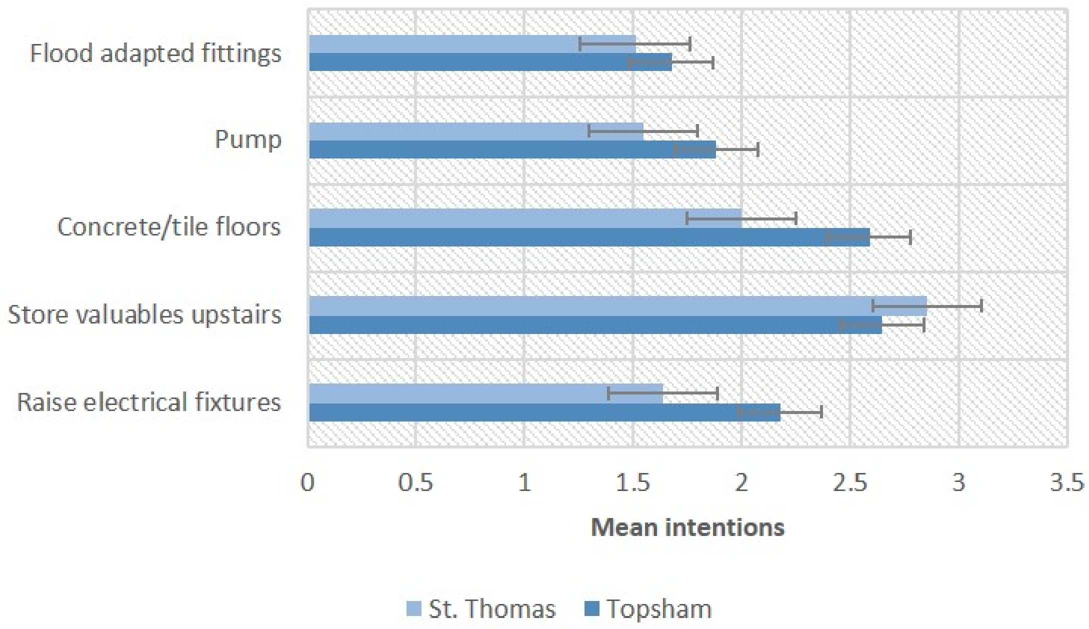


Figure 6.4: Mean behavioural intentions towards flood resilience measures.

Thomas and Topsham respectively, indicated that they would not be changing their floor material. Others were undecided or plan to change their flooring. Approximately 30% of participants from both communities indicated that they were already storing valuables in upper floors whilst another 30% indicated that they plan to do so. Some participants commented that they would store valuables in upper floors if a flood warning was issued for their community. These findings highlight the preference of most householders for less structural changes to the house with regard to household flood protection.

Both communities displayed low intentions to implement resilience measures. The lack of willingness to implement the measures is perhaps most related to a combination of perceptions of likelihood, cost and the presence of flood defences. It is also of interest that most of the resilience measures can be considered as structural changes to the property. Some of these changes could seem quite significant in terms of time and financial costs as well as the general disturbances that retrofitting usually brings with it (Joseph et al., 2015). When these additional factors are added to the fact that participants perceive their flood risk as low it is not surprising that they would not implement these or similar responses.

Similar to the question on flood resistance measures, participants provided some quotes for the flood resilience question:

"More flooding would have to have taken place to activate this." (Survey participant #4)

"I do listen to the older people in the street who remember sandbags and boats but have no real idea how to keep my house from flooding." (Survey participant #18)

"Likelihood of flooding minimal so currently not thinking of flood prevention." (Survey participant #25)

Overall there was a significant difference in the behavioural intentions between the two communities towards the flood resilience measures of raising levels of electrical fixtures (U=654.00, z=-2.55, $p<.01$) and use of concrete/tiled floors (U=712.50, z=-1.99, $p<.05$).

6.3 Reliance, postponement, and past experience

This section assesses some of the socio-technical aspects of FRM such as past flood experience due to failed UWM systems, levels of reliance and trust on organisations and infrastructures, and some reasons for postponement in implementing flood coping measures.

6.3.1 Reliance

In assessing reliance, this thesis examined perceptions of the adequacy of public flood defence systems in protecting both participants' residential properties and the local area as well as perceptions about household roles in FRM. Regarding the adequacy of protection for the local area, >70% of participants from St. Thomas were in agreement compared with just 40% from Topsham. Less than 20% of participants from both communities neither disagreed nor agreed about the adequacy of flood protection for the local area. Where flood protection for the home from public flood defences was concerned, St. Thomas participants had correspondingly high agreement (>65%), whilst amongst Topsham participants perceptions were evenly distributed between agreement and disagreement. Close to twice as many participants (27%) from Topsham neither disagreed nor agreed about the adequacy of flood protection for their homes compared with those from St. Thomas (15%).

These results indicate greater reliance on public flood defence systems amongst participants from St. Thomas compared to those from Topsham. Topsham certainly does not have comparable flood defences as those in St. Thomas, a factor which to some extent, may account for the strong social networks that have been developed for flood (and emergency) planning and management. This links very well with some of the perceptions of practitioners in Chapter 4 where smaller, less urbanised communities tend to form strong networks and plan their community flood resilience strategies compared with those in larger, urban centres. The reliance of St. Thomas participants on flood defence systems may, to some extent, account for their low intentions towards household coping responses as will be investigated in Section 6.6.3.

Some relevant comments from the surveys that reflect this reliance are as follows:

> *"I have lived in Exeter all my life and the area has not flooded since the flood relief was built. My parents recall the flooding in the 60s which had a major impact on people in the St Thomas area but we have been well protected by the flood relief ever since. I do not believe I am at a significant risk of flooding, and any minor risk will presumably be alleviated by the improvements to the current flood relief."* (Survey Participant #17).

> *"I am sure the measures would be effective in a high risk area but I am sure the many millions being spent on updating the flood relief will offer protection and lower an already low risk."* (Survey Participant #33)

> *"With current flood prevention I feel secure that my area is very unlikely to suffer major flooding"* (Survey Participant #38).

Another aspect of reliance is the perceived roles of the various players in FRM. In addition to the roles to be played by government agencies, it was found that 75% of Topsham participants agreed compared to 47% of St. Thomas participants that they also had a role to fulfil in FRM. Only 6% of participants from Topsham did not agree whilst 19% neither disagreed nor agreed. Close to 40% of St. Thomas participants disagreed with that notion. However, this is not a straight forward case as there are many different roles that might be involved in FRM such as the role of government in reducing property risk but also the role of the householder to take action to improve their resilience in various ways but the boundaries are unclear. Joseph et al. (2015) found that participants who were flooded in 2007 were still uncertain about who is responsible for reducing the flood risk of their properties.

Although the question related to general FRM roles versus one flood event, Participant #19 reflected on this question as follows:

> *"For major flood (or drought) my role would be somewhat insignificant."*

This perhaps reflects the feeling of many participants in the community and elsewhere, who feel that they could not make a difference in an entire catchment. However, the cumulative effect of several households within a catchment could prove to be quite significant, a point which has not yet resonated with many people in flood prone areas. As a result people continue to depend on the capital expenditure of government as the main source of flood risk reduction and providing resilience to flooding as opposed to implementing coping measures at a household and community scale.

6.3.2 Trust

Trust in FRM organisations was much higher as opposed to those for drought management and planning in the previous chapter. At least 70% of the participants from both communities were somewhat confident to very confident of the capabilities of the four suggested organisations in planning and managing flooding. The EA received the highest confidence rating across the two communities (>70%) whilst South West Water had the lowest confidence ratings. This low level of trust in the water company might be explained by the perception that flooding is usually within the domains of the EA, and a combined effort of the LLFA and city council. Water Company roles in flooding relate mainly to sewer flooding which has low awareness versus the more commonly understood riverine and coastal flooding. When flooding occurs, blame is often levied at the EA or LLFA but Water Company is not usually being blamed by the public.

6.3.3 Postponement

Results of the survey also revealed that most participants of the two communities are reactive to policy or legislation versus being the proactive citizens of the FCERM policy. Over 70% of St. Thomas participants and 45% of Topsham participants would only implement some personal flood protection measure if there was a legal requirement to do so. Most participants from both communities (>60%) would also implement personal flood protection only if they were flooded in a future event and if there were an incentive which is conclusive with the findings of Joseph et. al. (2015). Where flood insurance premiums were concerned, 40% of participants from both communities indicated a willingness to implement measures if their insurance premium would be reduced. Surprisingly, over 40% of participants from both communities disagreed about implementing personal flood protection if their neighbours were doing the same. This finding is surprising in the sense that the actions of social networks have proven instrumental in increasing the uptake of household flood coping measures (e.g. Dittrich et al., 2016).

Postponement variables also did not show significant correlations with behavioural intentions. The findings indicate that although participants generally appear to agree about having a role in FRM, they are not necessarily ready to fulfil these roles.

6.3.4 Past flood experience

A large proportion (>80%) of the study population from St. Thomas had never experienced a flood before , whether at their current address or in another location in the past. The few who had experienced a flood since living at their current address only comprised 13% of the participants. This is most likely the flooding events of the 1960s which was the last time there was major flooding that reached residential properties in that local area. Another 20% had experienced flooding whilst living in a different location. It is not known where they experienced these floods or how long ago. The existing community, therefore, has little experience with floods and have not recently been exposed to the realities of the planning, response and recovery phases involved with a major flood. Subsequently, the need for a flood resilient household may not be a priority of the average household in St. Thomas.

In Topsham, 35% of the participants indicated they had never experienced a major flood since living at their current address. Given that there was severe flooding in Topsham in the 2013-2014 winter storms, it appears that the flood and its impact were unevenly distributed throughout the FAZ. It has been found that flooding unequally affects people in terms of factors such as health effects, loss of life, property and financial losses (Curtis et al., 2007 in Werg et al., 2013. Therefore, whilst the local area may have flooded, some properties that were not affected may consider the flood as minor versus major. Some may also opine that they did not experience a flood at all if their properties were not flooded as found by Green et al. (1991). Such findings are particularly applicable to Topsham which experienced tidal flooding that retreated within a matter of hours thereby minimizing the magnitude of its consequences to some properties and families. Those whose properties were not flooded were able to return to normality after the waters retreated which was less than a day. As a result, some of these participants would not consider that they have experienced a flood. It has been proposed that experiencing a flood in a second-hand fashion can perpetuate a false sense of security (Wachinger et al., 2013; Shultz et al, 2005 and Peacock et al, 2005 in Werg et al, 2013). For instance, if the flood consequences for neighbours were perceived as minimal, it might be expected that future floods will affect the area in a similar fashion. However, it may also be similar for direct experiences although, as will be seen later in this chapter, perceptions of future expectations of flood consequences can change with the implementation of flood coping response measures.

The remaining majority (65%) of Topsham participants considered that they had experienced a major flood at least once whilst living at their current location. Notably, there were four Topsham participants (20%) who had been flooded at least two times since living at their current location. These floods were estimated by these participants to be of medium and low severity. Less than 10% of Topsham participants have experienced flooding at previous locations.

6.4 Flood consequence appraisals

In this section, results of the consequence aspect of the PM theory threat appraisal are presented and discussed. It first examines perception of the vulnerability of property and local area to flooding. Then the remainder of the section focuses on perceptions of the severity of flood consequence for local area, property and family.

6.4.1 Perceived vulnerability to flooding

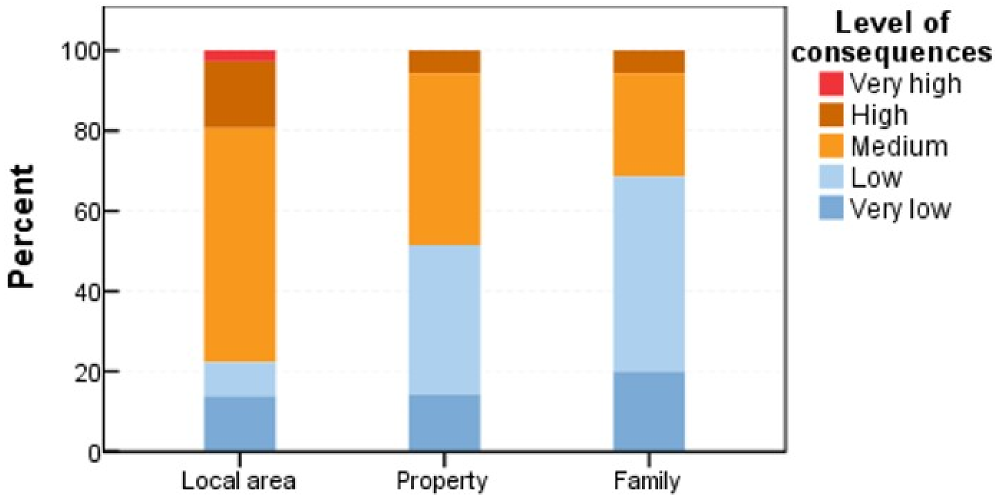
Participants from both communities seemed to largely agree that they face some measure of vulnerability to flooding. At least 60% of participants in each area believed that their properties could be flooded up to the ground floor with the remainder indicating flooding only in the yard and gardens or that the property would not flood. A Mann-Whitney U test shows that participants in the two communities displayed no significant difference in how they perceive the level of flooding within their property (U=841.00, z=-0.94, *ns*).

Although it would appear that the EA are improving their transparency at communicating residual risk and the potential of infrastructure failure as seen Chapter 4, they are still largely focussed on the probability aspect of risk. The fact that probability is still the main thread of their conversation lessens the effect on people's understanding and acceptance of residual risk. A risk focus reduces the potential for building resilient communities when the flood risk is low but the potential consequences are high as is the case of the communities in this study.

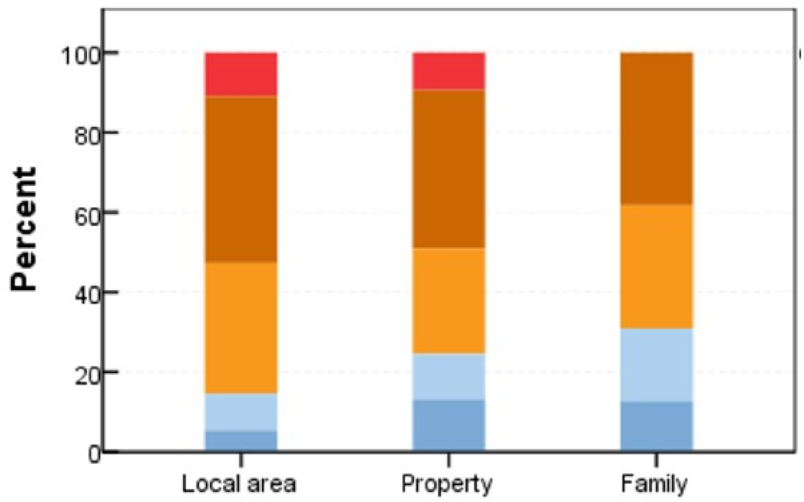
Consequence to local area

A combined 52% of participants from St. Thomas perceive that a major flood would be of high and very high severity to the local area (Figure 6.5). Another 33% believe that it would be of medium severity and the remaining 15% believed it would be low to very low severity. The severity of a major flood in Topsham was perceived somewhat lower with 55% of participants indicating that it would be of medium severity in the local area (Figure 6.5). The remaining minority was split between low and high severity. Participants in St. Thomas had an overall higher perception of severity of flooding on their local area. Results of a Mann-Whitney U Test (Mann and Whitney, 1947) shows that there is a significant difference in how both communities perceived the severity of a major flood in their local area (U=617.00, z=-2.93, $p<.01$).

Consequences of flooding to the local area can sometimes not be realised by households. This is because in many cases households and communities tend to let their guard down, once flood defence schemes are constructed or upgraded as found by researchers such as Fox-Rogers et al. (2016). The communities often forget that there could be failures of varying nature that might lead to significant flooding with far reaching consequences for the local area and their own properties.



Topsham



St. Thomas

Figure 6.5: Perceived extent of flooding on local area, property and family.

Consequence to property and household

Consistent with perceiving high severity of a major flood in their local area, a majority of the St. Thomas participants also believed that the flood consequences to their property and family would range from medium to very high (Figure 6.5). For the Topsham participants, the majority (55%) believed that the severity of consequences on their property would be low, whilst 35% and 10% thought it would be medium and high severity respectively (Figure 6.5). Also for the Topsham participants, the severity of a major flood for the family was overall perceived to be low (70%). Both communities displayed significant differences in how they perceived the severity of the flood on their property (U=522.50, z=-3.57, $p<.001$) and family (U=502.00, z=-3.70, $p<.001$). The severity is viewed as medium-high for those in St. Thomas compared to low-medium for those in Topsham. This links closely with how the vulnerability to flooding from a major event is perceived within each population.

Results of a cross-tabulation analysis between perceptions of severity of flooding on property and vulnerability of property to flooding, show that all St. Thomas participants who perceived high and very high severity of impact to their property also believed that their property would flood up to the ground floor of the house. Topsham participants who expected low to medium severity of the flood on their property also thought that their ground floor would flood. Based on these results, flooding of the ground floor seems to correspond to medium and high flood severity in St. Thomas whilst in Topsham ground floor flooding appears to be of low to medium severity. This is not to say that there is a direct relationship here but it does present several questions. At first glance, having one's ground floor flooded would appear to be a major flood consequence for some people if it means their lives and activities are affected for a prolonged period of time. This perception could vary depending on acceptable levels of flooding within a community and coping measures that have already been implemented.

The questionnaire survey also included questions on the severity of damages to building structure, home contents, vehicles, and gardens resulting from a major flood. In terms of building structure, home contents, vehicles and gardens, damages were expected to range from medium to very high by a majority of participants from St. Thomas (>50%) whilst a majority from Topsham (>60%) perceived these as ranging from very low to medium (Figure 6.6). Since the flood scenario was a previous flood (or one more severe), it is assumed here that they are responding based on their own experience and or knowledge of the most recent flood. Unlike the other damages, the two communities do significantly differ in their perception of potential damages to vehicles (U=524.50, z=-2.33, $p<0.05$).

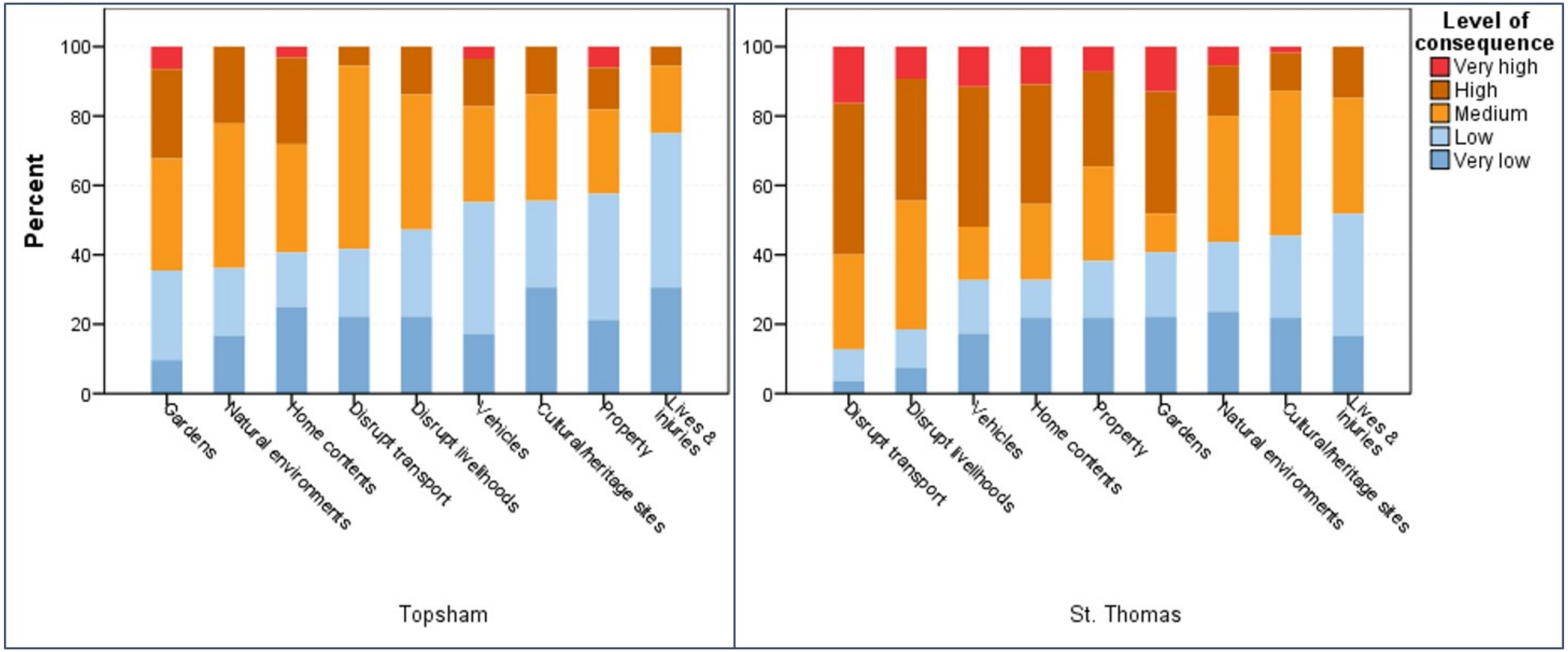


Figure 6.6: Comparison of the perceived extent of flood consequences across the two communities.

Indirect consequences

Other consequences that were examined included indirect consequences such as loss of lives and injuries, livelihoods, transport, cultural or heritage sites, and natural environments. In St. Thomas, disruptions to livelihoods (45% high and very high) and to transport (61% high and very high) were seen as the two highest consequences of a major flood in the local area (Figure 6.6. Damage to cultural/heritage sites (43% moderate and 44% low and very low) and natural environments (37% moderate and 43% low and very low) were perceived as very low to moderate. Loss of lives and injuries as a result of a major flood was perceived as mainly low and very low (53%) or medium (32%). For the Topsham community,damage to gardens, natural environments and contents of the home were perceived as facing the highest extent of the consequences (Figure 6.6). Disruptions of livelihoods and to transport were both envisaged as low (50% each) to moderate (50% and 45% respectively).

Explaining differences in perceived consequences

With their recent flood experience, it is interesting that members of the Topsham population had lower perception of flood consequences compared to the less experienced population from St. Thomas. Several reasons may account for these observations. Firstly, the scenario of major flood presented in the survey is the precursor to answering these questions. Therefore, if for instance some Topsham participants were not affected by the flood in 2014, and coupled with low exposure to prior flooding, they may tend to underestimate flood consequences. Limited direct flood experience combined with the knowledge and or memory of past flood events in their local area may conversely have led St. Thomas participants to envisage predominantly moderate to high consequences. The memory of flooding in St. Thomas is still quite alive within the existing community despite the last major flood having occurred in the 1960s.

Flooding in Topsham's recent past has not been as significant as those in St. Thomas and the recent winter flooding was no exception. Hence it might be expected that future floods will remain mild in their consequences and that households can return to their normal routines within a few hours. When both communities are considered, it can appear that those without flood experience do not appear to underestimate the severity of the consequences of flooding whilst the opposite maintains for those with flood experience. Both situations were found by Green, 1999 and Ruin et. al., 2007 in Wachinger et al. (2013).

Secondly, households that have implemented flood protection measures generally view their risk as being reduced as concluded by Bubeck et. al., 2012. They propose that this is the result of a negative feedback whereby the implemented coping measure provides a sense of reduced consequences in future events (Figure 6.7). This might explain why some participants in Topsham believed they will not be significantly impacted by a major flood since in their view, by implementing various coping response measures, they have reduced the risk at the household level.

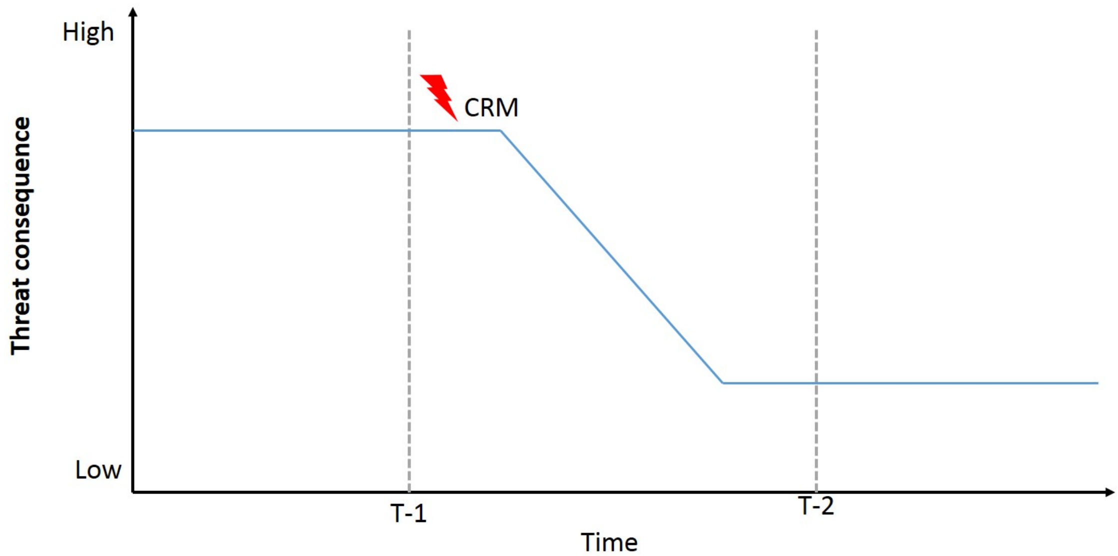


Figure 6.7: Schematics of the potential impact of implementation of a coping response measure on perception of the consequences. Following experience with the shock/threat the household implements coping response measures (CRM) after which they begin to feel more secure and that the consequences will not affect them to the same degree. Therefore their perceptions become reduced (blue line) (adapted from Bubeck et. al., 2012).

In St. Thomas FRM has been dominated by public defences versus household and community level interventions or a mix of both. Households have taken limited actions to prepare for future flooding hence they perhaps recognise that if the flood defences fail then the impact could be significant for much of the community. However, their belief and reliance on these systems have prevented any responses to these potential consequences.

6.4.2 Perceptions of the influence of climate change on flooding

A majority of participants believed climate change would result in increased flooding (80% St. Thomas, 85% Topsham) within their local areas and also produce stronger storms with increased damages (74% St. Thomas; 80% Topsham). This is contrary to the findings about climate change implications for drought in Chapter 5. These findings indicate that increasing flood frequency and consequences were recognised more readily as resulting implications of climate change compared to drought and its consequences. Heavy rainfall and flooding have been found to usually be most strongly associated with concerns about climate change by the UK public (Taylor et. al., 2014).

Additionally, UK residents were found by Lorenzoni et. al. (2006 in Taylor et al., 2014) as are more likely to reference 'rain' when asked to describe climate change, compared to US residents who are more likely to mention 'heat' and 'ice caps melting'. Other UK studies cited by Taylor et. al. (2014) found that in describing the impacts of climate change people often noted 'flooding' as the most common response and that people in the UK perceive heavy rainfall and flooding to have increased over the course of their lifetime versus hot weather (Whitmarsh, 2009 in Taylor et. al., 2014). Flooding is therefore one of the main perceived implications of climate change in the opinion of the British public and the householders within the current study.

6.5 Flood coping appraisals

This section examines participants' perceptions of the efficacy of the proposed measures for flood coping, perceptions of their own self-efficacy where implementation of the measures is concerned, and finally their perceptions of the cost of implementing the measures (financial and time). For many participants who undertook this survey, this was perhaps their first flood coping appraisal given their low perception of experiencing a flood.

6.5.1 Response efficacy of flood resistance measures

Effectiveness of several popularly marketed resistance measures for household flood coping will depend on various factors such as the effectiveness of early warning systems and the intensity of the flood event (Poussin et al., 2015). Early warning lead times are particularly important for properties in rapid response catchments where flash flooding occur due to the need for adequate deployment time.

There was mixed perception about the efficacy of the measures amongst the participants with higher perceived efficacy amongst those from Topsham (Figure 6.8). There was also greater uncertainty about the measures amongst Topsham participants. For instance 30% of the Topsham participants were uncertain about the effectiveness of raising floor levels, using air-brick vent covers and "no return" valves. Figure 6.8. In their study, Joseph et al. (2015) found that whilst there was consensus among households that they are in favour of adapting their properties to flood risk, there remained high uncertainty about the efficacy of resistance measures in preventing flooding.

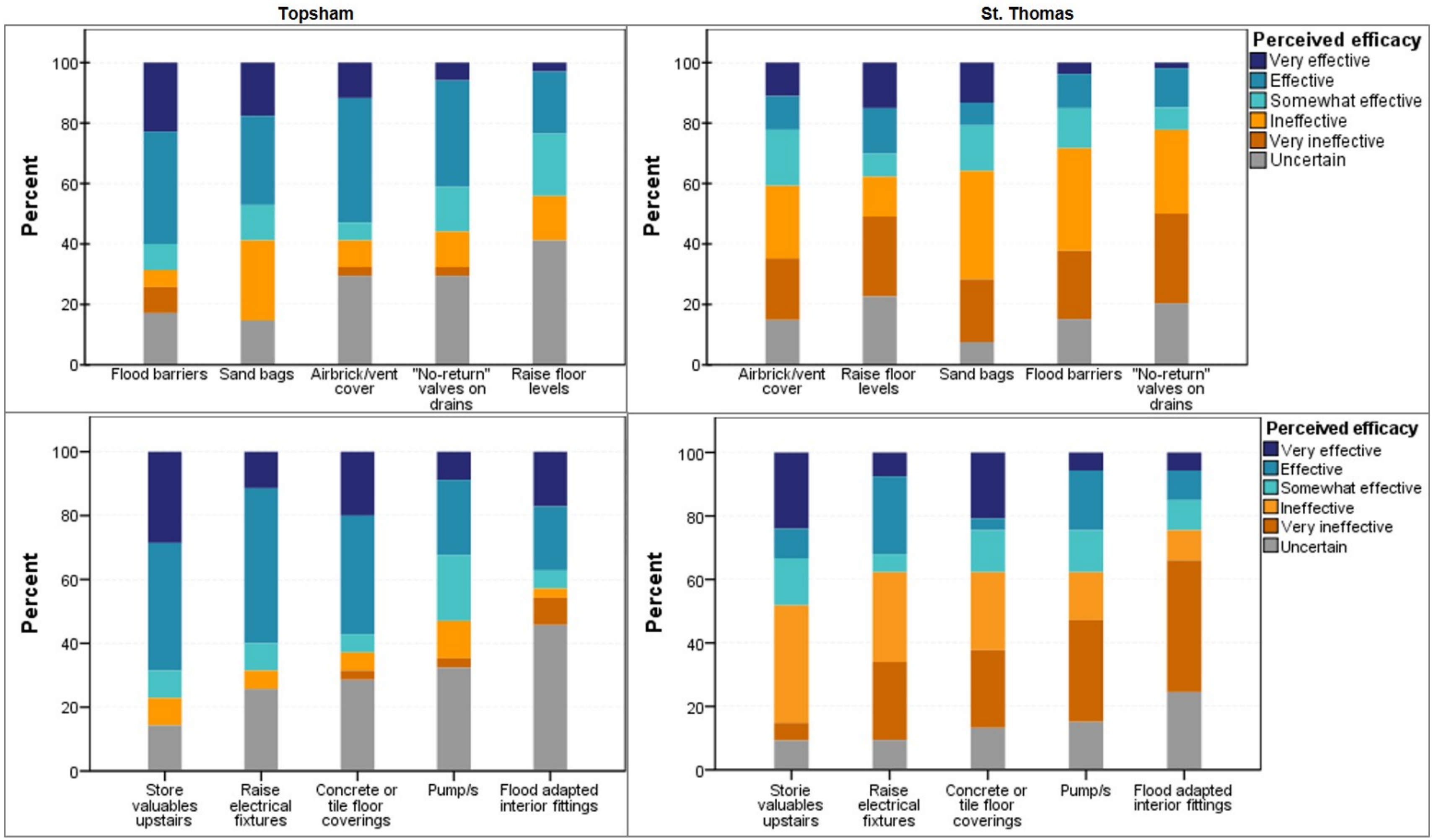


Figure 6.8: Perceived efficacy of flood coping measures. Flood resistance measures are displayed in the top charts and flood resilience measures in the bottom charts.

Figure 6.9: A demostration of the mounting of sandbags by the EA and the Fire Brigade at the Topsham community flood simulation excercise in September 2015. (Source: author)

Although there was less uncertainty with regards to the efficacy of resistance measures amongst the St. Thomas participants, the coping measures were largely viewed as ineffective as seen in Figure 6.8. The measures perceived as least effective were no-return valves, flood barriers, and sand bags. Indeed the efficacy of sand bags in flood coping is increasingly being challenged (Pitt, 2008). Sandbags are well known and they can be cheaply assembled and arranged in preparation for a flood given adequate lead time. However, their effectiveness in minimizing inflow of water remains in question due to their porous nature. Nonetheless their use is encouraged by RMAs such as the EA and first responders like the Fire Brigade as seen in a flood simulation activity in Topsham (Figure 6.9). The communities were only significantly different in relation to perceived efficacy of flood barriers (U=566.50, z=-3.13, p$<$.01).

6.5.2 Response efficacy of flood resilience measures

Similar patterns are noted with the perceived efficacy of flood resilience measures as for those of flood resistance measures (Figure 6.8). Topsham participants have expressed greater uncertainty but higher efficacy than those from St. Thomas who generally perceived low effectiveness of the measures.

Effectiveness of flood adapted interior fittings was the measure that $>$40% of Topsham participants were most uncertain about as opposed to 25% from St. Thomas. Just over 50% of the St. Thomas participants believed flood adapted interior fittings would be either ineffective or very ineffective whilst less than 30% perceived these measures as being effective. The perceived efficacy was again higher amongst those from Topsham ($>$40%). It is unclear whether or not the purpose and function of measures such as flood adapted interior fittings are well understood amongst the participants. Moreover, as participants generally did not have these measures implemented nor were recently flooded, then they would not necessarily be familiar with their use and certainly not with their effectiveness in minimizing flood damage within the house. This was the only resilience measure where there was a significant difference in perceived efficacy between the two communities (U=713.50, z=-1.99, p$<$.05).

Raising of electrical fixtures and use of concrete and or tiled floor coverings were both similarly perceived as being effective by a majority of participants from Topsham ($>$60%) (6.8). More than 50% of St. Thomas participants thought that raising the level of electrical fixtures was ineffective compared with only 6% of Topsham participants. There was 26% uncertainty about this measure's effectiveness amongst Topsham participants as opposed to only 9% for St. Thomas. Only 38% of the participants from St. Thomas believed this measure ranged from somewhat effective to very effective.

Storing valuables in upper floors was perceived as the most effective measure for participants from both communities. A majority of Topsham participants (77%) believed that storing valuables in upper floors would range from somewhat effective to very effective. Efficacy of this coping measure had the lowest uncertainty for Topsham participants. Approximately half of the St. Thomas participants (48%) viewed the measures as ranging from somewhat effective to very effective, while 40% viewed then as ineffective (Figure 6.8).

The efficacy of pumps to remove flood waters that enter the property or house in a flood was also viewed with high uncertainty by Topsham participants (50%) compared with St. Thomas (15%). Just over 30% of St. Thomas participants viewed these as effective compared with over 50% of Topsham participants. Similarly, it was found that Topsham participants were largely (60%) of the perception that having tiled or concrete floors was an effective wet proofing method as opposed to 38% from the other community. Additionally, 45% from Topsham and 13% from St. Thomas were uncertain. Only 5% of Topsham participants believed the measure would be ineffective versus 45% from St. Thomas.

Where correlations with behavioural intentions are concerned, response efficacy of the measures displayed significant positive relationships as seen in Table 6.2. These relationships will also be further explored in Section 6.6.

Table 6.2: Correlation matrix of flooding coping intentions and efficacy

	Efficacy									
Behavioural intentions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Place flood barriers	**.53****	-	-	-	-	-	-	-	-	-
2. Install "no-return" valves	.33**	**.44****			-	-	-	-	-	-
3. Use Airbrick vent covers	.29**	.25*	**.32****	-		-	-	-	-	-
4. Use sandbags	.11	.05	.11	**.35****	-		-	-	-	-
5. Raise floor levels above expected flood height	-.12	-.07	-.02	-.13	.15	-	-	-	-	-
6. Raise the level of electrical fixtures	.30**	.18	.08	-.06	.08	**.34****	-	-	-	-
7. Store valuables in upper floors	.33**	.28**	.25*	.19	.19	.33**	**.38****	-	-	-
8. Use concrete or tile floor coverings	.26*	.37**	.27*	.24*	.34**	.36**	.33**	**.57****	-	-
9. Install pump(s)	.29**	.24*	.23*	.11	.12	.19	.19	.14	**.36****	-
10. Use flood adapted interior fittings	.28**	.12	.11	-.09	.11	.21	.17	.13	.08	**.24***
** Correlation is significant at the 0.01 level (2-tailed)										
* Correlation is significant at the 0.05 level (2-tailed)										

6.5.3 Efficacy in reducing consequences and recovery time

A unique feature of this research is that it also investigated perceptions of the efficacy of household flood coping measures in minimising both direct and indirect consequences of floods as well as in minimising recovery efforts. Findings from the study following the 2007 Hull floods by Whittle et al. (2010) indicate that in addition to material damages, the non-material damages of flooding can often have long term consequences on households e.g. mental health implications. Therefore these aspects also require research attention in tandem with research on perceived material damages. As such perceptions of the efficacy of flood coping measures in minimising dislocation, discomfort, and emotional trauma and stress were also included along with material damages. Previous studies applying PMT in water management (e.g. Zaalberg et al., 2009; Bubeck et al., 2012; Poussin et al., 2014; Grothmann and Reusswig, 2006) have not incorporated these aspects of the efficacy of household flood coping measures. They have only examined perceptions of flood coping measures in reducing the level of flooding.

Participants' responses varied in terms of efficacy of flood protection measures in improving flood recovery. Over 80% of Topsham participants thought the measures could help improve recovery time whilst 14% were uncertain. 45% of St. Thomas participants perceived recovery capacity as ranging from somewhat effective to very effective, but with close to 40% being uncertain. However, there is no significant difference between perceptions of participants in both communities (U=725.50, z=-1.89, *ns*). Figure 6.10 displays these perceptions across both communities combined.

Whilst participants from both local areas generally rated the measures as ranging from somewhat effective to very effective in reducing the consequences of a major flood, there was more uncertainty amongst participants from St. Thomas. This finding is not unusual as this is a community with little or no recent experience of flooding whereas Topsham residents now have recent first-hand knowledge of flooding. It is possible that due to their recent flood experience, Topsham participants are more sensitised to the effect of flood coping measures on reducing both material and non-material consequences.

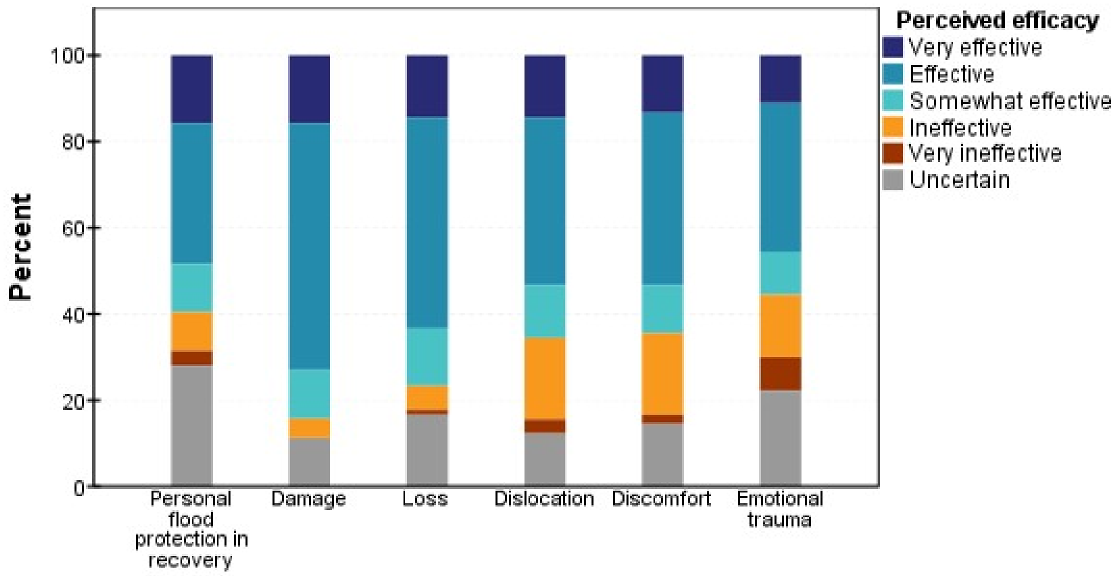


Figure 6.10: Perceived efficacy of flood coping measures in reducing flood consequences.

6.5.4 Efficacy of flood insurance

Flood insurance was not investigated in detail as it is not a coping response measure with the potential to minimise magnitude and duration of a flood but rather a recovery mechanism following a flood.

Two questions relating to flood insurance were included to determine its extent in the community as well as whether or not it was believed to be an acceptable flood response measure for the household. Although 65% of participants indicated that they currently have insurance coverage for flooding, some participants (17%) did not know whilst the remaining 18% did not have flood insurance.

Of those who did not know if they had insurance, less than 1% agreed that this option was effective to safeguard property from floods. Only 21% of the uninsured were in agreement compared with 49% of the insured. These findings indicate that whilst people perhaps recognise that insurance can provide the resources to implement recovery efforts, they also recognise that it does not reduce the consequences of a flood which can present long-lasting devastation.

6.5.5 Self-efficacy and response cost of flood coping

Where self-efficacy was concerned a lack of abilities or skills was the most significant limiting factor for the participants from both communities with more than 50% of St. Thomas participants agreeing about these factors. Lack of awareness and lack of knowledge were identified as the two least limiting factors towards self-efficacy. This implies that participants believed they possess adequate knowledge about flood protection despite the fact that there was some uncertainty about how the effectiveness of household coping measures were perceived. The communities were significantly different in how they perceived self-efficacy (U=493.50, z=-3.78, p$<$.001).

Harries (2012) reported that the flooding of an unprotected UK home causes on average £30,000 damage compared with the approximately £2,900 required for flood protection per home. Such measures have been found to reduce the financial cost of damage by between 65% and 84% (Thurston et al, 2008 in Harries (2012)). Despite this being the case, financial cost was found to be a limiting factor for household flood coping implementation. The majority of St. Thomas participants (71%) agreed that financial costs could pose a barrier to implementation of flood coping responses compared with 41% from Topsham. Some 50% of Topsham participants agreed that money was not a limiting factor. A difference in income in the two communities may account for this. Similarly, 59% of St. Thomas participants agreed that time and effort were both also limiting factors whilst only 35% of Topsham participants agreed. That financial cost is an issue for St. Thomas participants was reflected in some of the quotes throughout the survey:

> *“Cost v. risk considerations.”* (Survey participant #09)
>
> *“Some of these appear very costly”* (Survey participant #11)
>
> *“These measures would be costly given unlikely event of flooding. Little known about above preventions.”* (Survey participant #15)

The two communities were significantly different in their appraisal of response cost (U=688.00, z=-2.10, p$<$.05). In the open-ended section of this question, 10 participants went on to explain that they were limited by the fact that: 1) the house was rented (40%) and so it would be landlord’s decision and or responsibility to undertake any such measures; 2) the existing flood defences and ongoing upgrades were adequate for flood protection and hence they did not believe there was a need for these measures (40%); and 3) perceived likelihood of flooding is low and hence the need for any of the measures was not realised (20%). Neither response cost nor self-efficacy displayed significant correlations with behavioural intentions towards implementation of flood resistance or flood resilience measures.

6.6 Understanding flood coping behavioural intentions

6.6.1 Assuring validity and reliability

Similar to the previous chapter, this section provides results and discussions about the analyses undertaken using aggregate variables including latent variables. As seen in Table 6.3, all the latent variables were found to be both valid and reliable in their measures. These variables were then aggregated in a similar way as explained in Chapter 5 to provide an average value for each construct. The constructs for the flood regression models included the following:

1. Flood consequences
2. Efficacy of flood coping measures
3. Self-efficacy
4. Response cost
5. Past experience
6. Reliance
7. Postponement
8. Behavioural intentions - resistance and resilience measures are combined for a single variable

6.6.2 Developing the regression models

Hierarchical block-wise multiple linear regression models were developed with the outcome variable being intentions towards implementation of flood coping responses (all resistance and resilience measures combined except flood barriers). This is because the uptake of flood barriers was found to be quite different from the other measures and so it was removed from the analyses. Similar to the models in Chapter 5, two blocks of variables were used, first being socio-demographic variables in Block 1, and the Block 2 consisting of Block 1 plus PMT and extended variables such as past experience.

Table 6.3: Results of the validity and reliability tests for the latent variables used in the analyses.

Factor	**Measured variable**	**Variance (eigenvalue)**	**% Variance**	**Cronbach's alpha**
Consequences	• Severity to property • Severity to family • Level of flooding within property • Damage to property • Damage to building structure • Damage to home contents • Damage to vehicles • Disruption of livelihoods • Disruption of transport • Loss of lives and injuries	6.395	21.32	0.928

Table 6.3 – *Continued from previous page*

Factor	**Measured variable**	**Variance (eigenvalue)**	**% Variance**	**Cronbach's alpha**
Efficacy in recovery	• Dislocation • Discomfort • Loss • Damage	3.58	11.92	0.902
Self-efficacy	• Lack of abilities • Lack of knowledge • Lack of awareness	2.54	8.45	0.786
Reliance	• Flood defences adequate to protect home item Flood defences adequate to protect local area	2.1	7.01	0.91

Table 6.3 – *Continued from previous page*

Factor	**Measured variable**	**Variance (eigenvalue)**	**% Variance**	**Cronbach's alpha**
Postponement	• I would implement flood protection if incentive • I would implement flood protection if legally required	1.88	6.27	0.61

6.6.3 Indicators of household flood coping

Results of the hierarchical models

Model 1: Socio-demographic variables

Although income accounts for less than 3% of the variance in the intentions towards household flood coping measures, it was removed from the final model due to the fact that it only considers 56 cases as the remaining participants did not indicate their income. When income is removed from the model, the SPV ratio increases as more cases are represented in the model. There is no significant contribution to behavioural intentions as seen in Model 1 in Tables 6.4 and 6.5. As with the case of drought coping intentions in Chapter 5, socio-demographic variables also had very weak relationships with behavioural intentions for flood coping measures amongst participants of both communities (Table 6.5). Hence, on their own, they did not significantly account for the variance in behavioural intentions.

Table 6.4: Model summary of the hierarchical regression models for flood coping

Model Summary [c]						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.
1	.163[a]	r0.027	-0.024	0.58903	0.525	.717[a]
2	.642[b]	0.412	0.32	0.48003	4.464	.000[b]
[a]Predictors: (Constant), Age, Years_lived neighbourhood, Education levels, Housing status						
[b]Predictors: (Constant), Age, Years_lived, Edu_levels, Housing_status, Response_cost, Postponement, floodcop_eff, Reliance, Flood_conseq, Pastflood_expe, Self-eff						
[c]Dependent Variable: Floodcop_intentions						

Several researchers have found socio-demographic variables to have minimal to no effect with regards to flood coping intentions. For instance, Bubeck et al. (2013) found non-significant effects of socio-economic variables as mediating

Table 6.5: Coefficients for flood coping hierarchical regression models.

Model		Unstandardised Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.16	0.44		4.93	.000
	Edu_levels	-0.02	0.07	-0.03	-0.24	.81
	Housing_status	0.05	0.19	0.03	0.24	.81
	Years_lived	-0.04	0.03	-0.16	-1.41	.16
	Age	0.004	0.05	0.01	0.09	.93
2	(Constant)	2.17	0.63		3.49	.001
	Edu_levels	-0.03	0.06	-0.06	-0.60	.554
	Housing_status	0.05	0.20	0.03	0.29	.777
	Years_lived	-0.03	0.03	-0.12	-1.23	.222
	Age	-0.02	0.04	-0.05	-0.41	.684
	Flood_conseq	0.17	0.06	**0.27**	**2.68**	**.009**
	Floodcop_eff	0.21	0.05	**0.43**	**4.38**	**.000**
	Self_eff	0.00	0.06	0.00	0.05	.957
	Response cost	-0.10	0.06	-0.20	-1.70	.10
	Pastflood_expe	0.22	0.07	**0.30**	**3.99**	**.004**
	Reliance	-0.08	0.05	-0.17	-1.65	.103
	Postponement	-0.13	0.10	**-0.22**	**-2.15**	**.035**
R^2=.03, ΔR^2=.41 ($p<.000$)						

factors. Although Thieken et al. (2007) found significant effect of socio-economic variables on flood coping intentions, this was minimal effect (coefficients less than 0.2). Grothmann and Reusswig (2006) found a socio-economic model yielding statistically significant effects on protective responses for age, household income, and ownership of home but these were found to be much weaker than the psychological determinants of PMT.

Clearly the influence of socio-demographic characteristics on flood coping intentions varies depending on context as concluded by Poussin et al. (2012) following a case study in the Meuse region. Behavioural intentions towards flood coping responses extend beyond an individual's socio-demographic profile. The psychological variables of PMT and socio-technical variables are suggested by scholars such as Grothmann and Reusswig (2006) to be some of the most important contributors to behavioural intentions. These variables are assessed in the Model 2.

Model 2: PMT and socio-technical variables

The next step of the regression model was to test if there were any further effects on the predictive capacity of the model attributed by the PMT and socio-technical variables. These variables (consequence, efficacy, self-efficacy, response cost, past experience, reliance, and postponement) were hence entered into a second block after Block 1 variables.

The results of this model showed several variables that significantly contribute to its predictive capacity (Model 2 in Table 6.4). These variables were perceived consequences, efficacy, past flood experience, and postponement as seen in Table 6.5. Together these variable significantly accounted for 32% of the variance in behavioural intentions (Table 6.4). These significant variables appear to have differential effects on behavioural intentions as expected based on earlier results of the correlational analyses. For instance, an increase in postponement significantly led to a decrease in behavioural intentions, while an increase in perceived consequences led to an increase in behavioural intentions.

Although self-efficacy had a positive relationship with both resilience and resistance behavioural intentions, it was not found to contribute to the predictive capacity of the model. This is unlike much of the literature which finds self-efficacy to be a significant variable in shaping intentions to cope with flooding (Bubeck et al., 2013, Poussin et al., 2014 and Dittrich et al., 2016). Differences in measurement as well as sample size may attribute to this, but it is also possible (as mentioned elsewhere), that self-efficacy may not necessarily be a major issue where household flood coping responses are concerned in these specific case study areas. They are perhaps not implementing flood coping measures chiefly because they believe it is not necessary, rather than a belief that they will not be able to implement the measures. It is possible that they are not yet at the stage of thinking how they can implement the measures because they are still in the stage of why implement a flood coping measure. The assessments on decision stages will further illuminate this matter.

Response cost which had negative correlations with flood coping intentions was not a significant predictor in the model unlike the case of drought coping intentions in Chapter 5. Like self-efficacy, it is possible that participants do not weigh the cost of measures due to the lack of perceived need for implementing household measures. Additionally some participants may be driven by cost but the regression model is not able to reveal this. Hence, cost will be further investigated to establish its importance in decision-stages and flood coping intentions.

Results of the best-fitting model

The next step involved use all significant variables in the hierarchical model into a single best-fitting model:

$$Fci = b_0 + b_1FC_1 + b_2CRE_2 + b_3FE_3 + b_4P_4 + \epsilon \tag{6.1}$$

Where:

- b = the coefficients
- Fci = Flood coping intentions
- CRE = Coping response efficacy
- FE = Flood experience
- P = Postponement
- e = the independent error term

This best-fitting model included more cases (89 out of 91) compared with the previous hierarchical model which only included 79 of the 91 cases due to missing data in mainly the socio-demographic variables. More variables increases the SPV ratio thereby increasing the reliability of the model. All the variables are significant predictors of behavioural intentions with the exception of postponement. Although this model accounts for slightly less variance (31%) in behavioural intentions, the difference between R square and adjusted R square is much reduced (3.2 percentage points compared to 9.2 percentage points in the hierarchical model), increasing the accuracy of the model. Not only are there the SPVs increased and change in R square reduced, the residuals also meet the assumption of being normally distributed, with no multicollinearity amongst predictors, and no unusual cases (Table D.2, Appendix D).

Response efficacy is the most significant contributor to the best-fitting model with β value of 0.40 and *t* value of 4.36 (Table 6.6). That response efficacy is a significant contributor to behavioural intentions is consistent with all leading research on PMT in flood management (Dittrich et al., 2016; Koerth et al., 2013; Bubeck et al., 2013; Thieken et al., 2007; Kreibich et al., 2005; Grothmann and Reusswig, 2006). These studies all found that response efficacy significantly accounted for variance in the behavioural intentions of various categories of flood coping response measures. Interventions that highlight or allow for discussions around the efficacy of coping response measures require greater visibility so that those in flood risk areas can make more informed decisions whether or not they believe that their local area will flood severely and/or frequently.

Table 6.6: Results of the best-fitting model for flood coping intentions

Variables	**Unstandardized Coefficients**		**Standardized Coefficients**
	B	***Std. Error***	***Beta***
(Constant)	1.28	0.25	
Flood_conseq	0.19	0.06	$.31^{**}$
Floodcop_eff	0.20	0.05	$.40^{***}$
Pastflood _expe	0.22	0.07	$.30^{**}$
Postponement	-0.10	0.06	-.16
R^2=.35, R^2 (adj) = .31 ($^{**}p<.01$, $^{***}p<.000$			

Resilience at the household and community levels can hence be promoted through interventions that engender decision-making and action. Other sectors have already managed to use the idea of efficacy to improve uptake of response measures to specific threats, despite probability. A prime example is fire where the consequences can be catastrophic and fatal. Most property owners understand these consequences and will undertake an annual fire inspection to ensure that fire fighting equipment such as fire extinguishers and fire blankets are in good working condition. They do this despite the fact that they are probably not anticipating starting a fire but rather to ensure that if the worst happens then they are in a position to respond to some extent. A similar approach to promoting the efficacy of flood coping measures can significantly increase the uptake of flood coping measures (outside of flood insurance), particularly if twinned with the potential consequences of flooding. Consequence was also another significant contributor to the model (Table 6.6), highlighting its importance in behavioural intentions.

Past experience, the final significant contributor to the best-fitting model, has repeatedly been found by researchers to be a significant predictor of flood coping behavioural intentions and is dependent on the nature, recency, and severity of the event. In Chapter 4, practitioners highlighted how important this variable can be to the participation of households and communities in flood intervention strategies. It is hence important that it be considered for use in an informative way in intervention strategies to provide various types of information about flooding in the local area.

6.6.4 Section summary

This section highlights significant predictors of flood coping intentions, which will guide further analyses as indicator variables in the next section of this chapter. The indicator variables are response efficacy, perceived consequences, and past flood experience. Analysis and identification of indicator variables provide the basis for the development of an intervention strategy aimed at enabling greater success in enhancing individual and community flood resilience. Variables such as cost did not prove to be significant contributors to the models but may still be of importance for some people in forming their intentions and hence their decision-stage about coping measures. Therefore, further exploratory analyses in the next section examines if and how the variables combine in shaping decision-making of individual households in flood zones.

6.7 Assessing the decision-stages for household flood coping

6.7.1 Results of cluster analyses

Input variables

As explained in the Chapter 3, the choice of input variables is a critical aspect of undertaking cluster analysis. Results of the multiple regression models already provided three indicator variables as they were found to significantly impact behavioural intentions and hence were automatically selected. After undertaking several preliminary experiments, it was found that these three variables alone were not enough to cluster the sample with the *k*-means algorithm. Therefore, several experiments were undertaken with different combinations of variables being input into the cluster model. The following variables were the complete set of variables used for clustering where flooding was concerned:

- Perceived flood consequences
- Perceived response efficacy
- Past flood experience
- Perceived financial cost
- Perceived efficacy in consequence reduction
- Behavioural intentions

These variables were found to be the most valid in developing clusters within the data. Socio-demographic variables were not very useful to the clustering algorithms used in the study, further highlighting their non-significant effect in explaining why some people are more willing to implement measures versus others, but also perhaps why those more willing have yet to implement most measures.

Cluster solution

From the hierarchical cluster results, a four cluster solution was interpreted. These four clusters are illustrated in the dendrogram in Figure 6.11 below. This was the best partitioning of the data without selecting too many clusters.

However, upon further exploration with the more robust *k*-means clustering method, via the NbClust package in R, a three cluster solution was found to be the optimal solution. The results stated that among all indices:

- 5 proposed 2 as the best number of clusters
- 11 proposed 3 as the best number of clusters
- 3 proposed 7 as the best number of clusters
- 2 proposed 9 as the best number of clusters
- 2 proposed 10 as the best number of clusters

A total of 89 cases were represented in the cluster analysis, strengthening the

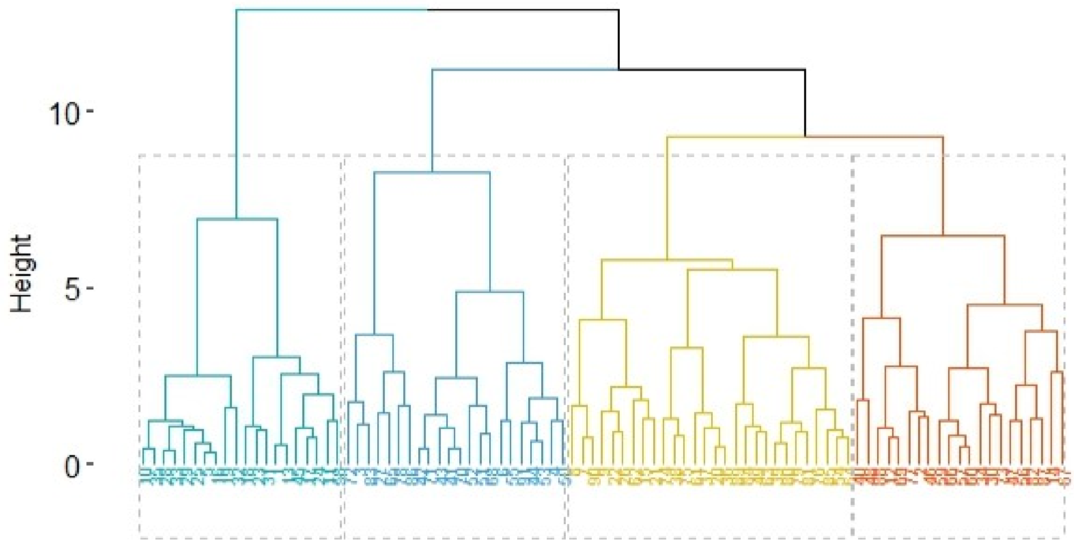


Figure 6.11: Dendrogram illustrating four flood coping decision clusters.

SPV ratio, and hence the validity of the cluster model. Each cluster was assigned a name based on TTM characterisation of decision-stages. Only two decision-stages were identified amongst the three clusters, the pre-contemplatives and the contemplatives. The pre-contemplatives were divided into two clusters on the basis on their past experience, and perceived efficacy of the measures. There is therefore an experienced pre-contemplative cluster and an inexperienced pre-contemplative cluster.

The three clusters displayed significant difference in perceived efficacy, while for the other input variables only two of each cluster had significant differences from the other cluster. As a result, clusters 1 and 2 share some similarities where certain variables are concerned but are different with other variables. Similarly, clusters 2 and 3 are similar in some areas but different in others (Figure 6.12 and 6.13).

Where non input variables were concerned, the clusters were usually quite similar. For instance, both self-efficacy and postponement which were not input variables showed no significant difference across the three groups as can be seen in Figure 6.13. The socio-demographic variables also did not show any major variation from cluster to another and are hence not indicators of flood coping behavioural intentions. Each cluster is discussed in detail below.

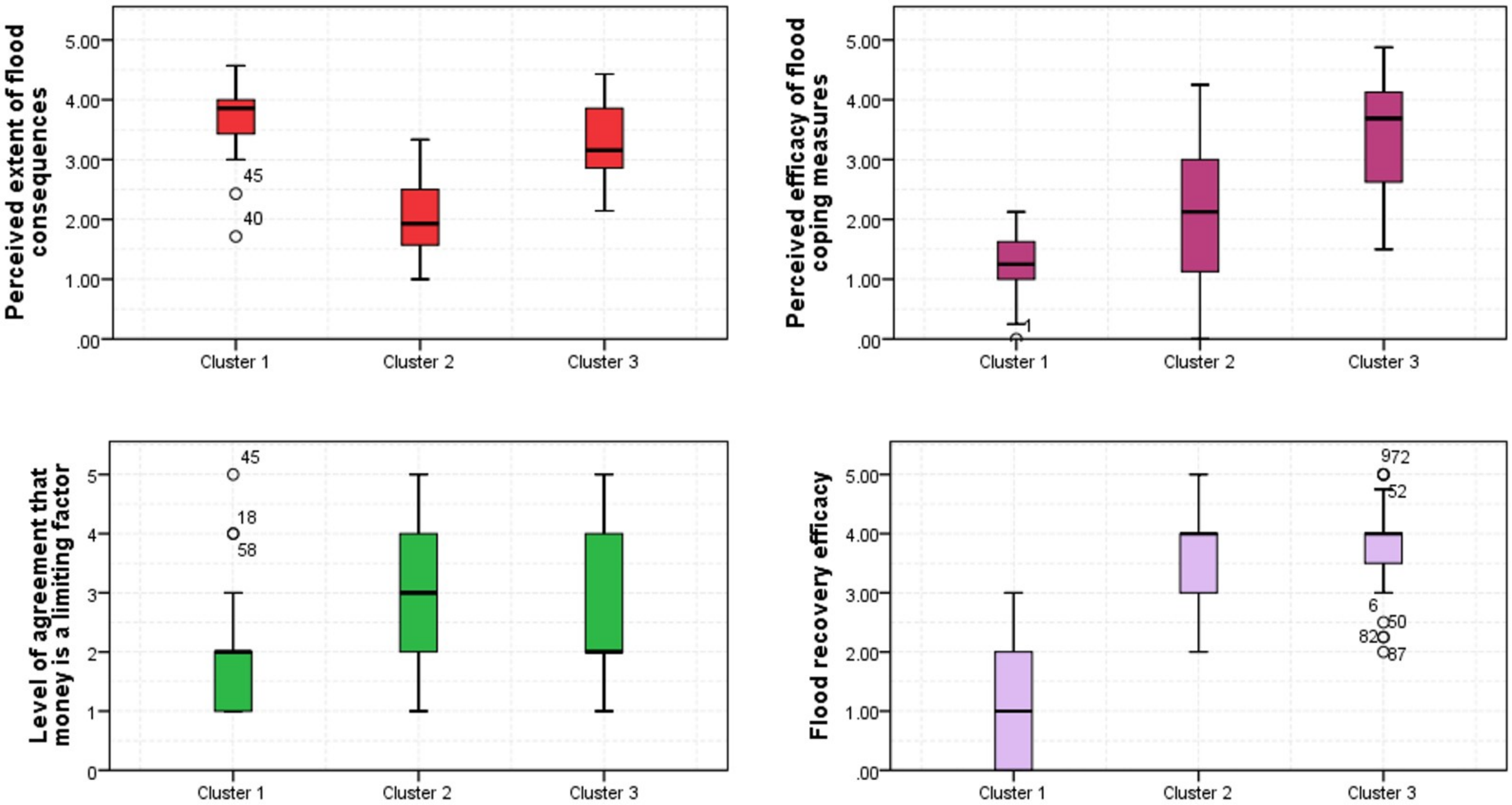


Figure 6.12: Distribution of variables across the three clusters.

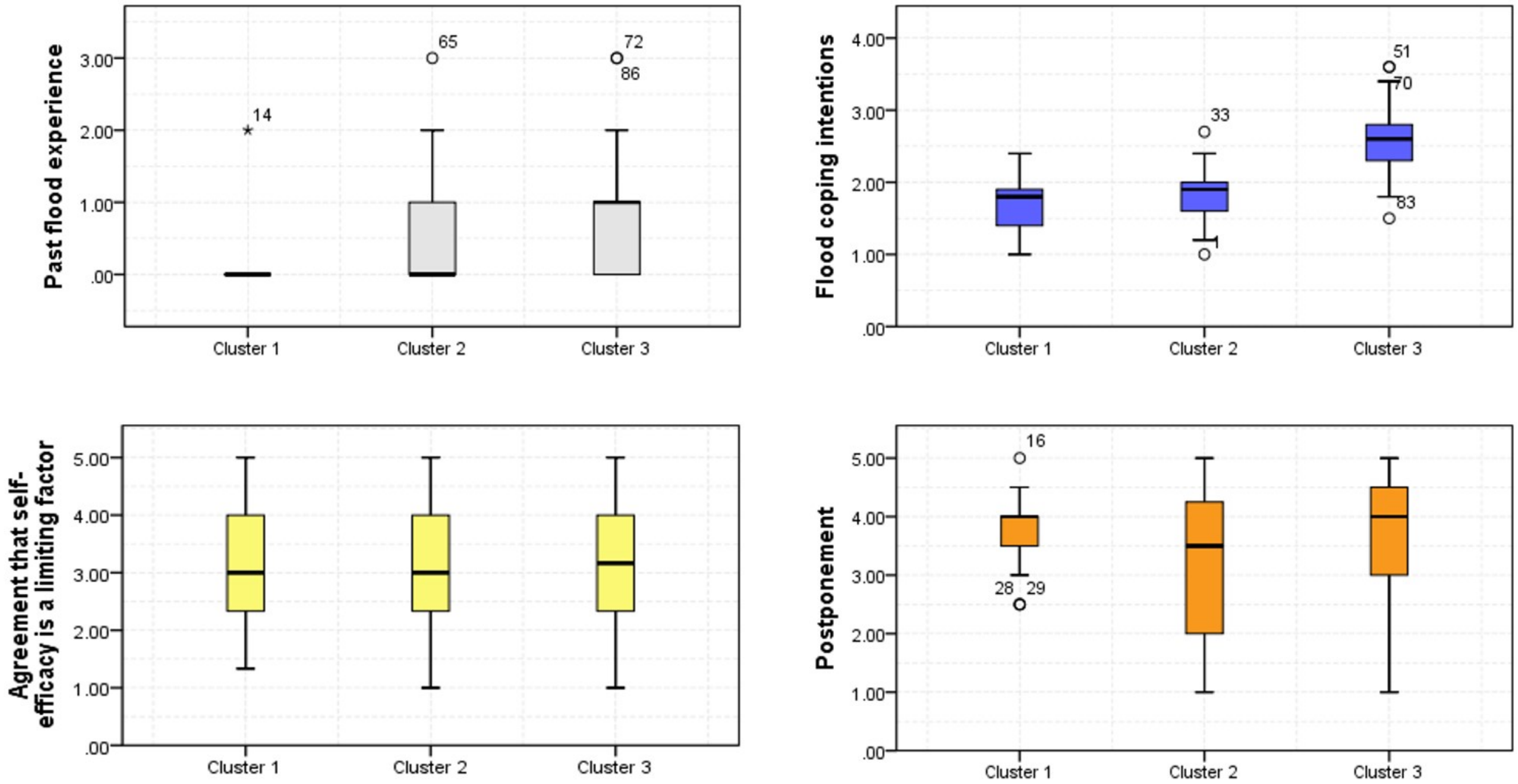


Figure 6.13: Distribution of variables across the three clusters (Past flood experience, behavioural intentions, self-efficacy and postponement).

6.7.2 Clusters and their profiles

Cluster 1: Inexperienced Pre-contemplatives

Cluster 1 was the smallest of the three clusters and consisted of 21 participants or 24% of the sample. This cluster almost entirely consist of St. Thomas participants with just one member from the Topsham community. They are labelled as inexperienced due to their lack of past flood experience either at their current home address or at a previous location. They are pre-contemplative because they are generally unwilling or uncertain about whether or not they will implement flood coping response measures.

The inexperienced pre-contemplatives perceived moderate to high consequences of a major flood (Figure 6.12) making them significantly different from the experienced pre-contemplatives of cluster 2. In fact, the inexperienced pre-contemplatives had similar perceptions of flood consequences to the contemplatives (cluster 3), albeit somewhat higher. This finding is quite surprising but may indicate that those with limited experience do not necessarily underestimate the consequences of flooding as found by some researchers.

Whilst they believed consequences would be high, the inexperienced pre-contemplatives were of the opinion that household flood coping measures would have low effectiveness in reducing flooding (Figure 6.12), and low to medium effectiveness in reducing some of the consequences associated with flooding such as loss, dislocation and emotional trauma (Figure 6.12). Furthermore, the inexperienced pre-contemplatives perceived that financial costs would not limit their coping capacity Therefore, although this group perceived high flood consequences, their intentions seemed to be limited by perceived low effectiveness of flood coping measures. This finding may imply that members of this group hold fatalistic views that no matter what is done they would still be impacted by a flood.

Cluster 2: Experienced Pre-contemplatives

Experienced pre-contemplatives included 38 participants (43%) and was the largest cluster amongst the three. The participants included 16 from St. Thomas compared with 22 from Topsham. Naturally some members of the group had experience with flooding, either at the current address or a previous location.

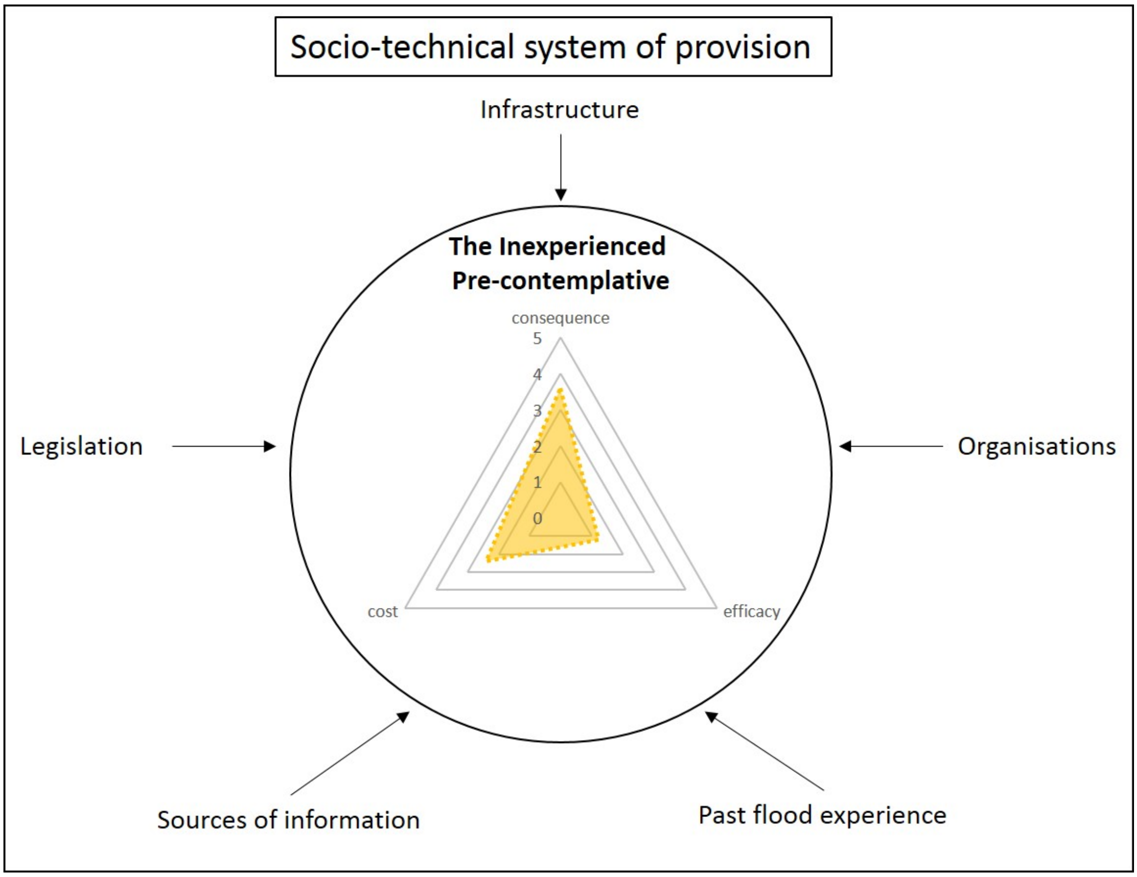


Figure 6.14: Cluster 1 - Inexperienced pre-contemplatives

The experienced pre-contemplatives were not highly engaged in household flood coping responses and were either unwilling or uncertain about whether or not to participate at a household level. Hence the labelling of pre-contemplative.

Experienced pre-contemplatives are distinguished from the other two clusters based on their perception of the extent of flood consequences which they believed would be low on average and ranging up to only medium severity (Figure 6.12). Where the other variables are concerned, this group shared similarities and differences with both clusters 1 and 3. They are most similar to cluster 1 in terms of low intentions to implement flood coping response measures and similar to cluster 3 in terms of perceived efficacy of flood coping measures in minimising flood recovery. Where perceived financial cost was concerned, there was no significant difference between this cluster and cluster 3 (contemplatives). However, this cluster was significantly different from cluster 1 (inexperienced pre-contemplatives) in their perception of financial cost as a limiting factor towards implementation of flood coping responses. In summary, this group appeared to have low intentions to implement a coping response measure due to the combined effect of low perceived consequences from a flood and the low effectiveness of the coping response measures.

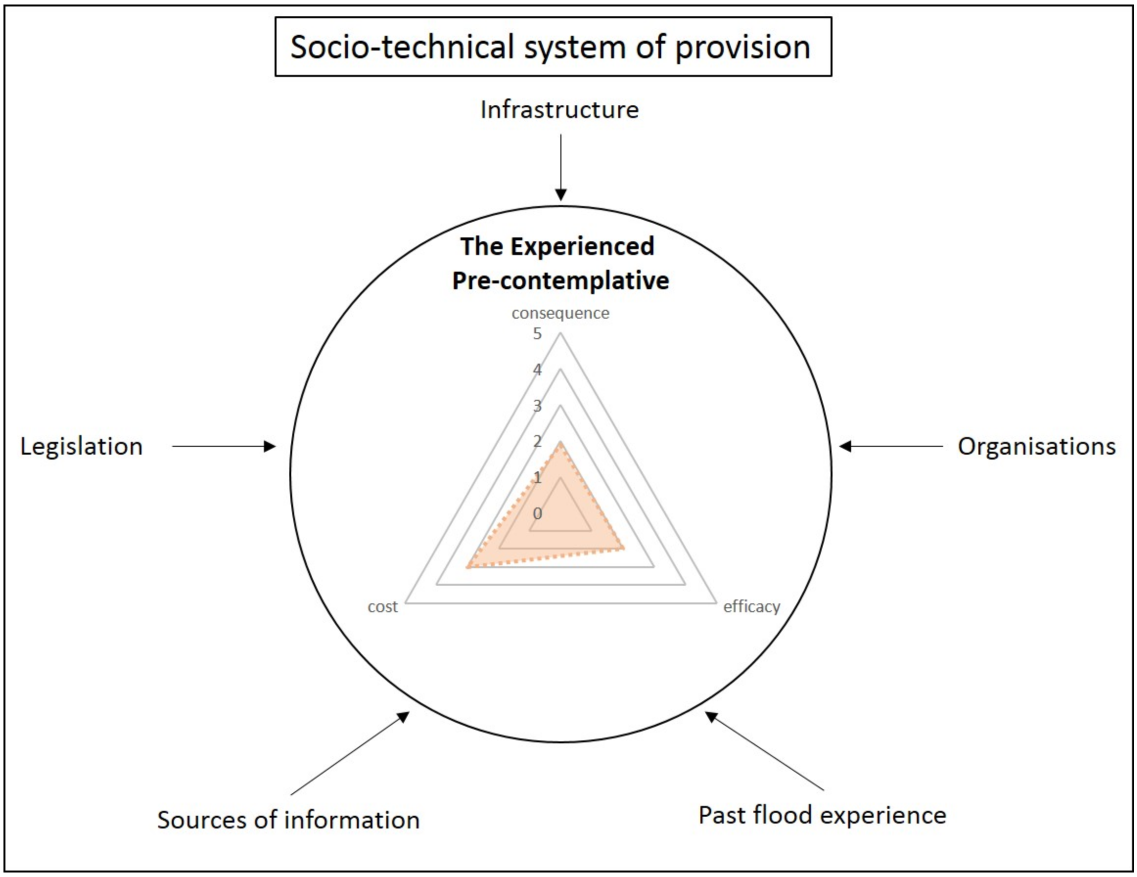


Figure 6.15: Cluster 2 - Experienced pre-contemplatives.

Cluster 3: Contemplatives

Cluster 3 represents 34% (30 participants) of the sample. Of the 30 participants, 18 were from St. Thomas whilst the remaining 12 were from Topsham. The participants of cluster 3 displayed characteristics that best display a contemplative decision-stage and are hence referred to as contemplatives. Those who were classified as being amongst the contemplative group, included a mix of participants who were either uncertain about whether or not to implement flood coping response measures as well as a majority who indicated that they plan to implement some of the measures. A small portion had already implemented at least one measure (particularly flood barriers), but in general they were not outright acting on implementing flood coping response measures.

Consequences of flooding were perceived as moderate to high by the majority of participants in this group. On average, they perceived the measures to be moderately effective in minimising the magnitude of flooding their property would face and effective in minimising the consequences of flooding (Figure 6.12). There was more agreement amongst this cluster that financial cost could be a limiting factor towards coping response implementation. The contemplatives have experienced at least one flood on average showing that they are experienced with flooding, although some were several decades ago (St. Thomas) compared with a few years ago (Topsham). This group is displayed by its three most distinguishing characteristics in Figure 6.16.

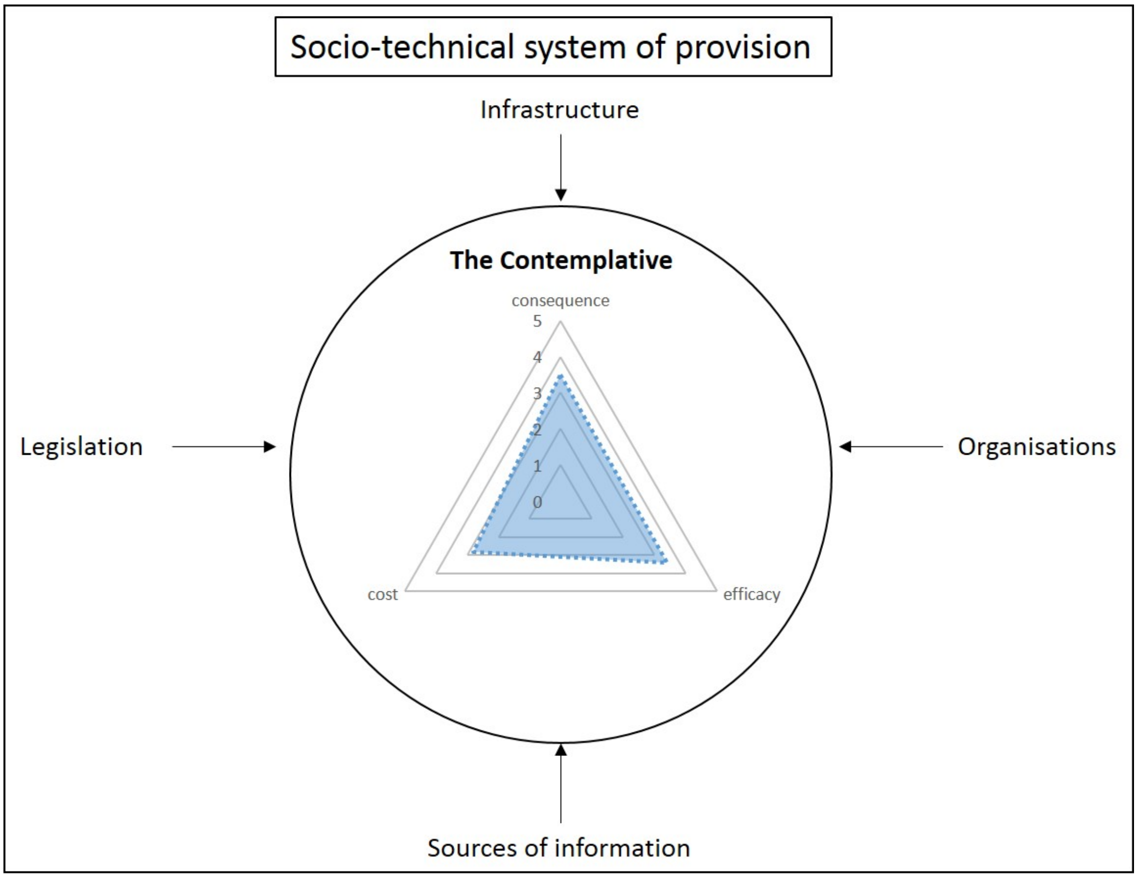


Figure 6.16: Characteristics of Cluster 3, the ‘Contemplatives’.

6.8 Chapter summary

Climate change was often readily associated with flooding and was expected to impact the frequency and intensity of storms and related damages. The frequency of the storms were expected to increase as well as the magnitude of the consequences. Most participants believed climate change would affect their local areas as well as them personally.

Whilst flood consequences were expected to range from medium to high by a majority, the proposed coping response measures were not expected to be very effective overall. Perceptions of self-efficacy related to household coping were mixed with some reporting that they would be limited by one of or a combination of abilities, knowledge and awareness whilst others did not think these were limiting factors. Financial cost was expected to be a limiting factor in a majority of cases. In general, households within the studied flood risk areas had low intentions to participate in household level flood coping. This is despite most participants expecting some measure of flooding in the event of a major storm. Past flood experience correlated significantly with behavioural intentions. Socio-demographic variables did not have significant effect on behavioural intentions.

The best-fitting multiple regression model showed that perceived efficacy, past experience and consequence were the most significant contributors to behavioural intentions. Other PMT variables, self-efficacy and response cost were not significant in any of the models. However, in addition to consequence, efficacy, and past experience, perceived financial cost was important in forming clusters within the data that define different decision-stages and motivations. Another variable, perceived efficacy to reduce consequences, also proved critical to the formation of clusters. Hence, these variables are identified as indicators of flood coping intentions.

Although there were three clusters, only two decision-stages were identified, these being pre-contemplative and contemplative. The pre-contemplative decision-stage was segmented based on past experience with flooding. The key indicators of flood coping intentions, perceived consequence, efficacy (both in minimising the magnitude of flooding and minimising the consequences of flooding) and cost, appear to combine in different ways to set people along different decision-making trajectories. Those with high intentions to implement flood coping measures were perhaps not doing so due to the high perceived cost associated with such ventures in addition to being situated in a STS of acceptable flood defence provision. Those with low intentions were not motivated to act based on a combination of one or more of the following: low perceived consequences, low efficacy of the response measures, and the perception that financial cost could be a limiting factor.

The same variables have been found to be indicators of both drought and flood coping intentions and are hence concluded to be suitable indicators. These variables find similar agreement in the literature. In the next chapter, it is proposed that these indicators be used to develop a framework that can be used at the community level to influence decisions and actions at the household level, thereby enabling greater flood resilience amongst households and communities.

7 COMMUNITY SURE FRAMEWORK AND TOOLKIT

> *"I think what we're, what these sort of initiatives are trying to encourage, is for people within the community to start to take responsibility...when it came to the crunch that night the Fire Brigade weren't around because they were busy being called out to incidents here there and, bigger incidents."* (Topsham Workshop Participant (TWP) 001, male 70+)

7.1 Introduction

The above quote reflects the recognition of communities of the need to build their resilience in an effort to better cope with extreme events that cause infrastructure failure, service disruption, and hence presenting several consequences for them. This chapter aims to integrate the research findings into the development of a decision framework to further fulfil the research aim of engendering or promoting resilience to water management extremes at the household and community levels. This decision framework is meant to be used to operationalise household and community resilience planning (Objective 5). The previous three chapters provided detailed understanding of key lessons for community engagement and participation in drought and flooding, as well as perceptions and behavioural intentions of households to the intervention of coping with drought and flooding. In addition to the findings from Chapters 4 - 6, feedback from community and practitioner engagement will be integrated into the development of this decision framework.

The following research questions are pursued in this chapter are as follows:

1. What are the cross-cutting themes that need to be considered in interventions for community participation?
2. How can indicators be incorporated into a framework and toolkit for community planning?

Prior to presenting and discussing the framework, this chapter reflects on the the implications of the previous research findings and how these led to the development of a framework for assessing and enhancing community and household drought and flood resilience (Section 7.2). This is followed by an explanation of the conceptual framework and the key ingredients that are needed for its success (Section 7.2.2). Section 7.4 explains and discusses the transformation of the framework into an action-oriented decision making toolkit. A series of discussions with community members, practitioners and academics have been undertaken to co-produce the development of a toolkit for facilitating community action in addressing specific challenges. Each constituent part of the toolkit is further discussed with examples from the community that used it in a testing workshop. Finally the chapter closes (Section 7.5) with a summary of the processes highlighted, as well as some reflections on the research questions posited here.

7.2 Implications of the research findings

The previous three chapters presented detailed insights into some of the past and ongoing community engagement and participatory efforts in the UK water sector, in addition to the perceptions and intentions of households regarding drought and flooding. Key insights from these findings are discussed below and integrated later in the chapter.

7.2.1 Integrating cross-cutting themes for community drought and flood participation

Analyses of practitioner interviews revealed several key themes that were emergent or learnt in previous community engagement and efforts for promoting participation in drought and flood resilience or to better understand experiences and perceptions. From the interviews, the three cross-cutting themes that appear to be most significant across both drought and flooding related engagement are: 1) communication, 2) social networks and, 3) empowerment. These themes have their own intricacies and are all highly interlinked as illustrated in Figure 7.1. They are central to the development of any intervention framework for resilience and hence are discussed below with regards to participation.

Communication

Within both drought and flood engagement and participatory activities, the importance and challenge of communication repeatedly emerged from various perspectives. The most noticeable trend was that communication is concerned with the ‘who’, ‘what’, ‘why’, ‘where’, ‘how’, and ‘when’, all of which are critical to the success of the particular intervention.

Where the ‘who’ is concerned it was important that the right people and groups be targeted especially in initial engagements as they can then leverage their influence to increase interest in activities that are aimed at building and enhancing resilience within the local area. Therefore knowing who to engage with is a key issue for increasing participation in programmes that strive to build resilience to drought or flooding. The ‘what’ to communicate aspect was very much concerned with the framing of various aspects of the threat as it is through discussions of the threat that there can be change and action towards resilience. For instance, it might be more useful to discuss residual risk of the threat or linkages with climate change impacts versus probability of a threat which might be less easily understood. Based on the findings of Chapters 5 and 6, discussing potential consequences might prove useful in communication related to drought and flood vulnerability and resilience. The ‘why’ of communication builds on this by placing focus on the benefits to households and communities for enhancing their resilience to the consequences of drought and flood extremes and climate change impacts on rainfall patterns.

The ‘how’ of communication will vary according to circumstances such as the size and structure of the community which introduces the matter of ‘where’. For instance, it was explained that rural communities may respond to certain approaches that may be different from approaches that those located in large urban centres would be more responsive to. These two must therefore be considered in tandem. With respect to the ‘when’, ongoing communication is required to encourage continued participation and proactive response that can be instrumental in triggering a re-configuration of community relationships with water management.

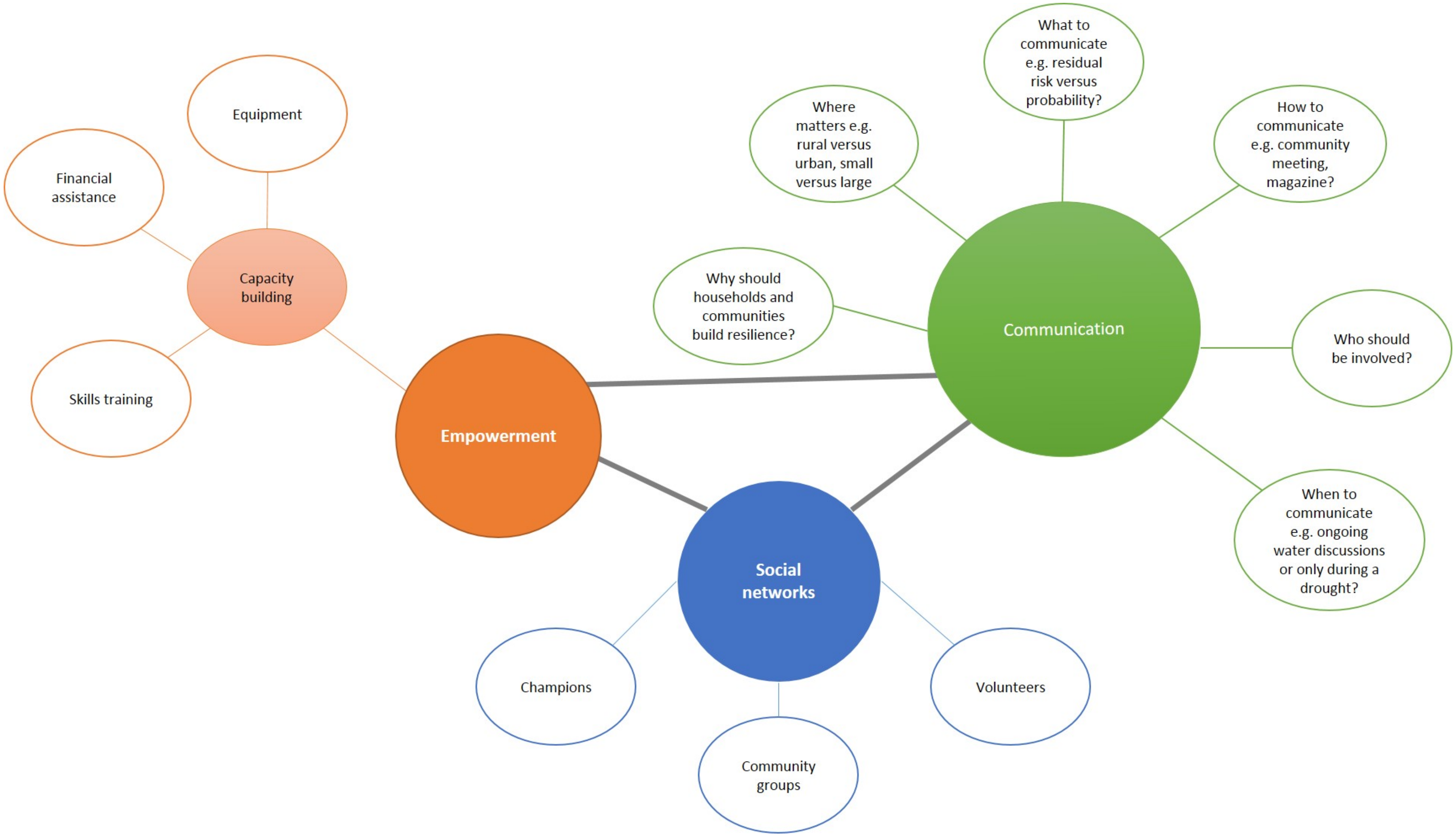


Figure 7.1: Cross-cutting themes that are integral to community engagement and participation efforts for both drought and flood related issues.

Empowerment

Practitioners working with communities in water management issues have found that empowerment is a necessity for the ongoing participation of local people. It has been suggested in this research that one of the best routes to empowerment is through building the capacity of the individuals within a community. Capacity building can encompass a combination of the skills and resources which enable households and communities to work together to make decisions, develop strategies and action plans, manage resources and seek out new ones (e.g. funding to implement a new action plan), and to be able to evaluate their actions for the future. It was shown in the Pathfinder project that the Flood Warden training programmes implemented in target communities have provided them with a base of people with the appropriate skills and knowledge to assist the community in an emergency in the interim of emergency services arrival. In other instances, communities may already have the skills and motivation to develop strategies and plans for enhancing resilience but do not possess the resources needed to implement them. Therefore, access to resources serve to empower communities by building their capacities to reduce inequities in vulnerability, and hence increase their resilience.

Social networks

It is now well recognised that social networks are a necessary part of community engagement in addressing a wide range of social, environmental and economic issues within local areas. The Pathfinder project found that social networks can be both helpful in terms of leveraging community support, as well as being quite the opposite in other instances. Issues of power can sometimes affect the way communities operate, sometimes resulting in long-standing feuds as found by some practitioners. It is therefore important to identify reliable champions within the community who can stimulate and motivate the activities that seek to enhance resilience to water related issues. Therefore, this links back with the 'who', 'where' and 'how' of communication. Community service groups as well as community interest groups that are concerned with social enterprise are useful avenues into communities when it comes to sustainability and resilience issues.

7.2.2 Utilising indicator variables

A key finding of this research, is that the effectiveness of coping measures in minimising the consequences of a threat appears to be an important variable in the intention and decision to implement coping measures. As discussed before, this variable has consistently been found to be associated with motivating behavioural intentions towards natural hazards such as drought and flooding. Households and communities must have some sense of *"will this actually work/help us"* as part of their decision-making process. A major barrier towards making this assessment can sometimes be the lack of capacity to identify appropriate and feasible measures in the first instance. This highlights the need for communities to be empowered through capacity building that places specific focus on coping with water management extremes.

In addition to the efficacy of potential coping response measures, households and communities want to know how much a given measure will cost them. This is usually in terms of financial cost of the appropriate response measure but may also include other costs such as the time and effort involved in either the planning or implementation. If these two variables combine favourably, households and communities may be more inclined to move from forming an intention towards the actual implementation of measures that facilitate their coping with flooding or drought.

However, before appropriate coping response measures are identified, it is important to understand what potential consequences may be experienced as a result of the threat. The results of this study imply that the perceived consequences of a major drought or flood event is another significant variable in their decision-making about whether or not to respond locally. This also combines with the individual's past experience with the threat/hazard. Past experience in itself is a complicated issue relating to both direct and indirect experiences and can either coax households into a sense of complacency or drive them to become active responders in anticipation of future events. It is the indirect experiences that can sometimes be the most influential moderators of intention forming. Indirect past experience might include information from others or the media as well as witnessing others' experiences which was noticed amongst some of the participants from Topsham. As demonstrated in Chapters 5 and 6, those who do not directly experience a drought or flood, often perceive that they will not be affected in future or that if they do happen to be impacted that the consequences will be minimal. Practitioners and academics have also noticed similar relationships. Therefore, perceptions of the magnitude and duration of consequences is often bound up with the past experiences of the household with the hazard. As an indicator variable in the intention forming process of households, incorporation of the assessment of consequences of drought and flooding is deemed critical for any intervention framework.

This research sought to pool together those variables that can be incorporated into a problem focussed process to promote action. As an alternative, the research could make recommendations about how to use these indicator variables to target specific groups of people based on the decision-stages identified. However, such approaches are at best short-term and do not align with the integrated and participatory management approach that the water sector is aspiring to achieve. An appropriate response aiming to embody the ultimate trajectory of a sustainable and resilient water sector consisting of communities of co-producers and co-managers is required.

In this regard, a community framework has been co-created to facilitate participation in the necessary appraisals that preclude decision-making and action towards resilience. Already there are several frameworks on community resilience as discussed in Chapter 2. These frameworks place focus more so on assessing and defining features of a well developed community rather than how to achieve resilience to any specific threats. As indicator variables that influence the way households form intentions and make decisions to respond to a threat, it is proposed that consequences, coping response efficacy and cost be incorporated into a decision framework in the context of enabling communication, building, expanding and tapping into social networks, and enabling empowerment through capacity building.

The proposed framework hence focuses on the threat through assessment of its consequences for households and communities, thereby addressing the question of 'the resilience of what to what?'. In planning for a more resilient future, the framework provides grounds for developing strategies and plans by means of assessing the effectiveness and costs associated with coping with specific consequences. The framework is hence problem-focussed (the specific threat or hazard) and consequence-based. Scholars such as Buckle et al. (2001), have proposed a shift towards a 'consequence management' paradigm with regards to the management of hazards such as flooding. A consequence management paradigm would see policy attention shifted away from the hazard and how to defend against it, towards a focus on understanding, prioritizing and dealing with the full range of the consequences associated with the hazard (Buckle et al., 2001, pg.82). This research has shown that consequence does matter in intention forming and decision-making, and hence the proposed community framework embraces a consequence-based approach towards solving the problem of flood and drought resilience at the household and community levels.

7.3 Engendering a problem-focused consequence-based approach to community resilience

Developed from the main findings of this study is the community transition framework for resilient urban water management. This framework proposes an assessment approach that is rooted in the coupling of consequence and coping to provide more resilient outcomes for communities in response to water management stresses. This framework has been the subject of two major engagement phases in an effort to co-create a final product that will be useful for communities in enhancing their resilience to water management extremes. These included engagement with practitioners and with a community group. The final version of the framework is illustrated in the conceptual diagram in Figure 7.2.

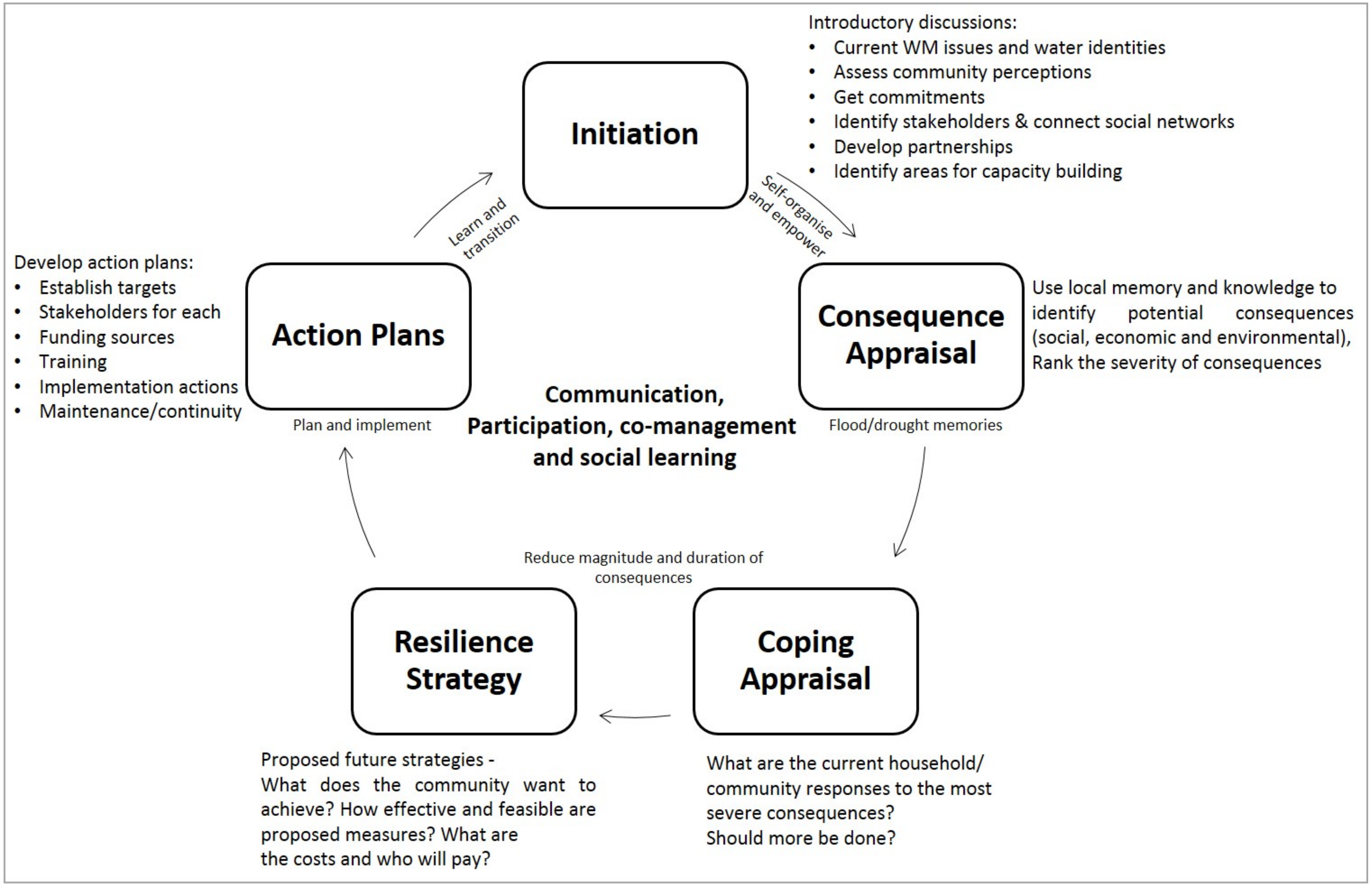


Figure 7.2: The proposed community transition framework for enabling resilience to water management extremes.

This conceptual framework is based on a bottom-up approach that can be used to complement other strategies already being undertaken or planned from a top-down level (e.g. existing programmes with the Local Authority, EA, or Water Company). However, its core purpose is for engendering household and community level participation. The framework has also been expanded into a toolkit for community use. This toolkit was co-created through consultations with practitioners, academics, and community members. The aim of such a toolkit is to foster capacities of communities to prepare for, cope with, and recover from drought and flooding by assessing the consequences and potential household and community response measures in detail.

7.3.1 Framework engagement and co-creation

The first of two engagement rounds occurred in November 2016, at the Safe and SuRe project steering group meeting. One of the activities at this meeting involved a session where groups of academics and practitioners were asked to apply the framework which is an output of the project (Work package 5). Five groups of practitioners and academics of varying disciplines were given scenarios of flooding and drought in a hypothetical community of place. An assessment worksheet developed to meet the requirements of the framework was used by each group to aid their assessments and planning. Some examples of the completed worksheets are illustrated in Figures 7.3 and 7.4 below.

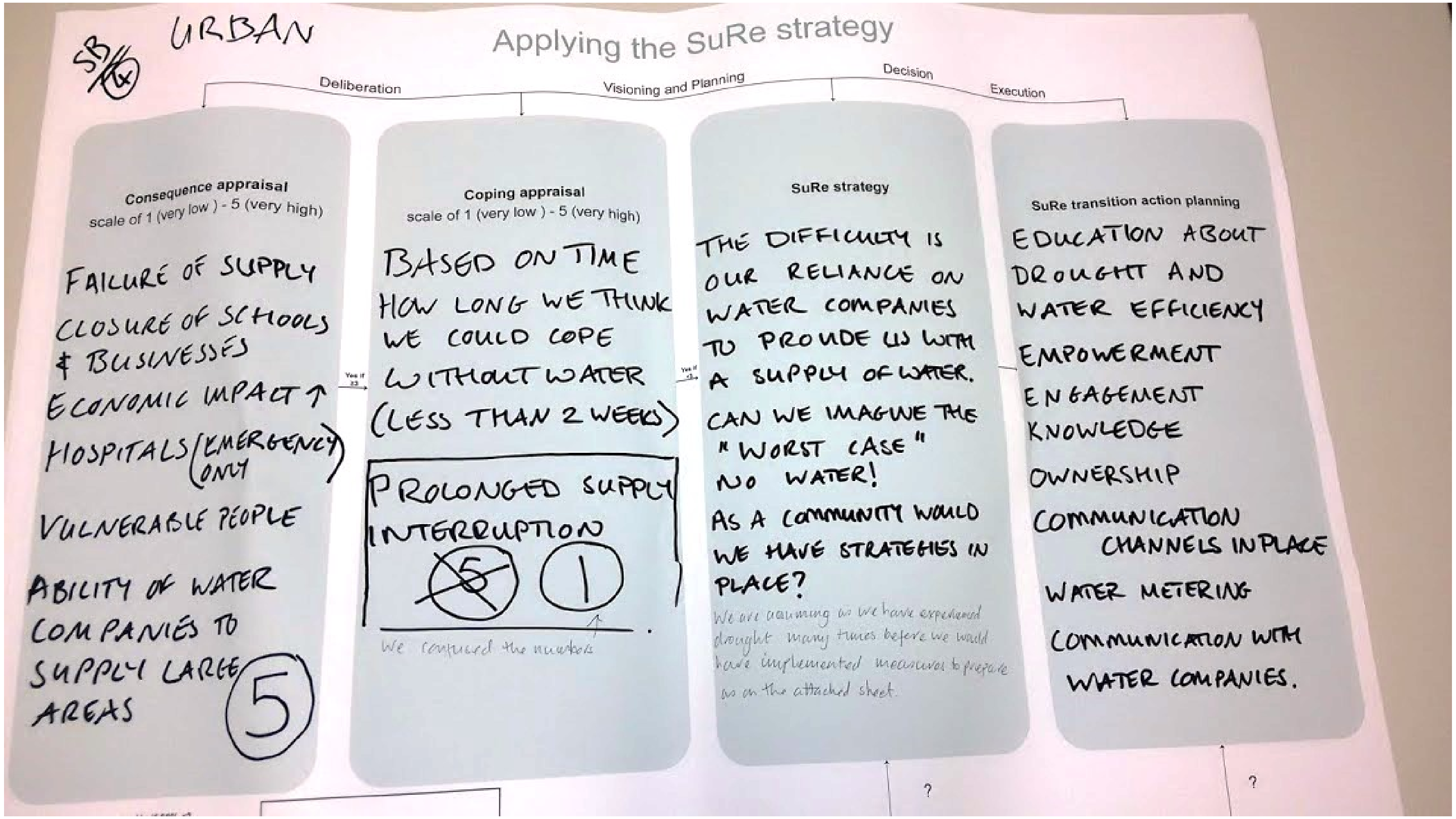


Figure 7.3: Example #1 of the use of the framework by practitioners and academics.

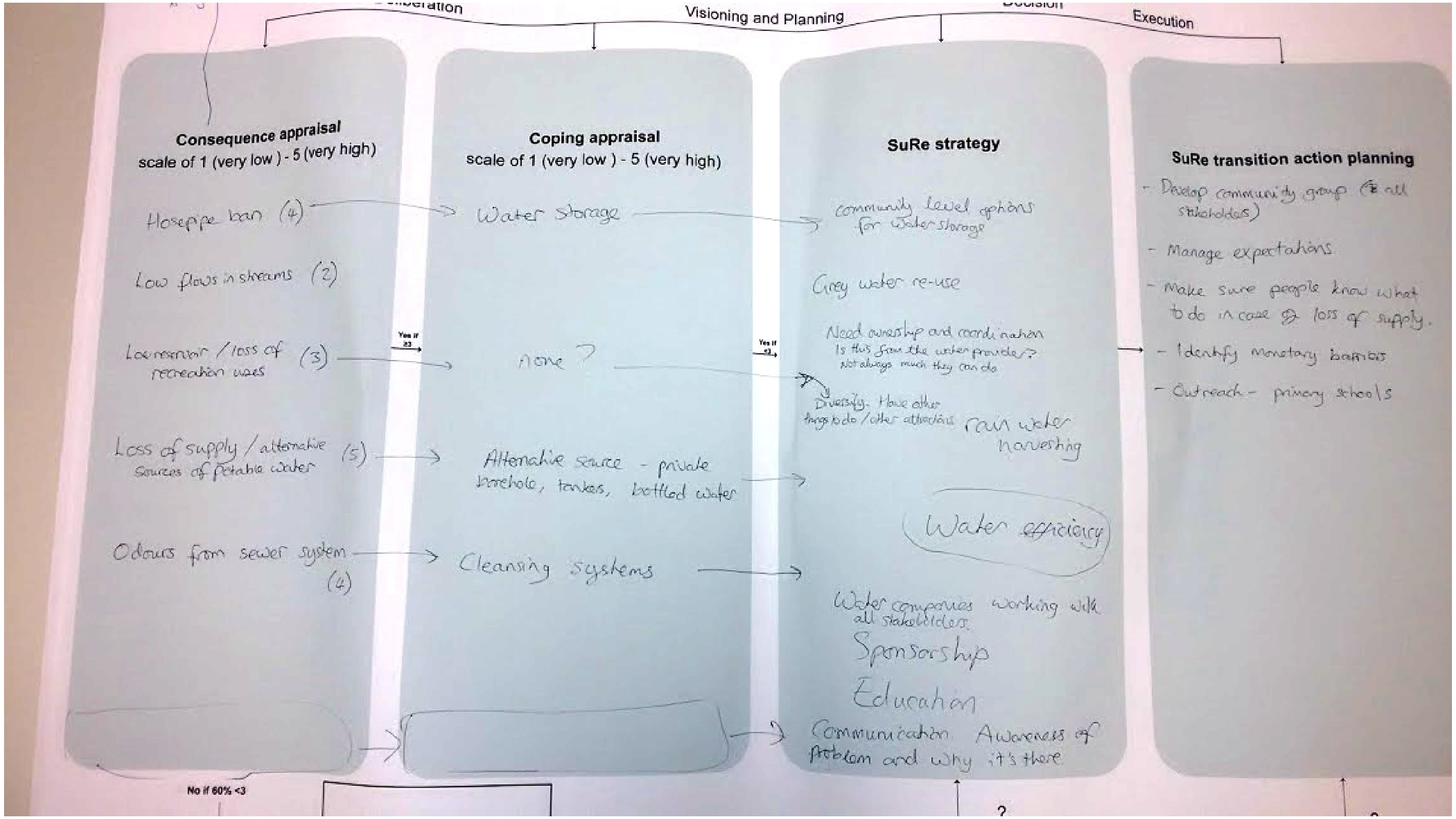


Figure 7.4: Example #2 of the use of the framework by practitioners and academics.

The main discussion points amongst the groups are summarised below:

1. Use of technical or difficult terminology - It was identified that there were some technical terms used with no explanation. Some community groups might find it challenging to engage with such a tool. These terminology included for instance consequence appraisal. In response, it was suggested that other words be used or that more detailed explanations be provided as to the nature of the assessment expected in this section;

2. This therefore led to further suggestions that each section should be further simplified. This was supported by the argument that each assessment block of the worksheet should be made into a tool that community groups and households can relate to thereby improving their future assessment and planning capabilities. The community SuRe framework provides a strategic approach to planning for extreme events within a community or local area hence the rationale for expanding it further into a toolkit approach going forward.

3. Rating scales - It was discussed amongst groups that the rating scales were confusing. This is because the second scale increased in value in descending order compared to the first and third which increased in ascending order. There needed to be more targeted explanations of the rating scales or a standardisation of the scales so they all increase or decease in the same order. The key was to reduce complexity as far as possible.

As a result of these discussions the framework was modified to improve the language and utility. This resulted in a toolkit involving several stages that the community would need to undertake in order to develop a successful programme for enabling resilience to water management extremes. In the process of developing a toolkit, it was noted that it could very easily complement the already existing community emergency plan toolkit (CEPT) developed by the UK Government. Therefore, it does not focus on the elements already incorporated into the existing CEPT such as lists of emergency contact details or addresses of vulnerable community members. Instead, the community SuRe toolkit includes guidance and focus for each of the key appraisal process in the framework, and provides a communication tool for community engagement, discussion, and eventual decision-making.

The main sections of the toolkit as illustrated by the flow diagram in 7.5 are as follows:

1. initiation of the programme for community water management
2. Consequence appraisal in a sustainability framework involving inputs from the community
3. Appraisal of any current strategies and plans
4. Appraisal of future strategies to address the most severe consequences in a sustainability framework
5. Action planning
6. Communicating the strategies and plans to the wider community

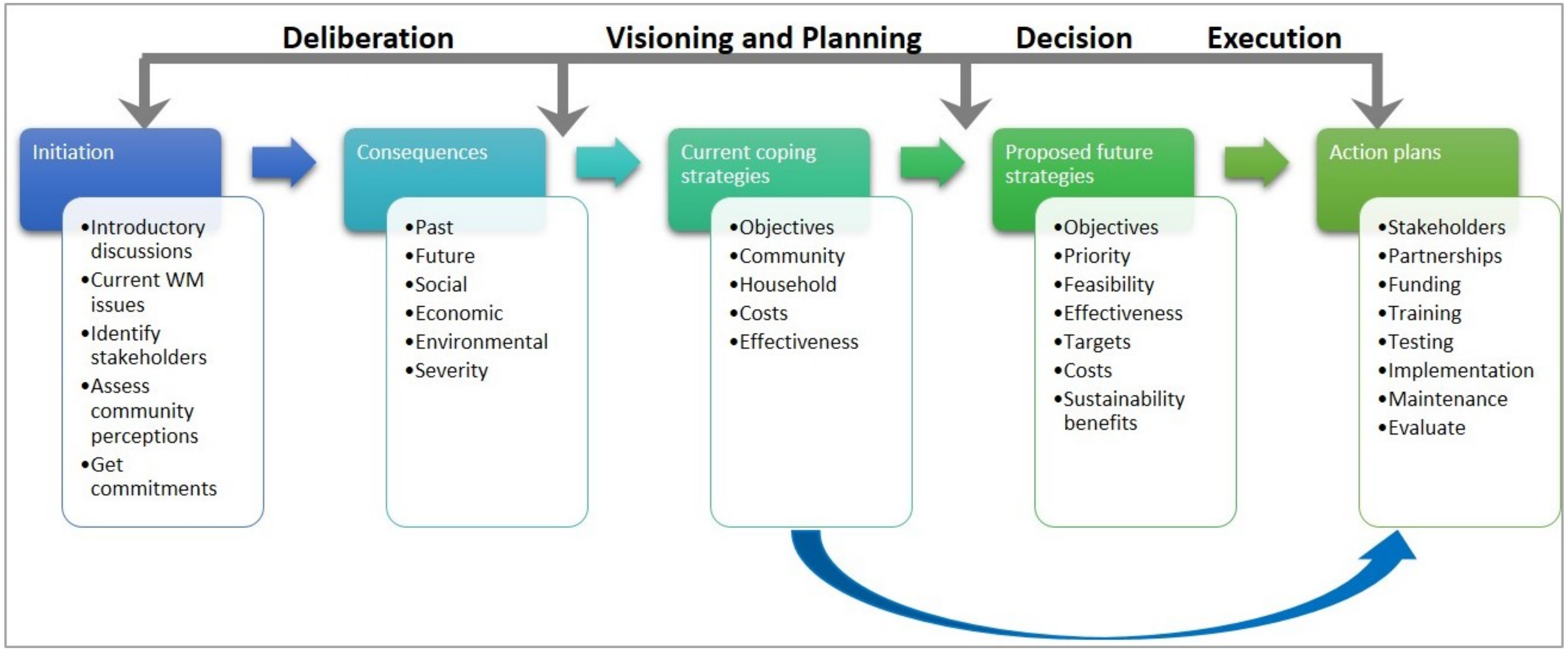


Figure 7.5: Main aspects of the community SuRe toolkit.

Figure 7.6: Community members discussing and sharing memories of recent flooding in their community.

7.3.2 Toolkit engagement and co-creation

The above toolkit was tested with the Topsham Community Emergency Group (TCEG) in April 2017. With 10 participants in attendance, the meeting was very much in the form of a focus group where the researcher as a facilitator, provided prompts to guide discussion as the group engaged with each other in working through the toolkit. Figure 7.6 shows some of the community members discussing flood consequences. A major disadvantage of this approach is that it did not involve a long term use of the toolkit which is necessary for the community to undertake all the required appraisals. Therefore, it was not possible to identify in detail the strengths, weaknesses, and threats associated with its utility.

7.4 The final community toolkit

7.4.1 Stage 1: Initiation and engaging the community

This framework recognises that communities must self-organise and leverage their collective capacity prior to commencing any programme of change and planning. Therefore an initiation stage is required at the very beginning of implementing the framework and includes establishing connections within the community as well soliciting commitments from its members to participate in the various stages and processes. The community must therefore be at a stage where it is accepted that they need to take matters into their own hands by utilising and expanding social networks to bring stakeholders together who all have an interest in the local area. This is especially important to solicit commitments for future participation and action, as well as to impart the importance of local knowledge to the process of building a more resilient community. Initiation activities should bring communities together in a participatory style allowing them to gain further understanding of the issues and eventually recognising that they too can be part of the solution.

Initiation activities may take different forms depending on who does the initiating. This may be through an already existing community group, a Local Authority, or other organisations such as the EA, with a similar mandate of building resilience to a threat or group of threats facing the local area. Lessons learnt from the recent Pathfinder project highlight just how important the initial engagement process is for future success of participatory projects. This is particularly relevant to organisations such as the LLFA or EA who can sometimes be seen by the community as an outsider trying to impose something else on them or expose problems.

Some of these approaches may include flood surgeries and exhibitions, town hall meetings, workshops, or may even be a part of a community group meeting. The most effective strategies will create an environment of inclusiveness and connectedness for those who have an interest in participating.

One very promising approach for initial discussions, is to frame these talks around the idea of water citizenship in an effort to embrace the drought-flood dichotomy. Discussions on water tend to be polarised with focus solely on either drought or flooding and rarely marrying the two to promote the importance of water. In the community workshop under this research, it was very difficult to get discussions on drought underway because most people were unengaged on the matter. They could only relate to drought through second hand knowledge such as friends from Australia or through the time they lived abroad.

It is clear that there are various ways in which a community can be engaged and relates very much to the type of community, the group that is engaging the community, and the shared experiences of that community. In this light partnership building with experts on water related issues such as a Local Authority, and other RMAs, is an important element of the community initiation agenda. These organisations can lend credibility to the engagement effort. Additionally partnerships with such organisations may be the avenue towards the redistribution of power to communities as discussed by Arnstein (1969) in her seminal paper on participation typology. Although she also notes that "in most cases where power has come to be shared it was taken by the citizens, not given by the city" (Arnstein, 1969, p.222), illustrating the often times antagonistic nature of participation when the community does not feel empowered.

Findings from the community Pathfinder project evaluation report concluded that the use of a combined community-led and institution-led approach was integral to its success (Twigger-Ross et al., 2014) and enabled empowerment of the communities. Interventions led by community priorities may result in more effective flood resilience in the long term. The community must therefore have a strong leadership structure and a process for engendering accountability and transparency. This also assures public confidence and trust which lends well to participation.

Public confidence and trust were perhaps the most influential factors for the success of public participation throughout the literature (Domenech and Saur, 2010). In a US study on public perception and participation in water reuse (Hartley, 2006), it was found that there were five critical themes required in building and maintaining public confidence. These include: managing information for all stakeholders; maintaining individual motivation and demonstrating organisational commitment; promoting communication and public dialogue; ensuring a fair and sound decision-making process and outcome; and building and maintaining trust (Hartley, 2006). These themes are certainly not specific to water reuse but rather encompass good governance practice. Hence they are applied here as essential ingredients in the initiation and continued growth of a community group or an organisation such as the LA concerned with resilience or sustainability issues. These key points are highlighted in the toolkit for community leaders to use as a guide to success.

Upon initial engagement and community commitment, the framework requires them to undertake a series of appraisals that eventually lead to the development of action plans based on agreed objectives, strategies, and targets. The action plans enables the community to experiment and test their ideas as well as open further dialogue in the community for evaluation and future improvement of the plan.

7.4.2 Stage 2: Consequence appraisals

A consequence-based approach accepts the notion that regardless of a threat being of low or high probability, it brings with it certain consequences. Consequences resulting from removal of a critical system or service can be predictable and several of the same types of consequences can result from different known and unknown events (Butler et al., 2017). As a result, an assessment of the potential consequences should be done to aid in the process of developing specific and appropriate strategies to address them. This is the aim of the community framework - to assess potential consequences and develop appropriate strategies and responses to minimise both the magnitude and duration of the consequences for the household and community. These consequences affect different households, communities, and populations in different and varied ways and are defined by their severity (magnitude) and duration. Therefore it is this variable associated with a flood or drought that intervention strategies should first focus on. Although there is a clear cost-benefit rationale for assessing probability in intervention strategies, low probability events/hazards are often times not prioritised for action despite their tendency to have severe consequences. So whilst an investment, development, or change in operation may not appear cost beneficial compared to the frequency or expectancy of the event, the very catastrophic nature of such an event warrants that various strategies at different scales be at least assessed in light of the potential consequences for various recipients.

The approach proposed for the appraisal of consequences involves reflective discussions of past experiences and memories of the consequences of the threat/hazard in question. In their project of co-producing flood knowledges in the Barle catchment, Barr and Woodley (2013), found that hearing from community members who had already experienced a flood was a major priority for future knowledge co-production processes. Furthermore, recent research by McEwen et al. (2016) suggests that memories can be instrumental in forming lay knowledge necessary for community resilience planning. The consequence appraisal process therefore encourages the use of memory and exchange of experiences, knowledges, fears and expectations. In doing so, a social learning laboratory is created whereby the community expands and co-creates its knowledge of the potential nature and extent of the consequences of a threat. This type of knowledge co-production is critical for enhancing sustainable memory (i.e. integrating individual, collective, communicative and archival memory) which is essential for stimulating and sustaining local action (McEwen et al., 2016).

The consequence approach generated much discussion amongst the participants. It was clear that this format provides a useful guide for community discussion about how they have been affected by flooding or drought in the past and hence how further events could affect the household and community. Potential consequences are appraised within the context of the sustainability pillars of society, economy, and environment. Therefore, consequences are examined based on social, economic and environmental aspects of both the household and the local community. The merit of such an approach is that it facilitates an in-depth appraisal of consequences and provides more robust justification for further appraisals with respect to specific response strategies. During the workshop, having the three categories incorporated into the worksheet provided the community members the opportunity to discuss some consequences that would otherwise be overlooked. For instance contaminated water which is an environmental consequence with health related implications, can easily be overlooked by community groups in their planning. However, it was clear that there needs to be skilled facilitation of this process in identifying and appraising consequences based on sustainability pillars.

In the toolkit, it is recommended that consequences are ranked on a scale of 1 to 5 (where 1=very low; 2=low; 3=medium; 4=high and; 5=very high) depending on experience, memory and current expectations (for instance new improvements may have been made since the last event and so the scale of disruption may be much less for future events). However, based on observations made during the community engagement phase, it seems it might also be useful to rate consequences in other ways such as temporally, e.g. short, medium and long term timelines. For the participant below who was one of the worst affected in the community, it was difficult to put a number to the extent of the consequences and therefore it might better be described temporally.

> *"So what would you say were the social impacts then on your household?"* (Researcher)
>
> *"It just wiped out everything else in your life for six months, it just dominated...there were trees that fell down so I had huge, and mud...at the highest level. I would put really high priority on being prepared."* (TWP 008 - retired female over age 65)

Consequence appraisals can also be dovetailed with other innovative tools such as visualisations, or more simple methods such as use of a map of the local area to provide spatial guidance particularly concerning specific areas, properties, and people who might be affected and to what extent. Use of a map might enhance the assessment by helping participants to spatially identify potentially troublesome areas or properties and also where interventions might best be located, e.g. a swale or retention pond. Although the participants did not voice this, based on the depth of their discussions, it seems that a map of the local area would have added more value to their discussions. Therefore it is recommended that communities utilise maps of their local area in undertaking the process of consequence appraisal and in other planning aspects of implementing this toolkit.

7.4.3 Stage 4: Assessing current coping strategies

Following an appraisal of the consequences, a community may then want to proceed to the development of objectives and visions to guide them in planning how to cope with or mitigate the consequences. These objectives should relate to reducing the magnitude and or duration of flood or drought consequences. No doubt, some communities will already have some plans underway to counter the consequences of flooding and or drought and as such the toolkit provides an appraisal of current strategies.

Under assessment of current coping strategies, the toolkit provides the opportunity for identifying any current strategies and action plans on the ground or in the pipeline. Additionally, this assessment encourages the evaluation of the extent to which the current approaches are able to mitigate the magnitude and duration of the consequences. In this way the community can determine if the current strategies and plans are adequate to meet planned objectives in abating future consequences.

Also included within the scope of this section of the toolkit, is an appraisal of the stakeholders who were involved, sources of funding for planning and implementation, level of effectiveness of the measures already implemented, and challenges that were encountered in the planning and implementation process. Through this process, the community therefore reflects on what they have already done, how this was done, who was involved, how well (or not) the strategy was planned and executed, and why certain challenges were experienced in implementing the current strategies and plans. They also reflect on the effectiveness of these strategies as well as communication programmes and community efficacy in implementation. Table 7.1 below provides an illustration of some of the information that might be included in this appraisal process.

Table 7.1: Coping appraisal worksheet 1 – Current strategies.

What are your objectives?:

- To reduce flooding of households and SMEs within the community;
- To reduce the levels of loss and damages resulting from flooding

Current strategies and measures	**Scale of implementation**	**Stakeholders**	**Source(s) of funding**	**Lessons learnt**
• Strategy: Minimise the potential for flood waters to enter property or house • Measures: Flood boards, no-return valves and air brick vent covers	Household SMEs	• Residential property owners • SME owners • EA • LLFA	• EA grant	• Some property owners may not wish to participate; • The abilities and skills in mounting the flood boards correctly must be tested; • There needs to be adequate lead time to mount boards, etc.; • If away on holiday, etc., households may need to leave barriers up in case it is needed; • Some householders may not like to leave barriers up if they are away

In the community engagement workshop, participants discussed the flood boards which was their main project aimed at improving community flood resilience:

> *"I'm perfectly happy, even with what I've been through...I've got two flood barriers and I've got another one for the drains as well which is perhaps totally unnecessary. I couldn't, you know I have absolutely no fears, no worries whatsoever about flooding".* (TWP 005, female 60+)

In implementing this flood coping response measure, community members believe they have reduced the extent of potential future consequences, which was the aim of implementing the response to begin with. However, they continue to undertake other activities and update their plans for flood response so the participation continues even after an action plan has been implemented.

7.4.4 Stage 5: Assessing future approaches

It is through the assessment of coping measures that researchers have found the strongest empirical link regarding household intentions to implement coping responses (Bubeck et al, 2012). Similarly, this study found a consistently significant positive relationship between coping intentions and coping response efficacy. Additionally the significant negative association between cost and behavioural intentions implies it's consideration may be critical to any intervention strategy. Therefore these elements of the coping appraisal are incorporated into the final community framework and toolkit.

In assessing future strategies, the community should set out some objectives to address specific categories of consequences (e.g. social, economic). This appraisal looks at the proposed coping strategy, their potential effectiveness (on a scale of 1 to 5), expected costs involved and who will pay, as well as priority for action and feasibility of the the response as seen in Table 7.4.4. This appraisal therefore allows the community to discuss several options that can be prioritised based on their effectiveness, cost, and feasibility.

Those strategies that are deemed to be feasible can then be further assessed and planned for by setting targets. The toolkit also provides the community with the opportunity to consider and identify relevant stakeholders, sources of funding and risks and uncertainty. Stakeholders will tend to include agencies and organizations as well as the private sector and other community and special interest groups, thereby incorporating both internal and external stakeholders. The identification of both internal and external stakeholders allows the community the opportunity to form partnerships that can often prove useful to the success and longevity of the programme. Different partners can leverage different resources which can include leadership, funding, actual skills, equipment and even local knowledge which is useful in community projects. Sustainability benefits can also be outlined in this process.

Table 7.2: Coping appraisal worksheet 2: What more can you do at the household/community level to minimise the consequences? Effectiveness, priority and feasibility should be ranked on a scale of 1-5 based (1=very low, 3=moderate, 5=very high)

<table>
<tr><td colspan="7">Objective (s):
• To reduce flooding of households and businesses (SMEs) within the community;
• To reduce the levels of loss and damages resulting from flooding</td></tr>
<tr><th>No.</th><th>Proposed strategy & measure</th><th>How effective is it?</th><th>Costs involved? Factors to consider?</th><th>Who pays for it?</th><th>Priority</th><th>Feasibility</th></tr>
<tr><td>1</td><td>Strategy: reduce the amount of water that gets into property and household, Measure: install air brick vent covers on low lying houses</td><td>4-5: Will depend on flood depth</td><td>Money
to purchase the vent covers</td><td>Households, Community</td><td>5</td><td>5</td></tr>
<tr><td>2</td><td>Strategy:
avoid as much damage and loss as possible when flooding is not preventable, Measure: raise electrical appliances and electrical fixtures</td><td>5</td><td>This might require services of an electrician - fees</td><td>Households, business operators</td><td>5</td><td>5</td></tr>
</table>

Table 7.2 – *Continued from previous page*

No.	Proposed strategy & measure	How effective is it?	Costs involved? Factors to consider?	Who pays for it?	Priority	Feasibility
3	Strategy: reduce stormwater runoff, Measure: install water butts	3 - Limited capacity in major flood but provides additional source of water for gardens	Financial costs include the tanks, pipes and fittings as well as labour to assemble correctly, Maintenance costs	Collaborations between Water Company and Local Authority? Community groups, Households, Private sector	4	5
4	Strategy: reduce stormwater runoff, Measure: install rainwater harvesting system (e.g. a central system for groups of houses)	4-5: If designed for stormwater control	Financial costs include: engineering designs; tanks, pipes, and fittings as well as labour to assemble correctly; Maintenance costs	Collaborations between Water Company and Local Authority?, Community groups, Households, Private sector	5	3

In discussing future plans, when the community was asked to talk about drought and water scarcity, it was very clear that they were unengaged on the topic. Some of these discussions are highlighted below:

> *"Coming from Scotland there's not that many droughts up there"* (TWP 003)

> *"Really there's next to no concept of it, I mean in the summer we had some friends from Australia who came over, they're just much more aware of saving, you know saving water and reuse of water and that sort of thing. It's difficult to get that sort of thing over to people like don't flush the loo so often and reuse grey water and use water butts and things like that."* (TWP 001)

> *"it's very much like the flooding issue in that until you're affected by it you just don't really bother, it's not high priority."* (TWP 009)

> *"A drought is so much less a worry than a flood that they're not even comparable, unless you're farming."* (TWP 004)

There was limited experience with drought and water related stresses. However, when it was suggested to them that one approach for the future would be to consider how they can use less mains water for non-potable purposes they started to better understand the connections with drought resilience.

7.4.5 Stage 6: Developing action plans

In the action planning section, the toolkit provides and opportunity to plan and guide the implementation steps of a chosen strategy. By mapping specific consequences, objectives, target with action plans each strategy can be linked to a resilient outcome in this section of the toolkit.

The action planning phase has several steps that lead to the development of an effective and efficient action plan:

1. Identify the effective and feasible response measure(s) from the previous appraisals that can be developed or implemented to minimise the

magnitude and/or duration of social, economic and environmental consequences.

2. Establish targets with regards to reducing the magnitude and/or duration of social, economic and environmental consequences.
3. Identify stakeholders who will be involved e.g. households within a certain section of the community or local community groups, etc. The roles of the various stakeholders should also be described in this section to ensure transparency and accountability in responsibilities.
4. Identify potential sources of funding including community sources as well as government grants for community development and water management issues
5. List the series of actions that need to be undertaken in order for the measure to be implemented. This is where partnership is an important element as the community may be able to seek guidance on some of the more technical aspects that might be involved with more sophisticated projects.
6. Discuss measures that will be taken to ensure that the plan is maintained and that there is continuity as the community grows or changes (e.g. new households or ageing households)

An example of the action planning worksheet of the toolkit is provided below (Table 7.3) with a potential action plan developed by the community (Appendix E presents verbatim of this discussion between community members). Once the plans are activated the community group should develop timelines for their evaluations which allows them to make more strategic decisions as they go along. This can be done using a survey which facilitates the collection of quantitative data which can might prove useful for the next phase of a project (e.g to secure funding or community commitments), as well as in providing evidence to help others who might wish to learn more about the projects and taking them into their own communities.

Table 7.3: Action planning worksheet of the toolkit completed based on community discussion.

Consequence(s) to address: Flooding of houses and gardens; **Objective(s):** 1) to minimise the level of flooding that properties receive; 2) to ensure that vulnerable groups are considered				
Proposed activity	**Targets**	**Stakeholders**	**Source(s) of funding**	**Risks and uncertainty**
Establish a sand dump for distribution before a major flood	All vulnerable properties (most likely to flood first and those with vulnerable people) to be targeted first for sand delivery and assistance in filling and assembling.	Households, Community groups, Flood wardens, Other volunteers	Community	Some properties will not want to be involved; Volunteers who live outside of the flood zone could be inaccessible; Sand bags may not be filled assembled in the correct way.
Sustainability benefits: Sandbags may be able to offer some filtration of flood waters that might enter the property thereby reducing potential contamination.				
Monitoring and evaluation: 1) The sand dump should be monitored and discussed at the monthly community meeting; 2) A roster should be updated of volunteers to distribute sand in specific zones				

7.4.6 Communicating action plans

After finalising the strategies that will be brought forward for implementation, a communication tool is available to summarise each major action plan. This communication sheet (Figure E.1, Appendix E) is useful to facilitate discussions with a much wider cross section of the local community at risk or with an interest in water management and sustainability. Through the use of this tool, the community will be able to follow the process of decision-making, i.e. from consequences to coping strategies for engendering resilience. As discussed before, transparency in communication is a key facet of building trust within the community, as well as to stimulate discussion and provide opportunities for feedback and improvement. The sheet used in the first workshop has been upgraded to facilitate this tool.

In addition to communication, at the centre of the framework are the features of co-management and social learning. Although households and communities are locked into the current UWM-STS regime in the role of a passive user/consumer (e.g. water service customer), this framework proposes that they have the capability to shape the regime and become an active part of it. It therefore seeks to encourage communities of co-managers as proposed by Wong and Brown (2009).

7.5 Chapter summary

Following detailed assessment of households perceptions and intentions, and analysis of practitioner engagement and participatory experiences, this research has led to the development of an original consequence-based framework aimed at engendering greater resilience to water management extremes of drought and flooding. By integrating ideas on community engagement related to communication, social networks and empowerment, the framework provides a series of appraisals that will help guide communities in their decision-making about strategies and action plans that they can implement to reduce the consequences of drought and flooding. Key findings from the application of PMT in the research context has guided the development of the appraisal processes of the framework.

The framework has been expanded into a toolkit co-created through engagement with community members and practitioners. The processes of engagement and consultation enabled the researcher to reframe various elements of the framework in order to produce a toolkit that is useful for communities. In addition to promoting decision-making and action for resilience, the toolkit also provides scope for the integration of sustainability benefits into long term community planning around water management.

8 CONCLUSIONS

8.1 Thesis summary

The national rhetoric on flood management in the UK is increasingly calling the role of individual householders and communities into question. This is in light of growing concerns about increases in flood frequency, magnitude and duration resulting from multiple threats such as climate change, urbanisation and population growth. Communities are therefore poised to take ownership of certain non-technical aspects of flood management in their local area in the effort to increase their resilience to flooding under an FRM agenda. This FRM approach is certainly not without its challenges but it has made strides in including households and communities in a participatory process for enabling decision-making for increased flood resilience. However, no parallel emphasis is yet to be placed on similar bottom-up responses for drought and or water scarcity. The literature review of this thesis further confirms this situation and reveals that as the water sector becomes more advance and regulated, the user becomes more disconnected with the reality that water is a resource with both finite bounds and sometimes destructive tendencies.

Furthermore, the literature review has shown that there is concerted effort in the water sector towards making UWM systems more sustainable and resilient in order to minimise the frequency, magnitude and duration of consequences for users now and in the future. However, in a world of increasingly emerging threats to UWM systems, it is also recognised that the users themselves should be more resilient as infrastructures, organisations and institutions will tend to fail under extremes. The research context is therefore concerned with water users as households and their interactions with extreme UWM system failures. When elements (e.g. water supply) of these systems fail (they do not meet the desired LoS), there are consequences for the user. These consequences are of various natures and forms. It is proposed that coping at the household and community levels be pursued as an intervention towards increasing their resilience to the extremes of drought and flooding. The thesis hence aimed to develop detailed understanding of water user perceptions towards drought and flood coping in order to promote/engender action towards resilient water management at the household and community levels.

A combination of research methodologies, data collection approaches and analytical methods have been used to fulfil the research aim through five research questions. The research methodologies included a mix of qualitative methods with quantitative methods in order to best answer the research questions.

Qualitative methods embraced the philosophical perspective of interpretation through inductive reasoning. A qualitative approach to data gathering included interviews with practitioners involved in the implementation of policy and projects on drought and flood management. These practitioners included a mix of drought/water resource and FRM and engineering specialists and academics. Interviews were undertaken within the context of the research questions: 1) Is the water sector transitioning to a more resilient water user? and; 2) What are some of the challenges in promoting drought/flood resilience amongst water users? These data were analysed using thematic analysis.

Quantitative methods set out to test PMT and its value in providing detailed understanding of coping intentions and indicators of intentions. These data were analysed using analytical techniques that tested relational associations and clustering of features. Household perceptions and intentions about coping were examined in detail in order to understand which variables are most significant in motivating household intentions and behaviours to cope with failures such as drought and flooding. The questionnaire survey developed within the framework of PMT, involved questions that assessed both the consequence element of the threat appraisal (TA) and all aspects of the coping appraisal (CA) of households in two Exeter communities. In this research, the TA assessed perceptions of vulnerabilities to the given threat through an appraisal of the perceived extent of the consequences of the threat (drought and flooding). The CA identified perceived capacities (in terms of self-efficacy and the perceived cost of coping response measures) of the household to implement coping response measures, as well as perceived efficacy of response measures that might reduce the magnitude and duration of the consequences at the household level.

Prior to the development of regression models, the aggregate variables were developed. This was preceded by tests of validity and reliability of latent variables. Validity tests were undertaken by means of factor analyses followed by use of split sample method that produces a Cronbach's alpha of reliability of the results produced by the given variable/construct. All variables of interest were aggregated on the basis of their means.

Regression models were developed with behavioural intentions as the outcome variable. Explanatory variables included perceived consequences, perceived effectiveness of the coping measures, perceived self-efficacy, perceived coping response costs, and socio-technical variables related to reliance, trust and past experience. Additionally, socio-economic variables were included in the models. The most significant variables in predicting the models were found to be 'indicators' of behavioural intentions.

The next stage of the research included an exploration of these indicator variables through clustering techniques. The aim of undertaking this type of analysis was to explore the presence and characteristics of decision-stage sub-groups. If the variables are indicators of intentions, they should combine in different ways that influence a household's decision stage. By analysing these processes in detail, it was possible to validate indicator variables that were further incorporated into a decision framework to operationalise resilience to drought and flooding at the household and community levels. Incorporating these indicator variables into a framework, facilitates detailed appraisals of the factors that matter most to household decision-making in response to the threat of drought and/or flooding. It is recognised that many variables will impact the decision-making of a household but the indicator variables have been proven to significantly account for variance in intentions and in shaping decision-stages.

As the framework is expanded into a toolkit, the community can engage more widely on specific issues as its use provides an opportunity space for building partnerships, strengthening communication, enhancing social learning, establishing and maintaining co-management arrangements, self-evaluation and improvement, and widening and strengthening of social networks and participation.

8.2 Main conclusions

The main findings of the study are discussed below in relation to each objective.

8.2.1 Objective 1: To understand the role of the water user in a transitioning water sector

As the water sector has transitioned through the ages, reliability in service delivery has improved so significantly that droughts do not affect water supply to the same extent as nineteenth century droughts. Although flood management has received significant advancements and investment, flooding is emerging as an issue as is reflected in the national and regional FRM policy agenda which encompasses not only flood defence, but planning controls, risk transference, and public participation. However, in both the case of drought and flood management, the user as part of the STS, whether as households, businesses or communities, remain distanced from the functioning of UWM systems.

Emerging threats such as climate change, urbanisation, population growth, and increasing demand, mean that the water sector is in an era of uncertainty and hence seeks to achieve resilient outcomes. In this regard, a flood management approach which embraces the need for enhanced resilience amongst households and communities is underway. As such current flood policy has led to the implementation of new mechanisms such as the Defra Pathfinder project to increase household and community participation in flood resilience. Some of the key insights gained from practitioner interviews related to communication of the risk flooding and issues associated with that, as well as wider communication issues. This is particularly evident in flood risk communication and engagement efforts in the UK where the idea of probability can be interpreted in a completely different way compared to the way technocrats interpret them and expect them to be interpreted. Flood engagement strategies can overcome this issue through a shift in focus of what to communicate as well as through more empowering strategies.

The Pathfinder project saw a shift in communications from a traditional focus on probability to a focus on residual risk and climate change which seem to be more useful in engagement strategies. However, as issues such as climate scepticism still persists, these approaches will continue to have challenges. Communities need to be empowered in various ways such as through capacity building which might include skills and training, but certainly also financial empowerment, and as such mechanisms must continue to be put in place for communities to access funding to implement various projects on their own. The EA and LLFAs in combination with the National Flood Forum, continue to improve their relations with communities and assist them in accessing training, equipment and funding schemes. The water sector has hence made significant changes and improvements in enabling flood resilience through various means. Nonetheless, there is still much work to be done in enabling households and communities towards more sustainable and resilient water management futures.

In terms of drought management and the household, the situation is quite different since they are customers in a sector that is highly regulated to ensure adequate delivery of the LoS. Companies must continually work to ensure that services will be met despite naturally occurring droughts. Hence the household is even more far removed from the system. Nonetheless, water services face the same threats as flood management and as such there is a recognition that the user at the household level may need to become more resilient. As such, there are several efforts underway to engage with households, communities, and businesses on the matter of drought and drought resilience. Practitioners involved in some of these efforts have found that discussions on drought risk and drought resilience often result in sarcasm and psychological distance. This is the result of the above STS setting of current water services in addition to other perceptual matters such as the stereotypical ‘wet and green’ UK, as well as the idea that droughts are not natural but rather the result of water company mismanagement. A privatised industry that has made significant investment in a highly regulated system, ensures that water resources are well managed and diversified where possible. A hydrosocial contract therefore sees the lock-in of users as passive customers reliant on their service contracts. The renegotiation of this hydrosocial contract is much less advanced than in FRM, but just as critical in adapting to future water supply shortfalls resulting from the combination of changing climate, stringent environmental standards, urbanisation, and population growth.

8.2.2 Objective 2: To understand resilience and related concepts and how they are applied to social systems

Resilience, with roots in ecology and engineering, has several challenges in how it is interpreted and hence how it can be applied, achieved, and measured. These challenges have not gone un-noticed when it is applied in social systems. A central critique of resilience for social systems relates to the idea of returning to the original state following a disturbance. Social scientists believe that such a feature would be conducive to retaining inequalities and uneven power relations in some systems. However, this research has found that resilience in its diverse and rich scope of application embodies other features that are useful to limit the persistence of such negative features. Resilience in complex systems involves adaptation and self-organisation, features that are important for influencing change and advancement.

The Safe and SuRe project, of which this research is a part, proposes that resilience in a STS can be achieved at different levels through various interventions - mitigation, adaptation, coping and learning. Coping is applied at the user and community level of the STS to address vulnerabilities to the consequences of UWM system failures. This thesis has therefore set out to better understand coping and coping intentions to water management extremes of drought and flooding. With the need for greater participation of households in water management issues, it is proposed that community be an integral unit for promoting resilience of households. In applying resilience to communities, the challenges of defining resilience become obvious. Furthermore, much of the work on community resilience have not provided a means of addressing the question of 'resilience of what to what'.

8.2.3 Objective 3: To determine indicators of behavioural intentions in household drought and flood coping

In order to address the issue of resilience of what to what in community resilience, this thesis has undertaken detailed analyses of the household in their perceptions of a range of issues relating to drought and flooding, perceptions of coping with drought and flooding, and their intentions to do so. This was done in an effort to identify the key determinants of behavioural intentions that could be developed into indicators in a framework for enhancing community resilience to droughts and floods.

Results of multiple linear regression models, show that past experience was a significant predictor of behavioural intentions for the adoption of household flood coping measures. Other key predictors of flood coping intentions were perceived efficacy of coping response measures, consequences of flooding, and costs of coping measures. The predictors of drought coping intentions were perceived efficacy of coping measures and their costs. These variables are therefore identified as indicators of flood and drought coping intentions.

8.2.4 Objective 4: To identify and account for sub-groups of behavioural intentions

As indicators variables, efficacy, consequence, and cost were expected to form sub-groups defining specific behavioural intentions. The potential for the presence of these sub-groups was explored by means of various clustering algorithms. When detailed analyses of the cluster were conducted, the key variables responsible for segmenting the participants into valid sub-groups were: perceived consequence, perceived effectiveness and perceived cost. These variables were significant in differentiating between the clusters. The clusters included sub-groups of people at different decision-stages.

Participants who had intentions to implement a measure but had not yet done so - contemplatives - appeared to be influenced by perceptions of low consequence combined with high cost and sometimes low effectiveness. In the case of drought coping, low perceived consequences was perhaps a strong factor in negating future responses whether or not the measure was perceived as effective. If a threat is not perceived or expected to have significant negative consequences then there is perhaps little incentive for the household in responding to it, particularly if the response measure is perceived to be costly. Therefore whilst it is appreciated that a response could be worthwhile, this combination of variables does not allow for intentions to move into the adoption of a coping behaviour or measure. In the case of flooding, even though contemplatives perceived the consequences and effectiveness of measures to be medium-high, the high perceived financial cost was a barrier towards making the decision to actually implement flood coping measures. This no doubt combined with low perceived likelihood of a major flood in the local area due to the presence of reliable flood defence schemes and no recent floods.

Those who had already implemented some of the household drought and drought coping measures - responsives - displayed high perceived effectiveness combined with low cost. So whilst the consequences were low, the low perceived costs were an influential factor in adopting drought coping response measures. Such measures also serve the purpose of lowering water bills through less potable demand which in turn can reduce the cost of heating for hot water.

Pre-contemplatives, who were unwilling and uncertain about coping responses, were found where flood coping responses were concerned. There were experienced pre-contemplatives who although they recognised that the consequences could be high, were not convinced that any response measure at the household level could be effective in minimising the magnitude and duration of the consequences. They also perceived the financial costs to be high. Whilst the inexperienced pre-contemplatives did not view financial cost as a challenge, they had low expectancy of flood consequences and low efficacy of coping response measures.

Protection motivation variables of consequence, coping response efficacy and cost have been found to be key indicators of behavioural intentions. These variables should be combined in a decision framework to support community resilience to drought and flooding.

8.2.5 Objective 5: To co-create an assessment and decision framework for engendering household and community resilience planning

The identified indicators of behavioural intentions have been incorporated into a framework. This framework includes several appraisal processes that eventually lead to the development of action plans for community resilience projects. Practitioners and community members have been engaged in the co-creation of the framework into a toolkit. The toolkit focuses on assessing the consequences for households and communities on the basis of social, economic and environment factors. These consequences are linked with coping strategies for enhancing resilience based on appraisals of effectiveness, cost, priority and feasibility.

8.3 Recommendations

The main recommendations from this thesis relate to the diffusion of the toolkit that has been developed. Whilst this toolkit is for community use, it is expected that its diffusion will need to be facilitated by RMAs such as the LLFA and the EA. These RMAs are usually involved in community engagement and as such, they are best placed to introduce the toolkit to communities. It is recommended that the toolkit be introduced not just to communities with frequent flood events or those who would generally experience drought or water supply shortfalls (such as areas in the south east of England), but also to those communities where there is the potential for low probability-high consequence events (such as those included in this research).

Introduction to the toolkit should be undertaken in a participatory manner versus a consultative one where experts come in to instruct the community on how to become more resilient. General discussions on water and its meaning, use and value are recommended to encourage participants to fully engage with the framework and toolkit. The complete toolkit should be made available to the community both in hard copy as well as the electronic versions so that in future they can undertake their own assessments and plans.

8.4 Future research

Following on from the work of this thesis are several areas that could be further developed through research to provide more robust basis for the promulgation of the toolkit from a policy perspective. In order of importance, these are: 1) the administration of a nation wide survey in the context of PMT and similar to the one applied in this thesis; 2) experimentation through agent based models to test how communication and empowerment can best be approached under varying circumstances and to understand the influence of social networks in promoting decision-making and communication; 3) development of a combined community resilience toolkit; 4) implementation of a national programme for sustainable and resilient water management in communities. Each of these are elaborated further in the sections below.

8.4.1 Launch national household survey

Although the study employed the best practice guides to ensure a representative sample, the results of this study are limited both by the size of the sample and the location in one city. A national survey that replicates and builds on the weaknesses of the current survey (e.g in its measure of self-efficacy) could be undertaken of a wider cross-section of the county. A survey yielding similar results would be most useful in validating the current research findings making them even more reliable and robust where future decision-making is concerned. Some areas of focus to ensure this would certainly relate to measuring the variables that were identified as indicator variables. This aspect of research also provides an opportunity for the development of standardised measures for PMT variables.

8.4.2 Agent-based modelling

The complex processes involved in household decision-making can be better understood through a combination of social-psychological and technological models such as agent-based models (ABMs). ABMs use a dynamic system of interacting, autonomous agents which represent social groupings and physical entities in an environment with which the interact, perceive and act (Bookstaber, 2012). Experimentation through the use of ABMs can be undertaken to provide more robust justification of the influence of indicator and other variables on behavioural intentions. The environment is where agents perceive and act.

They may also be used to explore the influence of social networks, the various aspects of communication for community participation, and how best to empower communities through capacity building.

8.4.3 Developing a combined toolkit

The current community emergency plan toolkit (CEPT) prepared by the Cabinet Office includes useful elements that the proposed community resilience toolkit in this research does not include. For instance it facilitates an assessment of skills in an effort to identify relevant resources that exist within the community to improve their response and recovery efforts. Additionally, the CEPT requires that lists of relevant contact persons or organizations be completed. This toolkit with its focus on emergency response would complement the proposed toolkit of this research which is directed at the implementation of household and community resilience strategies through discussion and participation, planning, decision-making, and learning. Lessons learnt from both the ABM and the national survey can be used to further improve the framework and combined toolkit.

8.4.4 National programme

Following the augmentation of the toolkit, a national programme aimed at improving sustainable and resilient water management in communities could be implemented. Such a programme would be similar to the Pathfinder project but would be more encompassing in that it would also consider drought resilience at the household and community level. Such an approach has not been implemented in the UK before and would provide a laboratory of learning similar to that of the Pathfinder project. The difference here would be that there would be a defined framework and toolkit that has been co-designed for community use.

8.5 Summary of contributions

8.5.1 Indicator variables

This research has provided detailed insights into not only the perceptions of flood plain residents about household flood coping, but also about household drought coping. Such a study has not been undertaken in the UK previously. It identifies variables that show promise as indicators of behavioural intentions to implement both flood and drought coping responses. As a result, such indicators will no doubt be useful to policy makers and implementers of government policy. For policy makers these indicators can be used to develop projects and programmes that enable the participation of households, communities and businesses in water management issues. These might include the development of schemes that incentivise the use of water efficiency strategies such as rainwater harvesting and grey water reuse technologies. Policy implementers such as the RMAs of FRM will be instrumental in providing guidance to the communities in the implementation of some of these schemes. They also have the opportunity to collect important data that can be fed back to policy makers in adaptive decision making for future projects and programmes.

8.5.2 Decision-stages

Although more large scale research is needed, this research has employed a method that identified the decision-stages of households where flood and drought coping are concerned. These decision-stages are generally contemplative and pre-contemplative which means that households are not actively working to develop strategies to cope with water management stress. By examining the various decision-stages, this thesis has highlighted how indicator variables combine to drive these decision-stages. It shows that household uptake of coping measures, particularly flood coping measures, remains low not simply because households are unwilling to implement measures. On the contrary, the results indicate that they are driven by their perceptions of certain key decision-making variables and their existence within a wider STS. As such, policy makers may be able to use this information to develop programmes, other than marketing campaigns, that encourage greater participation at the household and community levels.

8.5.3 Contribution to the Safe and SuRe project

As discussed in the introductory chapter, this thesis aims to fulfil a specific work package of the Safe and SuRe project for urban water management. It set out to provide guidance on the SuRe living aspects for water service users. The thesis has led to the development of a framework and toolkit that directly addresses this matter of encouraging and enabling greater sustainability and resilience to water related issues at the household and community levels. The toolkit provides an avenue to link the consequences of the threat of flooding and drought to objectives that identify coping strategies and measures that may also have sustainability benefits, thereby providing a scope for the water user's involvement in a wider STS problem.

A APPENDIX A: CHAPTER 3

This appendix refers to the data collection methods in Chapter 3 and are presented in order as follows:

1. Flood defence scheme of Exeter constructed after the major 1960s floods - Figure A.1
2. Flood risk areas in St. Thomas, Exeter under a 1 in 100 year storm event - Figure A.2
3. Surface water flooding potential in St. Thomas, Exeter - Figure A.3
4. Upgrades to Exeter's flood defence schemes - Figures A.4 and A.5
5. Flood risk map of Topsham - Figure A.6
6. Pilot survey consent form
7. Participant information and pilot survey
8. Covering letter - final survey
9. Final survey
10. Stakeholder interview guide

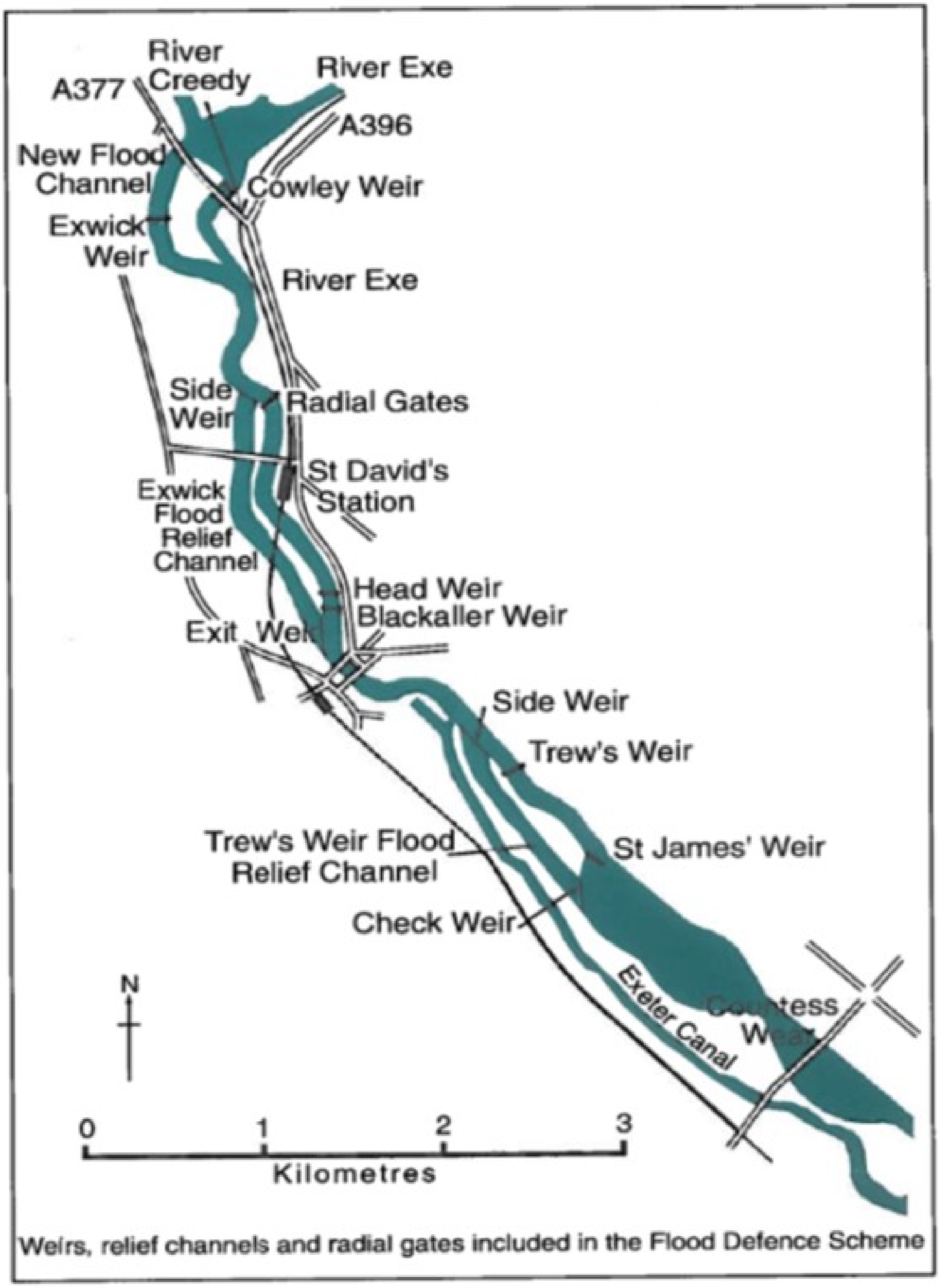


Figure A.1: Flood defence scheme of Exeter constructed after the major 1960s floods.

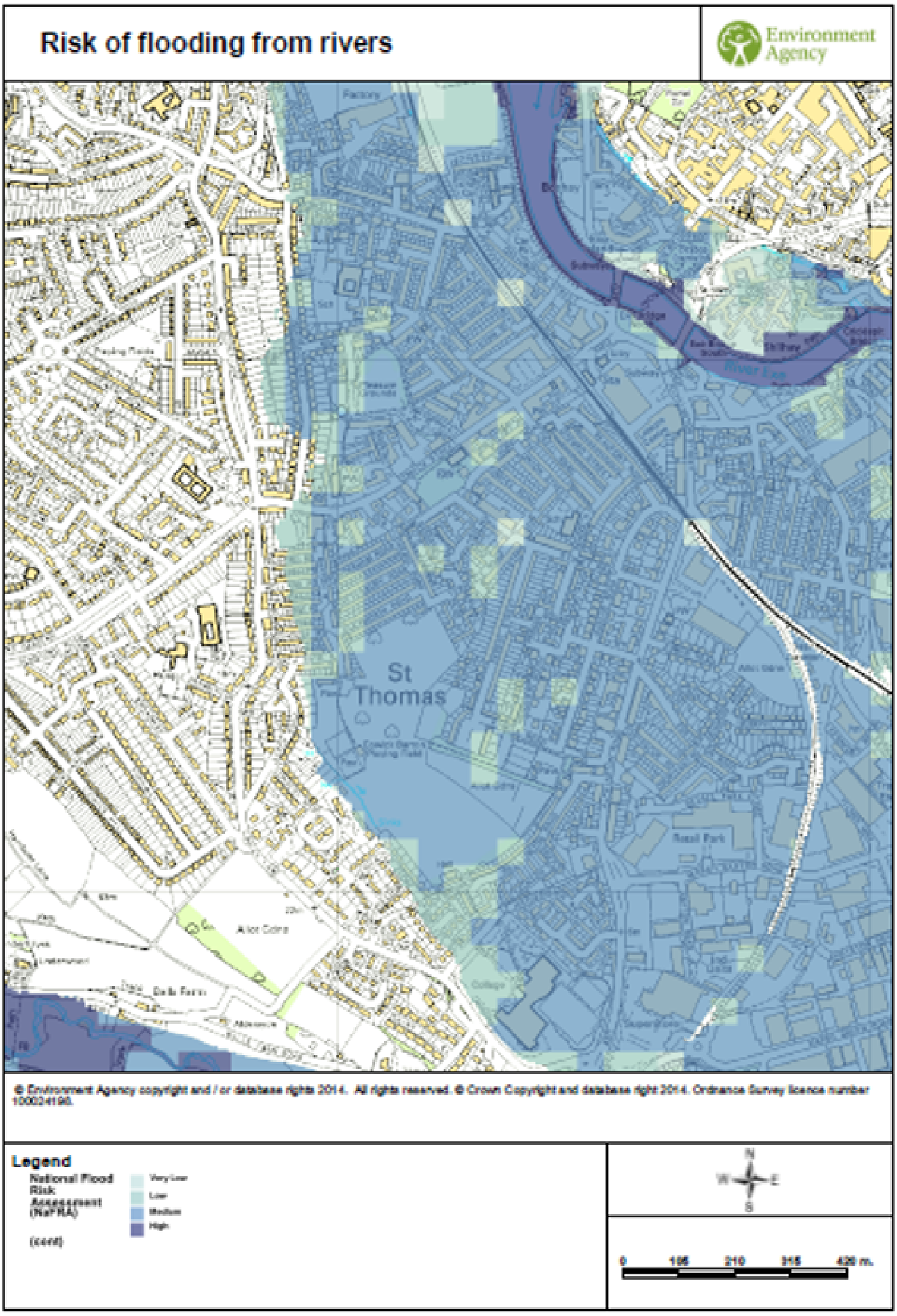


Figure A.2: Flood risk areas in St. Thomas, Exeter under a 1 in 100 year storm event. (Source: Environment Agency)

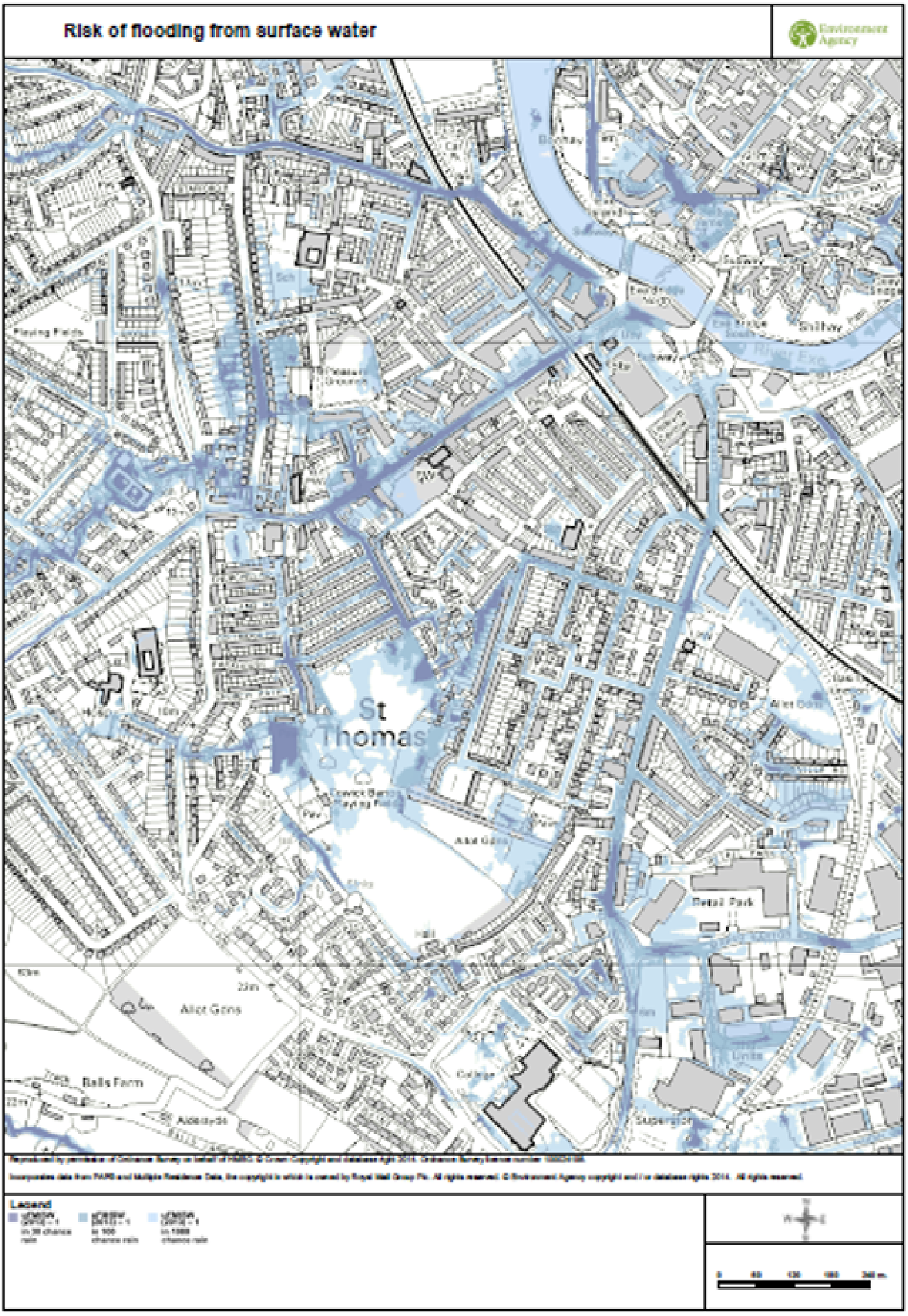


Figure A.3: Surface water flooding potential in St. Thomas, Exeter.

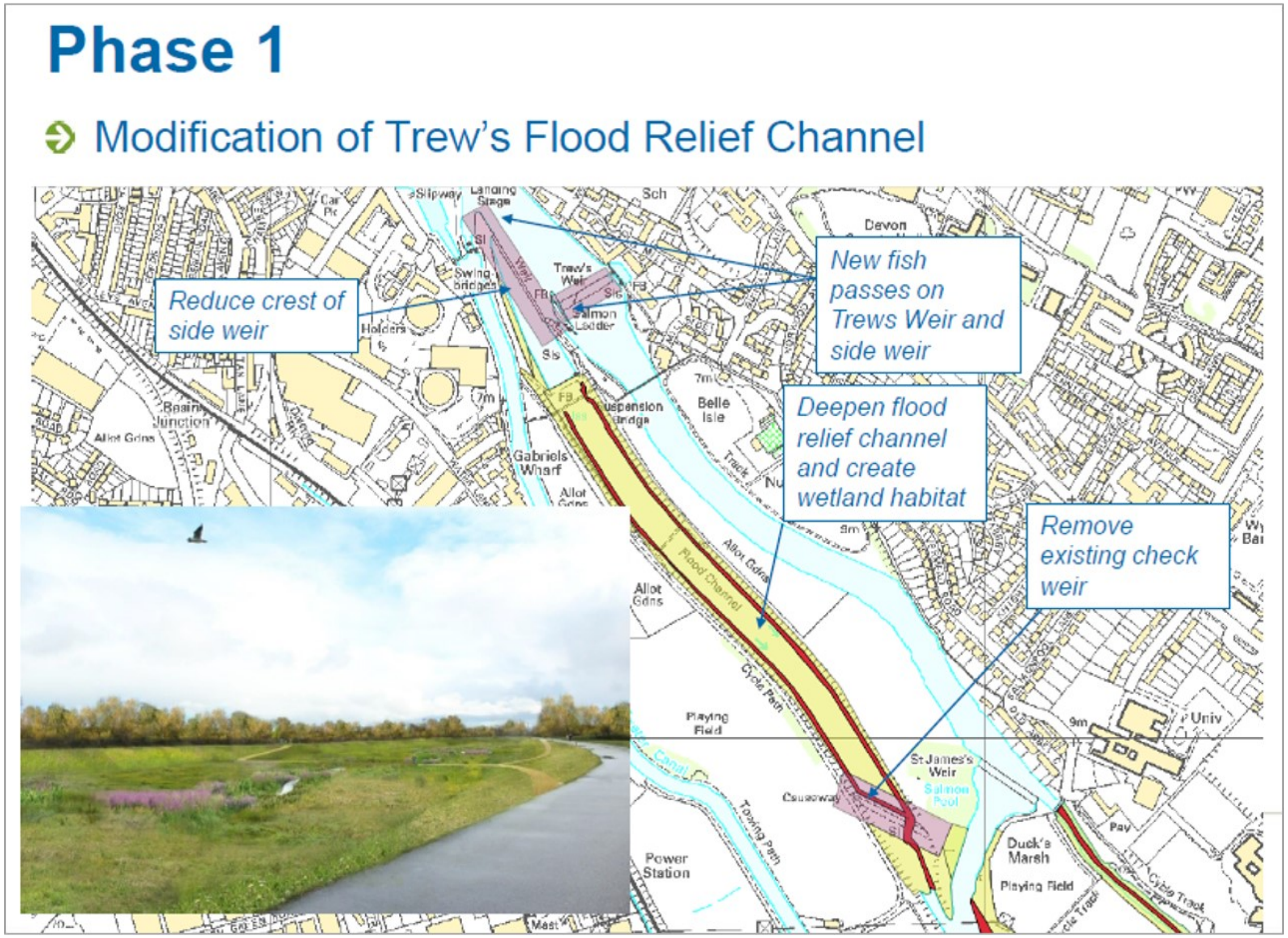


Figure A.4: Phase 1 of the upgrades on southern section of the Exeter flood defence scheme completed in 2016.

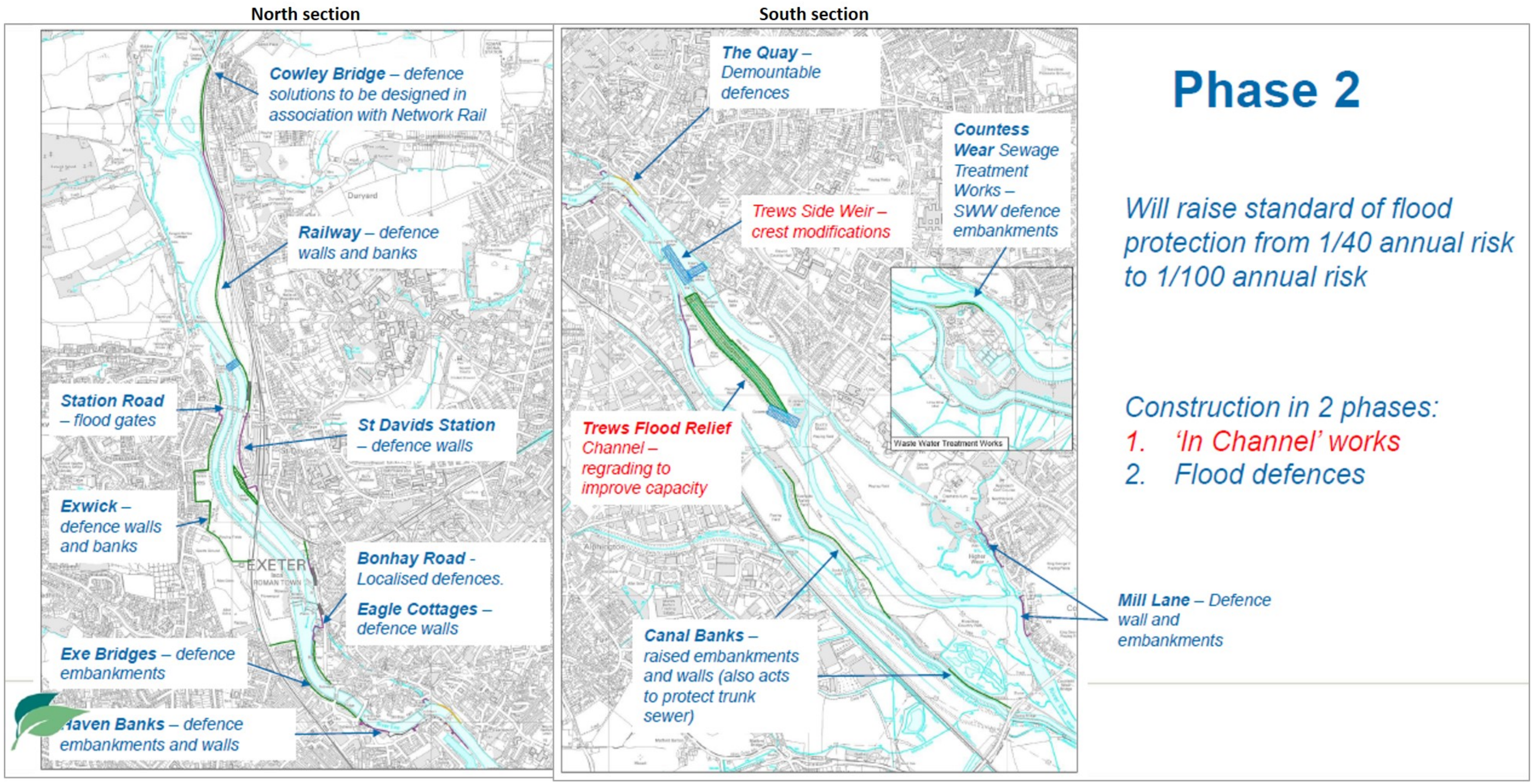


Figure A.5: Phase 2 of the upgrades to sections of the Exeter flood defence schemes currently underway.

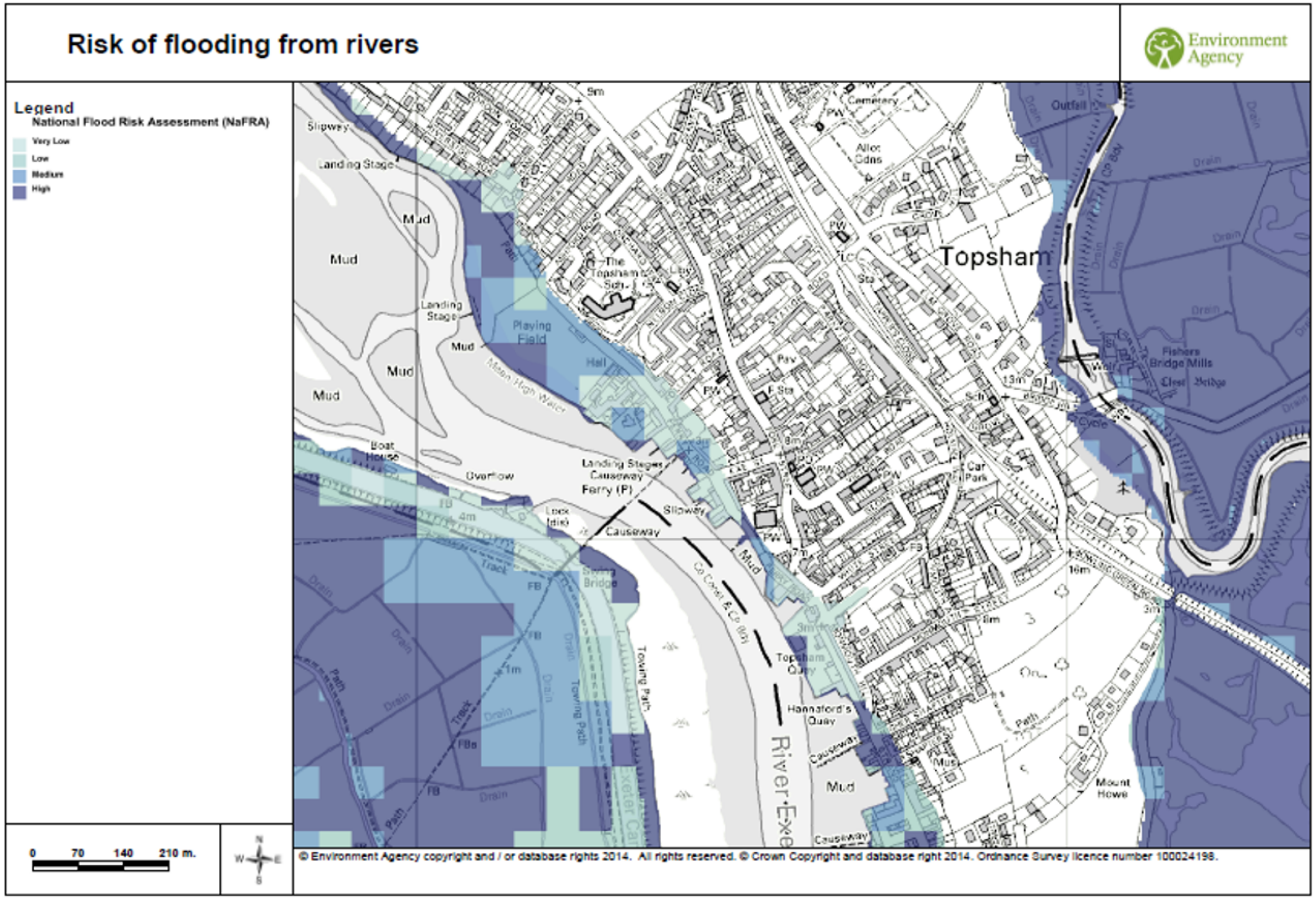


Figure A.6: Flood risk areas in Topsham, Exeter under a 1 in 100 year storm event. (Source: Environment Agency)

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PILOT SURVEY - CONSENT FORM

Please complete this consent form:

- I/We have received and read the Participant Information Sheet
- My/our participation [household] in the Interview is entirely voluntary and I/we understand that I/we am/are free to withdraw at any time
- I/we agree for the researcher to take photos and use them for the project.
- I/we am aware that my personal information will be kept confidential
- I/we understand that data files from interviews will be kept for 2 years from the end of the study.
- I/we understand that data will be anonymised and that I/we will not be identifiable in any written reports unless I/we choose to do so.
- I/we give consent for anonymised data to be used for publication.
- I/we agree that the anonymised information I/we provided can be used for publication in print and electronic media. Please note that all such publication is strictly anonymous and you will not be identified.
- I would like my name to be used in the project:
  Yes ❍ No ❍

Please note that a decision to withdraw or not to take part will not affect participation in future studies.

Signature ________________________________ Date ______________________

Please write your name and full postal address clearly in block capitals.

Name ____

Address

____

____ Postcode ___________________

Landline telephone: ____

Signature (Researcher) ____________________________ Date ______________________

Threat and coping appraisals: precursors to resilient water users?

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PARTICIPANT INFORMATION SHEET - INTERVIEW

Threat and coping appraisals: precursors to flood and drought resilient urban water users?

We would like to invite you to take part in a research study.
Before you decide if you would like to participate, you need to understand why the research is being done and what it
would involve for you. Please take time to read the following information carefully. Take time to decide whether or not you wish to take part. Thank you for reading this.

What is the study about?
Researchers from the University of Exeter are undertaking a project about a the need to shift to more sustainable and
resilient management of water in the UK. We are looking specifically at the urban water user and their role in flood and drought management. We want to examine how water users cope with flood and drought.
If you are happy to talk about flooding and drought and how they impact your life and your wider neighbourhood, then we are interested in hearing from you. Please note that this is only a research project and that no individual advice can be given.

Do I have to take part?
It is up to you to decide. Participation is voluntary. If you do decide to go ahead, we will ask you to sign a consent form
to show you and members in your household (including children over 7 years old) have agreed to take part. You are free
to withdraw at any time, without giving a reason. This would not affect you taking part in other research in the future.

What will happen to me if I take part?
You will be invited to complete a questionnaire survey. The researcher will meet with you to administer the survey and view any self-protective measures at your property that you wish to

discuss.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence.
Upon completion of the project, we may use some of the material you provided in publications but not your name.

For further information and/or if you have any questions whilst completing please contact:
Ms. Kimberly Bryan,
Tel: 0744 364 9965
Email: kab226@exeter.ac.uk

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Threat and coping appraisals: precursors to resilient water users?

1. What is your gender?

- Female
- Male

2. Please indicate your age category from the options below.

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older

3. How many people currently live in your household?

4. What is the name of the street where you currently live?

5. How long have you lived in this neighborhood?

Years

Months

6. How would you describe the status of your home?

- Own
- Renting - Private tenant
- Renting - Council/Housing Association tenant
- Prefer not to say

7. What is the highest level of education you have completed?

- Secondary school
- Some college
- Other vocational training
- Bachelors degree or equivalent
- Higher degree or equivalent

8. What is your approximate average household income?

- Less than £15,000
- £15,000 - £24,000
- £25,000 - £34,000
- £35,000 - £44,000
- £45,000 - £54,000
- Over £54,000
- Prefer not to say

9. What do you think is the likelihood of your local area being significantly flooded or experiencing a severe drought? (Please select one option per line.)

	Very low	Low	Moderate	High	Very high
Flood	○	○	○	○	○
Drought	○	○	○	○	○

10. How many times have you experienced a flood or a hose pipe ban (usually used during a drought to preserve water for essential uses such as drinking) since living at your current location? (Please select one option per line.)

	Never	Once	Twice	Three of more times
Flood	○	○	○	○
Hose pipe ban	○	○	○	○

11. Have you ever experienced a flood/drought whilst living at a previous location? (Please select one option per line.)

	Yes	No	N/A (if you have only lived at your current location)
Flood	○	○	○
Drought	○	○	○

12. How would you estimate the chances of a major flood affecting your local area on the following scales? (Please select one option per line.)

	Uncertain	Low	Medium	High
Once in 10 years	○	○	○	○
Once in 25 years	○	○	○	○
Once in 50 years	○	○	○	○
Once in your lifetime	○	○	○	○

13. How would you estimate the chances of a major drought affecting your local area on the following scales? (Please select one option per line.)

	Low	Medium	High
Once in 10 years	○	○	○
Once in 25 years	○	○	○
Once in 50 years	○	○	○
Once in your lifetime	○	○	○

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Threat and coping appraisals: precursors to resilient water users?

14. In the event of a flood, to what extent do you think your home and property will be affected?

Uncertain	Slightly	Moderately	Severely
○	○	○	○

Further Comments

15. In the event of a flood/drought, to what extent do you think your local area will be affected? (Please select one option per line.)

	Uncertain	Slightly	Moderately	Severely
Flood	○	○	○	○
Drought	○	○	○	○

Further Comments

16. To what extent do you think your health (and that of your family's, if applicable) will be affected by a flood/drought? (Please select one option per line.)

	Uncertain	Slightly	Moderately	Severely
Flood	○	○	○	○
Drought	○	○	○	○

Further Comments

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Threat and coping appraisals: precursors to resilient water users?

17. The following list shows some common physical self-protection measures that can increase flood protection of your home. Which of the following measures would you put in at home? (Please select only one option per line.)

	Will not do	Undecided	Already done	Plan to do
Raise the level of electrical fixtures	◯	◯	◯	◯
Store valuables in upper floors	◯	◯	◯	◯
Concrete or tile floor coverings	◯	◯	◯	◯
Place Barriers on doors and windows	◯	◯	◯	◯
Maintain drains around your property	◯	◯	◯	◯
Install "no-return" valves (allows water to flow in only one direction and can be fitted to drains around your home to prevent floodwater backing-up)	◯	◯	◯	◯
Install pumps	◯	◯	◯	◯
Roof water collection	◯	◯	◯	◯
Airbrick/vent covers	◯	◯	◯	◯

Other/Further Comments

18. How would you rate the effectiveness of each of the following for flood protection of your home? (Please select only one option per line.)

	Ineffective	Uncertain	Effective
Raise the level of electrical fixtures	○	○	○
Store valuables in upper floors	○	○	○
Concrete or tiled floor coverings	○	○	○
Barriers	○	○	○
Maintain drains around your property	○	○	○
Fitting No-return valves on drains around your property	○	○	○
Pumps	○	○	○
Roof water collection	○	○	○
Airbrick/vent cover	○	○	○

19. How do you feel about the following self-protective measures for flood protection? (Please select all that apply per line.)

	Unaffordable	Too much time and effort	Don't know how to	Don't know enough about it	Not too much time and effort	Affordable
Raise the level of electrical fixtures	○	○	○	○	○	○
Store valuables in upper floors	○	○	○	○	○	○
Concrete floors	○	○	○	○	○	○
Maintain drains around your property	○	○	○	○	○	○
Barriers	○	○	○	○	○	○
Fitting no-return valves on drains around your property	○	○	○	○	○	○
Pumps	○	○	○	○	○	○
Roof water collection	○	○	○	○	○	○
Airbrick/vent cover	○	○	○	○	○	○

Other (please specify)

20. To what extent do you agree that self-protective measures such as those listed above can be effective in reducing the following consequences of floods? (Please select only one option per line.)

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
Damage	○	○	○	○	○
Loss	○	○	○	○	○
Dislocation (e.g. having to move from your house for months due to flood damage)	○	○	○	○	○
Discomfort	○	○	○	○	○
Emotional trauma and Stress	○	○	○	○	○

21. As a water user, how do you feel about the following activities to cope with a drought? (Please select one option per line.)

	Would not do	Undecided	Already doing	Plan to do
Use roof water for non-drinking purposes	○	○	○	○
Store water at home	○	○	○	○
Use recycled water supplied by South West Water	○	○	○	○

22. As a water user, if you took on more sustainable practices in water use (e.g. using roof water for non-drinking use, installed low flow showerheads, etc.), this may increase overall coping in dry spells. To what extent do you agree with this statement?

Disagree	Neither Disagree Nor Agree	Agree
○	○	○

Further comments

23. Please describe your involvement in any other activities for flood and drought protection both at a household level and within your local area (e.g. Family Flood Plan, developing Community Evacuation Plan, etc.).

24. How confident are you in the abilities of the following organisations in managing floods and droughts? (Please select only one option per line.)

	Not at all confident	Not confident	Uncertain	Somwhat confident	Very confident
Environment Agency	◯	◯	◯	◯	◯
Exeter City Council	◯	◯	◯	◯	◯
South West Water	◯	◯	◯	◯	◯

25. The existing public flood defences can provide effective protection to my local area and home in the event of major floods. As a result of this I do not think there is any remaining risk of flooding. To what extent do you agree with this statement? (Please select one option per line.)

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
At home	◯	◯	◯	◯	◯
In my local area	◯	◯	◯	◯	◯

26. I would be more willing to undertake self-protective measures at home if the Government (e.g. Environment Agency, Exeter City Council, etc.) or South West Water rewarded me (e.g. subsidies, incentives, etc.). (Please select only one option per line.)

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
For flooding	◯	◯	◯	◯	◯
For droughts	◯	◯	◯	◯	◯

27. In addition to organisations such as the Environment Agency, Exeter City Council and South West Water, I also have a role in flood and drought management. To what extent do you agree with this statement? (Please select only one option per line.)

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
Flood management	◯	◯	◯	◯	◯
Drought management	◯	◯	◯	◯	◯

Further Comments

Please use the space below to tell us about any further issues that we have not covered in this questionnaire to do with you or your household's flood / drought coping or any other comment regarding this questionnaire. These comments cannot be attributed to you or your household.

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Dear Resident

We are conducting research at the University of Exeter on resilience amongst householders and communities in Exeter to extreme weather causing flooding and drought. Although we are aware that flooding is not a frequent occurrence in your community, we wish to understand how you think of flooding in your community and what you think about household coping with floods. Likewise we are interested in your thoughts and opinions about the potential for drought in your community and potential coping at the household level.

Some of you participated in a pilot questionnaire survey in December 2014 for which we are very grateful! These results were both insightful and informative for understanding how issues of flooding and drought are viewed in your community. Those results provided valuable information useful for facilitating household and community resilience to flood and drought. The survey has been expanded to further investigate flood and drought issues in your community and is available on the internet as follows:

* **Questionnaire website address** on the internet: https://www.surveymonkey.com/r/Exetercoping
* **Password**: guest

You may complete the survey either on a computer, tablet or mobile phone. If you prefer to complete a printed copy one is provided which you may return to the researcher in the enclosed self-stamped envelope. Whichever version you decided to complete, it should take around 20 minutes. You have the chance to **win a £75 shopping voucher** (usable at a store of the winner's choice e.g. John Lewis, Marks and Spencer, Amazon, etc.) for completing the survey.

We would like to thank you in advance for your providing your valued time and opinions.

Yours sincerely

Kimberly Bryan

Research Associate (kab226@exeter.ac.uk)

Flood and Drought Resilience in Topsham households

1. <u>Participant Information Sheet and Consent</u>

We would like to invite you to take part in a research study being conducted by researchers at the University of Exeter. It is adviseable that the person considered to be the head of the household complete this survey. Please consider this information carefully before deciding whether to participate in this research.

What is the study about? We want to examine how householders and communities in and around Exeter will cope with major flooding and drought should they happen.

Do I have to take part? It is up to you to decide. Participation is voluntary and you may refuse to participate or you may choose to withdraw at any time, without giving a reason. This would not affect you taking part in other research in the future.

Risks? There are no anticipated risks associated with participating in this study. If completing online, the effects of participating should be comparable to those you would experience from viewing a computer monitor for 15 minutes and using a mouse or keyboard.

Benefits: This study provides no direct benefits to you individually. The study provides important information about the way communities perceive flood and drought risk and how they will cope with future floods and droughts. This has potential implications for public domains, such as flood risk management, where understanding the processes governing behaviours (e.g., risk perception, community participation, etc.) can lead to more sustainable and resilient households and communities.

Compensation: Whilst there is no compensation for completing this survey, the valuable information will be used to feed into the wider institutional and policy framework governing flood risk management in the UK.

Will my taking part in the study be kept confidential? Your participation in this study will remain confidential. No personally identifiable information will be associated with your data in our publications. Please note that all such publication is strictly anonymous and you will not be identified.

How to contact the researcher: If you have questions or concerns about your participation **please contact Kimberly Bryan, Email: kab226@exeter.ac.uk, Tel: 07443 649965**.

<u>Feedback and/or further research</u>: Please indicate any options for which you would like to be contacted. (OPTIONAL)

☐ Research findings/feedback ☐ Further research e.g. focus group or interview

Contact Information if you checked any options above. Your details will not be used for anything other than for contacting you based on the box you previously ticked. (OPTIONAL)

Name	
Postal Code	
Email Address	
Phone Number	

Agreement:

The nature and purpose of this research have been sufficiently explained and I agree to participate in this study. I understand that I am free to withdraw at any time without incurring any penalty.

Please consent by clicking "I agree" to continue. Otherwise you may exit the study.

- ◯ I agree
- ◯ I do not agree

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Flood and Drought Resilience in Topsham households

2. Understanding your perception of flood risk

We understand that some sections of the Topsham community are at risk of flooding due to high tide on the river Exe. The risk of flooding from the wide and shallow river increases when high tidal conditions combine with heavy rainfalls oftentimes creating high runoff from upstream, strong winds, and failures in the drainage network. Some of these conditions combined in the severe winter floods of February 2014 which affected many properties in Topsham. This type of flooding and even more severe conditions include what we consider as a major flood in this survey.

Flooded areas of the community during the winter 2014 floods in Topsham, Exeter (Left image: Topsham TV; Right image: Topfloods website).

1. How many times have you experienced a flood since living at your current address? (Please select only one option)

- ◯ Never
- ◯ Once
- ◯ Twice
- ◯ Three times
- ◯ Four or more

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Flood and Drought Resilience in Topsham households

3. <u>Understanding your perception of flood risk</u>

2. On scale of 1 to 5 (very low = 1 and very high = 5), how severe was the flood that you experienced? (Please select only one option)

- ◯ Very low severity
- ◯ Low severity
- ◯ Medium severity
- ◯ High severity
- ◯ Very high severity
- ◯ N/A

3. Have you experienced a flood whilst living at a previous location? (Please select only one option)

- Never
- Once
- Twice
- Three or more times
- N/A if you have only lived at current location

Flood and Drought Resilience in Topsham households

4. Flooding Consequences

In this section we are interested in learning what you think are the possible problems you might face and how you might be affected by a flood disaster in your local area.

4. How severe do you think a major flood, similar to the one shown in the picture in Section 2 above, would be for your local area (very low = 1 to very high = 5)? (Please select one option per line)

Very low	Low	Medium	High	Very high
○	○	○	○	○

5. In the event of a major flood how severely would the flood impact your property and family (very low = 1 and very high = 5)?

	Very low	Low	Medium	High	Very high
Property	○	○	○	○	○
Family	○	○	○	○	○

6. In the event of a major flood how much flooding would you expect within your property? (Please select one option)

- My property will not flood
- The yard and garden(s) only
- Up to the ground floor
- Up to the first floor
- Up to the roof

7. In relation to your property, how much damage do you think the following would face as a result of a major flood (very low = 1 to very high = 5)?

	Very low	Low	Medium	High	Very high	N/A
The building structure	○	○	○	○	○	○
The contents of your home	○	○	○	○	○	○
Vehicle/s	○	○	○	○	○	○
Garden/s	○	○	○	○	○	○

8. To what extent do you think the following would be affected by a major flood in your local area (very low = 1 to very high = 5)?

	Very low	Low	Medium	High	Very high
Lives and injuries	○	○	○	○	○
Disruption of livelihoods	○	○	○	○	○
Disruption to transport	○	○	○	○	○
Damage to cultural or heritage sites	○	○	○	○	○
Damage to natural environments	○	○	○	○	○

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Flood and Drought Resilience in Topsham households

5. **Understanding your perception of drought risk**

We understand that Exeter and the rest of the South-west do not have frequent droughts and is one of the wettest regions in the UK. However, the area can become vulnerable to drought if there is a long period of low rainfall as happened during the long hot summer of 1976 and more recently in the 2010-2012 drought period. We are interested in finding out how you feel about a major drought caused by extreme dry weather. During the drought of 1976, water customers in the South-west had to depend on standpipes for water supply for some period of time as seen below. It was one of the worst droughts in the UK in recent times.

Water cservice customers in north Devon using a standpipe during the 1976 drought (image by John Walters).

9. How many times have you experienced a drought since living at your current location? For water service customers a hose pipe ban is usually the first sign of a drought in their local area.

- ◯ Never
- ◯ Once
- ◯ Twice
- ◯ Three times
- ◯ Four or more times

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Flood and Drought Resilience in Topsham households

6. Understanding your perception of drought risk

10. How severe was the drought that you experienced (very low severity = 1 to very high severity = 5)? (Please select one option only)

- ◯ N/A
- ◯ Very low severity
- ◯ Low severity
- ◯ Medium severity
- ◯ High severity
- ◯ Very high severity

11. Have you ever experienced a drought whilst living at a previous location? (Please select one option only)

Never	Once	Twice	Three or more times	N/A if you have only lived at current location
○	○	○	○	○

12. What do you think is the likelihood of your local area experiencing a major drought (very low = 1 to very high = 5)? (Please select one option only)

- ○ Very low
- ○ Low
- ○ Medium
- ○ High
- ○ Very high

13. To what extent do you think that your health (and that of your family's if applicable) would be affected by a major drought (very slightly = 1 to very severely = 5)? (Please select one option only)

- ○ Very slightly
- ○ Slightly
- ○ Moderately
- ○ Severely
- ○ Very severely

14. How severe do you think a drought similar to that in 1976 would affect your local area (very low = 1 to very high = 5)? (Please select one option per line)

Very low	Low	Medium	High	Very high
○	○	○	○	○

15. How severely do you think a major drought would affect your property and family? (very low = 1 to very high = 5) (Please select one option per line)

	Very low	Low	Medium	High	Very high
Local area	○	○	○	○	○
Property	○	○	○	○	○
Family	○	○	○	○	○

7. What do you think about climate change?

The issue of climate change has been very popular in the media in recent times. We would like to understand what you know and think about climate change in your local area.

16. Have you heard the term "climate change" before?

- ○ No
- ○ Yes

17. Do you think climate change is something that is affecting, or going to affect, your local area or you in any of the following ways? (strongly disagree = 1 to strongly agree = 5)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Higher temperatures	○	○	○	○	○
Rising seas	○	○	○	○	○
Increased risk of floods in my local area	○	○	○	○	○
Increased risk of droughts in my local area	○	○	○	○	○
Stronger storms and increased damage	○	○	○	○	○
More intense droughts of longer duration	○	○	○	○	○
I don't think climate change will affect my local area	○	○	○	○	○
I don't think climate change will affect me	○	○	○	○	○

8. **Protecting your home, family and local area**

Individuals, families, communities and neighbourhoods all over the world are taking on more responsibilities in flood protection. The UK Government, Environment Agency and Lead Local Flood Authorities are working to support community involvement in flood risk management. In this section we wish to understand how you are responding, or planning to respond, to the threat of floods.

18. The following list shows some common measures that can helpprevent or minimise water coming into your home. Which of the following measures would you put in at home? (Please select only one option per line) (would not do=0 to already doing=3)

	Would not do	Undecided	Plan to do	Already done
Place flood barriers on doors/windows/gates	◯	◯	◯	◯
Install "no-return" valves (allows water to flow in only one direction and can be fitted to drains around your home to prevent flood water backing-up)	◯	◯	◯	◯
Use Airbrick vent covers	◯	◯	◯	◯
Use sandbags or similar	◯	◯	◯	◯
Raise floor levels above expected flood height	◯	◯	◯	◯

Other/Further Comments

19. The following list shows some common measures that can help to<u>reduce damage should your home be flooded</u>. Which of the following measures would you put in at home? (Please select only one option per line)

	Would not do	Undecided	Plan to do	Already doing
Raise the level of electrical fixtures	○	○	○	○
Store valuables in upper floors	○	○	○	○
Use concrete or tile floor coverings	○	○	○	○
Install pump(s)	○	○	○	○
Use flood adapted interior fittings	○	○	○	○

Other/Further Comments

20. How would you rate each of the following for flood protection of your home? (very ineffective = 1 to very effective = 5) (Please select only one option per line.)

	Uncertain	Very ineffective	Ineffective	Somewhat effective	Effective	Very effective
Raise the level of electrical fixtures	○	○	○	○	○	○
Storing of valuables in upper floors	○	○	○	○	○	○
Concrete or tile floor coverings	○	○	○	○	○	○
Flood adapted interior fittings	○	○	○	○	○	○
Flood barriers/walls/gates	○	○	○	○	○	○
"No-return" valves on drains	○	○	○	○	○	○
Raise floor levels	○	○	○	○	○	○
Pump/s	○	○	○	○	○	○
Airbrick/vent cover	○	○	○	○	○	○
Sand bags	○	○	○	○	○	○

21. What factors would limit your use of measures such as those in 17-19 above? (strongly disagree = 1 to strongly agree = 5) (Please select more than one if applicable)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Money	◯	◯	◯	◯	◯
Time and effort	◯	◯	◯	◯	◯
Lack of abilities/skills	◯	◯	◯	◯	◯
Lack of awareness	◯	◯	◯	◯	◯
Lack of knowledge	◯	◯	◯	◯	◯

Other (please specify e.g. physical ability to do, perceived risk, etc.)

22. Is your property insured for flooding?

◯ No

◯ Yes

◯ Don't know

23. Do you believe flood insurance coverage is a suitable response measure for safeguarding your home against possible flooding?

◯ Strongly disagree

◯ Disagree

◯ Neither disagree nor agree

◯ Agree

◯ Strongly agree

24. Please describe your involvement in any other activities for flood and drought protection both at a household level and within your local area (e.g. Family Flood Plan, Community Emergency Group, etc.).

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9. Drought responses

In this section we would like to understand how you view responses to droughts especially as they are not a major or common threat to your local area.

25. As a water user, how do you feel about the following activities to cope with a drought? (Please select one option per line.)

	Would not do	Undecided	Plan to do	Already doing
Using a Water Butt for non-drinking purposes	○	○	○	○
Storing water at home	○	○	○	○
Reusing greywater from shower and laundry using buckets	○	○	○	○
Using recycled water supplied by South West Water	○	○	○	○
Taking shorter showers	○	○	○	○
Installing water saving devices	○	○	○	○
Adhering to a hose pipe ban	○	○	○	○

26. As a water user, how effective do you feel the following measures would be at increasing overall coping in dry spells? (very ineffective = 1 to very effective = 5) (Please select one option per line.)

	Uncertain	Very ineffective	Ineffective	Somewhat effective	Effective	Very Effective
Using a Water Butt for non-drinking purposes	◯	◯	◯	◯	◯	◯
Storing water at home	◯	◯	◯	◯	◯	◯
Reusing greywater from shower and laundry	◯	◯	◯	◯	◯	◯
Using recycled water supplied by South West Water	◯	◯	◯	◯	◯	◯
Taking shorter showers	◯	◯	◯	◯	◯	◯
Installing water saving devices	◯	◯	◯	◯	◯	◯
Adhering to a hosepipe ban	◯	◯	◯	◯	◯	◯

27. What would limit your use of drought protection measures at home? (strongly disagree = 1 to strongly agree = 5)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Money	◯	◯	◯	◯	◯
Time and effort	◯	◯	◯	◯	◯
Lack of abilities/skills	◯	◯	◯	◯	◯
Lack of knowledge	◯	◯	◯	◯	◯
Lack of awareness	◯	◯	◯	◯	◯

Other (please specify e.g. lack of abilities/skills or physical capability, etc.)

28. As a water user, if you took on more sustainable practices in water use (e.g. using roof water for non-drinking use, took shorter showers, turned the tap off whilst brushing teeth, etc.), this may reduce the use of mains water and in turn increase overall coping in dry spells. To what extent do you agree with this statement? (strongly disagree = 1 to strongly disagree = 5) (Please select only one option)

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neither disagree nor agree
- ◯ Agree
- ◯ Strongly agree

Further Comments

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Flood and Drought Resilience in Topsham households

10. **Flood and Drought Recovery**

In this section we would like to understand your expectations about return to normal conditions after facing a potentially major flood or drought.

29. Do you think that personal flood protection can be effective in helping to improve recovery time after a major flood affects your home? (uncertain = 0 to very effective = 5)

- ◯ Uncertain
- ◯ Very ineffective
- ◯ Ineffective
- ◯ Somewhat effective
- ◯ Effective
- ◯ Very effective

30. How effective do you believe that measures such as those previously listed above (e.g. flood barriers, concrete floors, etc.) would be in reducing the following problems caused by floods? (Please select only one option per line) (Uncertain = 0 to very effective = 5)

	Uncertain	Very ineffective	Ineffective	Somewhat effective	Effective	Very effective
Damage						
Loss						
Dislocation (e.g. having to move from your house for months due to flood damage)						
Discomfort						
Emotional trauma and Stress						

31. How important would the following be for you in recovering from a flood? (not at all important = 1 to very important = 5)

	Not at all important	Not important	Somewhat important	Important	Very important
Removing water and drying contents quickly					
Disinfecting surfaces and furniture					
Resuming normal/regular use of your space within a week					
Assistance and/or support from community groups					
Assistance and/or support from Local Government and other government bodies					
A quick insurance settlement					

Any other comments

32. If you were affected by a major flood event, how soon do you think you would be able to fully recover?

- Within a few days
- At least one week
- A few weeks
- A few months
- Up to one year
- More than one year

33. If there was a major drought in your local area, what is an acceptable period of time that regular water supply services are unavailable?

- No loss of service is acceptable
- Only a few days
- Up to one week only
- A few weeks at the most
- A few months at the most

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Flood and Drought Resilience in Topsham households

11. Water management influences

We would like to understand how existing infrastructure and organisations affect the way you think about flood and drought risk in your local area.

34. How confident are you in the abilities of the following organisations in managing floods? (Please select only one option per line.)

	Not at all confident	Not confident	Somewhat confident	Confident	Very confident
Environment Agency	○	○	○	○	○
Exeter City Council	○	○	○	○	○
Devon County Council	○	○	○	○	○
South West Water	○	○	○	○	○

35. How confident are you in the abilities of the following organisations in managing droughts? (Please select only one option per line.)

	Not at all confident	Not confident	Somewhat confident	Confident	Very confident
Environment Agency	◯	◯	◯	◯	◯
Exeter City Council	◯	◯	◯	◯	◯
Devon County Council	◯	◯	◯	◯	◯
South West Water	◯	◯	◯	◯	◯

36. In addition to organisations such as the Environment Agency, Devon County Council and South West Water, I also have a role in flood and drought management. To what extent do you agree with this statement? (strongly disagree = 1 to strongly agree = 5) (Please select only one option per line.)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Flood management	◯	◯	◯	◯	◯
Drought management	◯	◯	◯	◯	◯

Further Comments

37. I would be more willing to undertake some of the measures for flood protection at home...(Select more than one if applicable) (strongly disagree = 1 to strongly agree = 5)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
If my neighbours were doing the same	◯	◯	◯	◯	◯
If there was a subsidy or incentive (e.g. from the Water Company, City Council, Central Government, etc.)	◯	◯	◯	◯	◯
If it became a legal requirement	◯	◯	◯	◯	◯
If my home were to be badly flooded in the future	◯	◯	◯	◯	◯
If it would reduce my insurance premium	◯	◯	◯	◯	◯

38. I would be more willing to undertake some of the measures for drought protection at home... (Select more than one if applicable) (strongly disagree = 1 to strongly agree = 5)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
If my neighbours were doing the same	◯	◯	◯	◯	◯
If there was a subsidy or incentive (e.g. from the Water Company, City Council, Central Government, etc.)	◯	◯	◯	◯	◯
If it became a legal requirement	◯	◯	◯	◯	◯
If a major drought seriously affects me in the future	◯	◯	◯	◯	◯

39. The existing public flood defences, and the current and planned upgrades, can provide effective protection to my local area and home in the event of major floods now and in the future. To what extent do you agree with this statement? (strongly disagree = 1 to strongly agree = 5) (Please select one option per line.)

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
At home	◯	◯	◯	◯	◯
In my local area	◯	◯	◯	◯	◯

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Flood and Drought Resilience in Topsham households

12. About you and your household

This section is useful to provide us with information that could be important to the way you cope with floods and droughts.

40. Please indicate your gender?

◯ Female

◯ Male

41. Please indicate your age category from the options below.

- ◯ 16 to 24
- ◯ 25 to 34
- ◯ 35 to 44
- ◯ 45 to 54
- ◯ 55 to 64
- ◯ 65 to 74
- ◯ 75 or older

42. What is your highest formal educational qualification?

- ◯ No formal qualifications
- ◯ GCSE / O-Level
- ◯ A-Level / Higher / BTEC
- ◯ Vocational / NVQ
- ◯ Bachelors degree or equivalent
- ◯ Postgraduate qualification or equivalent

43. Please state your postcode in the space below.

44. How long have you lived in this neighbourhood?

45. How would you describe the status of your home?

- ◯ Owner occupied
- ◯ Renting - Private tenant
- ◯ Renting - Council/Housing Association tenant
- ◯ Prefer not to say

46. How many people currently live in your household (including any children and lodgers)?

47. Please indicate your approximate annual household income (before tax).

- ◯ Less than £15,000
- ◯ £15,000 - £24,999
- ◯ £25,000 - £34,999
- ◯ £35,000 - £44,999
- ◯ £45,000 - £54,999
- ◯ Over £54,999
- ◯ Prefer not to say

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PhD Research Stakeholder Interview Guide

Prepared by: Kimberly Bryan

List of Stakeholders:

1. Exeter City Council
2. Devon County Council
3. Environment Agency
4. Southwest Water
5. Others suggested by participants

Expected Outcomes:

The following outcomes are expected from the interview process:

1. Better understanding of how water users are being involved at a household/community level in a move towards greater resilience to extremes
2. Lessons for successful engagement and participation in water related issues such as drought and flooding

Flooding: perceptions and engagement for resilience

- How is risk being communicated?
- What are your experiences with household and community perception of the probability and severity of flooding in Exeter?
- What is your perception of the community's (case study communities) capacity to cope with a major flood e.g. 1 in 100 year return period?
- Do you think discussions on climate change are useful for community engagement on flooding?
- Does the community have the necessary risk information to make an informed decision on coping with infrastructure failure resulting from extremes?
- Do you think householders and communities are willing to undertake measures to cope with residual risk of flooding?
- What are some challenges for communicating and engaging households/communities on building personal resilience to flooding?

Drought: perceptions and engagement for resilience

- What are your experiences with household and community perceptions of drought in the UK?
- What factors contribute to these perceptions? (e.g. historical, Water Company profits, media influence, etc.)
- Do you think discussions on climate change are useful for community engagement on drought and water demand related matters?
- What is your perception of the capacity of households and communities in the UK to cope with a major drought? Do you think householders and communities are willing to undertake measures to cope with droughts?
- What are the most effective strategies for community engagement about drought and the need to build resilience at the household level?

B APPENDIX B: CHAPTER 4

This Appendix presents a section of one of the interviews undertaken. The full interview transcript is 18 pages long and covers 44 minutes of discussions. The first five pages of the interview are presented here.

Exeter University
Safe and SuRe
Respondent ID: REC013, NERC
February 2017
Key: INT = interviewer; RES = respondent

[Start 00:00]

INT
All right thank you for agreeing to have this interview and as a reminder could you just state again that you agree with me voice recording this.

RES
Oh yes certainly yes, yes that's absolutely fine.

INT
Yes OK thank you. All right so I've been working on my PhD looking at flood and drought resilience particularly at a household level but also looking at it on a wider scale you know community level and what the government's doing from a policy point of view and so on. In terms of drought, I have spoken to the water company here so South West Water and to one person in the Environment Agency you know just to get their feel and their perspective of you know the householder role and if there is a role and you know that kind of investigation. So you know generally speaking to the water company of course they're going to come from their angle that you know drought it's not something that will happen obviously they have a level of service that they have to meet and so on and the Environment Agency they are more from a regulatory angle so now it would be useful to hear from someone who is doing actual engagement relating to the householder and I know you've been working on Historic Drought. I'm working here on this large project called Safe and SuRe so it's looking at building resilience into systems so largely from an engineering perspective but also we're looking at resilience from a social point of view of the water user. I'm concerned with understanding the water user as a householder in terms of how they build resilience to drought and flooding.

RES
Right, OK.

INT
So you know is there a role for householders in drought resilience and how is the water sector enabling this? Should they be undertaking maybe more responsibility in water management or as they say in Australia water sensitive lifestyle and that kind of stuff. So tell me about the experiences of people you have encountered in your project, have they experienced drought and how do they see themselves fitting in to that whole arena of drought and water management?

RES
Oh OK right, that's what you're interested in. So in the Historic Drought project obviously we are, we are basically developing the national drought inventory so what we're trying to do is to put

together a whole load of data about drought in one place so one accessible portal if you like to everything from weather data and my side of it is putting in social data. So we've got river flow models going in, we've got ground water data going in, there's lots and lots of instrumental data already available that we're just trying to put in one place and then where I mean instrumental data isn't always as brilliant as you think you know there are times when the instruments aren't working and some of the time series are very short and we're going back to 1890. So it's required quite a lot of back casting of models to try and identify the droughts.

INT

Where they happened, yes.

RES

And time and filling gaps in the time series. So that's all been going on on the physical side and then I have been in archives looking at old newspapers, old reports, old diaries, old legislature about previous historic droughts. I've tried to use some of the physical data to give me an idea of when I should be looking for because obviously it's like looking for a needle in a haystack, you go to an archive, pick up anything, there might be something about drought in it. So some of the models have given me some idea of the timeframe in which I should be looking which years, sometimes even which months. It doesn't quite work the same way in terms of the social impact because obviously droughts begin, I mean very often you don't know a drought has even started until quite a long time into it so people aren't talking about drought straight away so I don't follow their timescale perfectly, I tend to kind of go a few months in and then start looking for evidence and then obviously sometimes I just stumble across things and then I can say to the physical scientists there apparently was a drought here and you don't have it in your model. So it kind of works both ways.

INT

Interesting, yes.

RES

But anything in living memory I've been trying to collect recordings of people just remembering.

INT

Oh, people who have experienced them.

RES

Having droughts and I've tried to do that just not just any memories but I've also tried to find people that would have been particularly affected, so fire-fighters that might have fought heath fires in particular areas. Our key one health workers, farmers you know people who were doing something that, people in holiday businesses who have benefited from nice hot summers in some of the droughts that we've had and I've also talked to people who have been working in water companies over time or reservoir wardens, those sorts of people so I've got quite a big mixture of people from conservationists to people that have been responsible for sort of drought management in places like the Environment Agency for over a very long period of time so you get kind of and water managers. So some corporate discussion, some environmental knowledge then just ordinary people, housewives you know, people with particular hobbies, gardeners, that kind of thing, people that run for example parks departments and have to manage water resources as time goes on during a drought so people managing sports surfaces, all sorts of stuff. So there's lots of, I've got a massive collection now of recordings of people remembering droughts very often they remember more than one depending on what they did and their interests or where they live and but it's of course everything they discuss on these are after the fact. What's interesting about that then is they might say well of course back then we did this but if it happened again I would do that so you get some understanding of perhaps how things have changed. So one of the classics you know if people are talking to me about I don't know, say the 1959 drought or maybe 1976 they'll say things like well of course we didn't bath very often you know we maybe had a bath once a week then and of course now we have a shower every day so that would be different and obviously people don't anticipate there being things like standpipes any more but they are very well versed in hosepipe bans and I would say that the number one trigger in people's mind if there's a drought or not is not, they don't look at weather forecasts and go oh yes there's a drought or they don't hear a communication that says this is you know this is a drought warning but the first thing they tend to know about it if they're not say a farmer or someone who, I mean even farmers to a certain extent because they can, a lot of them can irrigate now it doesn't necessarily come into their mind as a drought but the first understanding they have of there being any kind of drought or water shortage is when there's a hosepipe ban.

INT

Right, yes.

RES

So that in their mind if there isn't a hosepipe ban there isn't a water shortage and if there is a hosepipe ban very often they will then go well is it really a drought and they need to, people often need to feel and see proof so they want to see crops dying, cracked earth, that kind of stuff before they'll really acknowledge that there's a problem. So that's quite interesting for me it's like well prove it to me you know because water's still coming through the tap. So what they would you know their observations now living in a time when water's on tap and it's and they've got a privatised industry promising them supplies they very often give some throwaway comments about well of course that wouldn't happen now and if it did I would want to know why because now we've got all these resources and to a certain extent people are very much protected from drought now whereas they weren't in, up until the late 50s drought was much more common or water scarcity was much more common because we didn't have the infrastructure that we have now. So am I giving you anything that you want to know?

INT

Yes, no that's great because it also ties in very well with the literature because that's exactly what they have been finding in their research.

RES

Right.

INT

So I've been looking at willingness to implement drought coping versus flood coping measures. What have you found about about the willingness of households to you know implement drought coping measures?

RES

Well I guess drought is more manageable isn't it, it's slow building. The thing about a flood is that it's for some people it's an ever present threat there could be a flood and a certain number of factors have to come into play you know you have to have a lot of rainfall or a big storm surge or do you know what I mean?

INT

Yes, yes exactly.

RES

Something has to happen and in general it's going to happen in a short period of time so they're kind of anticipating it at any time these days and they know it can be devastating when it comes and there's some people feel they need to be protected by others from flood and others who are regularly flooded are a bit more proactive but it's almost like it happens and then it goes and depending on how prepared you are the cleanup is either takes years or you're very organised.

INT

Or very quickly, yes.

RES

And it's a short process so that's a containable thing. Now with drought it's a slow build, you don't know when it started, you don't know when it's going to end. You are powerless to do anything about it other than manage resources that you've already got if you happen to have a signal or an inkling that there might be a drought or you happen to be the sort of person that likes to have a lot of reserves. So for the common household gardener who has one water butt in their garden which would probably last them a fortnight in a severe drought you know their options are limited and the sorts of things that they will do to save water are the things that they're told to do which they remember which are to you know put surplus water on the garden you know like vegetable washing water or whatever or bath water even.

Not to leave the tap running, flush the toilet less, not wash the car maybe you know and these are controllable things aren't they and what they will do are the things that are least offensive to them or they're not going to give up having a shower every day for sure but they will maybe you know not wash the car so.

INT

It's yes it's kind of a compromise that they

RES

Because it's all within their control and of course while the resources are being supplied and there's no hint of them not being supplied they can exercise, they have control over what they will or will not do for the drought effort and of course the more they pay for water or the more they see water companies being successful and creating profit the less inclined they are to do anything other than the bare minimum because they feel it is a service that is supplied to them that they pay for and they should have the luxury of it and so there is a critical crossover point there you know they will bend to a certain extent to the water company's appeals you know and then they will draw a line and say well you know that's it you've got to supply. So I mean it's not really been fully tested ever you know this idea that we're at breaking point what does happen. So I don't know what the outcome if a water company one day just couldn't provide water through the taps any more I mean we would presumably have to evacuate people before that happened and so it's never, we've never really got there, it doesn't mean to say we're not going to and absolutely people, generally people don't have the first idea about what the consequences of not having any water would be, that's a standard. So they, if they remember past droughts and they remember water rationing and of course you've got to be of a certain age to a certain extent to really remember that then they know what to do. If they've been a bit of a keen water saver to save money because they're on a water meter then they're a bit more likely to do things but of course there are some savings that aren't really savings as far as I'm concerned. Like you know you'll get people say well of course and they even say this in Australia you know well when you're waiting for the water to run hot, initially it comes out cold, well you put a bucket under then keep that and put that on the garden but of course what you could do is plumb your house correctly so that your shower is very close to your water heater as it were so you, do you know what I mean, so some of these things are like a sticking plaster on a much bigger problem really aren't they you know.

INT

Yes the way we've developed our houses over.

RES

Yes I don't feel, I feel that in the future water resources could become so scarce that we'll have to, it won't I mean because if you put that spent water as it were on the garden did you need it? In a drought you do but generally speaking do you need it? I mean are you adding water to something to a shrub that doesn't need it? This is a sort of a function that people will perform to show outwardly that they are saving water but my question is you know is it, it's not actually a saving it's just going somewhere else and it is only useful if you would have drawn off more water to do that function, for a lot of people they wouldn't, they just throw it on the garden anyway or whatever and actually it's probably not required, do you know what I mean. So I don't know, there's lots of instances like that where we give people something to do but it you know, they're still not saving/saving, they're still not acting early but of course we rarely talk about drought now, we talk about water supply situations and restrictions and shortages and the value of it and all sorts of other rubbish you know people are quite scared to say the word drought.

[CONTINUED to 44:33]

C APPENDIX C: CHAPTER 5

This appendix presents model diagnostics for the best fitting model predicting drought coping intentions in Chapter 5. The tables and figures are presented in order as follows:

1. The coefficients to assess multicollinearity - Table C.1
2. Details of the residual statistics for examining whether or not the condition of homoscedasticity is met - Table C.2
3. Plots that assess the normality of the residuals of the outcome variable - Figures C.1, C.2, and C.3

Table C.1: Coefficients associated with the best-fitting model for drought coping intentions. In addition to a correlation matrix, these values were assessed to determine multicollinearity amongst the input variables and reviewing their ranges.

	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	1.520	2.750					
drought_eff	0.160	0.420	0.460	0.420	0.400	0.950	1.050
drought_rescost	-0.230	-0.010	-0.302	-0.230	-0.210	0.950	1.050

Table C.2: Residual statistics to determine homoscedasticity in best-fitting model on drought coping.

	Minimum	Maximum	Mean	Std. Deviation
Predicted Value	1.78	3.45	2.81	0.28
Std. Predicted Value	-3.63	2.14	0.00	1.00
Standard Error of Predicted Value	0.06	0.25	0.10	0.03
Adjusted Predicted Value	1.76	3.46	2.80	0.29
Residual	-1.06	1.06	0.00	0.48
Std. Residual	-2.14	2.16	0.00	0.98
Stud. Residual	-2.25	2.21	0.00	1.01
Deleted Residual	-1.16	1.11	0.00	0.51
Stud. Deleted Residual	-2.31	2.26	-0.00	1.02
Mahal. Distance	0.18	22.02	2.97	2.80
Cook's Distance	0.00	0.14	0.01	0.02
Centered Leverage Value	0.00	0.25	0.03	0.03

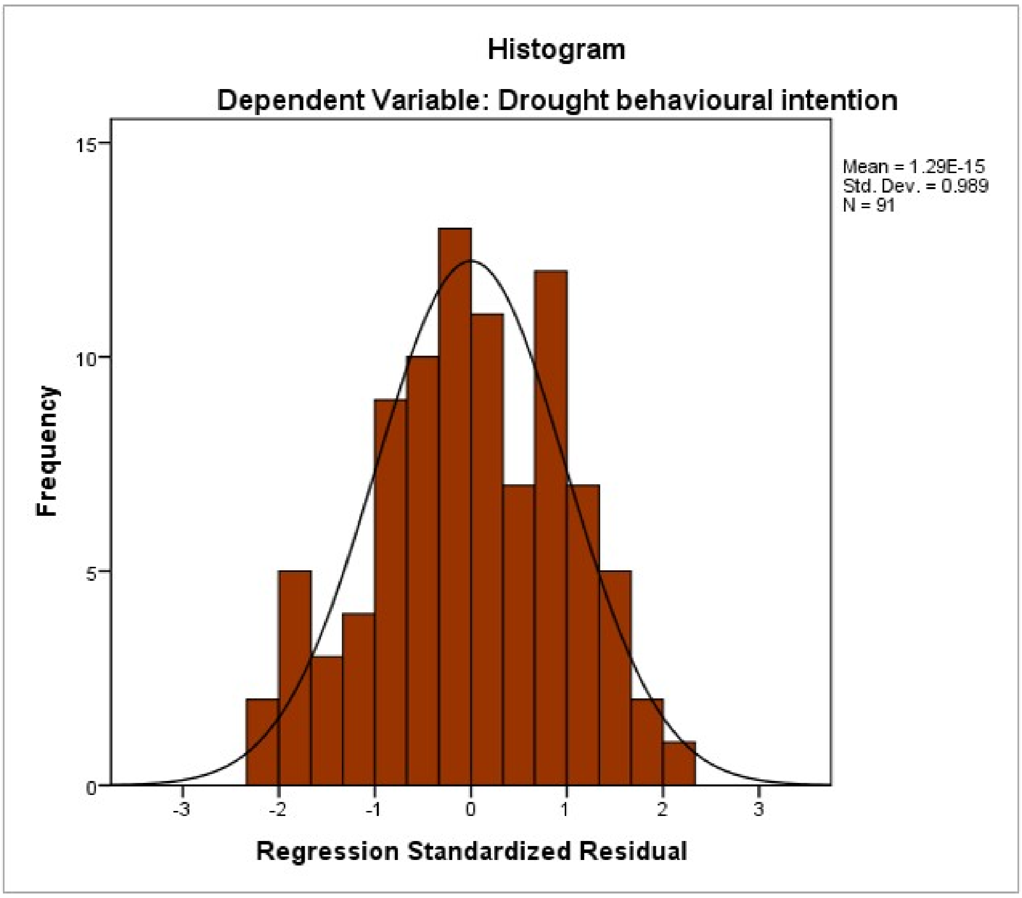

Figure C.1: Normal distribution plot of the residuals of the best fitting model for drought coping intentions.

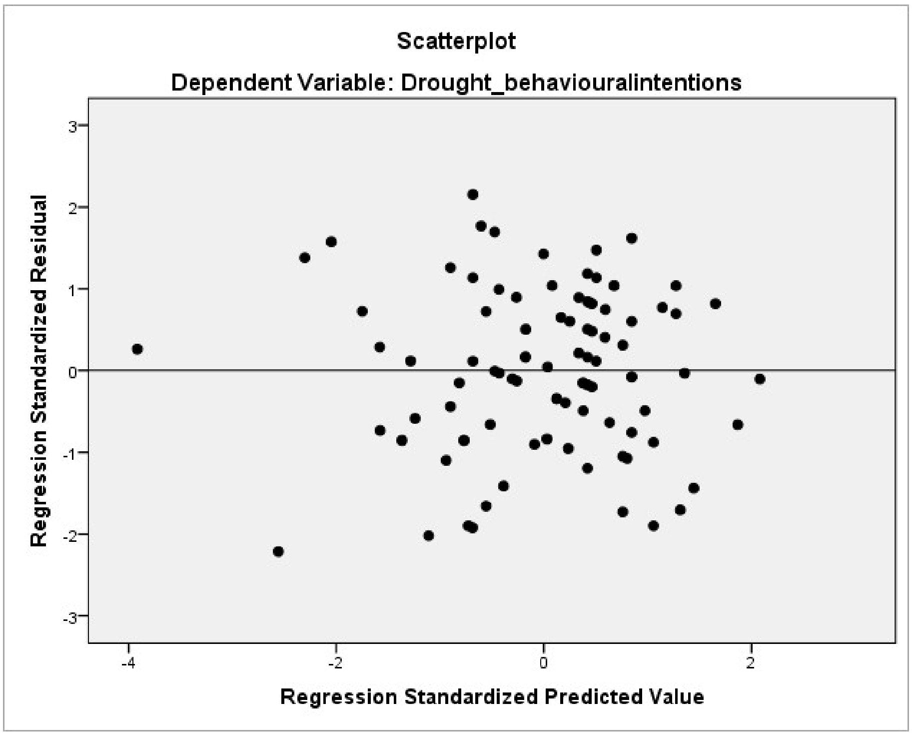

Figure C.2: Scatter plot of the residuals of the outcome variable in the best fitting drought coping intentions model.

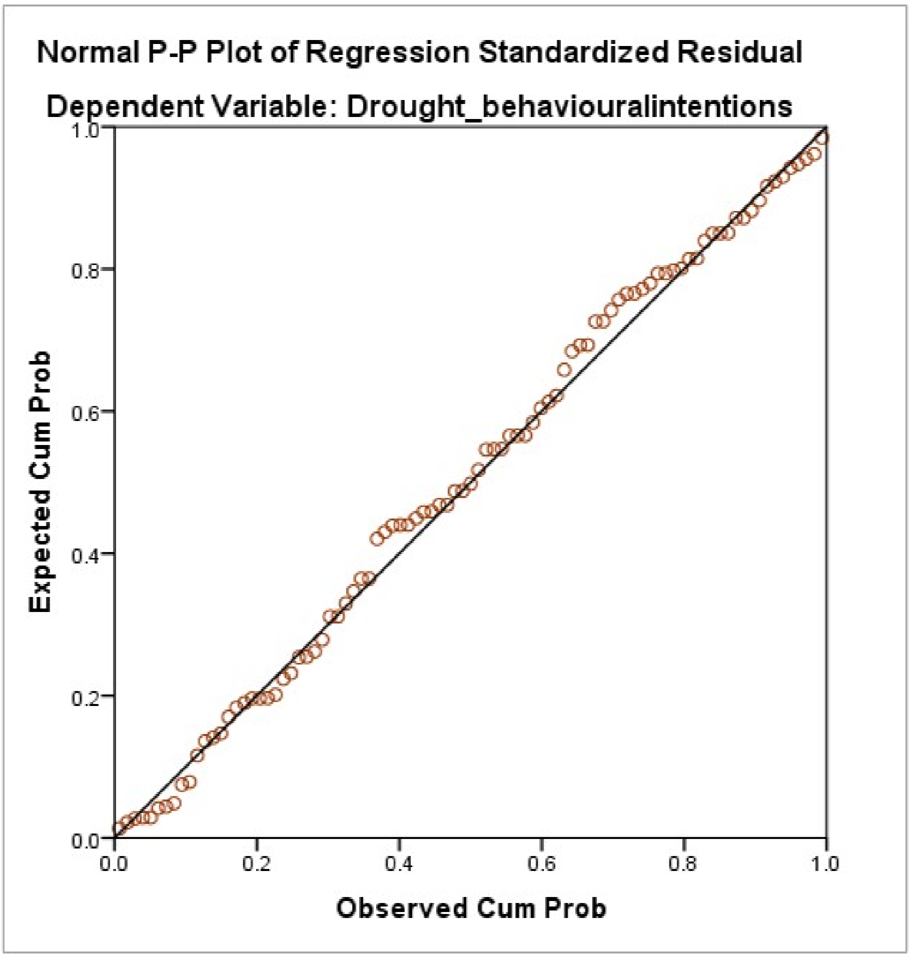

Figure C.3: A normal p-p plot of the regression standardised residuals for the best-fitting drought coping model.

D APPENDIX D: CHAPTER 6

This appendix presents model diagnostics for the best fitting model predicting flood coping intentions in Chapter 6. The tables and figures are presented in order as follows:

1. The coefficients to assess multicollinearity - Table D.1
2. Details of the residual statistics for examining whether or not the condition of homoscedasticity is met - Table D.2
3. Plots that assess the normality of the residuals of the outcome variable (flood coping behavioural intentions) - Figure D.1, D.2, and D.3

Table D.1: Confidence intervals, part and partial correlations and collinearity statistics associated with the best-fit model for flood behavioural intentions. In addition to a correlation matrix, these values were assessed to determine multicollinearity amongst the input variables.

	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	0.81	1.79					
Flood_cons	0.07	0.30	0.19	0.33	0.28	0.88	1.14
Flood_eff	0.11	0.29	0.45	0.44	0.40	0.95	1.05
Pastflood_exp	0.07	0.34	0.32	0.32	0.28	0.92	1.10
Postponement	-0.21	0.01	-0.06	-0.19	-0.16	0.90	1.11

Table D.2: Residual statistics to determine homoscedasticity in best-fitting model on flood coping.

Residuals Statistics a

	Minimum	Maximum	Mean	Std. Deviation
Predicted Value	1.35	3.00	2.07	0.34
Std. Predicted Value	-2.09	2.76	0.03	1.00
Standard Error of Predicted Value	0.07	0.19	0.11	0.03
Adjusted Predicted Value	1.29	2.93	2.07	0.35
Residual	-1.23	1.04	-0.002	0.48
Std. Residual	-2.53	2.15	-0.004	0.98
Stud. Residual	-2.62	2.19	-0.01	1.01
Deleted Residual	-1.31	1.08	-0.003	0.51
Stud. Deleted Residual	-2.73	2.25	-0.01	1.02
Mahal. Distance	0.68	11.56	3.99	2.47
Cook's Distance	0.00	0.10	0.01	0.02
Centered Leverage Value	0.01	0.15	0.05	0.03

a. Dependent Variable: tot_bhi

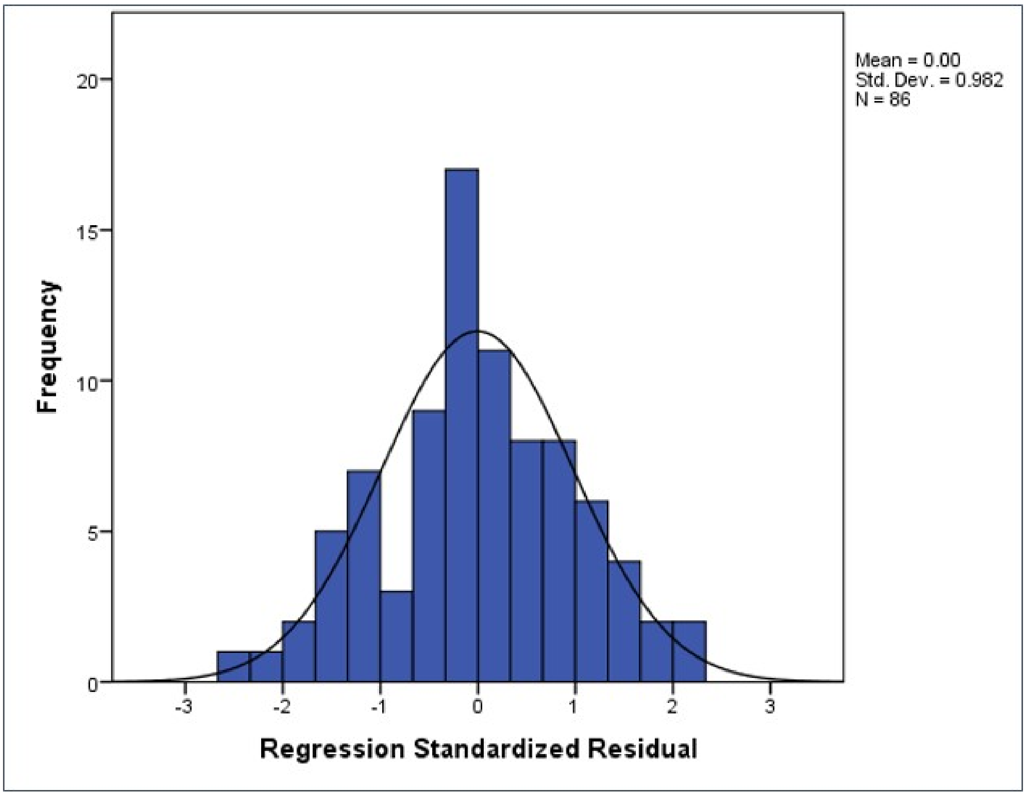

Figure D.1: Normal distribution plot of the residuals of the best fitting model for flood coping intentions.

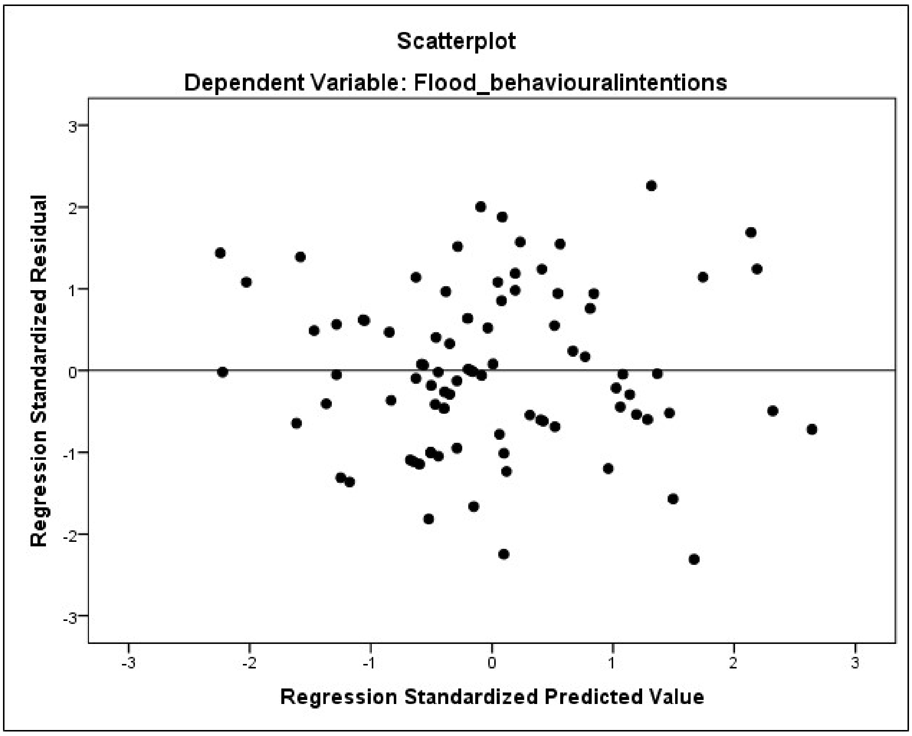

Figure D.2: Scatter plot of the residuals of the outcome variables in the best fitting flood coping intentions model.

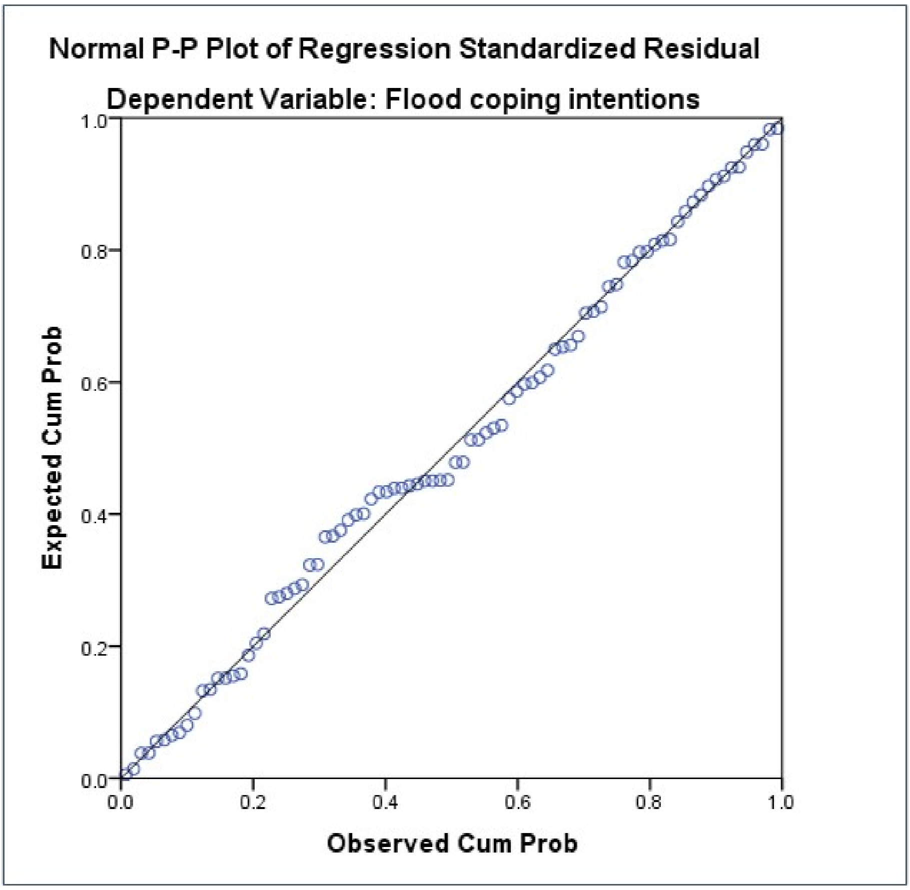

Figure D.3: A normal p-p plot of the regression standardised residuals for the best-fitting flood coping model.

E APPENDIX E: CHAPTER 7

The community toolkit for promoting resilience to water management extremes of drought and flooding has several worksheets that aid in the planning process and are presented as follows:

1. Consequence appraisal worksheet - Table E.1
2. Coping appraisal worksheet 1 - Table E.2
3. Coping appraisal worksheet 2 - Table E.3
4. Verbatim of community action planning
5. Communication sheet - Figure E.1

Table E.1: Consequence appraisal worksheet

Consequence appraisal worksheet				
How have you been affected by flooding or drought in the past? How severe was it? How might you be affected in a future flood or drought? The severity can be ranked from 1 to 5 (very low to very high) or time based (short, medium, and long term).				
Category	**Household**	**Severity**	**Community**	**Severity**
Social				
Economic				
Environmental				

Table E.2: Coping appraisal worksheet 1

Coping Appraisal Worksheet 1 – Current Strategies				
What are you currently doing at the household/community level to manage flooding?				
What are your objectives?:				
Current strategies and measures	Scale of implementation	Stakeholders	Source(s) of funding	Risks and uncertainty

Table E.3: Coping appraisal worksheet 2

Coping Appraisal Worksheet 2 – Future Strategies					
What more can you do at the household/community level to minimise the consequences? Effectiveness, priority and feasibility should be ranked on a scale of 1-5 based (1=very low, 3=moderate, 5=very high)					
Objective (s):					
Proposed approach/measure	How effective is it?	Costs involved?	Who pays for it?	Priority	Feasibility

Verbatim of discussions relating to the development of action plans to address flooding in Topsham

Route 2 Café, Topsham - April 5, 2017

"If you had advance notice that something was going to come that something was going to happen, could you have a sand dump? Then the community churns in and starts filling sand bags? Cos that's something we could get involved with". (TWP 003)

"That's another thought because you've got a point that in if you have your flood boards and flood defences there's nothing to stop you augmenting that with sand bags" (TWP 001)

"But if it's 3:00am and the high tide's at 3:00 am and we're perhaps over the age of 65, we're not gonna be grabbing no, it's unrealistic" (TWP 004)

"That's what I'm saying if we had a sand dump somewhere, maybe in a skip and I'm sure that you can use volunteers to help people for each property....What I could definitely do, if there was a sand dump. I've got a four by four pick-up. So I have a pick-up truck so we can just load that and take it to the most vulnerable people, get some wheelbarrows and get around" (TWP 003)

"We already identified in our area who the vulnerable people were so if it happened then we would know who would need extra help" (TWP 001)

"We had that practice day didn't we, where we checked up on people who were…" (TWP 009)

"I mean I think that that is, well in my experience as far as the flood wardens, that's the bit that's been most valued. Going round just some of the older people who for instance don't have aren't computer literate so therefore they can't check on websites and actually going round and I've been giving my personal number out because if they want to know anything just the fact that they know that someone is there who they can phone if they are worried about." (TWP 008)

“Is there anything else, we’ve got this excellent idea of doing sand bags, is there any other thing that we could think of that we can…” (TWP 001)

Many themes discussed such as mapping vulnerable houses and empty houses so as to prioritise in the event of an emergency.

“So how many houses do you think are affected? Realistically?” (TWP 003)

“It’s about 200 properties” (TWP 001)

“So would some sort of a leaflet drop be good? So what to do in the event? So a leaflet drop you know have basics. Have you got a torch, where is your electric shut-off, where’s your gas shut-off?” (TWP 003)

“Yup, well when the when we did the training flood warning training…there were a whole lot of leaflets….it’s before the flood bit, I mean that is so important” (TWP 008)

“If you have a plan you can respond to it reasonably” (TWP 001)

“Emergency packs, so emergency grab bag with your basics in it not too big cos people won’t use it then…something you can just grab and you’ve got it and you’ve got a little bit of emergency plan. It’s better to be prepared than under prepared.” (TWP 003)

“I do think that that’s quite an interesting idea….With that though you wouldn’t want to do that for 200 properties. You’d have to look at the mixture of and you know we’ve got some information about where is vulnerable so (discussion on the target zones along Ferry Road)….that is where the water accumulates so it’s almost maybe there that you need to focus and then within that is are there some vulnerable people there? Because again you’ve got to be quite careful because If I was to turn up at (named cottage) and say to named person here’s an emergency grab bag he’d probably throw it back at me and say I’ll go for my own thank you” (laughs) (TWP 001)

“You know we can always offer it up for sale or something isn’t it really?” (TWP 002)

“But at least we’d offer it if some people take and some won’t.” (TWP 003)

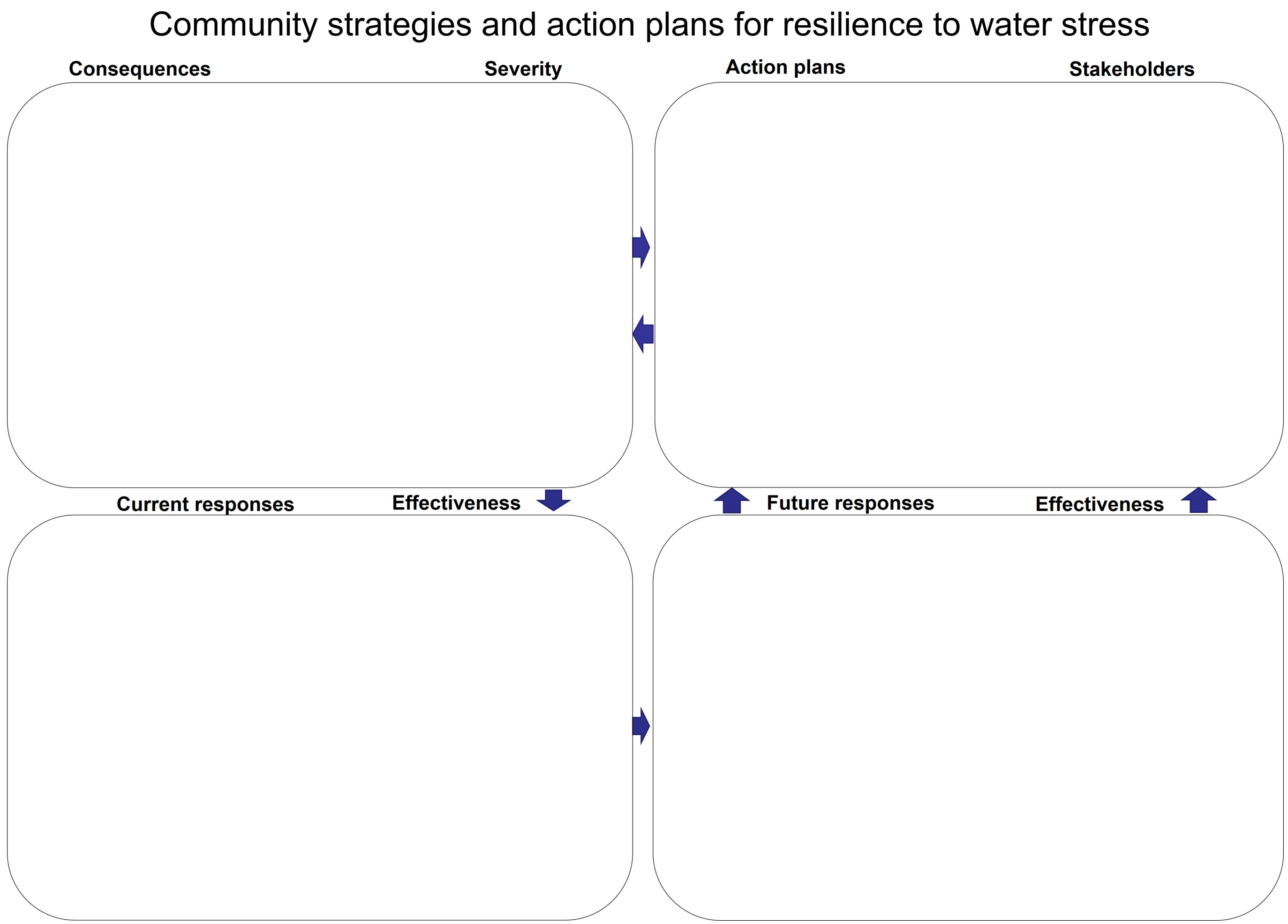

Figure E.1: Communication sheet of the toolkit.

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