Re-configuring Local Governance for Community Resilience: social learning for flood adaptation under a changing climate - A Literature Review

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Executive Summary

Introduction

This literature review was commissioned by Exeter University in conjunction with the Environmental and Sustainability group within the Humanities and Social Science (HASS) strategy. The purpose of this project was to contribute towards research into the impacts of flooding, climate change and community resilience.

Summary

Flooding represents a significant hazard on a global scale. In recent years the UK has been affected by numerous major flooding events, which have resulted in significant environmental, economic and social impacts. It is possible that these impacts of flooding will intensify in the UK as a result of the physical processes associated with climate change.

For many years flood management in the UK focused on physical protection from the impacts of flooding, using hard (structural) approaches (Flood Defence Management). In recent years it has been appreciated that such an approach is neither logistically or economically viable during financially uncertain times and when future scenarios outline expected increases in floodplain occupancy, as well as increased population and assets at risk of flooding. This structural approach also fails to encourage individual/community resilience or associated reductions in vulnerability.

A paradigm shift towards Flood Risk Management appreciates the unavoidability of flooding and subsequently the futility in continuing a management approach almost solely focused around wide-scale protection of individuals and property against the incursion of flooding. Instead, Flood Risk Management advocates personal acceptance of flood risks. This approach encourages both individuals and communities to become more resilient to flooding through increased risk perception, as well as flood awareness and preparedness. Combinations of property-level non-structural adaptations are designed to enhance resilience through minimising damage caused by the ingress of flood-waters; subsequently improving recovery following flooding events. The overall improvement to individual/community resilience has the potential to contribute towards reducing vulnerability to flooding.

One key factor in the successful transition towards a non-structural approach to Flood Risk Management is the role of Stakeholder participation. Flood Defence Management disengaged and disempowered individual stakeholder responsibility for flood management, due to centralised and generalised top-down management practices which failed to account for locally-specific lay stakeholder knowledge and opinions in management practice. Alternatively, the success of Flood Risk Management practice is intrinsically linked with the promotion of stakeholder participation. Promoting resilience through non-structural approaches requires the devolution of risk responsibility from central government/authorities to stakeholders.

Under the Flood Risk Management paradigm, European Law defines the right of stakeholders to be involved in relevant decision-making processes, however successful application of such an approach is

still dependent upon stakeholder ability and desire to participate. Research has demonstrated a myriad of complex and potentially interconnecting social, psychological, economic, political and institutional barriers which provide determining factors in understanding individualistic stakeholder risk responsibility and willingness to adopt non-structural approaches to improving resilience.

Development stages of stakeholder participation have been theoretically explored by Callon (1999); these have subsequently been assessed and critiqued by various authors. There is clear importance in determining the role of stakeholders within contemporary Flood Risk Management decision-making processes in order understand how stakeholder participation can be enhanced in order to positively benefit individual and community resilience within a Flood Risk Management paradigm.

Future research directions

1. Developing a greater understanding of the barriers which limit the implementation of non-structural approaches within Flood Risk Management

2. Developing a greater understanding of how Callon's models of stakeholder participation relate (in practice) to the development of individual/community resilience through development of non-structural approaches to Flood Risk Management

Re-configuring Local Governance for Community Resilience: social learning for flood adaptation under a changing climate – A Literature Review

1. Introduction

In recent years the UK has been affected by several extreme flooding events which have resulted in significant environmental, economic and social impacts. From a historical perspective, flooding has long been considered one of the most damaging and costly natural hazards (Brown and Damery, 2002; Kellens *et al*., 2013; Harries, 2013). Over the past century, major flooding events have occurred in 1947, 1953, 1998, 2000, 2007 and 2009 (Johnson *et al*., 2005; Coumou and Rahmstorf, 2012). Such flooding events are responsible for significant economic damage. It is estimated that £200 billion of assets in the UK are at risk of flooding, £82 billion of which are at risk of fluvial flooding alone (Treby *et al*., 2006; Hardaker and Collier, 2013).

Every major flood event has unique characteristics; however there has been a general increase in the economic losses from major flooding events in the UK in recent years. This trend can be observed in the economic damages of three major flooding events that have impacted the UK in the past 20 years. The Easter flooding of 1998 resulted in damage to 4,500 properties and £300 million of damages (Johnson *et al*., 2005; Harries, 2013). These flood damages were surpassed by the autumn 2000 flooding, which resulted in damage to 11,000 properties and caused £1.3 billion of damages (Johnson *et al*., 2005; Pall *et al*., 2011). During the summer 2007 floods, 55,000 properties were damaged and estimated losses vary from £3-6 billion; the impacts of these floods are extensively covered in the *Pitt Review* (2008) (Pitt, 2008; Chatterton *et al*., 2010; Harries, 2013). Social and psychological impacts of flooding can be intangible and difficult to quantify as easily as economic impacts. In recent years, several authors have focused on physical and psychological health implications of major flooding events; these are more extensively reviewed in Appendix 1 (Tunstall *et al*., 2006; Sims *et al*., 2008; Pitt (2008); Chatterton *et al*., 2010; Walker *et al*., 2010; Walker *et al*., 2012).

There are currently around 5 million people and 2 million properties at risk of flooding in England and Wales (Burningham *et al*., 2008; Fielding, 2012). It is considered that over the next century the social and economic impacts of flooding will intensify; resulting from the impacts of climate change on flooding, increased population/floodplain occupancy, as well as the rising economic value of domestic/commercial infrastructure and contents (Brown and Damery, 2002; Evans *et al*., 2006; Penning-Rowsell *et al*., 2006; Johnson *et al*., 2007(a); Manojlovic and Pasche, 2008; Fielding, 2012; Harries, 2013; Kellens *et al*., 2013). In future scenarios, constructed by Evans *et al*. (2004) as part of the *Foresight Future Flooding Project*, it is predicted that the cost of flooding in the UK by 2080s (assuming continued construction and maintenance of structural defences) would increase between £1 billion and £27 billion (Harries, 2013). In the same report it was documented that the population at risk of flooding will also increase by the 2080s (Harries, 2013).

It has been suggested that current management strategies will fail to cope with increasing flooding frequency and exposure (Harries, 2013). It has become evident that it is no-longer sustainable to support the continued construction and maintenance of all structural defences, especially within an uncertain financial climate (Bichard and Kazmierczak, 2012). The *Foresight Project* (2004) forwarded the prospect of utilising a portfolio of approaches in reducing flood risk; the findings of this report paved the way for the promotion of non-structural approaches in Defra's 2005 conceptual report, *Making Space for Water* (Defra, 2005).There are many forms of non-structural defences; these are designed to enhance community/individual resilience to flooding through supplementation and replacement of structural defences (Manojlovic and Pasche, 2008; Rose *et al*., 2009). Transitioning from a predominantly structural flood management system to non-structural approaches under a paradigm shift towards Flood Risk Management can be impeded through a multitude of social, psychological, economic, political and institutional constraints known as barriers (Brown and Damery, 2002; Treby *et al*., 2006; Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Burningham *et al*., 2008; Johnson and Priest, 2008; Sims *et al*., 2008; Rose *et al*., 2009; Soane *et al*., 2010; Harries and Penning-Rowsell, 2011; Harvett *et al*., 2011; Tapsell, 2011; Bichard and Kazmierczak, 2012; Fielding, 2012; Penning-Rowsell and Pardoe, 2012; Harries, 2013). The success of non-structural approaches is dependent on stakeholder participation (Tseng *et al*., 2012). Stakeholders in local communities are required to understand the interconnectivity of concepts such as risk perception, vulnerability and resilience; subsequently promoting adaptation through mitigating actions. In accepting that structural defences no-longer solely represent a viable option in flood protection under future climate scenarios, there is an increased need to understand how stakeholder participation and other factors influence the development of non-structural approaches and enhanced community/individual resilience (Maynard, 2013).

This literature review provides an overview of physical and social dimensions of flooding, focused primarily around social dimensions in the development of flood management policies, practicalities of implementing non-structural approaches in flood management and the role of stakeholder participation in flood management.

2. Potential impacts of future climate change on flooding

It is wildly accepted in flooding and society literature that future climate change will have a significant impact on flooding (Fleming *et* al., 2001; Brown and Damery, 2002; McEwen *et* al., 2002; DEFRA, 2005; Penning-Rowsell *et al*., 2006; Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Coninx, 2008; Twigger-Ross *et al*., 2009; Harries and Penning-Rowsell, 2011; Whatmore and Landström, 2011; Bichard and Kazmierczak, 2012; Fielding, 2012; McEwen *et al*., 2012; Kellens *et al*., 2013; Samuels, 2013).

In August 2010 the World Meteorological Organisation outlined how the "unprecedented sequence of extreme weather events" over the past decade conformed to Intergovernmental Panel on Climate Change (IPCC) predictions of increased intensity of extreme weather events resulting from global warming (Coumou and Rahmstorf, 2012). Analysing the impact of climate change on flooding and associated features remains complicated by both the limited amount of observational data of infrequent extreme weather on a regional/global scale and identification of the largely untraceable factors which contribute to specific flooding events (Marsh and Hannaford, 2007; Pall *et al*., 2011; IPCC, 2012). This lack of regional data confines validation of the continuing influence of climate change on the magnitude and frequency of associated regional-scale flooding (IPCC, 2012).

There is a medium confidence that anthropogenic influences on greenhouse gas emissions have contributed to the intensification of extreme precipitation events (Coumou and Rahmstorf, 2012; IPCC, 2012). It is considered that greenhouse emissions have contributed to increased daily and five-daily precipitation totals over approximately two-thirds of the northern hemispheric landmass in the 20th century (Coumou and Rahmstorf, 2012). It is likely that the frequency of heavy precipitation events will increase over the 21st century along with shorter return periods of intense precipitation events (IPCC, 2012). It is also likely that there will be a polar shift in extra-tropical storm tracks in the northern hemisphere, thus subsequently implying the potential for increased storms and flooding in the UK (IPCC, 2012). The influence of global warming on extreme weather is clearly defined, whereby general increase in global temperatures results in higher capacity for atmospheric moisture content, increased latent heat and subsequently increased potential for storm activity (Coumou and Rahmstorf, 2012; IPCC, 2012).

Despite aforementioned conclusions regarding the complexity of attributing the influence of anthropogenic climate change to specific flooding events, Pall *et al*. (2011) have quantified this relationship in relation to the autumn 2000 floods in the England and Wales. This was achieve through comparing modelled actual conditions of the 2000 floods in England and Wales with a scenario omitting the influence of anthropogenic greenhouse gas emissions since A.D. 1900 (Pall *et al*., 2011). The findings of this investigation conclusively indicate the anthropogenic influence on increased flooding, with 90% of models indicating greenhouse gas emissions would have increased the risk of flooding in autumn 2000 by at least 20%.

3. The history of Flood Risk Management (FRM) in England and Wales

There have been two distinctive paradigm shifts in flood management approach in England and Wales since the beginning of the 20th Century (Penning-Rowsell *et al*., 2006; Johnson and Priest, 2008; Cashman, 2011).

Between the end of the Second World War and the 1970s flood management policy is defined as one of land drainage (Penning-Rowsell *et al*., 2006; Johnson and Priest, 2008). During this period, emphasis was placed on human dominance of nature with limited concern for environmental damage; subsequently protection of agricultural interests such as productivity and profitability were secured through hard (structural) engineering solutions (*ibid*). During this period regional and local government influenced by local-knowledge-oriented expert opinion were responsible for the implementation of flood policy through funding secured by Internal Drainage Boards (IDBs) (*ibid*). The presence of soft (non-structural) solutions to flooding such as flood risk communication, flood warnings, emergency management and development controls would have been limited and locally administered during this period (*ibid*).

3.1: The first paradigm shift in flood management

The first paradigm shift in flood management occurred between the 1970s and 1990s, defined as the structural defence period (Penning-Rowsell *et al*., 2006). This period witnessed a transition towards prioritising the protection of urban rather than rural areas through the construction of structural defences to protect urban populations and properties (Penning-Rowsell *et al*., 2006; Johnson and Priest, 2008). This period witnessed a continuation of both the human attitude of dominion over the natural system and technological optimism regarding the capacity of hard defences to withstand the influences of the natural system (Penning-Rowsell *et al*., 2006). As with the land drainage approach, this period witnessed a continuation of governmental responsibility for flood protection, culminating in governmental centralisation of funding for flood management (Penning-Rowsell *et al*., 2006; Johnson and Priest, 2008). The national, regional and local centralisation of flood policy caused a significant change from the previous system, since expert and elite opinions caused a transition towards a generalised system based on the preservation of economic prosperity through the protection of urban capital and development on floodplains, whilst neglecting locally specific knowledge and interests which had been prominent under the existing approach (*ibid*). The economic precedent accompanying this new approach was emphasised in the economically-grounded cost-benefit appraisal system regarding expenditure on structural defences, which could arguably be considered as causing the same social injustices in flood defence distribution as present under the previous approach of prioritising agricultural defence (Penning-Rowsell *et al*., 2006). Non-structural defence underwent several key changes during this period. There is the first evidence for understanding the probabilistic nature of risk and risk communication; however this related to top-down communications of expert oriented information and was not considered that important (*ibid*). This period demonstrated the first evidence of risk transfer involving insurance companies adopting the risk of individuals and businesses, which until that point had relied on government support (*ibid*).

3.2: The second paradigm shift in flood management

The second paradigm shift started in the 1990s and continues to the present day; flood management during this period can be referred to as Flood Risk Management (FRM) (Penning-Rowsell *et al*., 2006). During this period the pre-existing predominant view of human dominance over nature was replaced by the requirement to fulfil the social, economic and environmental requirements of sustainable development (Defra, 2005; Penning-Rowsell *et al*., 2006; Johnson and Priest, 2008). This period witnessed an acceptance that the pre-existing approach to flood management, where the government were responsible for protecting people and property (mostly through structural defences) was becoming ineffective (Penning-Rowsell *et al*., 2006). Ultimately the FRM period can be associated with the drive towards individual responsibility for managing flood risk and subsequently the reduction of state responsibility to organisation and consultation, rather than direct intervention (*ibid*). This new paradigm recognises the importance of the multi-directional exchange of knowledge (including local knowledge), information and education between various stakeholders and elite decision-makers; such an approach makes the participation of stakeholders and individuals a prominent part of the decision-making processes of flood risk management (*ibid*). The recognition of shortcomings of continuing an approach which predominantly advocated structural defences and acknowledgement that the existing system failed to account for the impact of all types of flooding resulted in the acceptance that various non-structural approaches should be equally considered and applied in conjunction with continued structural defences (Penning-Rowsell *et al*., 2006). Developments in non-structural defence during this period include a growing awareness of the importance of understanding and conveying flood warnings; increased importance in developing flood awareness; increased emphasis on the roles of local communities and individuals in self-help and flood-proofing; coordination of state, community and local emergency planning; and increased controls over development on floodplains (*ibid*). The further development of the insurance industry during this period allowed for flood risk transfer between individuals/householders/businesses and the private sector and subsequently aided the retraction of the state obligation, thus in-keeping with the FRM paradigm (*ibid*). Ultimately, there is clear recognition of the three-stage transition in flood management in England and Wales (Land drainage – Flood defence – Flood Risk Management) (Johnson *et al*., 2005).

4. Understanding the influence of flooding on policy change

It has been considered by Parker (2000) that flooding becomes a prominent issue on the political agenda when heightened media attention and public attitudes surrounding the issue result in a situation where "failure to act is politically unacceptable" (Johnson *et al*., 2005). It has also been suggested that politically reactive responses to flooding could actually have the negative effect by enhancing risk (Johnson *et al*., 2005).

Johnson *et al*. (2005) provide a detailed account of how flooding events influence flood policy developments. A number of authors, including Sabatier, Jenkins-Smith, Kingdon, Baumgartner and Jones have provided conceptual ideas which contributed towards the current theoretical framework for the evolution of flood policy (*ibid*). This framework suggests that flood policy develops incrementally during long periods of quiescent flood activity (without national flooding, but with the possibility of localised events) (Johnson *et al*., 2005; Penning-Rowsell *et al*., 2006). Flood events with a national influence tend to trigger catalytic policy changes (Johnson *et al*., 2005; Penning-Rowsell *et al*., 2006; Lane *et al*., 2013). Penning-Rowsell *et al*. (2006) note that the policies promoted during periods of catalytic change are manifestations of policies already rooted in flood management discourse. Some major flooding events subsequently provide a 'window of opportunity' in which increased prominence on flooding in the political agenda, media and public opinion allows various social actors to accelerated incorporation of pre-existing concepts into practical policy (Johnson *et al*., 2005; Penning-Rowsell *et al*., 2006). Penning-Rowsell *et al*. (2006) have suggested that in some cases the 'signals' present in early developing flood policy concepts could represent changes in flood policy which could become dominant during future catalytic events; subsequently understanding such 'signals' now would allow for a preparatory phase preceding catalytic events.

Johnson *et al*. (2005) identify key factors which influence the potential impact of flooding on promoting catalytic policy change, these include; environmental factors (flood magnitude), contextual factors (knowledge/information/technology/socio-economic factors and political structuring and administration) and behavioural factors (beliefs, attitudes and societal values). Johnson *et al*. (2005) provide a summary of how the aforementioned catalytic changes to policy discourse were evident following major flooding events in 1947, 1953, 1998 and 2000.

5. Understanding organisational responsibilities within contemporary flood management structure

The paradigm shifts in flood management over the past century have been accompanied by a series of changes to the jurisdiction of various national, regional and local authorities in flood risk management (FRM) approaches (Brown and Damery, 2002; Penning-Rowsell *et al*., 2006). The complex institutional arrangement of organisations, as well as structural arrangement of finance, administration and delivery of management within such organisations can be in part considered a continued disruption to the functioning of FRM in England and Wales (Brown and Damery, 2002). It is important to understand the current structural arrangement of FRM in England and Wales (Green, 2011) in order to appreciate the societal implications of the system, addressed later within this text.

The Department for Environment, Food and Rural Affairs (Defra) assume overall responsibility for FRM in England (Brown and Damery, 2002; Johnson and Priest, 2008); replacing the Ministry of Agriculture, Food and Fisheries (MAFF) in 2001 (Burningham *et al*., 2008)). Defra are responsible for establishing national FRM objectives, obtaining/providing central governmental funding and setting targets (Brown and Damery, 2002; Harries and Penning-Rowsell, 2011). Defra distribute and devolve operational responsibilities for enacting FRM policies to various semi-autonomous organisations (operating authorities) which operate at various spatial scales (Johnson and Priest, 2008).

The Environmental Agency (EA) is a quasi-governmental organisation representing the primary operating authority responsible for the delivery of FRM policies outlined by Defra (Brown and Damery, 2002). The EA are responsible for issues relating to flooding and flood defence on main rivers and critical ordinary watercourses; under the *Environment Act* (1995) these responsibilities are fulfilled through Regional and Local Flood Defence Committees (RFDCs and LFDCs). The RFDCs and LFDCs contain members elected by the EA and members of constituency councils; it is the responsibility of such committees to follow governmental guidelines and legally authorise construction of flood defences on watercourses under their jurisdiction (Brown and Damery, 2002; Johnson and Priest, 2008).

Brown and Damery (2002) outline the responsibilities of the EA, as defined through various Central and Local Government Acts, these include the following;

- Overall supervision over the administration of FRM policy (Johnson and Priest, 2008)
- Construction and maintenance of river defences on main and critical ordinary watercourses
- Developing floodplain maps which enable identification of floodplain extent
- Dissemination of flood warnings
- Providing a statutory consultation role on planning applications that could affect rivers/drainage

The instigation of FRM policy on ordinary watercourses is administered by both Internal Drainage Boards (IDBs) and Local Authorities (Brown and Damery, 2002). There are 235 IDBs situated in Internal Drainage Districts throughout England and Wales; the responsibility of these IDBs is managing flood defence and drainage in lowland agricultural areas (Brown and Damery, 2002; Johnson and Priest, 2008). Local Authorities have jurisdiction to construct flood defences on remaining ordinary watercourses; although this control has been weakened since the EA assumed control of critical ordinary watercourses (*ibid*). Despite being weakened by the aforementioned transfer of power, Local Authorities still significantly

contribute to FRM through the coordination of emergency planning and community support during flood events (Brown and Damery, 2002).

In recent years the EA have established a greater degree of control over the administration of FRM policy and related funding. In the past RFDCs and IDBs could source the funding required for the construction of flood defences, however since April 2006 the EA have become responsible for the distribution of grant-in-aid funding which allows these organisations to fulfil capital-intensive objectives (Johnson and Priest, 2008). The centralisation of funding-distribution from the EA, although beneficial to strategic considerations, creates disempowerment amongst authorities whose responsibilities have been reduced and weakens the application of local knowledge/support for implementation of locally-specific practice (*ibid*).

The *Flood and Water Management Act* (2010) outlined revised responsibilities of authorities. This Act recognised the requirement to reduce flood risk in respect to the predicted increase in extreme weather (*Flood and Water Management Act*, 2010). This Act also recognises the requirement for various authorities to co-operate and promotes sustainable development (*ibid*). Significantly, the *Flood and Water Management Act* (2010) expanded the previously established responsibilities of Local Authorities to include the development of strategies for managing flood risk and managing surface water and ground water in addition to ordinary watercourses.

In 2004 Defra implemented a new approach of providing the EA with annual block grants; this replaced a previous system under MAFF, whereby funding was based on a levy system in local authorities and supplemented with grants (Johnson *et al*., 2007(b)). In the 2012-2013 budget the EA received £670 million from Defra, with £290 million designated for establishing new schemes and £209 million for the maintenance of existing schemes (Penning-Rowsell and Pardoe, 2012). In June 2013 Defra announced a commitment to provide £370 million per annum for investment in flood defences between 2015/16 and 2020/21 for the purpose of investment in flood defences (Defra, 2013).

The degree of autonomy of various organisations within FRM is interesting in relation to the empowerment of such groups to influence concepts of social justice and equality. It has already been mentioned that centralisation of funding for regional and local-scale groups has diminished the importance of local knowledge in influencing FRM policy (Johnson and Priest, 2008).

There are few European Union (EU) or UK central government laws, administrative constraints and obligations which specifically define how the EA implement FRM policies; thus maintaining significant EA autonomy (Harries and Penning-Rowsell, 2011). The EA have permissive powers for implementation of FRM policy, rather than specific duties; however their actions are still influenced by funding restrictions and guidelines from Defra (Johnson and Priest, 2008). These guidelines and restrictions allow Defra to transfer and devolve responsibility for enacting government policy whilst maintaining control of the overall outcome (Johnson and Priest, 2008). Defra retain a level of control over the EA through restricting expenditure on projects exceeding £100 million without central government approval and the priority scoring of flood defence schemes through Project Advisory Guidance (PAG) (Johnson *et al*., 2007(b); Harries and Penning-Rowsell, 2011). Although the PAG system has undergone a series of

alterations since its conception, it remains a cost-benefit analysis system which incorporates environmental, economic and social considerations in determining funding allocations (*ibid*). Defra's PAG system quantifies the aforementioned variables and requires proposed defence schemes to have a minimum 5:1 return on investment, unless exceptions are made due to political priorities (*ibid*). The PAG system promotes social injustice in the distribution of flood defence resources, since it encourages the continuation of non-specific targeting of assistance for the most vulnerable groups in society (*ibid*). It would be incorrect to identify Defra's involvement through the PAG system as the only reason for continued injustices in the distribution of effective FRM approaches resulting from policy structures. The EA capital expenditure programme within catchment management plans is based on generation of strategic and sustainable approaches to FRM in communities where the greatest benefits could be achieved (Johnson *et al*., 2007(b)). This programme only accounts for a simplistic economic perspective and fails to correctly utilise available data relating to social vulnerabilities (*ibid*). Johnson *et al*. (2007(b)) consider social equality in FRM to be "unobtainable"; this can be justified through considering that the local equality created through distribution of FRM resources is subjective towards one group and the inequalities surrounding that distribution of resources would be enhanced with increasing spatial scales.

6. The transition from structural to non-structural approaches in Flood Risk Management

For many years the prevailing attitude in flood management in the UK was one of technocentric optimism, whereby state or institutionally administered project-specific hard-engineering (structural) flood defence schemes which were deemed the solution to flooding (Brown and Damery, 2002; Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Rose *et al*., 2009; Soane *et al*., 2010; Cashman, 2011; Bichard and Kazmierczak, 2012). In recent years there has been a shift in policy direction towards greater emphasis on soft (non-structural) approaches to managing flooding, in which the responsibility for risk is shifted from state to individual action (Goulter *et al*., 1987; Defra, 2005; Johnson *et al*., 2007(b); Johnson and Priest, 2008; Rose *et al*., 2009; Green, 2010; Soane *et al*., 2010; Cashman, 2011; Harries and Penning-Rowsell, 2011; Bichard and Kazmierczak, 2012). The transition from structural to non-structural approaches between flood defence and flood risk management (FRM) policy can be attributed to a number of causal factors.

Despite engineering advancements in structural defences, it became apparent that this approach to reducing the probable impacts of flooding events was no-longer sustainable (Treby *et al*., 2006). The protective capacity of existing structural defences can be significantly reduced by extreme pluvial flooding, which could become increasingly prevalent with increased high intensity precipitation events under future climate projections (Soane *et al*., 2010; Harries and Penning-Rowsell, 2011; IPCC, 2012). In addition to climate change, predicted population and social changes are likely to result in increased floodplain occupancy; subsequently resulting in increased vulnerability and damages resulting from flooding (Brown and Damery, 2002). Ultimately, it remains financially and practically unviable to continue flood policy based upon structural options (Treby *et al*., 2006; Cashman, 2011). Following major flooding in 1998, there were emerging signs of a transition in flood management, during which it was determined that structural defences were no-longer a viable means to cope with all potential flood risks (Johnson *et al*., 2005; Johnson *et al*., 2007(b)). This assertion was validated by the Select Committee on Agriculture (1998), whereby they deemed the replacement of defunct structural defences to be financially unviable (Brown and Damery, 2002). Over subsequent years, multiple reports published by various institutions began advocating a new paradigm, consistent with the emergence of FRM policy (Johnson *et al*., 2007(b)). This paradigm was the transition of risk responsibility from the state to the individual; whereby in accepting that flooding cannot always be prevented, the individual assumes responsibility for resistance and resilience against flooding events (Defra, 2005; Johnson *et al*., 2007(b)). Various aspects of the aforementioned approach have been advocated by the *Institute for Civil Engineers* (2001), *Office of the Deputy Prime Minister* (2002), Defra (2004) and the *UN International Strategy for Disaster Reduction (ISDR)* (2004) (Johnson *et al*., 2007(b)). The *Foresight Project* (2004) was commissioned by the government's chief scientific advisor (Sir David King); the main purpose of this report was the investigation of predicted changes to flood risk in the UK between 2030 and 2100. A two volume *Foresight* report (entitled *Foresight Future Flooding* (volume 1: Future risks and their Drivers, and Volume 2: Managing future risks) represents the collaborative work of 80 experts from various disciplines (led by Professor Edward Evans). This report provides an overview of the drivers and potential impacts of flood risk, as well as providing an account of the governance of flood management and future response options in relation to flood risk (Evans *et al*., 2004(a); Evans *et al*., 2004(b)).

Ultimately, it is considered that although the *Foresight Project* failed to resolve the uncertainties within national-scale scenario analysis, it succeeded in providing foundation evidence for the development of Defra's *Making Space for Water* concept (Evans *et al*., 2006).

6.1: 'Making Space for Water'

Defra clearly outline the UK government vision for a paradigm shift towards emphasising the application of non-structural approaches to FRM in a report called *Making Space for Water* (MSW) (Defra, 2005; Hardaker and Collier, 2013). The MSW report outlines a 20-year framework for increasing the prominence of non-structural approaches within FRM policy (Defra, 2005). MSW aims to generate a more holistic understanding of flooding in order to enhance coverage and reliability of flood warnings and awareness amongst the public, subsequently encouraging individuals to proactively manage risk responsibility for flooding, as well as promoting measures of individual (property-level) resistance and resilience which would lower overall vulnerability (Defra, 2005; Johnson and Priest, 2008; Rose *et al*., 2009; Bichard and Kazmierczak, 2012). MSW represents an attempt to maintain individual/property flood protection, whilst firmly establishing the principles of FRM within government policy, and promote environmental, economic and social aspects of sustainability (Defra, 2005; Johnson and Priest, 2008). MSW assigns importance to holistic understanding of the implications of flooding processes and management (including previously under-researched impacts of pluvial and groundwater flooding) across flood catchments, rather than project-level specific considerations present under previous flood defence policy (Defra, 2005; Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Johnson and Priest, 2008; Lane *et al*., 2011). It has become the responsibility of the EA to promote the ideals of MSW in future catchment-scale FRM policies; this holistic assessment is conducted through 50-100 year Catchment Flood Management Plans (CFMPs) (Johnson and Priest, 2008). MSW outlines alterations to the EA's statutory consultation role in floodplain planning procedures towards prioritising the mitigation and transference of risk (Defra, 2005; Johnson and Priest, 2008). The Planning Policy Guidance Note 25 (PPG25) was replaced by the Planning Policy Guidance Statement 25 (PPS25); this increased the responsibility of developers to ensure flood-resilient sustainable constructions, increased capacity for rejecting proposals which fail to meet flood resilience standards and devolved development responsibilities to the local-level (*ibid*). Increased empowerment of individuals through devolution of risk responsibility and local engagement/participation in local to national level decision-making processes within the FRM framework is crucial in delivering a transition to non-structural approaches within flood management (Johnson and Priest, 2008). MSW establishes that a combined 'portfolio' of non-structural approaches designed to reduce vulnerability to flooding could replace the prevailing approach, whereby structural defences were utilised to reduce the probability of flooding (Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Harries and Penning-Rowsell, 2011). This combination of non-structural approaches within FRM involves EA responsibilities for ensuring effective and reliable flood warning and awareness information, however ultimately individuals assume risk responsibility through how their engagement with such information translates into the development of personal resistance and resilience through mitigation measures such as building adaptation (Defra, 2005). Johnson and Priest (2008) note that MSW represents government intentions to reform FRM, however legal alterations to existing policy would require economic, social and cultural considerations.

6.2: EU involvement in non-structural approaches to Flood Risk Management

The rise in individual responsibility in FRM is reflective of a global change in risk management; with FRM succeeding flood defence as the dominant flood management approach on a global scale, due to greater acceptance that flood cannot be prevented (Johnson *et al*., 2007(a)). In recent years European Union legislation has supported the aforementioned transition towards promoting individual responsibility in managing flood risk. The *EU Flood Directive* (Directive on the assessment and management of flood risks (Directive 2007/60/EU)) and the *Aarhus Convention* represent examples of legally binding EU legislation that enforce the principles of FRM approach, as previously recognised within MSW (EU Aarhus Convention (Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters), 1998; Defra, 2005; EU Directive on the assessment and management of flood risks, 2007; Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Johnson and Priest, 2008; Maynard, 2013). The *EU Flood Directive* outlines a European Framework for delivering a transition to FRM through mandatory improvements to flood risk assessments, flood hazard/risk maps and flood risk management plans by 2015 (EU Directive on the assessment and management of flood risks, 2007; Hildén *et al*., 2012). The *Aarhus Convention* (1998) outlines the rights of the individual to obtain information regarding environmental matters, participate in decision-making regarding environmental decisions and challenge public opinion in the interests of justice (EU Aarhus Convention, 1998). These documents represent prominent examples of widespread integration of the core principles of FRM policy into international law. Alternatively, the *CRUE Vision* 2015 represents an international research effort to accumulate and process information regarding forwarding of a non-structural approach to FRM, without concerns over the practical implementation of knowledge collected (Samuels, 2013). The five specific research aims of the *CRUE vision* 2015 are outlined in Samuels (2013) and summarised as follows:

1. Developing resilience and adapting for increasing flood risk under climate change and new developments

2. Focus on risk assessment and management

3. Implementation of transnational strategies for flood prevention/protection in-keeping with sustainable development

4. Meeting the multi-functional demands on flood prevention/protection and sustainable management

5. Addressing public knowledge of flood risk and enhancing awareness, perception and communication

These aims were designed to meet the two research demands of the *CRUE Vision* 2015 project, as outlined in Samuels (2013):

1. ‘Risk assessment and risk management: Effectiveness and efficacy of non-structural flood risk management measures’.

2. ‘Flood resilient communities – managing consequences of flooding’.

The *CRUE Vision* 2015 provides clear evidence for international consideration of the importance in generating understanding of factors which influence the transition to non-structural approaches in FRM, as well as the importance of generating associated community-level resilience.

7. Flood hazard assessment, awareness and warnings

7.1: Flood mapping

The Environment Agency (EA) have been responsible for the identification of areas at risk of flooding or flood related problems since 1991, under Section 105(2) of the *Water Resources Act* (1991) (Brown and Damery, 2002). In 1997 the pre-requisite for flood hazard mapping as part of long-term flood management policy was recognised in the EA 'Declared Policy and Practice for the Protection of Floodplains'. The EA fulfilled their obligation through the creation of Indicative Floodplain Maps (IFPMs) for England and Wales; these denoted the natural undefended boundaries of river floodplains under scenarios of 1:100 year probability flood events (crucially excluding various types of flooding, including drainage and run-off flooding) (Brown and Damery, 2002). These maps combine both computational modelling and physical records of flood events (*ibid*). Such maps provide relative approximations of potential flood outcomes, since uncertainties can arise through the combination of physical data from either single or multiple flood events across various spatial domains (*ibid*). IFPMs are used by the EA in developing/implementing flood warning/defence strategies, flood risk education and emergency management/planning (*ibid*). More detail flood maps are available for some specific locations; these can be utilised by developers for planning purposes (*ibid*). Brown and Damery (2002) provide a detailed account of the limitations of utilising IFPMs. These limitations include, the areas and types of hazard covered, level/consistency/reliability of information presented, and the way in which uncertainties are incorporated in the mapping process (Brown and Damery, 2002). IFPMs have been available and updated annually on the EA website since December 2000 (*ibid*). Brown and Damery (2002) recognised the need for improvements to IFPMs; this improvement to detail and accuracy of maps (prioritising main rivers) was underway in 2002. EA recognition of the need to progress from out-dated opinions and embrace local (lay) knowledge within flood mapping resulted in adapted mapping from 2004; this incorporate data on historical accounts and local knowledge, but continue to fail in accounting for the impact of surface water or groundwater flooding (Brown and Damery, 2002; Evans *et al*., 2008).

7.2: The transition from Planning Policy Guidance Note 25 (PPG25) to Planning Policy Statement 25 (PPS25)

Flood maps provide an essential tool within the floodplain planning process (Brown and Damery, 2002). Management of floodplain development was governed by the *Planning Policy Guidance Note 25* (2001) (*Planning Policy Statement 25*); this outlined the responsibilities of developers in addressing potential flood risks of proposed developments (Brown and Damery, 2002; Defra, 2005; Treby *et al*., 2006; Johnson and Priest, 2008). In Defra's 2005 publication, *Making Space for Water*, PPG25 was replaced by the *Planning Policy Statement 25* (PPS25) (*Planning Policy Statement* 25; Defra, 2005). PPS25 was to improve upon the operational effectiveness of reducing flood risk in developments, as initially developed through PPG25 (Defra, 2005; Johnson and Priest, 2008). The PPS25 outlines the requirement for a national consistency in planning processes and decision-making; where a framework recognises the requirement for procedural equality between residents and developers (Johnson *et al*., 2007(b)). The PPS25 also recognises the need for a more holistic overview of the interactions between flooding and properties, encompassing assessment of the impacts of various types of flooding (including surface

water), assessment of various types of flood-resistant building materials and the potential for sustainable drainage systems (Johnson *et al*., 2007(b); Johnson and Priest, 2008). The PPS25 considers property use as a determinant of vulnerability to flooding, properties that are either less vulnerable (shops/offices) and more vulnerable (children's and elderly care homes) can be appropriately considered in the planning stages (Johnson *et al*., 2007(b)). The PPS25 devolves much responsibility of floodplain development to the local level, whilst increasing the power to reject new developments which fail to meet the aims of flood mitigation (Johnson and Priest, 2008). The PPS25 is practical in that it tightens existing regulations on the development of properties on low-lying floodplain environments in an attempt to lower social vulnerability, whilst accepting that some development is still needed to maintain social and economic agendas (Johnson *et al*., 2007(b)).

7.3: Flood warnings and risk communication

Kellens *et al*. (2013) broadly review the concept of risk communication. Using the work of Covello *et al*. (1986) and Trettin and Musham (2008), this paper outlines risk communication as the purposeful exchange of information regarding health/environmental risks between individuals, groups or organisations; thus stimulating interest/knowledge and influencing attitudes/behavioural change (Kellens *et al*., 2013). Since 1996 the EA have been responsible for the communication of flood warnings (Johnson *et al*., 2007(b)). The flood warning system underwent significant alterations following poor performance of the EA during the 1998 floods (*ibid*). The *Bye Report* (1998) provided an independent review and recommendations to altering the flood warning system (Johnson *et al*., 2005). These alterations included new incident management procedures, development of a national warning system (along with new/graphic warning codes), and replacement of the automated flood warning voice mail service with opt-in flood warnings, as well as development of a 24-hour FLOODLINE advise service (Johnson *et al*., 2005; Johnson *et al*., 2007(b)). The EA national approach to flood warning dissemination helped to fulfil the *EA customer charter* (2002), which stated that 'Prior warning will be provided (two hours in general) to people living in designated flood risk areas where a flood forecasting facility exists and where lead times enable us to do so' (Johnson *et al*., 2007(b)). Between 2006 and 2009 the EA corporate plan emphasised the use of flood maps and campaigns in enhancing uptake of flood warnings amongst those at risk of flooding (*ibid*). This approach promoted a minimum national standard of flood information regardless of risk; however there is targeted information to those in flood risk areas (*ibid*). The opt-in nature of the FLOODLINE warning system failed to promote increased awareness with only 41% subscription amongst eligible population in England and Wales by 2007 (Rose *et al*., 2009). During the 2007 floods only 27% of those signed-up to the FLOODLINE warning system actually responded to the call (Evans *et al*., 2008). The 2007 flooding appeared to have no affect on the uptake of the FLOODLINE warning service (Bichard and Kazmierczak, 2012). The EA solution to the ineffectiveness of FLOODLINE in communication was to revise the system to an opt-out default; consequently this vastly increased the coverage of the system, with only 2% opting-out (Rose *et al*., 2009). Although the current approach to flood warning is viewed as promoting social inequality through blanket coverage of information across a flood risk population without consideration of targeting the socially vulnerable (Johnson *et al*., 2007(b)); it is evident that the EA are investing significant effort in attempts to increase flood awareness within a FRM framework. In this respect the EA continued expansion of modes of

warnings to incorporate text messages and emails (Tunstall *et al*., 2006). The systematic structure to risk communication with the FRM framework is extensively reviewed by Faulker *et al*. (2011).

7.4: Dissemination of flood warnings

Flood warning timing, delivery and message content have all been suggested as important factors in determining response (Harvett *et al*., 2011; Tapsell, 2011). The medium and mode of flood risk communication has been identified and investigated by the EA as a significant factor in encouraging increased awareness (Johnson *et al*., 2007(b); Soane *et al*., 2010). The medium can be related to targeting information towards appropriate demographically-related media sources e.g. whereas many relate to television, the old/less educated might prefer direct authority contact and the young may prefer the internet (Johnson *et al*., 2007(b); Soane *et al*., 2010). The mode of communication is important with conveying information relating to temporal variations in frequency and probability of flood risk (*ibid*).

Research has suggested that content of information is important to acceptance of flood warnings; thus information deemed personally irrelevant is likely to be rejected (Harvett *et al*., 2011). The EA have researched the possibilities of targeting flood warning information within specific areas and socio-demographic groups (Johnson *et al*., 2007(b)). Soane *et al*. (2010) recognise the importance of targeting flood risk information; since information tends to affect individuals with existing pro-active attitudes. The EA have acknowledged that effectively targeted information dissemination remains difficult due to complex/dynamic nature of vulnerability, as well as the affects of individual, societal and organisational perceptions (Johnson *et al*., 2007(b); Lumbroso *et al*. (2009) *there in* Soane *et al*., 2010). It has been suggested as unlikely that flood warnings would remain value-free, objective and untainted, due to the specific influence of risk perception (Parker *et al*., 2009). Twigger-Ross *et al*. (2009) outline how the EA could incorporate local, regional and national-scale understanding of the influence of risk perception within campaigns designed to normalise preparedness for flooding. Understanding individual response to flood warnings has long been considered important in the targeted dissemination of flood warnings (Goulter, 1987). Some authors consider that inequality is still promoted through flood warnings, since such warnings remain generalised and not targeted amongst the vulnerable in society (Johnson *et al*., 2007(b)).

It has been hoped that increased education will result in improved flood awareness and associated behavioural changes (Parker *et al*., 2009). It is understood that the public do not respond well to top-down information transfer and the pre-established information deficit approach has received sociological criticism for representing an unrealistic view of social vulnerability (Brown and Damery, 2002; Burningham *et al*., 2008); Harvett *et al*., 2011). There are significant barriers preventing/influencing the effective translation of flood communications/warnings into effective response. Awareness of flooding has been determined as dependent on social class, community characteristics, flood experience and temporal/spatial characteristics of residence (Burningham *et al*., 2008). Increasing the awareness of those without direct flood experience or property damage during flooding can present a challenge (*ibid*). Fielding *et al*. (2007) note that flood experience is important to increased awareness and understanding of flood warning codes. Various levels of flood warnings appear

to be influential to different aspects of the population (Fielding *et al*., 2007). Only 6% of the population would not respond to severe flood warnings; subsequently it is considered important to understand targeting information towards this group (*ibid*).

The amount of the population that receive flood warnings is not necessarily indicative of individual flood awareness. There appear to be discrepancies in various author's estimations of the number of individuals either aware or unaware of flood risk (Burningham *et al*., 2008); Rose *et al*., 2009; Harries and Penning-Rowsell, 2011; Harries, 2013). This point is exemplified by Burningham *et al*. (2008) where one report indicating 80% awareness conflicts with another indicating 40% unawareness. Bichard and Kazmierczak (2012) indicate that EA free flood maps and FLOODLINE Warning Direct service covered 61% of properties at risk of flooding between 2007 and 2008, with the hope of increasing coverage to 80% by 2013.

The effectiveness of flood warnings can be related to trust in the source of the disseminated information e.g. public trust in authorities (Brown and Damery, 2002; Soane *et al*., 2010). There is evidence to suggest that unofficial (informal) local communication networks can be relied upon more than the official flood warnings (Harvett *et al*., 2011). Unofficial information dissemination networks (information from relatives, friends and neighbours) are suggested to fulfil the demands that are not met under the official flood warning system (Parker and Handmer, 1998). These systems allow for the communication of locally applicable information (flood observations/measurements/environmental indicators), combined with a sense of local vigilance, which can be beneficial where risk perception may be generally low (Parker and Handmer, 1998; Parker *et al*., 2009). These unofficial information networks can be more beneficial than official sources in addressing local and intangible losses as a result of flooding (Parker and Handmer, 1998). Although unofficial warnings can promote individual response through reaffirming official warning messages, such systems can have negative influences through discrimination, exclusion, and the distortion of official messages, resulting in heightened anxiety amongst the population (Parker and Handmer, 1998). The roles of official and unofficial warning systems are extensively reviewed in Parker and Handmer (1998) and Parker *et al*. (2009).

There are some indications that flood information in conjunction with flood experience is having a positive effect on behavioural change. Pitt (2008) notes that more than 20,000 people visited the EA webpage on 'Simple ways to protect your home from flooding' in May 2008 (following the summer 2007 floods), in comparison with only 7,500 visits the previous year. In addition, during May 2008, 11,000 people visited the EA webpage on creating emergency flood plans, in comparison with only 1,500 visits between January and May 2007 (Pitt, 2008). The EA now recognise that working with input from local flood prone communities improves the response to official flood-risk information and subsequently enhances individual-level flood protection (Burningham *et al*., 2008; Parker *et al*., 2008 *there in* Soane *et al*., 2010).

8. Risk perception, vulnerability and resilience

Societal attitudes towards flooding are represented through complex and interrelated concepts (Tapsell, 2011). Messner and Meyer (2006) recognise the importance of understanding the interrelations between these concepts. This section provides a literary overview of various concepts within societal interactions with flooding; including risk perception, vulnerability and resilience. Each of the aforementioned concepts will be addressed individually, despite recognising the inherent interconnectivity of these concepts.

8.1: Risk perception

The concept that past experience of flooding events has the potential to influence individual perception of future flooding was postulated in Gilbert White's 1945 thesis entitled 'Human Adjustments to Floods in the United States' (Kellens *et al*., 2013). Following this work the emergent applications of surveys and psychological analysis began to define individual perception of risk (*ibid*). Samuels (2013) defines risk as being entirely human as a concept. Risk is subsequently a manifestation of individually and subjectively determined risk perception (Treby *et al*., 2006; Tunstall *et al*., 2006). Risk perception has been considered to be a more complex issue than the physical nature of flooding (Goulter, 1987). The subjective nature of risk perception and how that perception translates into action can result in various outcomes from individuals experiencing the same event (Messner and Meyer, 2006; Tunstall *et al*., 2006). Risk perception has been considered to depend on a number of factors including flood memories, knowledge (including traditional knowledge and wisdom), personal experience, education, awareness, expectations of management authorities, interpretations of the threat (certainty/severity/immediacy), as well as various psychological and cultural factors, beliefs and values (Parker and Handmer, 1998; Messner and Meyer, 2006; Treby *et al*., 2006; Harvett *et al*., 2011; IPCC, 2012). Risk perception also appears to relate to certain socio-demographic characteristics, with research indicating lower levels of risk perception amongst poorer, younger and more elderly populations (Fielding, 2012). It has been noted that risk perception is not a static concept, since there is a temporal and spatial variability to the influencing characteristics; especially surrounding flood events (Treby *et al*., 2006).

Individual perception of risk can result in action to mitigate risk (Fielding *et al*., 2007). The traditional approach that the authorities adopted towards the dissemination of flood risk information is now referred to as the information-deficit approach (Parker and Handmer, 1998; Brown and Damery, 2002; Treby *et al*., 2006). The authorities considered that lack of information and public understanding provided explanations for the failed translation of risk information into behavioural response; subsequently concluding that the solution was the supply of more information (Brown and Damery, 2002; Treby *et al*., 2006). There is little evidence to support the assumption of a linear relationship between increased dissemination of risk information, increased risk perception and associated behavioural changes (Parker and Handmer, 1998; Treby *et al*., 2006). It is now considered that the way in which individual actors interpret risk information through their own perception of risk influences their response (Parker *et al*., 2009). This is known as the 'stimulus-actor-response' approach; in which the actor (individual) is the barrier which results in risk information translating into various and unexpected outcomes (Treby *et al*., 2006; Parker *et al*., 2009; Fielding, 2012). Various authors, including Kates

(1971), Parker and Harding (1979) and Burton *et al*. (1993) have noted that the individual determinant of risk perception transitioning to mitigating action is based on perception thresholds (Goulter, 1987; Harvett *et al*., 2011). These perception thresholds represent an individually specific point, below which stimuli will have no influence on mitigating action; these thresholds are determined by individual perception, personality, flood experience, and gambling tendencies (*ibid*).

Flood experience appears to be considered a significant factor in the translation of risk perception (Soane *et al*., 2010) and subsequent translation of perception into mitigating action. It is considered that direct experience of flooding is likely to promote greater acceptance of flood risk (Whitmarsh, 2008). Psychologically, the direct impact of flooding is likely to promote persistently strong attitudes towards behavioural change in individuals (*ibid*). Those with direct experience of flooding are likely to have more information, awareness of flood warnings/systems, greater understanding of flood impacts and recognise the efficacious advantages to mitigation (Messner and Meyer, 2006; Parker *et al*., 2009; Harvett *et al*., 2011). Harvett *et al*. (2011) suggest that it remains unlikely that individual risk perceptions can be altered in the absence of direct flood experience.

Flood memories are an important feature in influencing risk perception. Local knowledge, through oral accounts of flooding, understanding flood reference points (e.g. flood marks on local infrastructure) and understanding community capabilities in flooding are all important to perception (Parker and Handmer, 1998; McEwen *et al*., 2012). It has been noted that due to the infrequent nature of extreme flooding events, it is possible that individuals never experience these events or experience one or two floods in their lifetime (Parker *et al*., 2009). Amongst the minority of the population which can recall experiences of past flooding events it has been suggested that memories fade with time (Harvett *et al*., 2011). Goulter *et al*. (1987) outlines that individuals tend to have selective memories in relation to flooding events. Flooding memories have been considered to have negative impacts under certain circumstances, where perception governed by past experience can lead to underestimation of extreme rare flooding events (Fielding, 2012). It has also been considered that increased population mobility (transient populations) brought about through modernisation has resulted in the degradation of flood memories (Parker and Handmer, 1998).

Indirect experience of flooding (e.g. through media sources) is deemed as less likely to impact on risk perception than direct experience (Whitmarsh, 2008; Harvett *et al*., 2011). There are several reasons why risk perception is tainted through indirect exposure. Firstly, the media focus on flooding when the event is prominent; however absence of media coverage permits the unaffected individual to forget about the event (Harvett *et al*., 2011). Secondly, individual lack of flood experience is less likely to produce a response, since available information through media and imaged images promote unreliable risk perception; whereby the individual understands the physical impact of flooding, but not the emotional consequences (Parker *et al*., 2009; Harvett *et al*., 2011). Finally, incomplete understanding of flooding can simply result in denial (Harvett *et al*., 2011).

Fielding (2012) outlines the possibility for future investigation of whether dynamic turnover of population and frequency of exposure to flood risk could be connected with lower risk perception in relation to flooding.

8.2: Vulnerability

Vulnerability can mean a number of things (Fielding and Burningham, 2005). The integration of vulnerability into the conceptual framework of societal interactions with flooding is well summarised in Treby *et al*. (2006). The aforementioned paper considers that risk can be defined through a combination of the nature of flooding, exposure to flooding, and vulnerability (Treby *et al*., 2006). The IPCC (2012) define exposure as "The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected". Building upon the aforementioned concept, vulnerability can be defined as "The propensity or pre-disposition to be adversely affected" (IPCC, 2012). These definitions are generally synonymous with Fielding and Burningham's (2005) account of vulnerability as "the impact of exposure to hazard resulting in loss of life and property". The IPCC (2012) conclude that exposure and vulnerability are crucial to understanding risk; this validates the conceptual model of risk in Treby *et al*. (2006), which clearly demonstrates the inextricable interconnectivity of exposure and vulnerability. Vulnerability is influenced by a number of socio-demographic/socio-economic factors including age (young/old), pre-existing health, disabilities, poverty, gender, ethnicity, wealth, education, family structuring, social class, position within social networks (e.g. physical and emotional support networks) and other factors (Brown and Damery, 2002; Fielding and Burningham, 2005; Messner and Meyer, 2006; Rose *et al*., 2009; Fielding, 2012; IPCC, 2012; Walker *et al*., 2012). Research has demonstrated that vulnerability is quite dynamic, for example, in a study by Walker *et al*. (2012) it was discovered that vulnerability through post-flood financial concerns of a mother were manifesting as anxiety vulnerabilities in her children. Understanding flood vulnerability requires an amalgamated understanding of both physical (e.g. flood frequency, river proximity and inundation) and social (preparedness, coping capacity and resilience) characteristics (Messner and Meyer, 2006). Messner and Meyer (2006) outline vulnerability as the factors which impact upon individual/community ability to cope during flooding.

Vulnerability is not a static feature (IPCC, 2012; Walker *et al*., 2012). In a study by Walker *et al* (2012) there is the suggestion that events that occur either pre- or post-flooding (such as redundancy or poor-health) have the potential to alter an individuals' vulnerability. The dynamicity of vulnerability (and exposure) is considered to vary both spatially and temporally, based on a multitude of economic, social, cultural, governmental, institutional, environmental and geographical demographic factors (IPCC, 2012).

Vulnerability can be studied in several ways, which are applicable to flooding. Etic vulnerability studies assign vulnerability to social groups, based on location and socio-demographic characteristics; this approach is flawed, since it inaccurately assumes homogeneity within objectively stereotyped groups, subsequently potentially negating those that require post-flood assistance (Fielding and Burningham, 2005; Fielding, 2012; IPCC, 2012). The alternative Emic vulnerability approach subjectively assesses individual/community experiences and subsequently identifies that limited understanding of risk and vulnerability could provide contributing factors towards non-mitigation (Fielding, 2012). In a similar respect to the concept of etic and emic vulnerability, Brown and Damery (2002) also recognise the redundancy in a traditional technical approach, in which vulnerability is considered easily identifiable and objectively defined. Under the 'vulnerability paradigm' the role of individuals/communities is considered important in understanding how vulnerability is defined through resistance and resilience

(*ibid*). It is considered that assessment of vulnerability should combine both traditional (objective) and 'vulnerability paradigm' viewpoints, since alone these generate under- and over-socialised perspectives of vulnerability respectively (*ibid*).

Flood vulnerability has generally increased as a result of population growth, social expansion (including urbanisation) and increased amount of capital stock at risk of flooding (economic losses) (Harvett *et al*., 2011; Walker *et al*., 2012; Kellens *et al*., 2013). Much of the contemporary uncertainty in estimating future flood risk can be associated with the dynamic nature of social vulnerability (Morss *et al*., 2005). Risk is not a static feature and social vulnerability is expected to increase in the future (Fielding and Burningham, 2005; Evans *et al*., 2006). This vulnerability increase can in part be attributed to increasing demand for new housing; the Council of Mortgage Lenders (2002) noted an 11% increase in flood risk properties solely between 1997 and 2000 (Brown and Damery, 2002; Fielding and Burningham, 2005).

The current system of flood warnings fails to target vulnerability reduction amongst the most vulnerable groups and this system is likely to actually perpetuate vulnerability (Johnson *et al*., 2007(b); Twigger-Ross *et al*., 2009). Improvements to such warnings requires greater understanding of vulnerability (*ibid*). In addition, despite the mandatory nature of floodplain hazard mapping ('Declared Policy and Practice for the Protection of Floodplains', 1997), it has been recognised that there could also be benefit in understanding social vulnerability (Brown and Damery, 2002). Treby *et al*. (2006) recognise that flood policy should move away from loss reduction and focus on minimalizing vulnerability; this transition remains difficult, since research has indicated that single flood events normally encourage attitudes focused on reducing probability rather than vulnerability (Harries and Penning-Rowsell, 2011). It is considered that vulnerability could be reduced through a combination of resistant and resilient measures (Brown and Damery, 2002; Hildén *et al*., 2012).

8.3: Resilience

It is important to acknowledge that there are various definitions of resilience (Cashman, 2011). Beginning with Holling's (1973) premise, that ecological resilience defines "the amount of disturbance an ecosystem could withstand without changing its self-organising processes and structures", many authors have attempted to socially contextualise resilience (Cashman, 2011). Cashman (2011) provides an overview of significant author contributions towards defining social resilience. This text will adopt Few's (2008) definition, where resilience is defined as "The ability to prevent, withstand and recover from impacts (of extreme weather hazards)" (*there in* Rose *et al*., 2009). This view of resilience as the ability of individuals/communities to recover following an event is generally synonymous with definitions of resilience within Manojlovic and Pasche (2008), Pitt (2008), Cashman (2011) and the IPCC (2012) report. Resilience is not a static feature; Walker *et al*. (2012) recognises that although pre-existing resilience can manifest following flooding, such events can also create new resilience amongst individuals. Green (2010) contests the definition of resilience, since resilience implies the capacity to return to an original state. It has been questioned whether, following an event, it is possible to return to the original state or instead an altered state is created (Green, 2010).

Resilience represents a crucial element in societal interactions with flooding. The 'adaptive capacity' of a population refers to the practical, social and psychological adjustments that are required in order to enhance resilience (Rose *et al*., 2009). Practical resilience is closely related to practical resistance. It has been determined that resilience and resistance contribute towards determining vulnerability; whereby enhanced resilience promotes more effective long-term recovery and subsequently lower vulnerability (Brown and Damery, 2002). There are various cost-effective physical flood resistant and resilient measures which can be robustly and flexibly combined to reduce vulnerability (Hildén *et al*., 2012). Physical resistance measures are designed to prevent flood incursion into properties through permanent or temporary blockages of water ingress points; such measures include air bricks, flood gates, toilet non-return valves and sandbags (Manojlovic and Pasche, 2008; Pitt, 2008; Rose *et al*., 2009; Soane *et al*., 2010; Bichard and Kazmierczak, 2012). Physically resilient measures within properties are designed to minimise the damage caused by the ingress of water and subsequently reduce recovery times; such measures include removing carpets and exposing floor boards, the replacement of furnishings with waterproof alternatives and the re-location of electric fixtures above heights expected during flood incursions (Johnson *et al*., 2007(b); Manojlovic and Pasche, 2008; Rose *et al*., 2009; Bichard and Kazmierczak, 2012). Some of these resilient adaptation measures are cheap (e.g. air bricks and movement of electrical fixtures), whilst others present more expensive options (e.g. modifying flooring and floodgates) (Johnson *et al*., 2007(b)). Essentially, whereas resistant measures reduce the degree of risk at the time of the hazard, resilient measures enhance ability to cope with hazards (Brown and Damery, 2002). The establishment of property-level measures is considered to improve resistance and resilience to flooding (Bichard and Kazmierczak, 2012). Both Pitt (2008) and McEwen *et al*. (2012) recognise the importance of resilience from a societal perspective. It is the consideration of the aforementioned authors that community knowledge through individuals, memories, heritage and business is important in enhancing both individual and community levels of resilience. Community-level resilience has been considered to be beneficial within specific areas (e.g. village or housing-estate), where implementation of national organisation objectives can be assisted by voluntary groups with local understanding in case of emergencies (Pitt, 2008). Such voluntary groups are important since they fulfil community involvement in the FRM framework (Pitt, 2008). Children's experiences and perspectives of flooding can differ from those in adults; this is important, since children have the capacity to define the future of resilience (Walker *et al*., 2010; Walker *et al*., 2012). Ultimately, Pitt (2008) outlines the importance of continued promotion of resilience in stating "Strengthening resilience is essential since, even with stable climatic conditions the need for effective flood mitigation measures will not diminish (Pitt, 2008).

9. Barriers to implementing non-structural approaches in Flood Risk Management

Making Space for Water (Defra, 2005) clearly outlined intensions that the future of Flood Risk Management should be based on enhancing personal resilience through non-structural measures. Despite this, figures suggest that only 6-10% of households in the UK have adopted non-structural measures (Harries, 2009(b); Rose *et al*., 2009; Harries and Penning-Rowsell, 2011; Harries, 2013). There appear to be a number of individual and institutional factors which explain the low uptake of non-structural measures to date; these are referred to as barriers. This section will provide an overview of various barriers.

9.1: Ontological security

Ontological security has been recognised as a significant barrier to positive behavioural changes amongst individuals (Soane *et al*., 2010; Harvett *et al*., 2011). Ontological security refers to an individualistic sense of existence and identity (Harries, 2013). This principle can manifest in the home environment; which Harries (2013) considers psychologically associated with positive feelings and normality. This sense of security is perpetuated through conceptualisations of society as the guarantor of home security, as well as nature as benign (Harries, 2013). Harries (2008) uses the term 'phenomenological territory' to describe the psychological state of denial that individuals enter when their sense of ontological security becomes threatened (Harvett *et al*., 2011). The manifestation of denial or disbelief represents a fundamental human anxiety avoidance response to threats which undermine emotional attachments to property (Treby *et al*., 2006; Burningham *et al*., 2008; Tapsell, 2011). Ontological security also manifests as a barrier following flooding events. Sims *et al*. (2008) and Rose *et al*. (2009) note that individual desires to reinstate a sense of ontological security through reinstatement of post-flood properties to pre-flood conditions, perpetuates the barrier through neglecting an opportunity to undertake adaptations which would enhance future resilience.

9.2: Public opinions and attitudes

Public attitudes towards their responsibilities represent important barriers to adopting individual and community resilience within the FRM framework. Crucially, it has been recognised by several authors that the media and public still favour hard (structural) defence (Johnson and Priest, 2008; Sims *et al*., 2008; Bichard and Kazmierczak, 2012). Public opinion has become recognised as a barrier to reducing the emphasis on structural approach (Harries and Penning-Rowsell, 2011). It has been observed that risk denial represents a large emotional barrier to change (Bichard and Kazmierczak, 2012). In addition to denial, there is also evidence to support the assertion that some individuals are unconcerned about flooding (Burningham *et al*., 2008). Various authors have suggested numerous explanations for individual risk denial. It has been suggested that some individuals deny risk due to a generally optimistic attitude that flooding will not affect them; such an attitude could be based on past experience, which could result in underestimating the impact of rare/extreme flooding (Burningham *et al*., 2008; Harvett *et al*., 2011; Fielding, 2012). Denial in some individuals is exacerbated due to the limitations of indirect experience through media sources (Harvett *et al*., 2011). Individuals can be discouraged from adopting personal mitigation if (potentially resulting from past experience) they consider their actions to be

ineffective; thus resulting in continued favouring of structural options (Soane *et al*., 2010; Harvett *et al*., 2011). In addition individuals can justify their inaction over flood risk through comparing their vulnerability with those in more vulnerable settings (Harvett *et al*., 2011). A culmination of the aforementioned attitudes towards individual risk denial; resulting in barriers to pro-active resilient mitigation are epitomised within the title of Burningham *et al.'s* 2008 work; 'It'll never happen to me'. In addition to simple denial, there is also evidence of several other personal factors that present barriers to adopting resilience. Firstly, it has been suggested that individuals resent being categorised as either at risk or vulnerable and this could result in the dismissal of flooding as an issue (Burningham *et al*., 2008). Secondly, it has been suggested that some people face barriers to change, where they are aware of the risk, but are embarrassed by their limited understanding of how to translate that information into mitigation; subsequently resulting in inaction (*ibid*).

People require understanding in order to cope with the effects of flooding; such understanding is most likely to be present amongst the young, high earning and well educated population (Treby *et al*., 2006; Soane *et al*., 2010). This demographic category are subsequently considered the most likely to be able to both perceive risks and adopt mitigating action (Soane *et al*., 2010). Self-belief (in coping with flooding), self-efficacy and moral duty have all been identified as important features in overcoming personal barriers and the promotion of mitigation in the form of resilience (Rose *et al*., 2009; Soane *et al*., 2010; Fielding, 2012). There is evidence that increased flood experience is more likely to promote mitigation (Harries and Penning-Rowsell, 2011; Tapsell, 2011; Harries 2013). Harries (2013) discovered that those affected by 1-2 flood experiences were 3.92 times as likely to adopt flood mitigation measures than those unaffected. It has also been documented that between 1 and 4+ flooding experiences, there is an increased uptake of flood reduction measures between 76% and 96% (Parker *et al*., 2007 *there in* Parker *et al*., 2009). The repeated exposure to flood events is considered to reduce an individual's capacity to maintain pre-existing psychological barriers which promote anxiety reduction (Harries, 2013). This effect is clearly manifested in data, where the number of individuals fearing thoughts of flooding reduced 70-22% between exposure to one and two flood events (*ibid*). Harries (2013) theorises that individuals must either cope with the impacts of flooding or accept continuing existence in a state of anxiety.

The way in which individuals conform to social groups can provide barriers to mitigation (Harries, 2013). Individuals tend to form social groups; these are collections of individuals who share common beliefs and behaviours which govern their thoughts, feelings and actions (Harries, 2013). One core element of social groups is conformity, subsequently resulting in the rejection of non-conforming factors (Harries and Penning-Rowsell, 2011; Harries, 2013). This social conformity can bar individuals from adopting mitigating action towards resilience, though fear that non-conformity will result in disassociation from an accustomed social setting (Harries, 2013).

Ajzen and Fishbein's Theory of Reasoned Action (1980) outlines a series of questions/factors which determine individual response to a specific issue; this is determined by the following series of questions: Do I understand the problem? Do I care about the problem? Do I know what to do about the problem? Will my solution work/make a difference? What will others think if I act? (Bichard and Kazmierczak, 2012).

9.3: Expectations and blame

Expectation of others represents a significant barrier to personal mitigation through resilient measures. Bichard and Kazmierczak (2012) discovered a distinctive lack in pro-active attitudes, with only 30% of respondents in a survey willing to consider personal action towards mitigation. In the aforementioned survey it became apparent that the inaction of individuals resulted from their opinion that the government should be responsible for flooding (Bichard and Kazmierczak, 2012). In addition it has been suggested that residents either consider local authorities, companies and organisations as responsible for managing flooding or remain uncertain who is responsible for flood management (Pitt, 2008; Sims *et al*., 2008). This expectation in authorities is exemplified in Brown and Damery (2002), where it was discovered that public generate unrealistic expectations of the roles of authorities in flood risk, which are perpetuated by the media and result in public mistrust and inactive mitigation. In the aforementioned example, there is evidence to suggest a prevailing and yet infeasible opinion amongst the public that the EA should be responsible for the protection of all floodplains regardless of the cost (*ibid*). Blame represents another means by which the public are able to deny risk and subsequently fail to recognise personal responsibility for mitigation against flooding. Sims *et al*. (2008) recognise that infrequent flooding is less likely to result in mitigating behaviour rather than assigning blame towards authorities and natural features. Harries (2013) provides a detailed account of social groups assign blame over the negative consequences of events to external groups (e.g. the EA); subsequently reinforcing the positive ideals of their group. This concept of assigning blame to others is counter-productive in accepting individual responsibility required for mitigation (Harries, 2013). Trust is significant in relation to assigning blame.

9.4: Social inequality and injustice

The promotion of a non-structural resilient approach within FRM is complicated by various barriers relating to social inequalities. Harries and Penning-Rowsell (2011) outline that a non-structural approach to FRM cannot work unless social injustices are addressed. The integration of the concepts of equality and justice within flood management practice are reviewed in Johnson *et al*. (2007(b)). Poverty represents a core factor in social inequality. Poverty in lower social classes is likely to be associated with lower education, thus promoting a disadvantageous situation, whereby the vulnerable in society are also the least likely to understand/ interpret flood awareness information and act accordingly (Burningham *et al*., 2008); Johnson and Priest, 2008). The poor and the elderly are also discriminated against with the promotion of non-structure mitigation measures, since these groups are less likely to have internet access to easily review available mitigation options (Bichard and Kazmierczak, 2012).

Penning-Rowsell and Pardoe (2012) provide the perspective that flood management decisions can produce concurrent positive and negative effects depending on the individual; this is exemplified through a series of examples. Firstly, the distribution of taxpayer money under the current scheme results in people providing funding without benefits; however it has been acknowledged that replacement with a 'Payment for Outcomes' approach, where local communities paid for their benefits, would likely fail (*ibid*). Secondly, inequalities can be generated in circumstances where local groups have taken responsibility for the partial funding of flood defence schemes e.g. Morpeth, where £10 million of

county council funding matched available EA funding (*ibid*). In the aforementioned example, the raising of additional funding disadvantaged other communities, which could not raise such funding, since this made the Morpeth flood defence scheme higher priority than other locations (*ibid*). In addition the funding of site-specific defences may benefit local individuals, but such positive benefits diminish across greater spatial scales (*ibid*). Finally, there is a large difference between the value of agricultural land (£8500 per hectare in East Anglia (2011)) and land fit for urban planning permission (£2,371,000 per hectare, UK average); subsequently changes to land-use under flood risk management may generate inequalities for farmers (*ibid*).

There is inequality in considering flooding events to be universally negative features. Some individuals and groups within society have been suggested to benefit from the impacts of flooding (Penning-Rowsell and Pardoe, 2012). Positive features of flooding include, extra funding for the emergency services, employment for those involved with post-flood repairs to properties, benefits for those replacing damaged items, the short-term enhancement to local economies, increased business demand for goods and services and potential increases in property values (*ibid*).

9.5: Insurance

The UK insurance industry presents many barriers to the adoption of non-structural measures which would enhance resilience. Until recently the UK government had an agreement with the Association of British Insurers (ABI) known as the *Statement of Principles*; under which the ABI would guarantee the protection of all property within a 1.3% probability of flooding within a 75-year return period (Johnson *et al*., 2007(b)). In exchange for the aforementioned protection, the government were committed to continued provision of structural defence of insured properties; subsequently undermining promotion of resilience through non-structural defence (Treby *et al*., 2006; Harries and Penning-Rowsell, 2011). Non-structural approaches could not be integrated into this agreement, since the effectiveness of non-structural approaches cannot be effectively compared using cost-benefit analysis and subsequently cannot be quantified/statistically determined to meet the requirements of the agreement (Harries and Penning-Rowsell, 2011). Insurance also promotes social inequality. In 2009 the ABI calculated that 93% of property owning population had property insurance and 75%+ had contents cover (Penning-Rowsell and Pardoe, 2012). Flood insurance can often represent a part of an overall insurance package, where premiums may be unrelated to flood risk (Treby *et al*., 2006; Penning-Rowsell and Pardoe, 2012). The result of this inequality is that 21.7 million households that pay for insurance (estimated at an average of £28 per household flood insurance) gain nothing from supporting the 2.4 million households at risk of flooding (Penning-Rowsell and Pardoe, 2012).

A number of authors have recognised the social inequalities which exist within flood insurance. Flood insurance is affordable to the wealthy and detrimental to the poor (Green, 2010; Bichard and Kazmierczak, 2012; Fielding, 2012). The poor and vulnerable populations are the most impacted by the effects of flooding and the least likely to be able to afford insurance; thus exacerbating the effects of flooding (Johnson *et al*., 2007(b); Fielding, 2012; Bichard and Kazmierczak, 2012).

The principles of insurance present a barrier to the adoption of non-structural approaches. Insurance acts as a risk transfer from the individual, thus buffering against risk without actually addressing reductions in vulnerability or exposure to flooding events; subsequently perpetuating risk (Treby *et al*., 2006; Rose *et al*., 2009). Individuals fail to assume responsibility over property-level protection, since the insurance industry instigates a barrier through providing protection (Johnson *et al*., 2008; Bichard and Kazmierczak, 2012).

Within insurance considerations, there is psychological evidence to suggest that individuals avoid the concept of flooding and reject understanding of advancements in flood mapping techniques due to concerns over potential impacts on lowering property value, increasing insurance premiums or even being denied insurance (Burningham *et al*., 2008); Fielding, 2012). There is some evidence to suggest that individuals would be willing to adopt resilient and resistant measures, if there were associated insurance benefits e.g. reduction in insurance premiums (Sims *et al*., 2008). There is also emerging evidence that some insurance companies may be positively reducing barriers, through considerations of economically benefitting customers that adopt a pro-active stance towards flood adaptations (Harries, 2013). Insurance companies in the UK are in the unique position to be able to promote positive changes towards advocating non-structural adaptation under FRM, although it remains unlikely that such organisations would commit to changing policy (Lamond and Proverbs, 2008).

The UK flood insurance industry gains £1 billion per annum from household insurance (Penning-Rowsell and Pardoe, 2012). The insurance companies are businesses, with the purpose of financially benefitting their shareholders (Johnson *et al*., 2007(b)). It is unlikely that such companies would stop lobbying for approaches that continue to maximise profitability (Johnson and Priest, 2008). In their paper of 2012, Penning-Rowsell and Pardoe considered it unlikely that the end of the *Statement of Principles* in 2013 would actually address issues with the insurance system due to political objections; this assertion would be proven correct. On the 27th June 2013 the ABI announced a *Memorandum of Understanding* with the government (affective 1st July 2013) in which insurance cover would be provided to properties with 0.5% chance of flooding in a 200-year return period; this new agreement ends in 2015 (*Memorandum of Understanding*). Insurance is likely to be the worst affected financial service from the effects of climate change; the ensuing decline in flood insurance provision is likely to benefit the transition to non-structural mitigation (Treby *et al*., 2006; Bichard and Kazmierczak, 2012).

9.6: Economic barriers

Money represents a significant barrier in adoption of a non-structural approach within FRM (Soane *et al*., 2010). The poorer in society are suggested to have fewer resources to rebuild or recover assets following flooding and subsequently become disproportionately physically and psychologically susceptible to the short- and long-term adverse effects of flooding (Fielding and Burningham, 2005). Personal culpability and responsibility places property owners in the position of supporting the transition to non-structural approach through property-level adaptation; although such changes may be rejected over concerns that the appearance of defences could de-value their property (Harvett *et al*., 2011). A survey demonstrated that 24% of property owners consider the permanent non-structural defences to discourage potential property buyers and resulted in property de-valuation (Harries, 2013).

The cost of commercial non-structural flood adaptations can vary between £2900 and £4000, depending on the type of defence (Harries, 2013). Although 57% of people deem the cost of these adaptation measures expensive, no significant relationship was discovered between cost and uptake (*ibid*). Part of the problem with low uptake of non-structural defence is considered to relate to the limited amount of information available to both the public and tradesmen regarding non-structural defences (Sims *et al*., 2008). In 2003, the EA endorsed the Kitemark system (*British Standards Agency* with *HR Wallingford test facility*); this provides a standard for non-structural flood defence products; an idea endorsed by *British mortgage lenders* (Johnson *et al*., 2007(b)). Since the EA cannot directly endorse or offer advice on selecting private flood defence products, individuals can fail to protect property if they doubt their ability to select the correct adaptive measure(s) (Bichard and Kazmierczak, 2012; Harries, 2009(a); Harries, 2013). Individuals can consider the adoption of incorrect measures as potentially heightening negative emotions, with 27% of respondents in a survey considering their incorrect choice of non-structural defence measure would produce feelings of foolishness (Harries, 2013). This barrier could potentially be countered by the emergence of independent expert homeowner advice on adopting non-structural measures (*ibid*).

9.7: Non-structural approach to Flood Risk Management

The non-structural approach to flood risk management has been limited through a lack of promotion (Harries and Penning-Rowsell, 2011). The implementation of non-structural approaches is limited, since these cannot be accounted for by the government's cost-benefit appraisal system (*ibid*). This cost-benefit appraisal system cannot account for the effects of flooding which are intangible and difficult to quantify (Johnson *et al*., 2007(a)). There has been questioning of whether the current cost-benefit appraisal system works (Johnson and Priest, 2008). The current appraisal system and legislation would require alterations in order to promote non-structural resistance and resilience measures, whilst moving towards sustainability (Johnson *et al*., 2007(b)). Finance presents a significant barrier to the adoption of non-structural approaches, where there are no government grants available and usage of public finance for non-structural property-level adaptations could be controversial, especially if resulting in benefits to certain homeowners (Johnson and Priest, 2008). It is also unlikely that non-structural approaches would be adopted during times of financial crisis, since the reliability of these approaches can be unknown (Green, 2010). Ultimately, it has been determined that the direction of policy is dependent on taxpayer opinion, since they provide the finance (*ibid*). Some possible means of promoting non-structural approaches include the theoretical introduction of interest-free loans or new building regulations to incorporate non-structural defences (Bichard and Kazmierczak, 2012).

9.8: Testing the implementation of a non-structural approach in Flood Risk Management

Harries (2009(b)) provides a Defra review of a 2007 government pilot scheme (following *Making Space for Water*), designed to assess whether government financial provision would benefit the development of non-structural approaches to FRM in a local area which is susceptible to flooding (specifically a principle street in Appleby-in-Westmorland which is flooded by the River Eden). This project promoted a variety of adaptation measures (£70,000) designed to enhance resistance of homes/businesses; subsequently replacing unofficial resistant measures and accompanying more common pre-existing

resilient measures (Harries, 2009(b)). This scheme was positive in promoting community collaboration, local solidarity, community pride and generation of community acceptance that flood defence have limits in severe events (*ibid*). The scheme was also successful in developing community flood plans; local organisation, enhanced relations between authorities (e.g. EA) and locals, and reduction in the need for emergency response resources during floods (*ibid*). Finally the scheme succeeded in reducing anxiety amongst certain locals, as well as reducing damage and enhancing recovery during flooding in 2009 (Harries, 2009(b)). This scheme failed to encourage participants to completely trust protection provided by non-structural measures (*ibid*). In addition, Harries (2009(b)) indicates that the project appeared to fail in encouraging others to adopt non-structural measures, with evidence of poor local awareness of the scheme or associated behavioural change. Participants in the pilot scheme also failed to inform insurers of non-structural measures protecting property, since they did not consider insurance would alter as a result (*ibid*). Ultimately, Harries (2009(b)) considers that the benefits of local schemes could be undermined if the absence of flood events resulted in diminished local interest and neglect of non-structural measures. It is deemed important that local agencies involved in FRM can support long-term individual and community engagement (*ibid*).

10. Understanding stakeholder participation within Flood Risk Management

Stakeholder participation is an essential component in the successful application of non-structural approaches within Flood Risk Management (FRM) (Tseng *et al*., 2012). Since the 1960s, the role of stakeholders in participatory decision-making has become increasingly emphasised within various areas of research (e.g. natural resources management in the 1960s, central planning in the 1980s and sustainability in the 1990s) (Tseng *et al*., 2012). In accordance with the *EU Water Framework Directive* (2000) and *Aarhus Convention* (1998), stakeholder participation within flood management is now integrated into EU law (Coninx, 2008; Tseng *et al*., 2012; Maynard, 2013). In addition, Defra's (2005) report entitled 'Making Space for Water' clearly recognised that non-structural approaches within FRM will require increased stakeholder participation (Defra, 2005; Lane *et al*., 2011; Tseng *et al*., 2012). This section will explore literature regarding the changing role of stakeholder participation in flood management.

10.1: Old governance approach to stakeholder participation and Callon's Public Education Model

Traditional (old governance) approach to stakeholder participation in flood management has been regarded as conforming to a reactive and top-down unidirectional knowledge (information) transfer between authorities (e.g. government and scientists) and the lay public (stakeholder) (Coninx, 2008; McEwen *et al*., 2012). It has been suggested that this approach to stakeholder participation permits policy-makers to maintain legitimate power over the public (Coninx, 2008). This traditional approach corresponds to Callon's (1999) Primary Education Model (PEM) of stakeholder participation (Lane *et al*., 2011). In the aforementioned model, science is considered a universal, objective and autonomous practice, governed by procedural normality; subsequently enforcing the predominance of scientific knowledge over lay knowledge (*ibid*). Under the PEM it has been proposed that there is a linear relationship in the dissemination of scientific knowledge to the lay public; ineffectiveness within such an approach is attributed to lay public deficiencies (*ibid*). This concept can be aligned with the information-deficit model; a flawed approach which deems increased unidirectional scientist-lay public knowledge-transfer as a solution to restoring the aforementioned linear relationship (Brown and Damery, 2002; Treby *et al*., 2006; Lane *et al*., 2011). The PEM outlines that science is able to maintain a dominant position, as long as the public remain rational in their decision-making (Lane *et al*., 2011). This approach allows science to remain largely insulated from public engagement (*ibid*). Lane *et al*. (2011) identify that the public tend to support the special position of science outlined in the PEM.

It has been identified that using unidirectional knowledge transfer to persuade the public to adopt scientific opinions and strategies fails in engendering a sense of public trust (Landström *et al*., 2011). It has been indicated that public mistrust can ensue through realisation of scientific fallibility, failures of intermediary groups to maintain scientific dominance and media distortion of scientific knowledge (Lane *et al*., 2011). Due to the complexities of contemporary societal needs and government structuring it is difficult to maintain the old governance approach to stakeholder participation (Coninx, 2008). Under Modernity Theory it has been recognised that a desire for greater lay public individualisation and involvement in decision-making within policies is coincident with distrust of the predominant position of science (*ibid*). Landström *et al*. (2011) recognise that increased public participation could increase the

trust between scientists and the lay public and subsequently prevent conflicts. It has been recognised that over the last decade there has been an increased focus on stakeholder engagement with the realisation that stakeholders have the 'right for wider engagement in flood risk management decisionmaking' (Lane *et al*., 2011).

10.2: The rise of the new governance approach to stakeholder participation

The New Governance Theory within the FRM framework advocates a bottom-up approach to stakeholder participation with science and decision-making (Coninx, 2008). The approach advocates the democratic participation of the public in decision-making processes relating to relevant matters (Landström *et al*., 2011). This approach encourages the lay public to question the existing dominance of scientific knowledge and subsequently generate a re-distribution of expertise, whereby scientific knowledge is no-longer superior to local knowledge (*ibid*). Several authors recognise the importance of integrating lay (local) knowledge into scientific practice (Whatmore and Landström, 2011; McEwen *et al*., 2012). Coninx (2008) outlines how this new governance approach in FRM is not designed to disempower those with power, but rather re-structure the distribution of power to coordinate both public and private interests within the decision-making process. This restructuring is intended to create a horizontal structure to decision-making; subsequently removing the pre-existing hierarchical distribution of knowledge power (Coninx, 2008). Coninx (2008) recognises three main arguments for increasing stakeholder participation in policy decision-making. Firstly, the 'substantive argument', that stakeholder participation generates awareness of issues and informs politicians of prevailing social values (*ibid*). Secondly, the 'normative argument, that stakeholder participation increases democratic strength in policy and legitimacy of decisions (*ibid*). Finally, the 'instrumental argument', that stakeholder inclusion enhances decision-making processes (*ibid*). The features of stakeholder participation should enhance responsibility and improve decision-making, resolve conflicts, generate acceptance of policies which are representative of the values/options of those they affect, and empower citizens (Coninx, 2008; Tseng *et al*., 2012).

10.3: Callon's Public Debate Model and associated Participatory/Companion Modelling

Stakeholder participation does not necessarily correspond to the rectification of both knowledge power inequality and the predominance of scientific knowledge; this is exemplified through Callon's (1999) Public Debate Model (PDM) (Lane *et al*., 2011). The PDM promotes stakeholder participation through the opportunities for relevant parties to discuss and contribute towards scientific knowledge e.g. through focus groups, citizen juries and peer review (Coninx, 2008; Lane *et al*., 2011). The PDM permits previously unrecognised stakeholders to engage with science and contribute to widening knowledge (Lane *et al*., 2011). The PDM can be associated with Participatory Modelling (PM) and Companion Modelling (Landström *et al*., 2011). PM represents the process by which knowledge of various stakeholders becomes integrated into scientific knowledge (*ibid*). It is recognised (through a case study example) in Landström *et al*. (2011) that under a PM approach, local stakeholder participation is confined to the input (integration of local stakeholder knowledge) and output (consultation and discussion of results) of projects. Stakeholders are excluded and scientific practice remains dominant throughout the majority of the process e.g. the use of stakeholder knowledge in the quantification and

validation of data (Landström *et al*., 2011). The aforementioned approach demonstrates the perpetuation of unidirectional knowledge transfer within science-stakeholder interaction. It has been considered that the incorporation of community knowledge and views into scientific knowledge (PM approach) is merely designed to elude 'potential conflict, misunderstanding and even litigation' (Voinov and Gaddis, 2008 *there in* Landström *et al*., 2011). The PDM can also be associated with Companion Modelling; this approach provides tools, allowing stakeholders in the local community to learn about natural resource management (*ibid*). This approach further solidifies the dominant position of scientific knowledge over lay public knowledge and subsequently fails to address existing inequalities (*ibid*). It is viewed that the PDM allows science to reaffirm a trusted and superior position through using experimental replication, controls and statistics, as well as peer reviewing (Lane *et al*., 2011). Ultimately, the PDM fails to question the pre-existing attitudes towards the superiority of scientific knowledge (Landström *et al*., 2011). Although the idea of participation has been acknowledged as key to achieving democracy, procedural justice and equality; it has also been considered that such an approach simply further empowers the empowered (Tseng *et al*., 2012).

10.4: Barriers to stakeholder participation

Tseng *et al*. (2012) provides a detailed review of practical micro-political barriers which impact upon the viability of stakeholder participation in FRM. These micro-political barriers relate stakeholders, time and power inequalities (Tseng *et al*., 2012). Stakeholder participation is complicated by the closed nature of institutional culture; this results in limitations to transparent discussions, maintains unaccountability and poor communications (Lane *et al*., 2011; Tseng *et al*., 2012). Disempowerment can be generated amongst stakeholders, if the closed institutional culture limits resources (e.g. information) (Tseng *et al*., 2012). Tseng *et al*. (2012) also identify that late stakeholder engagement in decision-making generates objections and reduced sense of participation (McEwen *et al*., 2012). Alternatively, earlier stakeholder participation in decision-making is considered to generate enhanced ownership and responsibility of policies, as well as reducing conflicts that arise later within policies (Tseng *et al*., 2012). Tseng *et al*. (2012) also recognise the requirement to understand the relationships in power dynamics between stakeholders (Diversity Analysis); subsequently understanding the legitimacy of stakeholders and ensuring incorporation of all relevant interests/groups into decision-making. It is apparent that continual assessment of stakeholder interests and power throughout decision-making processes is essential, since stakeholder dynamics can change; thus altering factors such as local involvement, knowledge and directions of knowledge transfer (Tseng *et al*., 2012). Inequality has also been shown to vary due to social factors (*ibid*). Ultimately, the PM approach under the PDM is suggested to be limited by underestimation of both stakeholder heterogeneity and associated power-relations (*ibid*).

10.5: Callon's Co-production of Knowledge Model

Both the PEM and PDM fail to provide effective stakeholder participation in knowledge production (Lane *et al*., 2011). The Co-production of Knowledge Model (CKM) represents the most developed stage in Callon's theoretical model of stakeholder participation (*ibid*). The CKM expands upon previous models of stakeholder participation (PEM/PDM) through recognising the requirement for multidirectional transfer and assessment of knowledge between relevant stakeholders in creating new knowledge (Landström *et*

al., 2011; Lane *et al*., 2011). This approach continues to appreciate the role of scientific knowledge in decision-making, but removes the conceptualisation of superiority in scientific knowledge production which persisted under previous models of stakeholder participation (Lane *et al*., 2011).

Practical application of the CKM is based on the formation of Competency Groups (CGs). This CG approach enhances established stakeholder participation under Focus Group approach through introducing the concept of collaborative co-production of knowledge, rather than only discussion of pre-existing knowledge (Lane *et al*., 2011). CG's provide an open-ended medium in which scientists, intermediaries and local individuals (that may otherwise have been excluded) can collaborate during all stages of decision-making for the purpose of defining problems and presenting solutions based on the collective knowledge of participants (Landström *et al*., 2011; Lane *et al*., 2011; Maynard, 2013). The individual local community stakeholders within CG's cannot represent the pre-existing agendas of specific societal groups (Landström *et al*., 2011). Lane *et al*. (2011) recognises that there cannot be stakeholder groups due to the complexities of the social, economic and political aspects of society. The CG approach is also positive in allowing scientists to dissociate from institutionalised standards and subsequently consider new working approaches (Landström *et al*., 2011).

10.6: Practical implementation of Co-production of Knowledge theory in flood management

In 2007 the CKM was practically tested through the creation of a CG in the frequently flooded market town of Pickering (Ryedale, North Yorkshire); the output of this investigation was so successful that co-produced knowledge resulted in implementation of viable local solutions to flooding (Lane *et al*., 2011; Landström *et al*., 2011; Whatmore and Landström, 2011). The translation of theoretical principles of the CKM and the functioning of competency groups is extensively explored in Lane *et al*. (2011), Landström *et al*. (2011) and Whatmore and Landström (2011).

10.7: Arnstein's Ladder (1969)

The progression of stakeholder participation in decision-making processes is explored in Arnstein's ladder (1969) (Coninx, 2008; Tseng *et al*., 2012). Arnstein's ladder is a conceptual model of stages of stakeholder participation in decision-making processes; this provides a useful comparison to assess the degree to which stakeholder participation influences policy.

10.8: Continuing barriers to stakeholder participation in Flood Risk Management

Maynard (2013) provides a detailed account of the continuing problems with stakeholder participation with the FRM framework. Despite the clear benefits that co-production of knowledge offers society and science, it has been recognised that the practical implementation of this approach remains limited (Maynard, 2013). It has been noted, that despite legislation which promotes mandatory stakeholder participation (e.g. *Aarhus Convention*, 1998 and *Water Framework Directive*, 2000), organisations are still able to restrict the level of such participation (*ibid*). Maynard (2013) discovered that predominant prevailing attitudes towards supporting the PDM approach allowed organisations to gain from public and local knowledge bases, whilst restricting decision-making capacity. It is also recognised that Callon's concept of three progressive models of stakeholder participation (PEM→PDM→CKM) may be

unrealistic, since these simplify the degree to which stakeholders can participate in various stages of projects (Maynard, 2013). It is also noted that Callon's CKM is based on an optimum balance between participants (scientist/intermediary/local individual); although this model is practically sustainable within small-scale groups, increasing group size disrupts the effective exchange of knowledge (*ibid*). It is recognised that large organisations involved in FRM would find it difficult to incorporate effective increases in participation into their practices; subsequently the greatest benefits of high stakeholder participation could be within smaller organisations (*ibid*). There is necessity in the continued investigation into stakeholder participation in FRM (*ibid*).

11. Summary

A study of available literature, has indicates the multi-faceted and complex nature of interactions between flooding and society (Tapsell, 2011 (Figure 20.1)). Future UK scenarios indicate that potential increases in flooding will coincide with predicted rises in floodplain occupation and associated economic losses (Brown and Damery, 2002; Evans *et al*., 2006; Penning-Rowsell *et al*., 2006; Johnson *et al*., 2007(a); Manojlovic and Pasche, 2008; Fielding, 2012; Harries, 2013; Kellens *et al*., 2013). Under these scenarios, it is no-longer practically or financially viable to continue a flood defence policy, almost entirely based on structural flood defences (Treby *et al*., 2006; Cashman, 2011). Under this approach the government and authorities were responsible for instigation and enactment of policies; subsequently negating lay local stakeholder participation (Penning-Rowsell *et al*., 2006; Johnson and Priest, 2008). This system of hard protection may have reduced the probability of flooding, but failed to address community or individual vulnerability to flood events (Harries and Penning-Rowsell, 2011).

A paradigm shift in flood policy came about through the advent of Flood Risk Management (FRM) (Penning-Rowsell *et al*., 2006). This revised approach to flood management appreciated the inadequacies of the pre-existing structural approach in defending against consequences of worsening flooding (*ibid*). FRM advocated realignment of flood management objectives from providing physical protection to developing (community/individual) resilience and reducing vulnerability through acceptance of flooding (Johnson *et al*., 2007(a); Johnson *et al*., 2007(b)). The findings of the 2004 *Foresight Future Flooding Project* contributed towards Defra's 2005 policy framework, entitled 'Making Space for Water'; within which it was suggested that a combination of non-structural approaches could provide the means to enacting FRM policy (Defra, 2005). There are various non-structural flood measures, however within literature these tend to be considered as property-level resistant and resilience adaptations (Johnson *et al*., 2007(b); Manojlovic and Pasche, 2008; Pitt, 2008; Rose *et al*., 2009; Soane *et al*., 2010; Bichard and Kazmierczak, 2012). Resilience tends to be acknowledged as the capacity (of a community/individual) to recover following flooding (Pitt, 2008; Cashman, 2011; IPCC, 2012). These non-structural approaches are advantageous since they generally represent low-cost alternatives, which can be implemented in isolation or integrated into pre-existing structural approaches (Goulter, 1987; Manojlovic and Pasche, 2008). Non-structural approaches provide an alternative to unsustainable structural approaches (Bichard and Kazmierczak, 2012). The basis of the non-structural approach shifts the responsibility of flood management from government and authorities to the local stakeholders (Penning-Rowsell *et al*., 2006). In theory, this should result in the empowerment of individuals and communities; however the uptake of non-structural measures remains markedly low amongst the UK population (Rose *et al*., 2009; Harries and Penning-Rowsell, 2011; Harries, 2013). A wealth of literature exists to explain social, psychological, economic, political and institutional barriers which prevent non-structural measures becoming a more prominent part of flood management in the UK (Brown and Damery, 2002; Treby *et al*., 2006; Johnson *et al*., 2007(a); Johnson *et al*., 2007(b); Burningham *et al*., 2008; Johnson and Priest, 2008; Sims *et al*., 2008; Rose *et al*., 2009; Soane *et al*., 2010; Harries and Penning-Rowsell, 2011; Harvett *et al*., 2011; Tapsell, 2011; Bichard and Kazmierczak, 2012; Fielding, 2012; Penning-Rowsell and Pardoe, 2012; Harries, 2013). One of the most crucial factors

in establishing a non-structural approach to FRM is increasing stakeholder understanding and participation in the FRM framework.

For many years science has adopted a top-down approach to public stakeholder engagement; this focused around the assumption that mere education of the public would result in behavioural changes towards flood adaptations (Coninx, 2008). This approach, encapsulated under Callon's Primary Education Model (PEM), assumed that failed translation of scientific information into practice related to public deficiencies (known as the information-deficit model) (Brown and Damery, 2002; Treby *et al*., 2006; Lane *et al*., 2011). It is not sufficient to incorporate local stakeholder knowledge into scientific practice (e.g. Callon's Public Debate Model (PDM)), since this perpetuates the pre-existing disempowerment of the public (Landström *et al*., 2011; Lane *et al*., 2011). Callon's co-production of knowledge model (CKM) outlines how local stakeholder participation, within a multi-directional open discussion (of both local stakeholder and scientific knowledge) between relevant parties would allow for the co-production of new knowledge, with relevance to those involved (Landström *et al*., 2011; Lane *et al*., 2011; Maynard, 2013). This co-production of knowledge could facilitate empowerment of the public and create a sense of community, which is required in developing community resilience.

12. Future research directions

On the basis of this report, two key intellectual challenges emerged. These relate to developing greater understanding of the barriers towards implementing non-structural approaches and further understanding of stakeholder participation in Flood Risk Management.

1. **Developing greater understanding of the barriers which limit the implementation of non-structural approaches within the Flood Risk Management framework**. Literature has outlined a variety of social, psychological, economic, political and institutional barriers which affect translation of information/knowledge into positive behavioural changes towards promoting non-structural approaches to Flood Risk Management. Qualitative assessment is required to develop further understanding of the interactions between barriers and how these influence personal (individualistic) efficacy towards non-structural mitigation and adaptation under the Flood Risk Management approach. Literature has outlined the heterogeneous nature of society, even within social groups; it would therefore be necessary to understand how individuals within communities interact with various barriers before determining methods for overcoming such barriers and developing community-scale flood resilience.

2. **Developing a greater understanding of how Callon's models of stakeholder participation relate (in practice) to the development of individual/community resilience through the development of non-structural approaches to Flood Risk Management**. Literature has outlined the theoretical frameworks for development of stakeholder participation within a new governance approach to Flood Risk Management; however limited studies have focused on community-scale practical application of these theoretical frameworks within the context of Flood Risk Management. Callon's Co-production of Knowledge model represents a move towards optimising stakeholder participation, as required under transitions towards instigating successful Flood Risk Management. There has been a seemingly successful example of the practical application of Co-production of Knowledge within Flood Risk Management, through the experimental establishment of a flood competency group (Landström *et al*., 2011; Lane *et al*., 2011; Whatmore and Landström, 2011). Further establishment of community-scale flood competency groups would be required in order to determine whether practical application of Co-production of Knowledge is a universally viable option for enhancing community-scale flood resilience with a Flood Risk Management framework.

Appendix 1 - Health impacts of flooding

Tunstall *et al*., 2006 note the limited amount of research into the implications of flooding on health. Unlike the economic damages of flooding, health impacts can be harder to quantify and intangible in nature (Tunstall *et al*., 2006). Cost-benefit analysis cannot be used in accounting for the impacts of flooding on social aspects of both households and communities (Sims *et al*., 2008). Recent flood events (e.g. summer 2007 flooding in Hull) have demonstrated association with physical and psychological illness (Tunstall *et al*., 2006; Pitt, 2008). Pitt (2008) demonstrated 39% of adults (or their partner) experienced physical illness as a result of the 2007 flooding. The exact amount of people affected by physical illness resulting from flooding is difficult to quantify because of those not seeking medical assistance, possibly due to associated stigma (Pitt, 2008). The impact of flooding on physical health is considered short-term, whereas psychological health issues can be more long-term (Tunstall *et al*., 2006). Psychological illness can manifest in many ways following flooding, most commonly as stress, depression and anxiety (Tunstall *et al*., 2006; Pitt, 2008; Chatterton *et al*., 2010). It has been proposed that individuals affected by flooding are six times more likely to experience psychological stress than those unaffected by flooding (Chatterton *et al*., 2010). Psychological health issues can be protracted throughout the recovery period; subsequently determining an aspect of individual resilience to flooding (Sims *et al*., 2008). There is importance in studying and understanding the development of psychological health issues, since such issue could take time to manifest and subsequent be missed by immediate post-flood analysis (Chatterton *et al*., 2010). Sims *et al*. (2008) recognise the importance in understanding variables following a flood event.

The psychological health issues relating to flooding can manifest in a number of ways. Pitt (2008) likened flood experience to stages of bereavement e.g. a transition through shock, disbelief, anger, blame and acceptance. Post-flood psychological health can result in increased stress, anxiety and depression, as well as strain on family relationships and arguments (Pitt, 2008). Psychological health impacts of flooding are based on personal subjective perception and subsequently vary between individuals and groups (Tunstall *et al*., 2006). General fear of contamination in flood water is enough to heighten anxiety amongst the majority (77%) of the population (*ibid*). Women are often more psychologically impacted by the effects of flooding than men due to their attachment to property, responsibilities for children and care of the elderly; however women are also likely to seek medical assistance for psychological issues (*ibid*). In regards to property, psychological health issues appear to be more prevalent amongst those in the rental sector, due to lower protection and insurance than property owners. In addition, those occupying ground floor single storey dwellings without access to higher floor refuge are slightly more susceptible to psychological health issues than those in dwellings exceeding two stories (*ibid*). It has been suggested that anxiety can be exacerbated by the trauma of interacting with insurance companies post-flooding (*ibid*). Psychological health issues can also ensue from factors which deteriorate social networks, including long-term eviction from property (with loss of friends/neighbours) and the loss of community amenities (Tunstall *et al*., 2006; Pitt, 2008).

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