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Socio-economic complexities of flood memory in building resilience: An overview of research

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Abstract

Shocks such as flooding are sudden events that can affect the wellbeing of people, whether it's a single household or business or the entire community. Repeated flood shocks is one of the least researched phenomena associated with understanding the socio-economic dynamics in flood disaster but is acknowledged to be a significant factor in flood impacts. The memory within, and its dynamics interrelated with, the complex socio-ecological system is therefore the main focus of this research. It is virtually impossible to understand the dynamics of socio-economic complexities of flood memory of a system without accounting for the human dimension of vulnerability and interrelated feedbacks associated with it that alter the overall resilience within the system. The concept of memory within the context of disasters has largely been restricted to studies of a psychological nature, however, it is realized that to understand the components of adaptability in environmental, social, and economic contexts, with reference to memory and resilience to repeated physical stress, is equally important. Previous research has identified a number of factors that affect the socio-economic vulnerability of affected population but few attempts has been made to integrate the factors to develop an aggregated system structure. This research adopts a method of structured literature review to identify the concepts and scope of memory in the system and explores those multi-faceted aspects of multi-scale and multi-level processes of memory and socio-ecological patterns to identify how such complexities react to changing stresses. Based on the combined insights a new approach is presented in the form of conceptual map illustrating the need to highlight the role of memory in the process of enhanced resilience.

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Keywords: flood memory;feedback; resilience; socio-ecological system; coping-strategy

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1. Introduction to the problem

The overall impact of a natural disaster such as a flood event can be seen as an outcome of the changes in vulnerability society has undergone over decades. Patterns of frequent flooding can be seen worldwide, and these repeated shocks can adversely influence the communities affected in the long term (Merz et al. 2010). With potentially escalating losses, and more population and assets exposed to risk, it is evident that difficult choices need to be made by affected individuals or communities regarding the necessary adjustments in social, economic, cultural and environmental contexts (Cutter et al. 2013). These choices are framed within the vulnerability of socio-ecological systems constituted by both the human and natural environment (Wilkinson, 2011). Typically there is a need for a shift towards a more 'proactive' stance rather than the usual 'reactive' way disaster management policies and actions have been formed. In understanding future challenges, especially when it comes to proactive risk evaluation, human beings rely on calibrated knowledge from past events (de Vries, 2011). Therefore, to a large extent, the potential decision making for the future is expected to be influenced by historical knowledge and experience and this implies existing memory within the system. Whatever choices are made by individuals or society has the potential to be affected by antecedent memory within the system. However, the socio-ecological system is a multifaceted structure with multiple levels of complexities that can alter resilience within the system as a whole. Therefore the question arises here is: ***how does the memory within the system interact with the existing complexities of socio-ecological vulnerability to affect future resilience?***

In an attempt to answer the research question it was observed that, in-spite of acknowledgement of the importance of antecedent memory within the socio-ecological system it has been scantily addressed in the resilience literature. The temporal dimension of the knowledge base still gets less emphasis than the spatial dimension. On a temporal scale, memory acts as point of reference in time which demonstrates one or numerous experiences in the past sequence of events. This contributes eventually to the total memory in the socio-ecological system. Consideration of the effect of time on the window of opportunity to build resilience is essential as it reflects the equilibrium that the system can achieve before getting affected by another disruptive event. Therefore system memory stands as an important factor contributing to the vulnerability of socio-ecological system and needs further attention and incorporation in research. This paper makes a theoretical contribution to the emerging inter-disciplinary aspect and delivers an in-depth exploration of the factors and processes influenced by the complex dynamics of non-linear socio-ecological system that are affected by antecedent memory. This understanding can help stakeholders to gain insight into the triggering effects and pathways of flood memory towards changing resilience.

2. Methodology

The research adopted an enquiry based qualitative approach through structured review of literature to answer the research question. Review of literature has been performed in wider fields of geography, economics, psychology, system's ecology and specific field of disaster management research. The literature is still scattered and fragmented in this particular context and no major reviews of the field have been presented so far. Key word searches of academic literature were given priority over non-academic research. Various disciplines were integrated in search because of the inter-disciplinary nature of the enquiry. The first part of the review concentrated on discussing the various vulnerabilities involved in socio-ecological system. The review tried to focus on the identified weaknesses in the system which may cause the system to fail at the time of stress. The existing complexities were then reviewed in the context of antecedent memories within the system and how such elements can have an influence on the overall system resilience. A description of the identified factors demonstrated by eminent literature are listed and discussed in the following section. The outcome from the review shows a novel aspect of memory and its interaction with several socio-ecological complexities in the form of a conceptual map loop diagram.

3. Aligning the concepts

Rising from the concepts of systems ecology in 1960's and 70's and basing its background on non-linear dynamics of change in the complex socio-ecological space, the concept of resilience has evolved to the point where the focus is not only within the traditional ground of 'form of a system' but also the capacity of the system to renew, reorganize and regenerate from the stress (Folke, 2006; Wilkinson, 2011). Studies investigating the scope of resilience in complex socio-ecological environments have emphasized the capacity of the system to prepare and plan for future so that the system is more successful in adaptation against actual or potential adverse events (Cutter et al. 2013). The vulnerability of a system cannot only be considered an outcome of their capacity to cope and adapt to the situation but the interaction between the historical processes and socio-ecological status (de Vries, 2011). A vulnerable system can lose its adaptive capacity by losing resilience not only from a social, economic or environmental perspective, but its capacity to develop and change with the gradual or abrupt changes in the system in a holistic manner by taking informed decisions (Berkes et al. 2003).

Vulnerability of a system is commonly defined in disaster literature as "*the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard"* (Wisner et al. 2003). Vulnerability of a socio-ecological system has both endogenous and exogenous factors and literature suggests that it is complex to bring together all the indicators of such a system and generate a single all pervasive conceptual model (De Leo & Levin, 1997). Based on the current knowledge from various fields of natural and social science it can be concluded that complexities are in the form of non-linearity and multiplicity of both spatial and temporal scales in the natural system (Villa & McLEOD, 2002). Some rare studies have tried to synthesise different vulnerabilities such as economic vulnerability and physical vulnerability (Pantin, 1997), social vulnerability and physical vulnerability (Tapsell et al. 2010) or the recent study of vulnerability of value incorporating social, economic, environmental and physical vulnerability (Bhattacharya et al. 2013).

3.1. System memory of repeated impact

The concept of memory is described as the accumulated experience based on the history of a system which provides a basis for identifying sources of renewal, innovation, recombination, self-organization and novelty following stress conditions (Folke, 2006). The process of memory has both vertical and horizontal pathways. Vertical pathways of memory are passed on through individuals within the family over generations and horizontal memories take the route through community interactions (McEwen et al. 2012). Information of physical locations previously flooded can be gained from lay knowledge of flooded individuals, and archived informally. Activities such as resistance or resilience measures adopted by flood affected populations can reflect memory in the system. In this respect memories are part of a shared history which facilitates learning from the past and developing inter-generational learning for the future. However, sometimes the affected population is not ready to discuss the experience which can hinder the active process of learning, especially if information is withheld by leaders or decision makers among the communities at risk (Rose et al. 2012). Folke further describes the multi-scale balance between stress and memory which is the accumulated experience within a system, changing pattern as a result of this interaction in increasing resilience (Holling, 2001; Folke, 2006).

Active learning from the past and anticipatory learning for the future can be affected by the lack of reliability of peoples' memory, the lack of organized knowledge transfer in decision making process, and the lack of institutional support for channeling the knowledge to an appropriate level for undertaking for future resilience (Tschakert et al. 2010; Rose et al. 2012; Floodsite, 2007). People's memory subsides with time (timing sensitivity) and when there is a substantial gap between two events people may not remember and lack desire try to gather insights from their past experiences making them remain vulnerable to forthcoming stresses (Proverbs & Lamond, 2008). Social memory can be related to memories associated with sentiments, values, practices or knowledge and physical memories with memories of physical disruptions. People remember the physical damage and disruption for decades (Peters-Guarin, McCall & van Westen, 2012). Tobin & Montz discussed the lingering effect of visible physical damage on price of properties which can be associated with physical memory of flooding (Tobin & Montz, 1994). In case of social

memory, people with long term residency in a disaster affected area often refer to their childhood memories and try to relate them with changing attitude towards living with risk (Rose et al. 2012). People on the other hand, are also considered to be weak witnesses as sometimes they interpret the event not as it actually happened but the way it ought to have happened (Floodsite, 2007) creating false memory. Sometimes the memory decay does not come from the time gap between events but through knowledge transfer gap between individuals as a result of migration in or out of the flood plain (Soetanto et al, 2008) and having no or inadequate knowledge about the historical risk. Cutter suggested that memory is most efficient in capacity building and providing the best social learning when the knowledge transfer is performed soon after the event (Cutter et al. 2008). The antecedent environmental memory in a natural system is the collection of accumulated impacts of extreme weather events. These events can strike systems at different level of vulnerability, and based on the adaptive capacity of the system the impact of damage can be determined. Disasters always have an element of uncertainty associated with them whether it is in the form of timing, frequency or pattern of impact, understanding and awareness of the uncertainty of risk plays an important role in building up of adaptive capacity within the system (Arnell & Reynard, 1996; McCarthy et al, 2001). The capacity to adapt suggests that some groups within society may be less vulnerable than others because of their ability to cope against repeated disaster by utilizing their pre-existing knowledge and experience.

Social capital reflects the outcome of individual or community characteristics in the form of age, life stage, prior health (physical and mental), social demographics, living condition and setting, and income and so on (Floodsite, 2007; Tapsell et al, 2009; Drabek, 1999). The characteristics of the human component within the socio-ecological system indicate how memory from the past will be utilized for future knowledge management. As part of the cultural theory of risk, perception of risk for the future is often partly moulded by the philosophy of worldview among individual and community. Worldview can be fatalistic (looking at nature as unpredictable and dealing with risk as it arises), individualistic (nature self-preserves itself), egalitarian (nature is vulnerable to human actions and suspicious of misused authority) or hierarchic (sees nature as self-preserving and has trust in authorities) (Birkholz et al. 2014). Based on the perception and ideas generated by one's worldview, memory paths may be influenced. System risk communication factors such as trust are also vital for preserving memory (Regulation Advisory Council, 2009). If there is distrust of the authorities responsible for effective risk communication (at local, regional or national level), often it can have a damaging effect on people's perception and may have a long term effect on their memories for future reference. Therefore shaping the trust network is important for effective collective memory accumulation. Local practice and knowledge can also be effective influential factors for memory development. People learn from the habits they grew up with, and often practices and knowledge gained from childhood memories during the time of stress can assist in providing effective training for the building future resilience. Socio-ecological memory depends upon the existing resilience strategies can nurture conditions in a post disaster disruption scenario. This can be in the form of different aspects of recovery and renewal of the system (Berkes et al, 2003). Memories of social and external support can have positive or negative impact on developing resilience. Social support during stressful time can be effective for reducing pressure level and to stabilize the post disaster situation, especially for the well-being of more vulnerable section of the population (Alderman, Turner & Tong, 2012). However over dependence on social support may discourage motivation to improve within the system and enhance coping strategies. This can also affect continuity of sustained internal investment from institutions within the system and therefore delays progress (UNISDR, 2004).

Resilience enhancement requires realistic understanding of risk; as a result there is a need to avoid external bias. Often when memory is incorporated in analysis it introduces complexity; for example, if multiple memories of different events exist within the system, choosing the appropriate memory can be problematic in case of social memory analysis. In the case of physical system, the cumulative impact of existing memories (such as prevailing soil moisture) can have a significant impact on point of system failure. However, there is a large amount of uncertainty exists in identifying the right point of reference from memory (Thywissen, 2006; Pathiraja, Westra & Sharma, 2012). It is difficult to identify the point of reference where a small change in the complex socio-ecological system can cause large responses (Thywissen, 2006). Table 1 provides a list of factors identified and discussed above and selected references to get a glimpse of the complexities involved in measuring the impact of memory within socio-ecological systems.

Table 1. Influencing factors and potential effect on memory consequences and socio-ecological complexities

Memory	Effect	Socio-ecological complexities	Effect	Reference
Past event Experience	Adaptive strategies ; anticipatory learning for future; inter and intra-generational communication, platform for informal knowledge	People's memory, Lack of institutional support	Unreliability of people's memory, Lack of knowledge transfer; Effective flood risk management	(Tschakert et al, 2010), (Floodsite, 2007), (Rose et al, 2012)
Distress and disruption	Subsides with memory ;people mourn over irreplaceable personal possessions with low priority on structural adaptation	Desire to take action; Migration in and out of flood plain; lack of social learning; Little knowledge of local risk as a result of in-migration and lack of knowledge of historical disaster.	Timing sensitivity; decay of memory over time therefore impromptu social learning just after event helps	(Proverbs & Lamond, 2008), (Cutter et al, 2008)
Environmental change	Rainfall and weather pattern; climate change; physical phenomenon during an event	Lack of understanding of environmental change; lack of integrated approach through long term policy making on adaptation and mitigation; lack of cohesion between research and policy	Majority agreement towards climate change as problem to world but uncertain about this as personal threat	(Arnell & Reynard, 1996),(Crichton, 2006),(Adaptation Sub-Committee Progress Report, 2012)
Social capital	Practice; knowledge; values; worldview; urban rural setting	Lack of maintenance of local memory of resource use; cognitive and perpetual decision making; Characterisation of individual and community	Inability to pro respond to social cohesion and environmental feedback; Age, life stage, prior health (physical and mental), religion social demographics, and income; Social support	(Adger et al. 2005),(Floodsite, 2007)(Tapsell et al. 2009)(Drabek, 1999)(Alderman et al. 2012)
Intuition	Intuitive heuristics while considering risk;	Hazard adjustment decisions affected by interaction between psychological, economic and environmental factors	Decision making to build resilience	(Blanchard et al. 2001)(Tapsell et al, 2009)
Selective memory and perpetual distortion	Causal response to disaster impact and outcome is a function of perpetual distortion	Generalizability of memory response to other samples	Using memory for decision making	(Freedy et al, 1992)
Memory of relief/ external assistance	Discourages initiatives from within the local system	Lack of sustained institutional investment for risk reduction	Building resilience	(UNISDR, 2004)
Memory incorporation in analysis of level of vulnerability	Dilemma in identification of appropriate event; Longer term memory (such as existing moisture level) results in larger variability of final impact analysis; Memory acts a s appoint of reference and orient people in time	Different types of memory exists, different impacts of event exists in the memory; Already vulnerable socio-ecological system; Historical knowledge and experience base is a tool for future decision making.	Incorporation in analysis strategy; Faster failure; Cumulative effect of antecedent memory on physical impact analysis; Can be effective provided the uncertainties of the future are taken into account	(Thywissen, 2006) (Pathiraja, Westra & Sharma, 2012) (de Vries, 2011)

Insights gained from the literature illustrate that there are several tradeoffs that might affect the level of resilience; however, the interaction between memories within different socio-ecological complexities can provide a perspective of how resilience can be developed. Such conceptualization also helps in understanding the differential spatial and temporal scales associated with resilience. This involves accumulation of memories in the system and looking into future resilience enhancement.

3.2. Interaction between socio-economic complexities and resilience

Aligning the functional inter dependencies of various factors and processes of socio-ecological system memory often pose complexity in research due to their multiple linkages, scales, dimensions and lack of association between them. Literature suggested that memory can be distributed into two broad themes: environmental and social. The environmental memory deals with the physical or natural part of the system while the social memory concerns the people and society as a whole. The following loop diagram (Figure 1) shows the different interconnections between various aspects of environmental and social memory with reference to changing resilience in a fragile socio-ecological system.

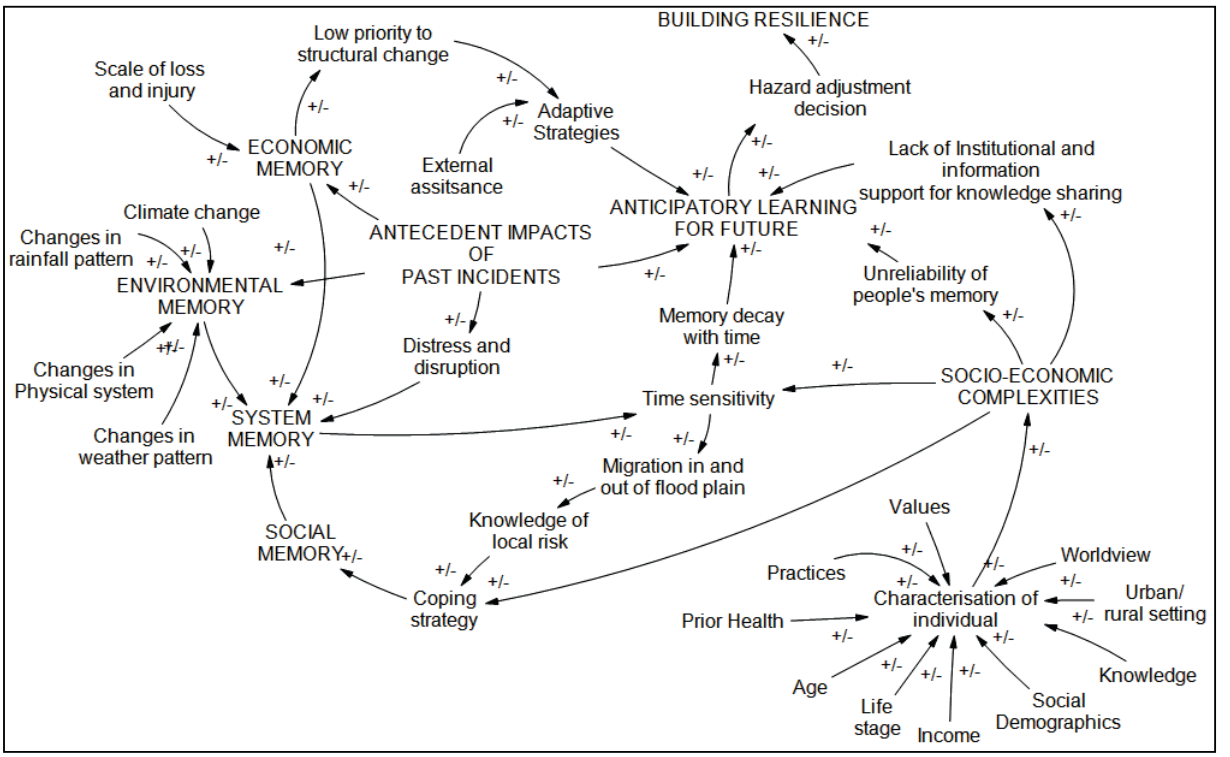

Fig. 1. Conceptual map illustrating interrelationship between memories within a system

The level of physical memory in a system is generally determined by the fragility function of the systems sensitivity and susceptibility (Kappes, Papathoma-Köhle & Keiler, 2012). There are various exposure and susceptibility variables involved in assessment of physical vulnerability such as magnitude, frequency, and characteristics of elements at risk. The physical vulnerability assessment often becomes one sided and biased towards physical damage only. The loss and damage functions are frequently restricted to one physical characteristic at a time, therefore, without consideration of other influencing factors (Kappes, Papathoma-Köhle & Keiler, 2012). This observation points towards the need for integrated approach of looking into physical system vulnerability and its memory. Environmental memory, on the other hand involves factors such as climate change and weather patterns which already incorporate large scale uncertainty; therefore it is difficult to discern the effect of environmental memory. Holistic understanding of the system memory requires contribution of human side (social memory). Social memory derives its multiple aspects from variety of individuals, community and institutions that pool the existing practices, knowledge, values and worldviews enabling the system to cope with changes and uncertainties and build up resilience (Adger et al. 2005). Psychological factors arising from past experiences in this context are not well understood and have been rarely integrated in analysis, but the factors affecting response to stressors does have an impact on the total coping strategy of people (Brown & Westaway, 2011).

Economic memory has often been given far more importance than social memory, especially in disaster research. This is because of the easier accessibility and comparability of financial and economic information and the difficulty in representation of subjective factors in the measurement framework. For instance, limitations of unreliability of human memory towards time and space can hamper anticipatory learning therefore provide false or biased information to the total memory of the system. The interaction between different memory systems work on the basis of a feedback system where there are direct and indirect links between feeds, representing the total system memory. This vulnerability of a system can vary in scale, spatially and temporally from one system to another (Rashed & Weeks, 2003; Hewitt, 1997). Therefore there is a potential for incorporating subjectivity in the system. This can be performed by choosing different spatial and temporal scenarios contributing to the holistic understanding of future resilience enhancement.

Local institutions often act as a support system for the community. However, if knowledge sharing is not seen as an important aspect of institutional support this can hinder the path of memory to make its way to the decision making process. Similarly memory decay might add to the uncertainty for anticipatory learning. Conversely such aspects can add to the learning process, building the capacity to deal with uncertainty so that coping capacity for the future will be flexible to cognitive shocks (Adger et al. 2005). Economic memory of socio-ecological system is part of the social memory, however, it has been singled out in order to emphasize the importance with which financial and value aspects of risk assessment are treated in disaster literature (de Vries, 2011). System memory is highly influenced by the way in which infrastructure and buildings cope with disaster. Therefore they form an important part in contributing to building memory for active learning for the future (Ginige, Amaratunga & Haigh, 2010). During the course of this review it was observed that uncertainties could arise as a result of incorporating memory into understanding of resilience building, however, it was also observed how subjective factors play a role in creating a knowledge base for the future and encourage active learning in both a spatial and temporal context in understanding the fragility of socio-ecological system.

4. Conclusion

The literature from multiple fields of research brings valuable insights into understanding concepts of memory as they relate to the complexities of resilience. It is seen that there are multiple facets of memory and various elements in an adaptive socio-ecological system. The meaning and distinguishing features of memory as distinct from simply having a past experience of flooding are rooted in the nature of the elements affected and their capacity and tendency to retain information and be shaped by it. In terms of engineering resilience – the ability to bounce back to the former state, memory is inimical. However in the broader ecological and social understanding of resilience memory can be a trigger to adaptation to a future, improved or equivalent, state. Therefore it is advocated that the nature of the problem of integrating memory in to the system is multi leveled and multi-faceted and should be treated accordingly. It is important to recognize, particularly in the social system that memory may be entirely subjective, contested or shared and that human intervention and systems of external recording and transfer can lead to mal-adaptation, over adaptation or complacency. Equally the study of memory can contribute to understanding of how best to intervene, store and transmit flood experience to harness the adaptive influence. To this purpose a conceptual map of the role of memory in the process of enhanced resilience is presented that displays the links and pathways through which memory impacts on adaptive processes and ultimately resilience of the system. Therefore it is important to understand that a changing attitude towards systems thinking in building resilience for socio-ecological systems are essential and memory, however subjective it might be, can contribute to the total knowledge base.

References

Adaptation Sub-Committee Progress Report (2012) *Climate change - is the UK preparing for flooding and water scarcity* Climate change commitee (ed.). London

Adger, W.N., Hughes, T.P., Folke, C., Carpenter, S.R. & Rockström, J. (2005) Social-Ecological Resilience to Coastal Disasters [online]. *Science*. 309 (5737), pp. 1036–1039.

Alderman, K., Turner, L.R. & Tong, S. (2012) Floods and human health: A systematic review. *Environment International*. 47pp. 37–47.

Arnell, N.W. & Reynard, N.S. (1996) The effects of climate change due to global warming on river flows in Great Britain [online]. *Journal of Hydrology*. 183 (3-4), pp. 397–424.

Berkes, F., Colding, J., Folke, C. (2003) *Navigating Social–Ecological Systems: Building Resilience for Complexity and Change.* Cambridge, U.K: Cambridge University Press.

Bhattacharya, N., Lamond, J., Proverbs, D., Hamond, F. & Searle, D. (2013) Development of conceptual framework for understanding vulnerability of commercial property values towards flooding. *International Journal of Disaster Resilience in the Built Environment*. 4 (3), pp. 334–351.

Birkholz, S., Muro, M., Jeffrey, P. & Smith, H.M. (2014) Rethinking the relationship between flood risk perception and flood management. [online]. *The Science of the total environment*. 478pp. 12–20. [Accessed 21 March 2014].

Blanchard R. D., B., Berry, K.A. & Showalter, P.S. (2001) Should flood insurance be mandatory? Insights in the wake of the 1997 New Year's Day flood in Reno-Sparks, Nevada [online]. *Applied Geography*. 21 (3), pp. 199–221.

Brown, K. & Westaway, E. (2011) Agency, Capacity, and Resilience to Environmental Change: Lessons from Human Development, Well-Being, and Disasters. *Annu. Rev. Environ. Resour*. 36pp. 321–342.

Crichton, D. (2006) *Climate Change and its Effects on Small Businesses in the UK*.

Cutter, S., Ahearn, J.A., Amadei, B., Crawford, P., Eide, E.A., Gerald, E., Galloway , Michael F. Goodchild , Howard C. Kunreuther , Meredith Li-Vollmer , Monica Schoch-Spana , Susan C. Scrimshaw, E.M. & Stanley, G.W.& M.L.Z. (2013) Disaster Resilience: A National Imperative, Environment. *Environment: Science and Policy for Sustainable Development*. 55 (2), pp. 25–29.

Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. & Webb, J. (2008) A place-based model for understanding community resilience to natural disasters [online]. *Global Environmental Change*. 18 (4), pp. 598–606.

Drabek, T.E. (1999) Understanding disaster warning responses. *The Social Science Journal*. 36 (3), pp. 515–523.

Floodsite (2007) *Evaluating flood damages: guidance and recomendations on principles and methods* Edmund Penning-Rowsell Frank Messner Colin Green, Volker Meyer, Sylvia Tunstall, Anne van der Veen (ed.). (T09-06-01).

Folke, C. (2006) Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*. 16pp. 253–267.

Freedy, J.R., Shaw, D.L., Jarrell, M.P. & Masters, C.R. (1992) Towards an understanding of the psychological impact of natural disasters: An application of the conservation resources stress model [online]. *Journal of Traumatic Stress*. 5 (3), pp. 441–454.

Ginige, K., Amaratunga, D. & Haigh, R. (2010) Developing Capacities for Disaster Risk Reduction in the Built Environment: Capacity analysis in Sri Lanka [online]. *International Journal of Strategic Property Management*. 14 (4), pp. 287–303.

Hewitt, K. (1997) *Regions of Risk: a Geographical Introduction to Disasters*. Harlow: Longman.

Holling, C.S. (2001) Understanding the complexity of economic, ecological,ecological, and social systems. *Ecosystems*. 4pp. 390–405.

Kappes, M.S., Papathoma-Köhle, M. & Keiler, M. (2012) Assessing physical vulnerability for multi-hazards using an indicator-based methodology [online]. *Applied Geography*. 32 (2), pp. 577–590.

De Leo, G.A. & Levin, S. (1997) The multifaceted aspects of ecosystem integrity. *Conservation Ecology*. 1 (1), pp. 3.

McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., White, K.S. (2001) *Climate Change 2001: Impacts, Adaptation and Vulnerability.* Cambridge: Cambridge University Press.

McEwen, L.J., Krause, F., Jones, O. & Garde Hansen, J. (2012) Sustainable flood memories, informal knowledge and the development of community resilience to future flood risk. In: *Flood Recovery, Innovation and Response III*. 2012 Dubrovnik, Croatia: WIT Press. pp. pp. 253–264. doi:10.2495/FRIAR120211.

Merz, B., Kreibich, H., Schwarze, R. & Thieken, A. (2010) Review article "Assessment of economic flood damage" [online]. *Natural Hazards and Earth System Science*. 10 (8), pp. 1697–1724. [Accessed 8 April 2014].

Pantin, D. (1997) *Alternative ecological vulnerability indicators for developing countries with special reference to small island developing states (SIDS)*. pp. 22.

Pathiraja, S., Westra, S. & Sharma, A. (2012) Why continuous simulation? The role of antecedent moisture in design flood estimation. *Water Resources Research*. 48 (6). Report Number: W06534

Peters-Guarin, G., McCall, M.K. & van Westen, C. (2012) Coping strategies and risk manageability: using participatory geographical information systems to represent local knowledge [online]. *Disasters*. 36 (1), pp. 1–27.

Proverbs, D. & Lamond, J. (2008) The barriers to resilient reinstatement of flood damaged homes. *4th International i-Rec conference 2008 .Building Resilience: acheiving effective post-disaster reconstruction*.

Rashed, T. & Weeks, J. (2003) Assessing Vulnerability to Earthquake Hazards through Spatial Multicriteria Analysis of Urban Areas. *International Journal of Geographical Information Science*. 17 (6), pp. 547–576.

Regulation Advisory Council (2009) *Rising Levels ? Public awareness and understanding of risks from flooding*.

Rose, C., Proverbs, D.G., Booth, C. & Manktelow, K.I. (2012) Three times is enemy action - flood experience and flood perception. In: S Mambretti D.Proverbs C.A. Brebbia, D.de Wrachien (ed.). *Flood Recovery, Innovation and Response III*. 2012 Dubrovnik, Croatia: WIT Press.

Slovic Kunreuther, H., White, G.F., P. (1974) Decision processes, rationality and adjustment to natural hazards G F White (ed.). *Natural Hazards: Local, National and Global*.

Soetanto., Proverbs, D., Lamond, J. and Samwinga, V., R. (2008) *Residential properties in England and Wales: An evaluation of repair strategies towards attaining flood resilience in hazards and the built environment: attaining built in resilience* Lee Bosher (ed.).pp. 124–149.

Tapsell McCarthy, S., Faulkner, H., Alexander, M., S. (2010) *Social Vulnerability and natural hazards*. Available from: http://caphaz-net.org/outcomes-results.

Tapsell, S.M., Tunstall, S. & Priest, S.J. (2009) *Developing a conceptual model of flood impacts upon human health*.

Thywissen, K. (2006) Components of Risk. *Studies of the University: Research, Counsel, Education- Publication series of UNU-EHS*. (2/2006) pp. 52

Tobin, G.A. & Montz, B.E. (1994) The flood hazard and dynamics of the urban residential land market. *Journal of the American Water Resources Association*. 30 (4), pp. 673–685.

Tschakert, P., Sagoe, R., Ofori-Darko, G. & Codjoe, S.N. (2010) Floods in the Sahel: an analysis of anomalies, memory, and anticipatory learning [online]. *Climatic Change*. 103 (3-4), pp. 471–502. [Accessed 21 March 2014].

UNISDR (2004) *Living with Risk. A Global Review of Disaster Reduction Initiatives*. 1 p.pp. 430.

Villa, F. & McLEOD, H. (2002) Environmental Vulnerability Indicators for Environmental Planning and Decision-Making: Guidelines and Applications [online]. *Environmental Management*. 29 (3), pp. 335–348. [Accessed 5 November 2012].

De Vries, D.H. (2011) Temporal vulnerability in hazardscapes: Flood memory-networks and referentiality along the North Carolina Neuse River (USA) [online]. *Global Environmental Change*. 21 (1), pp. 154–164. [Accessed 25 March 2014].

Wilkinson, C. (2011) Socio-ecological resilience: Insights and issues for planning theory. *Planning Theory*. 11 (2), pp. 148–169.

Wisner, B., Blaikie, P., Cannon, T. & Davis, I. (2003) *At Risk: natural hazards, people's vulnerability and disasters*. 2nd edition. Routledge.