A conceptual framework for understanding community resilience to flooding

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Abstract. Flooding, an already prevalent global hazard, is predicted to worsen in frequency and intensity. Flood Risk Governance has evolved from exclusively combating flooding to now also coexisting with it, aiming to enhance resilience comprehensively and over the long term. A narrative literature review presents diverse conceptualisations of resilience to flooding, highlighting ongoing debates about whether resilience is an outcome or process. This paper contends that resilience can and should encompass both the process and outcome-based components. Critically reviewing existing conceptualisations, this paper proposes a holistic framework for understanding community resilience. The framework comprises three components: the capacity to resist, the capacity to respond and recover, and the capacity to adapt. Six specific and potentially overlapping, capacities are identified as Social, Physical, Human, Economic, Institutional, and Natural. The paper also discusses the importance of qualitative research in providing more nuance when assessing resilience. The paper clarifies the complexity of resilience in the face of evolving flood risks, proposing an integrated framework that spans capacities, ongoing processes, and ultimate outcomes. This framework will provide the foundation for understanding and analysing community resilience to groundwater flooding in Buckinghamshire, UK.

1.0 Introduction and methodology

Flooding is the most common of global hazards. The 2022 World Risk Poll indicated that over 10% of the world's population has experience with floods, with the next most common hazard being hurricanes or cyclones at 7% [1]. Flooding is also associated with the most dangerous and costliest consequences around the world [2–7]. Even more worryingly floods, along with other climate change impacts, are expected to increase in both frequency and intensity [8].

In response, there has been a reported shift in Flood Risk Governance (FRG) from only 'fighting the water' to now the acceptance of also 'living with water', with the aim of enhancing resilience more comprehensively, holistically and longer term [9]. This shift in FRG to enhance resilience adds broader measures beyond the physical and structural flood defences and towards more integrated Flood Risk

Management (FRM), which incorporates social, economic and natural factors, characteristics, or capacities within communities [7,10–13].

An ongoing debate in resilience literature considers whether resilience is an outcome or a process [14]. Structural flood defences, associated with fighting the water, align with viewing resilience as an outcome [14], and are tied to the community's capacity to resist a flood [15]. Integrated Flood Risk Management measures, associated with living with water, encompass the community's capacity to respond, recover, and then adapt to floods [15], and align with viewing resilience as a process [14].

Various conceptualizations of resilience to flooding exist in the literature, and it remains a contested phenomenon without a universally agreed-upon framework [16]. This paper focuses specifically on 'community resilience' to flooding. 'Community' here is taken as referring to a group of people who share values, norms, beliefs, experiences, and connections, often with shared history and identity and strong emotional ties to one another [17] and likely to be geographically bound with shared fates [2,18–20]. The various community capacities constituting community resilience to flooding are contested, and this paper critically reviews them.

This paper addresses these complexities and contestations, proposing a revised conceptual framework for understanding community resilience to flooding. The conceptual framework underpinning this study is developed through a narrative, or traditional literature review—a time-tested method for evaluating existing literature that places emphasis on qualitatively interpreting prior information [21]. A narrative review is designed to succinctly summarize or synthesize existing literature on a given subject, without the need to derive overarching generalizations [21]. Despite occasional critiques for potential shortcomings in rigor, thoroughness, and susceptibility to researcher bias [21,22], narrative reviews serve as invaluable tools for accumulating and synthesizing an extensive body of literature to articulate a nuanced perspective. This stands in contrast to the systematic literature reviews, often characterized by exclusion criteria such as specific date ranges or geographical areas, resulting in a more circumscribed set of literature sources [21].

Moreover, the undertaking of a narrative literature review in this study plays a pivotal role in not only collating an abundance of literature sources but also in synthesizing them to present a distinct viewpoint. This approach allows for a comprehensive exploration of the resilience literature, particularly in identifying and unpacking inconsistencies and ambiguities within this domain [21]. The iterative nature of narrative reviews, coupled with the absence of rigid exclusion factors, permits a more expansive and inclusive examination of the available literature [21]. Such an inclusive approach is vital for capturing the diverse perspectives and insights that contribute to a richer understanding of the resilience landscape.

The narrative literature review undertaken in this study encompasses an exploration of insights from diverse domains that contribute to the discourse on community flood resilience. These domains include literature on disasters or hazards, social-ecological systems, flood risk governance and community psychology. The inclusion of these varied domains is deliberate, as they collectively constitute the bulk of literature relevant to community flood resilience. In addition to the broader domains, attention is given to works by highly cited authors in these fields and contributions by researchers influenced by these authoritative figures.

Embracing the non-structured approach characteristic of traditional literature reviews [21] this review facilitates the construction of a narrative that unfolds chronologically, shedding light on the evolution of different conceptualisations of resilience in the context of flooding. The non-structured nature allows for a holistic exploration of the interrelations between these conceptualisations. Furthermore, it provides the flexibility needed to elucidate how the proposed conceptual framework in this study builds upon and advances prior research in the field. This review method thus serves to contextualise the study within the broader landscape while offering a nuanced understanding of the conceptual foundations underpinning resilience to flooding.

2.0 Resilience to flooding.

2.1 The resilience spectrum – three components

The term resilience was first introduced in the field of ecology by C.S. Holling in 1973. Holling defined resilience as the ability of a system, such as an ecosystem, to withstand disturbance and persist [23]. Over time, the concept of resilience has been applied to a wide range of fields, including psychology, sociology, engineering, social-ecological systems (SES), social sciences, and disaster management, among others [14,16,24].

McClymont et al. [16] suggests that definitions of resilience in FRG can be looked at in a spectrum of resilience. i.e engineering resilience, systems resilience, and complex adaptive systems resilience. One end in the spectrum of resilience is the 'Engineering resilience' which essentially describes top-down approaches [16] that focus on maintaining the status quo during and after an event [19]. It is primarily concerned with preserving the functionality of the system, rather than allowing for change [16]. This type of resilience also known as 'reactive' resilience [25,26] is associated with the 'bouncing back' after the shock or resisting the impact of a shock and returning to 'normal' [14,24,27–29]. This type of resilience is also in line with popular terminology in resilience literature – 'resilience as an outcome' since it does not allow for any processes of change to system [14,30,31]. It aligns with the traditional flood defence approach to flood risk governance and management, which focuses on reducing the likelihood of flooding and employing resistance-based measures, and here resilience is viewed as a 'capacity to resist' [15,32].

Systems resilience can be viewed as a middle ground within the spectrum of resilience because even though it aims to preserve the status quo, it allows for some degree of change to ensure functionality of the system after a flood [15,16]. McClymont et al. [16] notes that even though the systems resilience is similar to engineering resilience, here systems or communities do not necessarily bounce back to how they were but they 'bounce forth' to a new normality. Hegger et al. [15] note that this component of resilience encompasses the capacity of a community or system to absorb, respond and recover from floods even where the community may be initially impacted. It is the capacity of a flood-affected community to remain functioning, respond to a flood, and recover without shifting to an entirely different state. Hence, since this component of resilience is associated with some degree of change of the affected system or community [15], it falls within viewing resilience as a 'process' [14].

The other end of the resilience spectrum can also be conceptualised as a form of adaptation and transformation [14] and it is referred to as 'complex adaptive systems' resilience by McClymont et al. [16]. This type of resilience focuses on using the impact of a flood as an opportunity for adaptation and learning, with a view to longer-term resilience [26] and it is also linked it to 'proactive' resilience [25]. The idea is that individuals or communities can learn from flood events, adapt their policies and practices, and evolve to better adapt to future floods [16,33]. Brown [14] argues it requires positive transformation and structural change, and therefore this type of resilience is also viewed as a 'process' since it allows for change to the system or community. This capacity to adapt is influenced when the FRM measures create opportunities for communities and citizens to learn, innovate, and experiment, and it fits within the people-centred approaches of FRG [32].

In summary, resilience to flooding can be conceptualised as the capacity to resist, capacity to respond and recover, and capacity to adapt, learn and change. This conceptualisation includes both the outcome and process-based views. A summary of different definitions of resilience identified in selected literature identifying the outcome and process components is highlighted in Table 1 below.

Table 1: Resilience (process or outcome).

Author	Definition or conceptualisation	Outcome or Process
NAS [34]	*'the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse event'*	Their definition contains both the outcome and process-based components.

Author	**Definition or conceptualisation**	**Outcome or Process**
Norris et al. [19] *pg 131*	*A process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance*	They argue that resilience is a process, and the outcome is adaptation. Though as discussed, adaptation is considered a key component of resilience.
Brown [14] *pg7 and pg 8*	Brown uses three definitions of resilience in her book highlighting the difficulty of defining resilience concisely. However, she suggests that the definitions have three things in common i.e; Resilience is a **capacity** of a system (individual or community). And it is both **process and outcome.**	Argue that resilience is both a process and outcome.
Cutter et al. [36] *pg 599*	*Resilience is the ability of a social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat.*	Their definition contains both the outcome and process-based components of resilience
Mees et al. [11]	A resilient FRG system, needs to possess the capacity to resist, to absorb and recover and to adapt.	Both resisting (outcome) and adapting (process) key to their resilience concept.
Hegger et al. [15]	Resilience is made of the capacity to resist, capacity to absorb and recover, and capacity to transform and adapt.	Both the outcome and process-based components in their conceptualisation of resilience in FRG.
Alexander et al. [38]	Resilience can be conceptualised as a capacity to resist, capacity to absorb and recover and capacity to adapt (including learning)	Both the outcome and process-based components in their conceptualisation of resilience in FRG
Djalante et al. [41] *Pg 2110*	*'Resilience concept should be considered both a process and outcome'*	Argue for both and note that resilience should be considered across the entire disaster risk reduction stages (mitigation, preparation, recovery, and reconstruction).

2.2 Community resilience and its capacities.

In its application, the concept of community resilience lacks coherence, clarity, and consistency [36–40]. Various authors have argued for different capacities or sources of resilience [41], resulting in challenges in comprehending resilience. This section addresses and critiques the diverse capacities of community resilience identified in the literature, in order to establish the specific capacities which will serve as the foundation for the conceptual framework.

Adger et al. [45] and Faulkner et al. [48] in the Socio-Ecological Systems (S.E.S) field highlight five capacities of community resilience. The first is 'place attachment' which refers to the emotional, mental, and tangible connection that individuals form with a particular location. Communities are believed to

be motivated by their attachment to a place, which drives them to preserve or improve the valued characteristics of that place, improving their resilience. The second capacity is 'leadership', which considers the role of individuals such as leaders, entrepreneurs, and champions that have an impact on outcomes, as well as organisations, qualities, roles, and activities. The third category is 'community networks', that is, the bonding and bridging ties that enable locals to work together. The fourth capacity is 'community cohesion and efficacy' which refers to the community's collective capability to collaborate as well as their belief in their own power to take action, act independently and make autonomous choices and effectively manage crises. The fifth and final capacity is 'Knowledge and learning' which involves the capacity of individuals and groups to effectively respond to local needs and issues including learning from past crises [38,42].

The focus in the S.E.S perspective is primarily on social groups or people working together to utilize their internal resources or capacities, and according to Faulkner et al. [48] and Adger et al. [45] resilience is seen as a property of independent self-organization and self-regulation. However, Wright [44] contends that this perspective, which is based on the concept of self-organization in ecology, may fail to take into account how external factors influence the availability of resources or opportunities for individuals and communities, as well as how resilience strategies are shaped by the larger context in which they operate. Additionally, the concept of self-organization, aligned with UK Government's policy of promoting communities and individuals to rely on themselves [37] in the face of public spending cuts and austerity, has been criticized as being neo-liberal [36].

In their article published in the American Journal of Community Psychology, Norris et al. [19] discuss the various capacities available to communities in the context of disasters. Notably, three out of the five capacities in the S.E.S field (Place attachment, Community networks, Leadership) are categorized under just one capacity of 'social capital' in their conceptualisation. In addition to the internal capacities mentioned earlier, such as place attachment, leadership, and social networks within social groups, the authors also emphasize the importance of the 'economic development' capacity. This capacity includes the *physical* capital and *natural* resource capitals, which are recognized as essential resource bases for building resilience within a community. In the disaster field therefore, researchers may take a much broader conceptualisation of community resilience including other 'external' capacities such as the physical and natural capacities.

The capacities highlighted by Norris et al. [19] are also unclear. They claim to have used Goodman's et al. [49] definition of 'community capacity' from the health field [43] to define community resilience. However, because Goodman et al. [49] employed a combination of multiple experts to formulate their conceptualisation of community capacity, they ended up with many classifications of capacities which are considered similar or the same by other authors. For example, social value and social networks were considered as different capacities by Goodman et al. [49] yet Putnam [50] categorises both social value and social networks under one term of 'social capital'. As a result, Norris et al. [19] include several disparate 'capacities' that could have been more simply classified under a few umbrella terms. Conversely, Norris' 'Economic development' capacity encompasses other capacities such as the physical and natural capacities in addition to the economic capacity. Therefore, Norris' framework seems to lack conciseness.

Other disaster field researchers who were influenced by Norris' work, such as Suzan Cutter [30,45] came up with more concise frameworks, including capacities such as Social, Economic, Infrastructural/Physical, Institutional, Ecological/Natural, and finally Community Competence [30] later changed to 'Community Capital' [45]. Cutter's framework has been frequently adopted. It has been modified and used by UK government agencies such as the Environment Agency [46] and by academic researchers such as Clare Twigger-Ross [13,36] in the Flood Risk Management field , and has been further modified by later researchers including Haase et al. [39] and Forrest et al. [7]. Haase's et al. [39] six capacities include Social, Economic, Infrastructural/Physical, Institutional, Ecological/Natural, and Human (absent in Cutter's framework). It is also important to note that the specific 'capacities' in this framework can be interchangeably referred to as 'capitals' [39,41]. Haase's et al. [39] resultant six

capacities/capitals are discussed and expounded upon in the next section where they are adopted for the community flood resilience framework proposed.

Table 2 below summarises some of the conceptualisations of community resilience identified.

Table 2: Capacities of community resilience.

Authors	**Journal/Book**	**Country**	**Type of capacity/resource /asset/capital**
Norris et al. [19]	American journal of Community psychology	USA	Social Capital (*Place attachment, leadership, social networks*), community competence, Economic development (*Physical and natural capitals*), Information and Communication
Cutter et al. [30]	Global Environmental Change	USA	Social resilience, community competence, Economic resilience, Institutional resilience, Infrastructure resilience, Ecological resilience
Cutter et al. [45]	Journal of Homeland Security and Emergency Management	USA	Social resilience, Community capital, Economic Resilience, Institutional resilience, Infrastructure resilience
Buikstra et al. [47]	Journal of Community psychology	Australia	Social networks, Learning, Diverse and innovative Economy, Infrastructure, and support (*Physical capital*), Leadership, Environmental factors (*natural capital*), Sense of purpose
Twigger-Ross et al. [13] and Orr et al. [25]	FLOODrisk 2016 – 3rd European Conference on Flood Risk Management	UK	Community capital, social resilience, Economic resilience, Institutional resilience, Infrastructure resilience
Faulkner et al. [42] and Adger et al. [38]	Ecology and Society – Faulkner et al. And Water (MDPI) – Adger et al.	UK	Community networks, Knowledge and Learning, Community cohesion and efficacy, Place attachment, Leadership
Forrest et al. [7]	Urban planning and Environment (Routledge)	UK	Social capital (*both social and institutional*), Natural and Built environment (*Natural and physical*), Human capital, Economic capital
Haase et al. [39]	***Natural Hazards (Springer)***	***USA***	***Social capital, Human capital, Economic capital, Institutional capital, Physical capital, Natural capital***
Keating et al. [41]	Natural Hazards and Earth System Sciences	Austria	Human capital, social capital, Natural capital, Physical capital, Financial (*Economic*) capital

There are arguments against the capitals approach for conceptualising community resilience. For example, Faulkner et al. [42] argue that viewing resilience as a static property of systems, and as a set

of discrete resilience-promoting capitals, as proposed by Suzan Cutter and her frameworks, does not show how the different capitals interact to influence or inhibit resilience. However, Haase et al. [39], who employ Cutter's framework, demonstrate the multidimensional and interdependent nature of the resilience capitals by noting how interventions in one capacity may improve capacities in others, and how one resilience capacity might compensate for inadequacies in another. In their study, participants noted that high levels of social capital (social capacity) were used to overcome deficiencies in the economic capacity of resilience.

Furthermore, the use of the capitals approach has been claimed to be mainly relevant for only the disaster response stage in risk management [40]. However, Twigger-Ross et al. [13] and Orr et al. [25] in their studies of England's Flood Resilience Community Pathfinder Scheme projects show how capitals such as institutional and infrastructural respectively were built proactively before any specific risk and most importantly not in response or reaction to a specific flood risk.

In summary, adopting a capital/capacities approach appears to improve understanding of the fundamental components of resilience, making it easier to assess areas of strength and weakness. As a result, by strengthening these capacities, communities may be better prepared to respond to and recover from and adapt to the effects of climate change [36].

As highlighted earlier, the developing community resilience framework builds on and extends on Haase's et al. [39] six capacities/capitals and this is discussed in the following section.

3.0 Developing a conceptual framework for community resilience to flooding.

3.1 The six capacities and their influence on resilience to flooding.

3.1.1 Social capacity

Social capital is the most widely used concept for referring to the various social factors that impact resilience [48]. Social capital generally refers to the social networks, norms, trust and reciprocity within a community that facilitate cooperation and coordination [48–52]. Other researchers [13,45] use the alternative term 'community capital'. There are generally three types of social capital identified, Bonding, Bridging and Linking. Bonding social capital pertains to the type of social connection that is focused inwards, and typically involves homogeneous groups of individuals (family and friends). Bridging social capital is about connections and networks among individuals or groups with differing characteristics or orientations and has an outward-looking perspective. Finally, Linking social capital relates to social ties and networks that exist between people or groups of different social positions, status, and power [13,44,48,51,53].

In the context of flooding and community resilience, social capital encompasses the degree of interaction among individuals in a community, considering both the community's internal social networks and structures, as well as the community's values in terms of their attitudes, beliefs, perceptions, and how all these factors influence their involvement with flooding and FRM [7].

The significance of social capital in facilitating collective community action [19] becomes even more critical in the transition towards holistic and multi-dimensional FRM strategies, since they tend to involve cooperation across multiple stakeholders including government and community groups [9,54,55]. Therefore, social capital is considered fundamental to the effectiveness of these integrated FRM approaches [56]. Social capital plays a crucial role in every stage of FRM in enhancing resilience. Before a flood, cognitive aspects of social capital, such as social trust, can assist in decision-making [56]. In the preparedness phase, robust social networks can facilitate official and informal risk communication through trusted sources and word-of-mouth [56]. During floods or in the immediate aftermath, flood victims have been reported to leverage help from neighbours [57].

Forrest et al. [7] include formal and informal institutional structures within their definition of social capital. Twigger-Ross et al. [13] also suggest that some aspects such as 'linking social capital' is similar to institutional capital. However, within the framework proposed here, social and institutional capacities are considered as separate. Figure one below shows social capacity as one of the six specific capacities

that can contribute to the overall community resilience in terms of the community's capacity to resist, respond and recover and adapt to flooding.

3.1.2 Institutional capacity

The presence of formal and informal institutions and practices that support better flood risk management is known as institutional resilience, or institutional capital [13]. Institutional resilience further encompasses relationships and networks that exist between people in local communities and organisations or agencies in charge of FRM [45]. These may include singular flood groups, networks of flood groups and community group initiatives related to FRM within communities [13]. Flood groups encompass a broad spectrum, including community flood forums and committees, and action groups solely dedicated to addressing flooding. There are also groups that address both flooding and broader community issues, such as parish councils and residents' associations, including parish council resilience groups [7]. Flood groups have been reported not only to enhance institutional capacity, but other capacities as well, such as social (creating social networks), physical (clearing and maintaining drainage), human (increasing awareness), and economic (fundraising for community flood assets). This is an example of where some capacities may mutually reinforce each other through interactions [7]. Institutional capacity is also included in figure one below as one of the specific capacities.

3.1.3 Human capacity

Human capacity or Human capital describes the present and future capacity of individuals to participate in addressing flooding issues within a community [7]. It includes components such as individual knowledge and skills, education level, language proficiency, aging population percentage in a community, and the overall health of community members that can be used within the FRM cycle (before, during, after a flood) [10,39,45]. It should be noted that Cutter's framework does not explicitly identify human capital as a separate capacity, and its components are included in the social resilience capacity. However, within the proposed framework these components are categorised as human capital as described by Keating et al. [41], Forrest et al. [7] and Haase et al. [39].

Local knowledge is typically excluded from this capacity. For instance, Cutter et al. [45] focus only on the proportion of individuals with college education. Yet viewing flood knowledge solely through the lens of official education overlooks the traditional latent knowledge possessed by certain community members. It has been reported that this valuable form of knowledge is often undervalued, despite its demonstrated significance in empowering communities before, during, and after floods [12].

Since some of the components in the human capacity are very individual, they can have different influences on resilience depending on the context. An example is 'age,' often measured through proxies like the percentage of older individuals, with the assumption that older people are more vulnerable [45]. However, older individuals in certain settlements frequently possess traditional knowledge on responding, recovering, and adapting to floods, derived from their past experiences. It is suggested that communities with prior flood experience tend to be better prepared and more resilient to floods [45]. Consequently, considering old age solely as a negative influence may overlook the nuanced experiential knowledge accumulated by older individuals over the years.

Therefore, human capital should encompass the local knowledge held by individuals within the community. Indicators used to analyse human capital should be approached holistically, primarily through qualitative methods, to gain a deeper understanding, as they may have an opposite influence on community resilience than initially thought. Figure 1 shows the human capacity aspect as one of the six specific components contributing to community resilience.

3.1.4 Natural or Environmental Capacity

Environmental or natural capacity/capital is concerned with the use of natural resources to enhance resilience measures [41]. It includes components such as pervious surfaces, and natural mechanisms such as wetlands that help to mitigate flood risks [7,10,39]. Therefore, this also encompasses Natural Flood Management (NFM) techniques or much broadly Nature Based Solutions (NBS) that employ

natural processes to manage the sources and pathways of floodwaters [58]. NFM can be used as a form of flood defence (protection) buffer especially at the coast [10], but it can also be used as a response during flooding, through storing excess storm runoff water within wetlands or Sustainable urban Drainage systems (SuDs) such as green roofs [58–60]. The Natural capacity component is showed in figure 1 below.

3.1.5 Physical or Infrastructural capacity

The Physical capacity is also known as 'infrastructure resilience' and refers to the physical infrastructure that not only can reduce the risks of floods (flood walls, dykes) but can also be utilized to provide resources and communication during and after flood events in the response and recovery stages of FRM [10,25,39,45]. This includes any physical measures taken to enhance community resilience to floods such setting up shelters in the response and recovery stages of FRM, flood stores which contain equipment such as sandbags important to response, flood action and warning systems including equipment such as rainfall gauges and sirens, CCTV river monitoring schemes, emergency systems, and mobile homes. Infrastructural resilience includes both the community-scale measures mentioned above and also individual property-level measures known as property flood resilience (PFR) measures[13,25,36]. The increasingly popular property flood resilience (PFR) measures are also part of this shift towards more flexible FRM measures [61]. The physical capacity is also shown in figure 1 below.

3.1.6 Economic capacity

Finally economic resilience, or economic/financial capital, plays a significant role in determining the level of resilience in a community. This is because economic capital encompasses the financial resources that individuals and communities require to sustain their standard of living and support their livelihoods before, during and after floods [39]. Several components of economic capital include employment rates, economic diversity, income equality, alternative and multiple livelihood sources, house ownership rates, and tax revenue utilized to maintain community emergency support systems [10,30,39,45]. Twigger Ross et al. [13] and Forrest et al. [7] also categorize flood insurance availability and extent as part of economic capital. However, Haase et al. [39] categorize flood insurance in the institutional capital since it can be institutionalised as well. This is another example of the overlaps that may occur within these capitals, which can depend on context. The economic capacity component is also present in figure 1 below.

3.2 Conceptual framework for community resilience to flooding.

The conceptual framework illustrated in Figure 1 delineates resilience into three fundamental capacities: the capacity to resist, the capacity to absorb, respond, and recover, along with the capacity to adapt. This conceptualization draws inspiration from the resilience spectrum in flood risk management (FRM), as expounded earlier in this paper.

As depicted in Figure 1, each of these six capacities is presented distinctly, with specific arrows denoting their individual contributions to the overall resilience of the community. It is crucial to note, however, that this graphical representation is a simplification intended for clarity. In reality, these capacities engage in multifaceted and diverse interactions that intricately influence community resilience to flooding, a complexity discussed in detail in the preceding section.

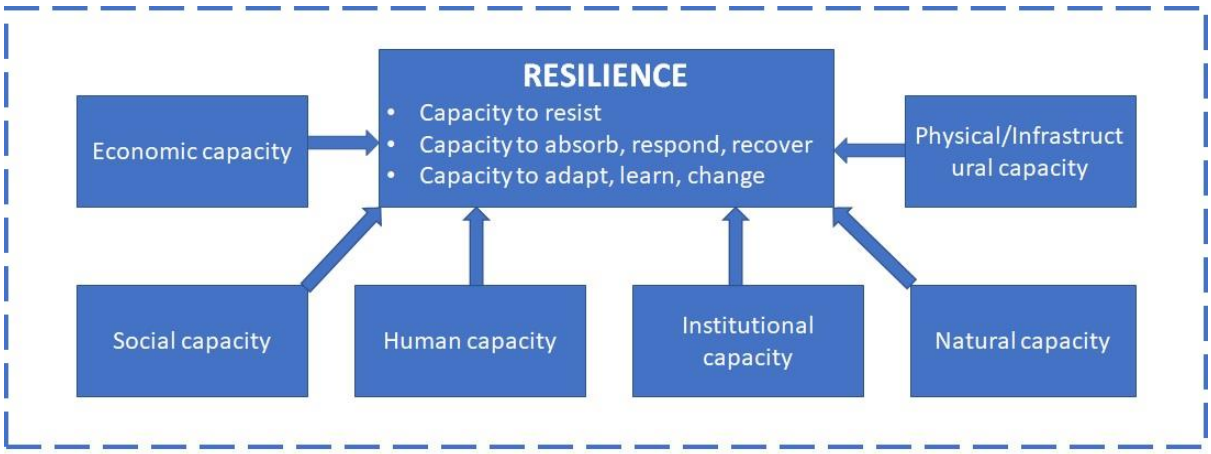

Figure 1: Conceptual framework to understand community resilience.

4.0 Conclusions and following work.

There is an ongoing debate as to whether resilience is a process or outcome [14]. This paper has argued that resilience combines both aspects. As this paper has highlighted, community resilience is the capacity of a community with both outcome-based aspects (engineering resilience/fighting the water) and process-based aspects (response, recovery, adaptation, learning and transformation).

This paper has reviewed the various capacities of community resilience proposed in different literatures, and highlighted the differences in their conceptualisations; for example within the SES field the capacities are more inward looking [38,42] while the disaster literature takes a much broader perspective including both internal and external resources and assets [39,45]. The framework developed within this paper follows that within the disaster literature and acknowledges six capacities or capitals i.e Human, Social, Physical, Economic, Institutional and Natural. Communities can focus on understanding and developing these capitals in order to enhance their community resilience to flooding, in terms of their capacity to resist, to absorb, respond and recover, and to adapt, learn and change.

This paper has also provided examples of the importance of using qualitative approaches when analysing resilience. For instance, in human capacity, aspects such as local traditional knowledge are often ignored in favour of easily assessed or quantifiable formal education when assessing resilience. Yet, local knowledge is considered very important in resilience-building efforts [12]. Additionally, certain components such as old age which are normally associated with reduction in community resilience [45] can in some instances be a positive influence where it may be older people who have local knowledge and experience of previous flooding. It is also important to recognise within this framework that although the capacities appear distinct, in practice they may have overlaps [7,39].

The framework is important as it allows efforts by governments and external agencies that build community resilience to flooding, to target these capacities [36]. In England, DEFRA (Department for Environment, Food and Rural Affairs) has led efforts to increase community resilience, previously through the Flood Resilience Community Pathfinder Schemes [13,25], and currently through the Flood and Coastal Resilience Innovation Programme (FCRIP). In 2021, 25 local authorities received 150 million from DEFRA (2021 – 2027) to improve the flood resilience of 25 local areas. Project Groundwater is one of the FCRIP projects, led by the Buckinghamshire council, and is focusing on improving the resilience of communities to groundwater flooding. It is one of three FRM projects focussed on groundwater flooding, which are the first of their kind, addressing the lack of attention groundwater flooding has received in both policy [62,63] and in literature [64–66]. This developed framework will be employed to gain a more comprehensive, enriched, and nuanced understanding of how Project Groundwater and other government-led programs are contributing to the enhancement of community resilience to flooding.

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