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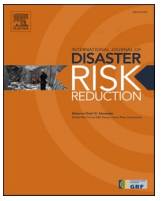

Community flood resilience factors; A community's perspective

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ABSTRACT

Efforts to reduce flood impacts have shifted towards more dynamic, resilience-based approaches, that encompass community make up and physical impacts. Despite this, there is a lack of understanding and the tools necessary to truly comprehend and measure flood resilience in detail at a community level. Previous community flood resilience models and the corresponding factors do not include the experiences and understanding (lay knowledge) of at-risk community members and hence what in reality makes a community resilient to flooding. A community flood resilience survey was designed and distributed to assess current understanding of community flood resilience, presenting a pre-determined list of 20 community flood resilience factors for consultation. Findings were split into three target groups, members of community flood groups (people who lobby for change in their community), those who have experienced flooding and those who have not experienced flooding. Opinions on community flood resilience differed between the groups, particularly its definition and the applicability of certain social factors (i.e. sense of community or community groups). However, there was consensus on the inclusion of physical factors, implying community flood resilience is still inherently considered physical in nature. Results from this study highlighted the importance of including community members in the analysis of community flood resilience and the design of subsequent community flood resilience frameworks. Ensuring lay knowledge is utilised and providing a community specific flood resilience framework with both established (i.e. land use) and novel (i.e. insurance rates) factors, designed not only for key stakeholders, but also community use.

1. Introduction

Flooding is the most common natural disaster worldwide, as well as being the costliest in terms of damage [1,2]. It is a hazard that is also continuing to grow year-on-year, being driven by climate-change and socio-ecological changes [3]. Risk to flooding is the result of a combination of elements including, (i) the physical components such as the spatial proximity to a hazard, e.g., a river; and critically (ii) the social components, such as community structure and durability [4]. It is widely noted that flood risk is heavily dependent on these social aspects, including the demographics of a community, and these critical factors can influence the way a person or community prepares for, copes with and recovers from flood events [5–10]. With this increasing focus on social flood risk factors, there has been a gradual shift in flood management policy, from flood defences and stopping water, now considered unattainable by some experts [11–13], to flood risk management and 'learning to live with water', i.e., flood resilience [14]. Whilst it is predominantly accepted that flooding cannot always be prevented [15], impacts can be reduced by adhering to resilient principals e.g. evacuation plans, greater awareness via enhanced community knowledge. Lowering levels of social vulnerability that that help reduce overall

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flood risk for a community and area.

Flood resilience attempts to maintain an emphasis on integrated solutions to flooding issues that are becoming increasingly complex [16]. This is important due to the rapid rates of global urbanisation, which can lead to environmental degradation [17] and drainage systems that are consistently overwhelmed, increasing levels of vulnerability within communities. Research surrounding the concept of flood resilience and community flood resilience has increased exponentially during the 21st century, especially following the publication of the Hyogo Framework in 2005 [18]. It is now widely used in flood risk management strategies yet still considered largely conceptual [19]. With over 70 definitions [20] flood resilience is widely contested within the sector yet considered vital to reducing flood impacts particularly in areas where vulnerability is high and may not be lowered by 'traditional methods' (i.e. flood defences). Furthermore, enhancing flood resilience is not just essential in our urban areas, it is also key for our rural communities, many of which may not be eligible, or suitable, for physical protective measures. Flood resilience is generally considered to be composed of both physical (i.e. Property Flood Resilience) and social (i.e. community measures) elements and for many, community-based flood resilience measures might be the only option/form of resistance present. It is therefore vital to understand and acquire the most accurate information, where possible, of the flood resilience levels present in vulnerable communities. To provide flood risk and environmental managers and the communities themselves with the necessary flood resilience knowledge and the skills needed to understand and frame their levels of community flood resilience, vital to informing where levels of resilience is limited and dangers may arise. Community flood resilience is an amorphous concept, that is inherently complex [21] and is generally considered to be multi-dimensional [22]. As with many other aspects of resilience, community flood resilience is heavily debated within both the academic and policy landscapes, however it has been shown that a community-level scale is important to build resilience on, as it not only encompasses individual/household level, but also the wider population as well [22,23]. Within this study, the definition provided by Keating et al. [24] of: "*the ability of a system, community, or society to pursue its social, ecological, and economic development and growth objectives, while managing its disaster risk over time, in a mutually reinforcing way*" was used to define community flood resilience. This provides an overall view of community flood resilience and is widely used by academics in the field.

Previous research has attempted to create a methodological framework to measure community flood resilience. Many of these are factor-based methodologies, focusing on qualitative data e.g., in-depth interviews and focus groups [15]. Previously, these models focused on knowledge of academics, researchers and key stakeholders within the field, whilst widely disregarding the lay knowledge of communities who experience flooding, a resource that is vital to acquire a deeper understanding of local systems, community dynamics, public understanding and the reality of levels of flood resilience within that community [25]. This is evident in numerous theoretical and practical flood resilience models including (i) the Disaster Resilience of Place (DROP) model [26]; (ii) the Fuzzy Logic approach to Flood Resilience [27]; and (iii) the Disaster Resilience Assessment of Coastal Areas [28]. However, Laurien et al. [29] Flood Resilience Measurement for Communities (FRMC) framework provides a welcomed notable shift in the approach to measuring flood resilience. Despite still mainly designed for use by stakeholders, this unique method consults with the communities through interviews, focus groups and other techniques. Nevertheless, the factors used within this model are still predetermined and do not use local lay knowledge and perspectives.

The factors used in previous flood resilience frameworks and models (such as those described above) also tend to fit the countries or communities they were designed for. Therefore, they are unlikely to be suitable for wider use, with many social factors such as relative levels of deprivation, native language and community composition not being given sufficient emphasis in many of these frameworks [30,31]. For example, due to the diverse demographic and societal elements of many communities in England and Wales, with 18% of the population belonging to an ethnic minority group [32], as well as a large difference in relative levels of social deprivation, frameworks such as these are unsuitable for use in England and Wales. Therefore, in order to create an effective methodological framework to measure community flood resilience within England and Wales, it is evident applicable community flood resilience factors need to be determined. , Not only to gain a deeper understanding of how communities can reduce the impacts of flooding through improving their flood resilience, but also to ensure that the complex structure and needs of these vulnerable communities are captured. Expert knowledge is more often seen as sparse when informing local decisions for flooding for specific local contexts [33–37]. It is also recognised to deliver sustainable solutions; participatory paradigms need to be used within decision making processes to ensure certified expertise and those with situated knowledge help co-create the information needed to inform resilient management decisions [37]. It is therefore essential that communities are included within the process of classification and evaluation of community flood resilience, including determination of its meaning and the possible factors to measure and even model it, utilising the key lay knowledge that is embedded within them. These community flood resilience factors can then provide a quantifiable measure for complex components of community systems, providing an estimation of the conditions of the systems and the area, for numeric comparability (Balica, 2012; [38]). I.e., assisting our understanding of the reality of the components/elements/characteristics that are influencing levels of community flood resilience. However, research into the public understanding/perceptions of community flood resilience, has been limited, and only developed in recent years (for example [39–41]). Despite the fact it is a seen as a primary element to building capacity for resilience in communities in England and Wales and one of the main recommendations for future flood policies to address [42]. Currently it is not known how the public perceive community flood resilience, or if they understand the concept. However, it has been found that in-depth examinations of community perceptions can aid in identification of hazards and inform organisations as to what resilient actions are best suited [43]. There have been further calls for hybrid knowledge exchange, that will allow lay knowledge that is embedded within these communities to be utilised, resulting in co-production of flood knowledge between professionals and the community (Haughton, Bankoff and Coulthard, 2015), however this has yet to be applied to community flood resilience and its analysis, including the appropriate frameworks and models and the associated factors to achieve this.

Over time communities in England and Wales since 2002/03 have created Community Flood Groups (CFG) (e.g., Flood action groups), with the help of lead intermediaries such as the National Flood Forum (NFF) (England and Wales' main charity that helps,

supports and represents people at risk from flooding), to give them a platform within flood risk management schemes. Critically honing and using this indispensable knowledgebase. Further, highlighting the importance and merits of integrating this vital lay knowledge within local flood risk management schemes. CFGs are grassroot community groups (>400 in England and Wales), who act as a representative voice for the wider community [44]. Research by Forrest, Trell and Woltjer [45] identified CFGs as groups of people who have an interest in flood issues and meet to discuss them. Providing advocacy for the local communities on pressing issues, as well as aiding in times of crisis [45]. Inclusion of groups of this type in community flood resilience research is vital as they provide the vital lay knowledge about community elements or systems that may otherwise be missed, allowing the complexity of local flooding to be captured, as well as the effects of any following events (McEwen et al., 2012). This knowledge usually lays latent in communities, and is only called upon in times of disaster, however, it could be used proactively to harness local expertise, help flood risk management be as effective as possible and fundamentally assist with the analysis of elements related to flood risk, such as community flood resilience.

Utilisation of lay knowledge from CFG members, as well as community members, is an essential element to identify key community flood resilience factors that could be used in creating a comprehensive and holistic community flood resilience framework and future model. It is therefore vital that further research is conducted to understand and analyse the concept of community flood resilience and its corresponding factors from all perspectives. Ensuring that the key lay knowledge that is embedded within communities is utilised and applied. Leading to the development of a community flood resilience framework and its subsequent factors that is collaborative, evidence-based and profoundly applicable to the communities it serves. Ultimately, leading to change to communities and areas most at risk.

The research presented in this paper attempts to close this gap and utilise the lay knowledge embedded within community members to gather a baseline understanding of the concept of community flood resilience and potential community flood resilience factors. This was achieved through the following objectives.

O1: Review of existing literature to identify previous community flood resilience factors, ensuring the suitability of factors through a multi-stage sift
O2: Conduct Community Flood Resilience questionnaire to utilise lay knowledge of community members in England and Wales
O3: Establish potential community flood resilience factors that will be suitable to frame levels of community flood resilience within communities in England and Wales and how these may differ from previously used factors.

2. Methodology

2.1. Community flood resilience factor identification and sifting

A systematic review was conducted between 2008 and 2021, using Scopus and Google Scholar, to identify any existing flood or hazard resilience models or factor analyses. Key word searches included ‘community flood resilience model’, ‘community flood

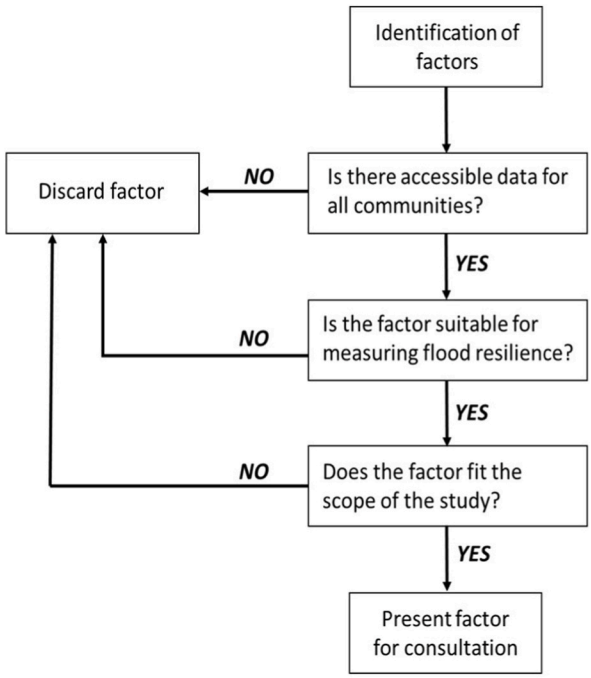

Fig. 1. Flow chart outlining the sifting process for community flood resilience factors.

resilience', and 'community resilience to natural hazards'. This resulted in 70 potential community flood resilience factors being identified from a total of 93 papers, covering a wide scope of themes within natural hazards and flooding. These factors were then sifted through 3 stages (outlined in Fig. 1), to ensure there was no deviation from the focus of the study. Leading to factors limited to association with community flood resilience (i.e. community spirit, flood defences and structural design) and being within the scope of the research (i.e., applicable within England and Wales). This resulted in 20 community flood resilience factors being identified.

To reduce bias further, it was also ensured that the predetermined factors were well routed within existing research, ensuring the resulting 20 factors could truly represent community flood resilience in England and Wales. This warranted that the most effective community flood resilience factors were identified, reducing the chance of multicollinearity, which may lead to bias or over-counting [46], whilst also encompassing all potential aspects of community flood resilience.

Stage 1 - Factors removed due to data accessibility and/or availability ($n = 14$). These factors included factors such as hope, fatalities and injuries. Even though many of these factors could be viable for measuring community flood resilience, there is no community level datasets, hence many will not be available for all communities across England and Wales, or some (such as hope) being extremely difficult to measure.

Stage 2 - Factors removed that were deemed not suitable for measuring community flood resilience in England and Wales ($n = 13$). For example, some identified community flood resilience factors (e.g., Healthcare) were suitable for the countries the research originated from (for example, the FRMC model concentrated their work in the USA, Mexico, Afghanistan (Campbell et al., 2019)), and not applicable in England and Wales due to national systems in place i.e., the National Health Service (NHS).

Stage 3 - Discount factors that would not fit the scope of the research ($n = 23$). Due to the small scale of the study, factors such as sense of belonging, community flood plans and confidence were discounted. Many of the factors that consider social reactions are important in creating a holistic approach to flood resilience [15], yet they are notoriously complex to measure [47] and currently there are no datasets that provide this information. Therefore, a more in-depth study would be required to measure and include them.

The resulting 20 community flood resilience factors were then split into 5 capitals (Fiscal, Natural, Physical, Human and Socio-cultural) (Fig. 2), based on the categories presented in the Community Capitals Framework (CCF) [48]. This has recently become rooted within the community research sector, greatly contributing to understanding of community development and sustainability [49]. Within this study, like many others (i.e. [49–51]), the capitals were used to help categorise the 20 identified community flood resilience factors into resources that could be important for a resilient community to possess, while also creating a preliminary structure for any future community flood resilience framework and models.

Within the CCF there are 7 capitals including Human, Social, Political, Cultural, Physical, Natural and Fiscal. Yet, 'Political Capital' was not included in this research as the study's focus was on embedded lay knowledge of flooding and flood resilience within communities rather than political influences on potential flood risk management strategies. Social and cultural capitals were also combined for simplicity, as observed in other flood resilience methodologies such as the FRMC [21].

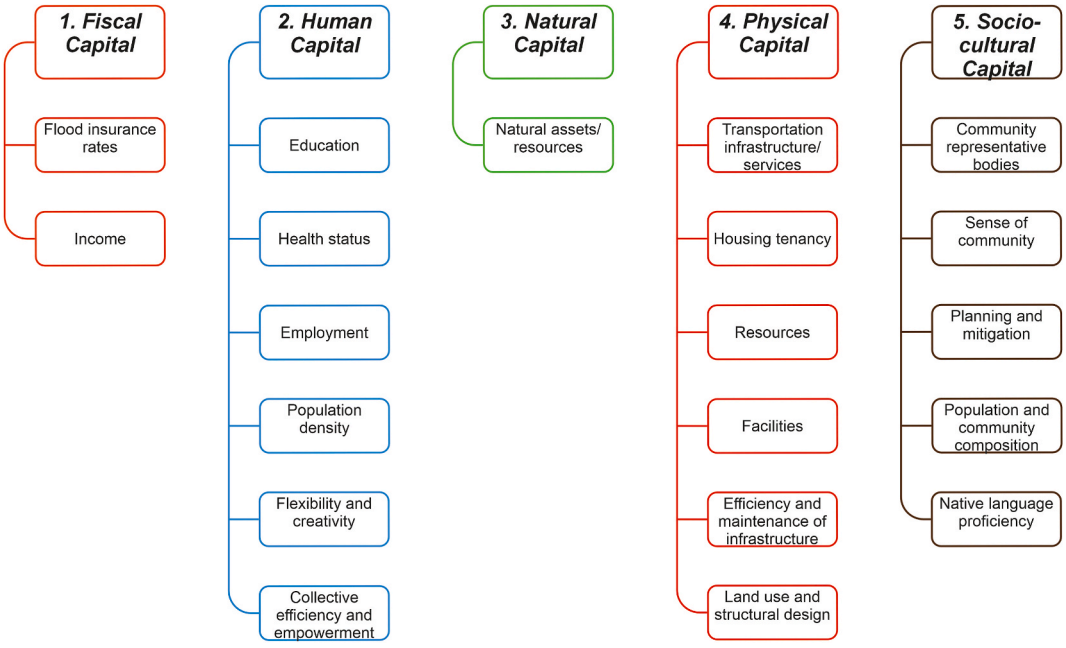

Fig. 2. Factor map outlining community flood resilience factors included in the survey, split into the 5 community flood resilience capitals applied to this study.

20 possible community flood resilience factors were carried through to the 'Community Flood Resilience Survey' to be further analysed and established in terms of significance and suitability from a community perspective. I.e. community knowledge and perspectives (lay knowledge) would be captured to help determine community flood resilience and the factors used to measure it.

2.2. Community flood resilience survey design and distribution

The survey was primarily designed to utilise lay knowledge to rate the validity and significance of the previously identified community flood resilience factors. However, it also provided an opportunity to analyse multiple concepts of community flood resilience, including previous flood experiences and perceptions of the definition of community flood resilience, still a relatively unknown concept. To achieve this, the community flood resilience questionnaire included a combination of open and closed questions. Closed questions were used to create structure and allow ease in analysis [52], as well as provide comparable data. Open questions were designed to allow participants to illustrate important points and ensure they could express their opinions [53], whilst also reducing researcher bias.

The questionnaire was broken into two sections. Section 1 included collection of demographic data, flood experiences and opinions on community flood resilience definitions. This approach was utilised thoroughly to explore the key lay knowledge embedded within communities when regarding resilience to flooding, determining the reality of current understanding of the concept that is community flood resilience. Section 2 then presented the study's identified and sifted community flood resilience factors (Fig. 2), in a Likert scale format (1-5), as well as open questions, to gauge opinions on the suitability of these factors and suggest further factors that may be missing.

The survey was initially distributed online through the NFF, using a targeted sampling strategy, to members of CFGs, to attempt to gather their knowledge of flooding, and their opinions on the importance of the pre-determined community flood resilience factors (Fig. 2). This resulted in 48 responses. To acquire further data, the data collection method was altered using convenience and random sampling, and the survey was opened out to the public, using online social media platforms and the 'Call for Participants' website, resulting in a further 29 responses. To collect further responses, the survey was also conducted in the field, resulting in another 48 responses, totalling 125 responses. The field sites were in the Northwest of England, including an area that had previously experienced severe flooding (Kendal, Cumbria - 2009 & 2015) and one that had not in the last 50 years (Chester, Cheshire). Those who had not experienced flooding were used to assess a potential baseline of public community flood resilience knowledge, which can be important not only to increase the flood awareness of societies (Adebimpe, Proverbs and Oladokun, 2020) but also for applying a community flood resilience framework and model to communities who have not previously experienced flooding. Added to this these sites were also chosen to establish if there is inherent lay flood knowledge within communities who have different experiences of flooding, or does it lie primarily with those who are the most involved in advocating for community level flood risk management practices (i.e. CFG members). This multi-pronged approach increased the reach and number of participants, widened the target audience and further reduced bias, as well as providing the opportunity to determine if experiencing a hazard dominates understanding and then resilience to it.

2.3. Background of field study area

2.3.1. Demographics from 2021 census data

The two field sites that were surveyed in this study are Kendal, Cumbria and Chester, Chesire, both of which are situated in the Northwest of England, an area in England that has experienced widespread flooding over time. Covering an area of 14,105 km^2, where demographics are diverse. According to 2021 census data [54], there are 7,417,397 usual residents living in this area, with a population density of 525.8 resident/km^2. Important demographics to consider for this study include.

- 3.7% of residents are in a household where no people have English as a main language.
- 41.1% of residents are classed as economically inactive (i.e. retired, students, carer, long-term sick or disabled).
- 34% of residents live in rented accommodation (private or social).
- 19.5% residents have no educational qualifications.
- Contains some of the most deprived areas in the country.

These elements are key when considering the community flood resilience factors that are deemed applicable to the survey respondents (shown in Fig. 2), to ensure that the factors presented were representative of the communities being asked.

2.3.2. Flood management and resilience measures

Consideration of existing flood management and flood resilience measures in the field study areas utilised within this research is crucial to understanding the current landscapes and possible lay flood knowledge embedded within the communities. There are currently over 20 known CFGs in the Northwest area, one of which is situated in Kendal, Cumbria. As discussed in Section 1, CFGs can be key in measuring and improving community flood resilience for the area. There are no known CFGs in or around Chester.

Within the Kendal area, there is also the 'Kendal flood risk management scheme'. This includes several measures, including Property Flood Resilience (PfR), Natural Flood Management (NFM) as well as the construction of a new flood wall [55]. Many of these can be considered both flood risk management and flood resilience measures that could affect the opinions within the area. However, there is a likelihood that many participants are unaware of these or how they affect the flood resilience of the area.

Within Chester, there is limited existing flood risk management or flood resilience strategies. The local flood risk management strategy has not been updated since 2016 [56], with limited information prior to that. This could be due to numerous factors, including having experienced limited flooding since then. These specific local contexts were also taken into consideration during the analysis. Resulting in two areas used with differing flood and community contexts.

2.4. Thematic analysis

Finally, a thematic analysis was conducted on several of the open questions (Q6, 8 and 9 [57]) to allow a conceptualisation of the dataset, examining experiences and opinions of participants [58]. This methodology has been used extensively within qualitative research, to produce an understanding of rich datasets (such as [59–61]).

Themes were identified within the answers, resulting in over 25 in some cases (Question 6, see Laidlaw, Percival and Kiriakoulakis [57]). Without having the restrictions of a structured methodology that draws from previous understandings, which is associated with deductive methodologies [62–64], inductive coding was used to allow the most dominant and significant themes to be drawn from the raw data. As with other qualitative methods, this was a multi-stage process [65,66], with the initial identification of themes being proceeded by categorisation of the themes by similarity. This was done to allow simplicity in coding, whilst keeping the richness of the data.

3. Results

The survey participants were split into three groups, (i) members of CFGs, (ii) those who had previously experienced flooding, and (iii) those who had not experienced flooding.

3.1. Demographic data

3.1.1. Age

The majority of the survey participants (42%) were over the age of 60, which increased to 75% for CFG members (Fig. 3). Although this is only a small sample size, these results indicate a lack of age diversity within CFGs, a common finding in voluntary community groups such as these. The remaining survey participant groups (those who have experienced flooding and those who haven't) contained a wider spread of ages, yet there were still fewer participants that were under the age of 30 (21% of those who had previously experienced flooding and 25% of those who haven't previously experienced flooding). A result that could predominantly be due to the time of day when the site visits and surveys were conducted (midweek and during term time). The average age of survey participants being over 40 at both survey site areas could have also been a result of this factor (Office for national statistics, 2023a; Office for national statistics, 2023b).

3.1.2. Gender

The gender of survey participants was predominantly identified as either ‘Male’ (42%) or ‘Female’ (56%), with ‘prefer not to say’ and ‘non-binary’ equating to the remaining 2% (Fig. 4). No participants responded as ‘other’. These identified participant makeup trends transcended throughout all the groups, with a higher percentage of participants who identified as female in each participant group.

3.1.3. Location

Understandably, most survey participants were from the North-West area (65%), as this is where both field study sites were situated (Fig. 5). However, 40% of CFG participants were also from the Midlands (Fig. 5), which is predominantly where newer CFGs have formed and are possibly more willing to participate in the research due to the recent flood events occurring in these areas. Whereas, in

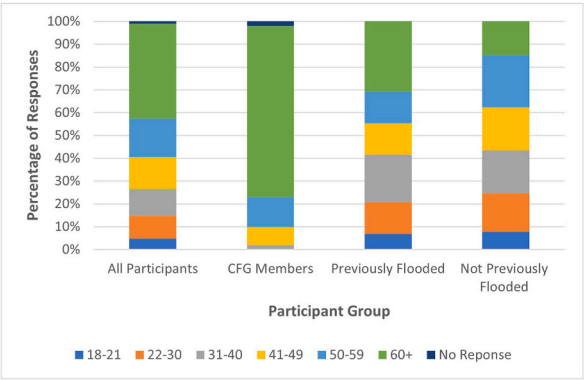

Fig. 3. Age of participants.

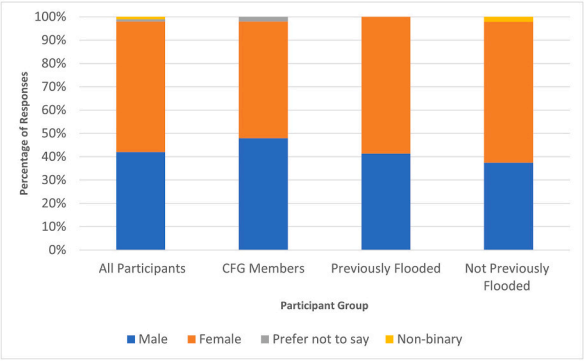

Fig. 4. Gender participants identified as.

other areas (such as Cumbria or the Southwest), the CFGs may not be as willing to take part in the study due to their lack of involvement in research the past or becoming increasingly independent from the NFF. Furthermore, many Cumbrian CFGs in the last few years have become independent groups (National Flood Forum, per comms, 2022), yet they still stay in contact and are supported by the NFF, including providing help to these CFGs during and post flood events and assisting with critical stakeholder relationships.

3.2. Community flood resilience definitions

One of the key elements to this study was to gauge communities existing understanding of community flood resilience (Question 6 of the questionnaire see Laidlaw, Percival and Kiriakoulakis [57]). As previously mentioned, there is no consensus within the academic community surrounding a community flood resilience definition, and thus lay knowledge is being explored as a crucial source to gauge a better understanding of this term within communities and help identify the factors needed to measure it.

Responses to the definition of community flood resilience were split into 9 categories that represented the results collected (Fig. 6), with differing opinions between the three groups. 56% of those who had previously experienced flooding believed that resilience is related to 'stop, withstand and prevent flooding/disruption', whilst CFG members stated that community flood resilience also means 'experience, preparation, prediction, knowledge and education' (24%). Those who had not previously experienced flooding had more varied opinions on the definition, with 17% being unsure, and 21% of responses highlighting 'defences, protection, maintenance and alleviation'.

3.3. Factors to measure community flood resilience

The 20 community flood resilience factors that were sifted and deduced from the initial thematic analysis (Section 2.1), were presented to the survey participants (Question 7*)* for them to establish the significance and validity of these factors. The possible community flood resilience factors were presented in a Likert scale format, ranging from unimportant to important (Table 1) and the average of these scores for each participatory group was used to assess the average importance of each factor (Fig. 7). Responses were then compared between the three participant groups, to assess the differences in opinions, as well as create a rank of importance of these community flood resilience factors.

The three groups generally had differing opinions on the importance of the factors presented to them, however agreed on the importance of some (Fig. 7). Those that had not previously experienced flooding tended to have a neutral view for the majority of the community flood resilience factors presented to them, including those that the other participants (CFG members and those that had previously experienced flooding) rated as important, such as 'flood insurance rates' (Fiscal capital), 'collective efficacy and

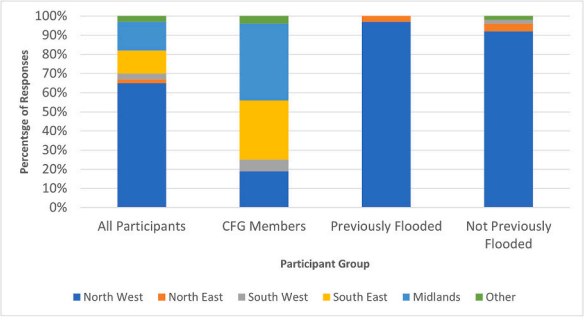

Fig. 5. Geographic location of participants.

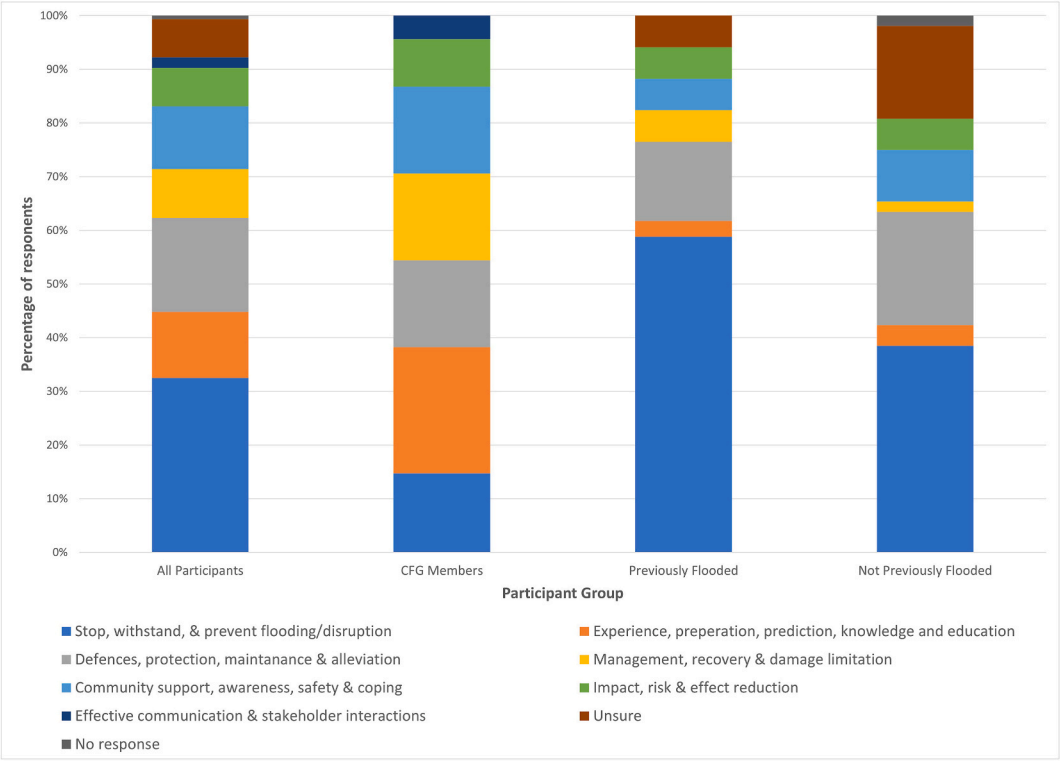

Fig. 6. Key categories for definitions of community flood resilience presented by participants.

Table 1
Coding of Likert scale for Q7 in survey.

Q7. Please rate the following factors according to how important you believe they are in measuring flood resilience.	
Code	Rank
1	Unimportant
2	Somewhat Unimportant
3	Neutral
4	Somewhat Important
5	Important
6	No Response

empowerment' (Human capital) and 'health' (Human capital). Factors that are not commonly associated with community flood resilience (e.g., income, education, and health) appeared to vary in importance between the groups. Even though health was ranked as 'important' by members of CFGs, this was not shared by the other 2 participant groups, with those that had previously experienced flooding rating it as 'neutral'.

Members of CFGs also ranked many of the suggested community flood resilience factors higher than those that had previously experienced flooding and those that had not previously experienced flooding. This is most noticeable with community flood resilience factors that are socially based (Fig. 2). CFG members ranked 'sense of community' (Socio-cultural capital) as somewhat important to important, whereas the other two groups ranked it lower, rating it as either neutral to somewhat important. Similar results were noticed with the 'community representative bodies for flooding' factor (Socio-cultural capital), where CFG members ranked it as somewhat important to important, those who had previously experienced flooding rating it as important, and those who had not previously experienced flooding rating it as neutral to somewhat important.

The factor that was ranked as the most important by all three groups when considering community flood resilience was, 'efficiency and maintenance of infrastructure' (Physical capital), which all three groups unanimously rated as somewhat important or above. This was closely followed by 'land use and structural design' (Physical capital), which had an average rank of somewhat important. The lowest ranked factor was 'native language proficiency' (Socio-cultural capital), which was ranked as neutral by the CFG members, but somewhat unimportant to unimportant by the other two survey participant groups.

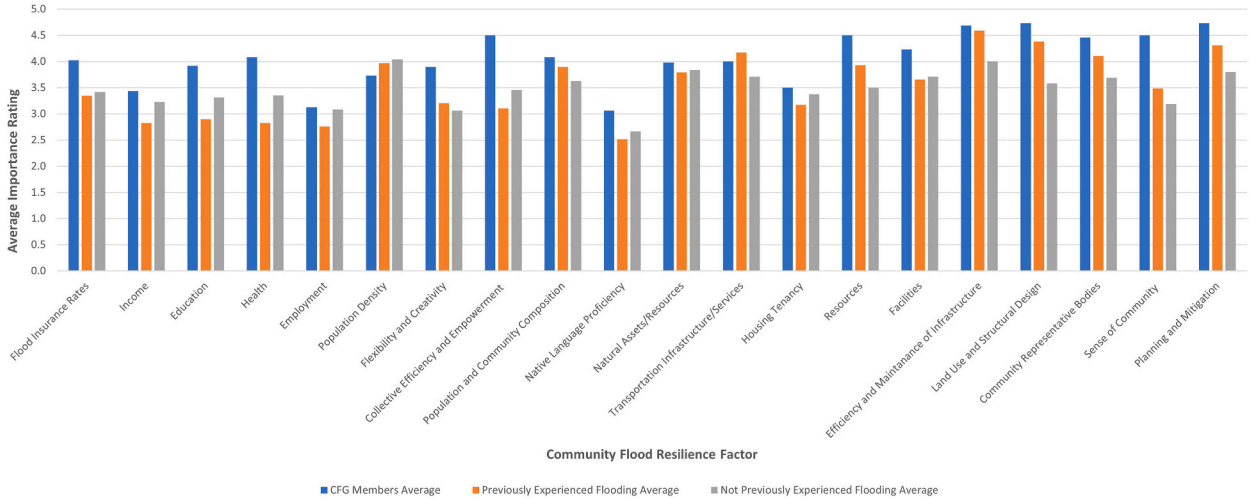

Fig. 7. Average rating of each factor presented in the questionnaire per participant grouping.

3.4. Community flood resilience factor applicability and further suggestions

Participants were also given the opportunity to express their opinions of the possible community flood resilience factors above (Section 3.3), and their applicability, including suggestions for potential additions.

3.4.1. Irrelevant community flood resilience factors

22% of all survey participants highlighted that they believed one or more of the presented community flood resilience factors were not relevant when measuring flood resilience in communities, with the focus of many of the comments on the demographic/social capital factors (See Fig. 8).

Income was the most contested factor (19%), closely followed by native language (13%), and housing tenancy and employment (13%). Many of the survey participants questioned the inclusion of these factors, with one participant, who had not previously experienced flooding stating, '*the main objective surely is preventing flooding*'. There were further comments surrounding demographic 'personal' data, suggesting factors such as income, education and age should only be used to ensure equality rather than community

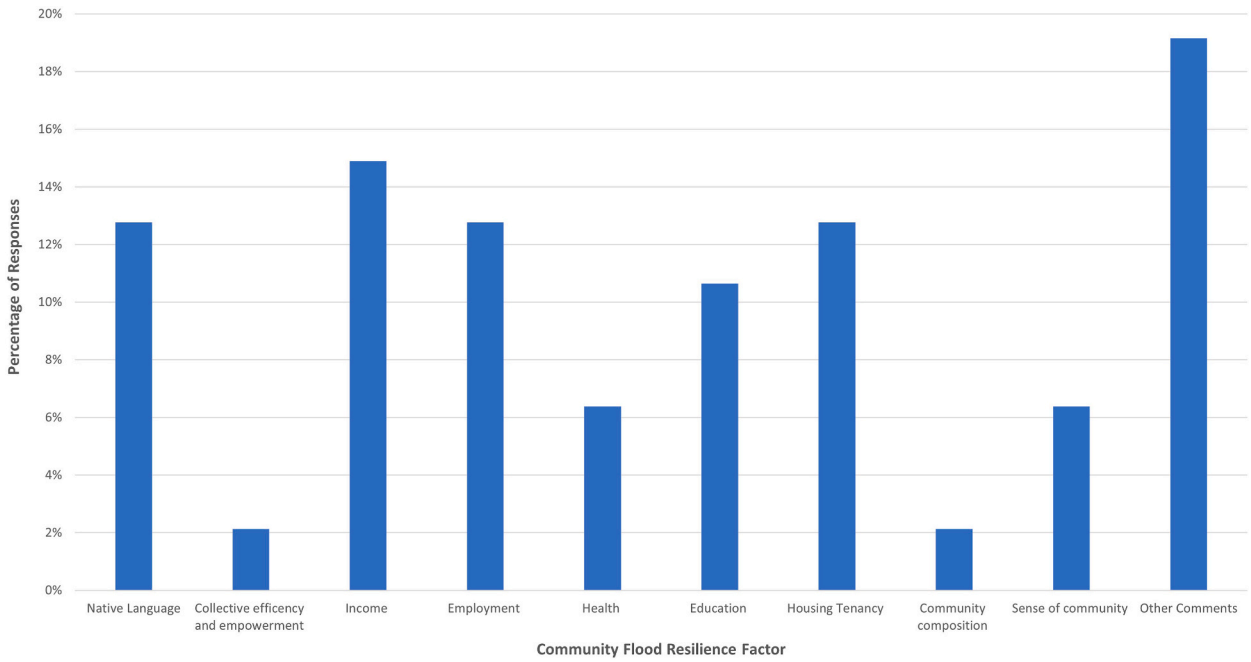

Fig. 8. Factors deemed irrelevant to participants for measuring community flood resilience.

flood resilience.

'Other comments' (19%) included responses that were not related to the factors included in the questionnaire, but the meaning of the factors or the question itself. Including responses such as '*I struggle to understand what you are asking and plan to get out of this info*' and '*not sure what a lot meant*'. This indicated confusion about the direction of the question as well as perhaps the definitions of some of the suggested community flood resilience factors. It also indicated that potentially there were design issues with this section of the questionnaire, which could have also confused the participants.

3.4.2. Additional community flood resilience factors

30% of respondents answered that there were additional factors that needed to be considered when measuring community flood resilience. 27% of these were in fact social based factors: 19% stakeholder relationships and engagement, 2% communication, and 6% community spirit, representation, and volunteering. The remaining 73% included more physical factors, such as 'Planning, building control, land ownership and structure' (17%), 'Climate change' (2%) and 'Flood type' (4%)) (Fig. 9).

Some of the additional factors mentioned could be seen as/included within the existing community flood resilience factors presented and analysed in the survey (Section 3.3). Community spirit, representation and volunteers could be included in community representative bodies (representation and volunteering) and sense of community (spirit). Further solidifying the potential inclusion of these factors, whilst also indicating potential issues with the terminology used for the initial community flood resilience factors.

17% of responses highlighted flood monitoring and defences as important. Although this was originally identified as a possible community flood resilience factor, it was disregarded during the initial sifting process as flood defences account to resistance and not resilience, as they reduce the amount of water that can enter an area [39], rather than aligning with the concept of adapting to live with water. However, there needs to be consideration of existing flood defences and how these affect communities, as well as plans for new defences, and how these are promoted to communities. Similarly, flood recovery and experience were also mentioned (2%). These were also discounted during the initial sifts, due to not being applicable in all areas, however, there needs to be considerations for areas that have previously experienced flooding, suggesting that not all community resilience factors identified would fit all areas and contexts.

Planning, building control, land ownership and structure was another physical capital-based factor that came up multiple times (17%). Even though this hasn't previously been discussed, this is a factor to consider within further research on community flood resilience. Furthermore, fiscal factors such as funding, *insurance prices and ability to sell buildings/land* were also discussed (10%). Although flood insurance rates were previously included, the other factors are novel. These novel factors can help create a more rounded and realistic model for measuring flood resilience in communities, including factors that may not be considered by other researchers.

4. Discussion

Flood resilience is an increasingly complex need, and it is questioned if community flood resilience can be measured as a stand-alone theory, or if it should be incorporated into wider management frameworks i.e. flood risk models. The problems stem from

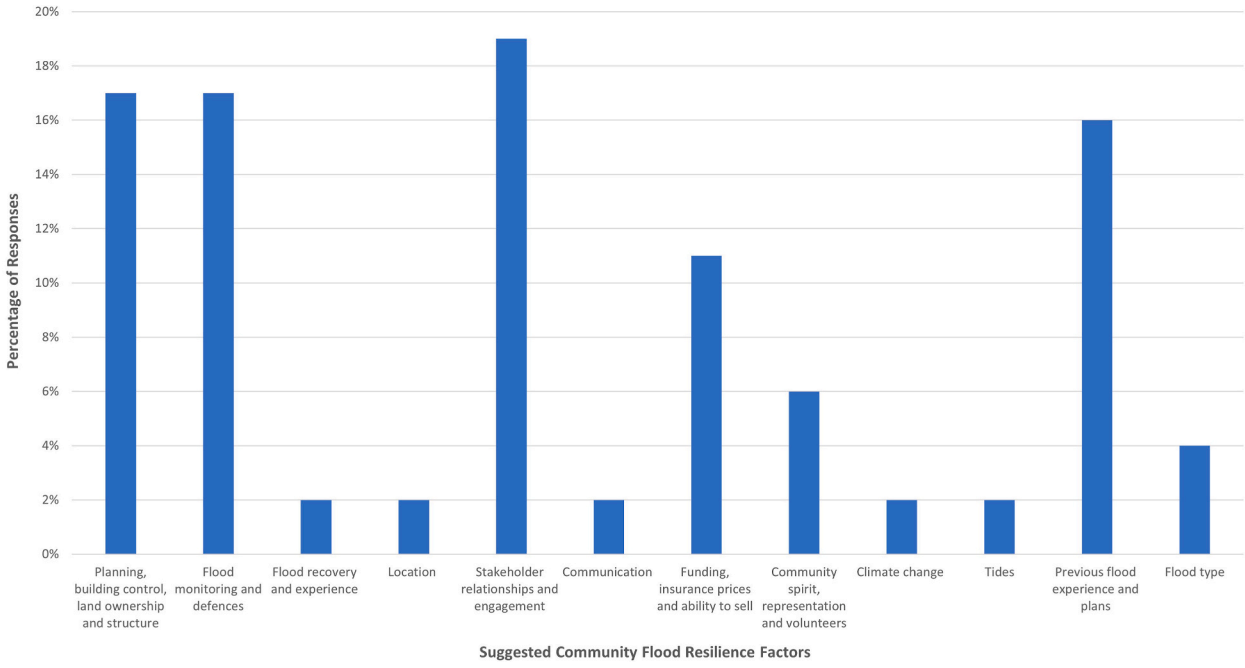

Fig. 9. Factors suggested by participants that may be applicable when measuring community flood resilience.

the lack of clarity in the definition of flood resilience [20]. I.e., when looking at social resilience, there is a lack of clarity and consistency on the issue [67] and furthermore there are difficulties with potential access to data due to the nature of resilience itself, as well as the context in which it is used in. It is therefore vital that communities are consulted when trying to determine how to measure their resilience, ensuring that vital lay knowledge is consolidated within the models to determine and capture the relevant features of community flood resilience, assisting our understanding of the reality of local resilience in flood prone communities, at the level of certainty needed to manage flood risk effectively. However, this lay knowledge can be hard to access, therefore it needs to be considered where this data can be accessed. Many of the socio-cultural capital factors presented in this study, such as health, education, native language, and population density can all be collated from census data. However, this is only updated every 10 years [68], and therefore the data may not be applicable or relevant. There are similar issues with qualitative methods, which are usually favoured within community-scale research, with social science perspectives being more prevalent [15]. However, building relationships and working alongside key community groups, such as CFGs, can allow this data to be accessed when required. Leading to a thorough assessment of current flood resilience levels within the community and a much better understanding and access to the factors driving it.

4.1. Community perspectives of community flood resilience definitions

As expected, there were differing opinions on multiple aspects of community flood resilience, especially the definition. CFGs had a different view about the definition of community flood resilience to the other two groups that participated in this study (those that have previously experienced flooding and those who have not). CFGs focused more on the socio-cultural capital aspects of community flood resilience, such as 'community support, awareness, safety & coping' and 'effective communication & stakeholder interactions'. As these are generally people who have experienced flooding and nominally want to advocate for their local community [69]. Hence this socio-cultural factor focus is expected. Whilst those who had previously experienced flooding, and those that had not experienced flooding focused more on physical capital aspects, such as 'defences, protection, maintenance and alleviation' and 'stop, withstand and prevent flooding/disruption'. This could be due to limited knowledge on flooding and its associated impacts, as some of the responses also stated 'unsure' as to the definition of community flood resilience in the first place. Or this could relate again to the lack of a standardised definition of flood resilience [20] which has transcended to many different levels.

It was expected that the community perspective of community flood resilience might concentrate on stopping flooding, particularly through physical measures such as flood defences, as this is what previous flood-risk management practices have promoted as deliverable and 'effective'. This was the case with those who had previously experienced flooding, as well as those who had not. 45% of those who had previously experienced flooding were from Kendal (not including CFG members), a community that has not experienced severe flooding since the commencement of the local flood defence construction in 2021 (Flood Hub, 2023b). Results such as these may lead to communities believing they are no longer at risk from flooding, and that hard structures are predominantly the answer to resilience. However, if they once again experience flooding in the area in the future, i.e. the defences 'breach/fail', opinions on community flood resilience may move away from a physical capital direction to potentially more of a socio-cultural capital one due to experiences akin to CFG members.

For those who have not previously experienced flooding, like some of the participants in this survey, it is likely they have been influenced by media coverage of extreme flood events [70], which in turn will likely to distort understanding of community flood resilience, as there tends to be a focus on flood defences and their roles after large flood events, such as the 2015 storms in England (Flood Hub, 2023a). Rather than broader elements of resilience such as socio-cultural factors like education, community or representative bodies. Potentially leading to a one-dimensional understanding of resilience, that can hinder their understanding of community flood resilience and the factors most important to measuring it.

4.2. Community flood resilience factor analysis

4.2.1. Existing community flood resilience factors

The community flood resilience factors that were presented to the participants in this study are rooted in previous flood research, with some factors appearing in over 20 papers. However, there was still a lack of consensus between the three participant groups about the importance of many of these factors. Nonetheless, there was a general agreement about the inclusion of physical capital factors, such as 'Efficiency and Maintenance of Infrastructure' and 'Land Use', which were ranked highly by the survey participants. Suggesting many community members believe resilience is still very much a physical entity through protection and infrastructure and coincides with how the community members predominantly defined community flood resilience in this study. Defining resilience as a physical element is also now suggested by the UK Government, who's focus of flood resilience lies with Property Flood Resilience (PfR), for example, the 'Be Flood Smart' scheme by FloodRe and the Environment Agency [71]. These are modifications to houses and buildings that are designed to lower a buildings flood risk, such as the inclusion of flood doors and non-return valves, and reduce the time needed and costs of repairs after a flood [72], aiding a more rapid recovery. This is suggested to improve flood resilience in the notion of a more rapid recovery rate, however, may not address all issues, such as make-up of the building i.e., construction/age, drainage failures or wider community issues. These findings solidify that most still see community flood resilience as inherently a physical entity, yet care needs to be taken when considering physical factors, especially PfR, however, physical factors should not be discounted but also not included solely.

Some socio-cultural capital factors were also rated as significant when measuring flood resilience in communities. One of the highest rated factors was 'Community Representative Bodies', with an average rank of 'important'. This was generally agreed between participants as important, particularly those that were CFG members (average score of 4.5) and those that had previously flooded

(average score of 4.1). However, this factor was also ranked lower by those who had not previously been flooded (average score of 3.7) (Fig. 7). It was expected that CFG members would rank this as an important factor. However, as previous research by Geaves and Penning-Rosswell (2015) has identified, the groups may not actually achieve their goals, mainly due to conflicts between different flood stakeholders. If community groups such as CFGs are consistently knocked back by these stakeholders (i.e. through lack of communication or involvement), they could view their role as unimportant and overlooked. Similarly, with those who had not previously experienced flooding, awareness of CFGs and their roles could be limited and therefore could have rated the factor as 'neutral' in terms of importance. The discrepancies in the perceptions of the importance of this factor between those that have flooded and those who have not, can highlight the importance when analysing elements such as community flood resilience, that real 'lived experiences' can identify elements that, are important, rather than subjective feelings [73], which those who have not previously experienced flooding may have based their answers on. This result also highlights that the opinions and experiences of those who have previously experienced flooding (including CFG members) is vital when measuring community flood resilience.

However, not all of the socio-cultural factors were deemed significant. One factor that was ranked low by participants was 'native language proficiency'. This stems from work by Cutter, Ash and Emrich [74]. With only 1.8% of usual residents within England and Wales not being proficient in English [75], it is therefore understandable this factor may not be considered essential within a community flood resilience measurement for England and Wales. However, with the UK receiving 31.2 million tourists in 2022 [76], native language capacity may need to be considered in areas where tourism levels are high, combined with a high risk of flooding (i.e., Lake District, Cumbria or Worcester, Worcestershire). Furthermore, the adoption of native language capacity should be included within a wider factor of tourism, this may be beneficial, particularly for coastal areas that could be affected by unprecedented flooding from sea level rise and/or extreme weather conditions i.e. Great Yarmouth, Norfolk or Portsmouth, Hampshire [77,78], and danger to life is more prominent.

Income was another contested factor, with 15% of respondents highlighting some of the community flood resilience presented factors to not be relevant, including income. However, this could be considered one of the key factors within fiscal capital, as well as within a future community flood resilience framework and models. Income can affect both preparation and recovery to flooding. Within recovery, income can affect humanitarian assistance, as well as residents' ability to relocate or stay within the community [79]. Ahern and Galea [80] highlighted the negative effects of low income on post-disaster functioning of communities, with those in neighbourhoods characterised by uneven income distribution experiencing higher levels of depression. This may reduce the coping capacity of the area, as people may not be able to deal with the stress generated by flooding, which is a major component of resilience [81]. This may be the case in England and Wales, especially in the northwest, where there are higher levels of social deprivation (as noted in Section 2.3.1). In 2019, 61% of Local Authorities in England had at least one neighbourhood in the most deprived decile nationally [82]. Consideration of income within this measurement is vital, however, it also considers other social demographics, such as health and barriers to housing and services. Therefore, consideration of how income can affect wider socio-economic community flood resilience factors is important. For example, those who have a lower income and live in flood prone areas are less likely to purchase flood insurance and its rising costs [83]. Therefore, if a flood was to occur, they would have no protection, which can decrease the flood resilience of the community and area as they may not be able to recover efficiently, or at all. This has been noted in a report by Cobbing and O'Hare [84], highlighting not only insurance and income, but other social capital factors such as health, tenancy and employment, and its importance in flood poverty, which again can reduce the flood resilience of a community and an area.

4.2.2. Suggested community flood resilience factors

Some participants suggested that 'Previous Flood Experiences' should in fact be integrated into a community flood resilience analysis/model, incorporating the 'lived experience' of communities, as considered within 'community representative bodies'. This can be classed as learning from flood experience and is usually mentioned in the context of adaptive capacity [85]. Previous flood experience can aid in future flood events, allowing adaptation and preparation [86], however, this does not mean that communities that have not previously experienced flooding are not flood resilient, yet previous experiences may have an influence in improving the underlying community flood resilience. There should also be a consideration of repeated flooding. Even repetition of smaller, 10-year magnitude floods over several years can have a huge impact on a community [26], and those that are directly affected by it. Most previous research on repeated flooding is focused on owners/caretakers mental health issues (e.g., Ref. [87,88]), and therefore prior to inclusion into a model to measure community flood resilience, a deeper understanding of the effects of repeated flooding is required including its effects on the surrounding environment, the affected buildings (including foundations and contents) and the community that reside there.

'Flood defences' were also suggested by numerous participants as an integral factor to measuring community flood resilience. Whilst these are still the chosen method of protection by the government (£2.6 billion spent over a 6-year period from 2014) [89], these defences aim to stop water, rather than increasing resilience by learning to live with water. A potentially more sustainable and community flood resilient option. Where there are existing defences, there is also a risk of complacency by communities, who may believe they are protected from future flooding, even when flood alerts are issued [90]. Construction of new flood defences can also encourage more development in flood zones, increasing the pressure on those defences [91]. This could suggest that presence of flood defences may affect community flood resilience, but in a negative capacity. Furthermore, this could also be the case for considerations of PfR as discussed in Section 4.2.1, where the term resilience in this capacity refers to reducing damage by flood water when it enters a property (Flood Hub, 2021), again a physical capital component of community flood resilience and with the aim of keeping the water out. There are concerns that the focus on PFR can hinder the resilience of buildings, especially if the PFR measures are inappropriate for that building as the resilience of our infrastructure to flooding is precarious and worryingly unknown. This is most likely to occur within listed buildings or those of traditional construction which are generally protected with inappropriate flood resistance products

or building products and specifications under the British Standards (BS) 851188, and PFR Codes of Practice. All of which can affect the post-flood integrity and recovery of the building [92].

4.3. Importance of community involvement in framing community flood resilience

Ultimately, community members are those that have the most lived experience, especially members of CFGs. It is widely acknowledged that communities need to be involved in FRM strategies, especially to help increase the effectiveness and efficiency of those strategies [93]. Yet they tend to be overlooked when measuring flood resilience within their own communities. It is argued that although encouraging participatory action from community members can encourage community involvement and ensure community values are 'retained', it is ultimately the stakeholders that strive for quantification of existing community resilience, therefore any FRM frameworks should be made with both the community members and stakeholders in mind [94]. Otherwise, FRM strategies may not be representative of the community themselves and lead to limited flood resilience in the communities and areas they are meant to protect.

The research undertaken and presented in this paper confirms is it possible to integrate community member's needs into FRM strategies, and furthermore that lay knowledge of community members in England and Wales can be utilised to understand and analyse community flood resilience. This research has provided a methodology to allow the voices of community members to be heard and considered in relation to the significance and validity of previously identified community flood resilience factors, as well as the space to suggest any novel factors that have not been but should be considered. This is critical in providing a holistic and realistic view of current levels of understanding of community flood resilience, whilst attempting to close the existing academic knowledge gap surrounding definitions and measurements of community flood resilience.

To take this work forward and strive towards the creation of a community flood resilience framework, it is recommended that further research is made to establish levels of understanding of flood resilience within wider communities and in turn how this affects community member understanding of the concept of community flood resilience. This can lead to subsequent research to further establish the suitability of the community flood resilience factors presented in this study for other communities within England and Wales. This preliminary assessment has indicated there are many interchangeable community flood resilience factors needed to create a place-based community flood resilience framework for different communities. Further research into those factors and their interactions is advised to ensure that as many communities as possible can be analysed with the factors utilised. Not only educating the communities on their flood resilience levels but also assist our understanding of resilience itself and help develop a body of evidence-based research to underpin the urgent flood risk management actions needed to reduce the potential impacts of future flooding in flood prone communities.

Although the factors that were derived from previous flood resilience models and frameworks were all (to a degree) considered valid by participants when measuring community flood resilience, this research has highlighted that further consultation with communities across England and Wales is required to create a functional, community driven community flood resilience framework, that encompasses the lived experiences of flood prone communities. Previous research [95] has investigated social contributions to local flood resilience, including CFG members and stakeholders. However, methods such as the one presented in this paper have not yet been done for measuring community flood resilience. Despite the increasing desire for flood resilience strategies to be embedded within communities, there is a lack of connection between lay knowledge and policy outputs. There is a concern that CFGs and communities, whilst being considered indispensable to resilience, are continually undervalued and lacking sufficient support [96]. Therefore, the inclusion of this vital lay knowledge and community experience within future frameworks and policy changes is vital in ensuring that any future outputs are representative of the communities' characteristics.

Finally, it is suggested that the survey conducted in this study is repeated in other areas of England and Wales where there are higher levels of diversity (i.e. London), as well as other areas that have experienced severe flood events (i.e. Monmouthshire, South Wales, Shrewsbury or Greater Manchester). Many communities who have experienced flooding will have memories of these floods that can be used in assistance of 'learning to live with floods' (i.e. flood resilience) [86], which will be useful when designing a tool to frame and measure the flood resilience of a community. This will assist in establishing if any other factors are required to create a place-based community flood resilience framework. Further consultation is also recommended with other key stakeholders (for example local council, EA, water companies etc.) to ensure that the community flood resilience framework developed is designed for all that may use it (e.g. community members, academics, key flood stakeholders etc.).

5. Conclusions

Flooding is expected to increase exponentially due to climate change and communities need to be helped to become more resilient to flooding. This shift in focus has led to an influx of research within the flood resilience sector and yet has also created confusion and lack of direction, not only in defining community flood resilience, but also how to measure it.

To close this gap, this study aimed to include community members in the decision-making process to identify the factors needed for measuring community flood resilience. Three key participant groups were targeted, CFG members, those who have previously experienced flooding and those who have not. Existing factors, taken from current community flood resilience methodologies (i.e., DROP and FRMC) and prior resilience research, were sifted in a 3 stage sift to ensure validity. These sifted potential community flood resilience factors were then presented to participants from the groups previously stated, through questionnaires, to analyse the factors validity and their significance. Participants generally agreed with the inclusion of some of the factors presented to them (i.e., planning and mitigation, land use and structural design), however, there were differing opinions between the three groups on many of the other

factors. CFG members tended to have stronger opinions on the inclusion of socio-cultural capital factors, whereas the other two participant groups tended to lobby for the inclusion of more physical capital factors, such as land use and structural design rather than those that were socio-cultural.

Participants also highlighted that flood experiences and flood defences should also be included when measuring community flood resilience, however these are not always applicable in all areas. This brings to question if there is a single methodology for all communities, or if a much more complex approach is required to ensure that it is a community specific measurement and frame community flood resilience correctly. Within this research it is concluded that measuring community flood resilience is not as simple as using a single set of factors within one framework and model, and may require a much more dynamic version, where some factors that can be added in or removed, depending on the hazard, the local environment, and the contexts of the community itself. This could be determined using the lay knowledge embedded within the communities and the methodology for doing so presented in this paper. However, for this community flood resilience framework and subsequent models to be achieved, a further understanding of how community flood resilience factors could be measured, the datasets needed, the data available, and the interactions between the factors need to be acquired.

Whilst further research is suggested to create a functioning community flood resilience framework, this research has highlighted the importance of including community members in the design of such community flood resilience frameworks. This ensures that lay knowledge is listened to and used to its full advantage, allowing not only well-established factors (such as land use) to be included, but also the introduction of novel factors (such as insurance rates) to be added.

CRediT authorship contribution statement

Laidlaw Sophie: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Percival Sarah:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Kiriakoulakis Konstadinos:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

I have shared a link to my data on the attach file step
Assessing community flood resilience factors from the community perspective (Original data) (LJMU Data repository)

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