Climate Risk Management 32 (2021) 100317

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

Contemporary flood risk perceptions in England: Implications for flood risk management foresight

Henry Ngenyam Bang *, Nicholas Church Burton

Disaster Management Centre, Bournemouth University, Dorset, Talbot Campus, Fern Barrow, BH12 5BB Poole, UK

ARTICLE INFO

Keywords:
Flooding
Climate change
Flood risk perception
Flood risk management
Climate risk management
England

ABSTRACT

Although England has been experiencing major floods dating back thousands of years, the hazard is increasing in frequency and intensity, exacerbated by climate risks with potentially serious consequences. Despite attempts to mitigate climate risks (manifested via recurrent flooding) in line with international disaster risk reduction agendas, the impacts/effects of floods continue to increase in England. This is partly due to negligence in inculcating contemporary flood risk perceptions (FRP) into climate risk management (CRM) strategies. This research aims to investigate contemporary FRM in England through a qualitative case study approach in Wainfleet All Saints in Lincolnshire County that experienced unprecedented floods in June 2019. Empirical investigation was conducted with the flood-affected community members and flood managers with oversight of CRM in the region. Key findings reveal the June 2019 floods had both tangible and intangible impacts for the affected community with dreadful effects. Challenges to CRM revealed issues around limited funding; climate changes' potential to increase flood risk and low community perception of their own risks reflected in poor/none-preparedness for contemporary floods. The multi-agency response to the June 2019 floods was found to be positive, albeit with a few concerns. Based on the analysis of the findings, a series of policy recommendations are proffered with the aim to spur organisational/institutional resilience to CRM. This article underscores the relevance to continuously include contemporary FRP into CRM strategies especially to enhance community participation and involvement in mitigating their own risks.

1. Introduction

The frequency and intensity of flood hazards continue to rise worldwide, are lasting longer and becoming more unpredictable and damaging (Ozger, 2017; Wing et al., 2018), exacerbated by Climate Change (CC) and development/infrastructural projects in enormous risk areas (Denchak, 2019; ASC, 2014). Floods have been the main natural hazards in Europe for more than a century. According to the European Environment Agency (EEA) (2018), between 1870 and 2016, 1,564 major flood hazardous events have occurred in Europe, dominated by flash floods.

To mitigate climate risks, nation states have been implementing international disaster risk reduction agendas (UNISDR, 2015) albeit with limitations partly because public flood risk perception (FRP) have not been sufficiently considered in climate risk management (CRM) measures (Sayers et al., 2018). Understanding public FRP, therefore, underpins enhanced flood resilience and successful CRM strategies (Terpstra and Lindell, 2012) because the social and economic contexts in which disaster risks occur shape

* Corresponding author.
E-mail address: hbang@bournemouth.ac.uk (H. Ngenyam Bang).

https://doi.org/10.1016/j.crm.2021.100317
Received 21 February 2020; Received in revised form 30 March 2021; Accepted 27 April 2021
Available online 8 May 2021
2212-0963/

perceptions of risk and the underlying risk factors (UNISDR, 2017). This necessitates a strategic approach to CRM by engaging risk reduction practices that target the most vulnerable communities (Sayers et al., 2018).

Contemporary characterisation of flood vulnerability in this article is based on the Neighbourhood Flood Vulnerability Index—features of a neighbourhood that determines its potential to experience a depletion of well-being when exposed to flooding and over which flood management policy has minimal or no control (Lindley et al. 2011). The Neighbourhood Flood Vulnerability Index requires consideration of five characteristics: susceptibility to flooding, which is influenced by age and health; the ability to prepare for, respond to, and recover from flooding, which are dependent on income, information use, local knowledge, property tenue, physical mobility, and crime; and community support, which is influenced by housing characteristics, direct flood experience, service availability and social networks (Lindley et al., 2011; Sayers et al., 2018). Vulnerable flood communities in England are the central focus of this research.

Knowledge of FRP in England is vital because flood risk vary in the different River Basin Districts since they have various levels of development, are of varied sizes and are vulnerable to diverse types of flooding (EA, 2018). Interestingly, many flood-prone communities are not aware of the climate risks they face (Lady and Kondolf, 2012) and there is insufficient analysis on the risks they can bear or accept, nor their shared responsibilities in mitigating these risks (Kundzewicz et al., 2018).

This research, therefore, aims to better comprehend contemporary climate risk in England through a case study approach in East Lindsey District of Lincolnshire County that was severely flooded in June 2019 and required that three main objectives be addressed: (1) To gauge how the affected household/community perceive climate risks (2) To evaluate how perceptions of climate risk might influence their individual attitudes towards an adaptive behaviour in flood risk management (FRM) and (3) To investigate whether professionals within the public administration are incorporating climate risk in their management approaches.

This study contributes to fill the knowledge gap that exists between vulnerable flood-prone communities who mostly rely on experiential knowledge to understand, anticipate, and manage flood risks and administrators whose CRM decisions are influenced mostly by scientific information. The analysis seeks to comprehend both the public and stakeholder FRP to examine any convergence and the potential implications for FRM.

This article has 7 sections: after the introduction, Section 2 provides theoretical underpinnings relevant to the article followed by a brief review of flood risk in England in Section 3. The methodology section is next in Section 4, followed by the research findings in Section 5 while Section 6 focuses on discussion. The last section (7) concludes the article and makes suggestions/recommendations.

2. Brief review of theoretical underpinnings

In this article, risk is viewed through the lens of CRM as a combination of hazards, and potential ramifications that are contingent upon a system's vulnerability (influenced by exposure, resilience, and susceptibility) to flooding and FRM objectives can be achieved by altering the risk variables/factors (Balica et al., 2013). Since risk perception studies focus on the relationship between how individuals perceive risk and how they respond to that risk (Slovic, 2000), they provide invaluable insights, in the context of this research, on the appropriate risk reduction and/or adaptation measures to climate risks.

Risk perception is conceptualised in diverse ways: as the intuitive judgement of groups and individuals of risks, in circumstances of limited, unknown and/or uncertain information; the subjective assessment of the probability of a specific type of accident occurring and how worried people are with the consequences and the ability to ascertain the amount of risk from a hazard (Slovic, 2000; Inouye, 2014). A variety of psychological, social, institutional, and cultural factors influence the risk perception of individuals, groups, or communities (Slovic, 2000; Lin et al., 2008). Factors such as the past experiences of individuals or communities to natural hazards, knowledge, attitudes, emotions, and values, influence people's thinking and judgment on risk acceptability and seriousness (Lindell and Perry, 2012). Risk can also be perceived through the relationship of risk characteristics such as worry, awareness and preparedness, or as the combined perceived probability, consequences, likelihood and/or severity of a certain occurrence, event, happening, incident, or activity (Lazrus et al., 2016; Birkholz et al., 2014). In addition, risk perception may vary depending on the individual's personality, social context, and risk type/context (Wachinger et al., 2013; Kellens et al., 2013).

Correlational evidence supports the association between risk perception and people's response attitudes/behaviors to risks. Indeed, the underlying premise for the attitude (decisions, actions, behavior) of people regarding natural hazards/disasters are shaped by individual/collective perceptions of risk (Bourque et al., 2012; Terpstra and Lindell, 2012). Perceptions enable the evaluation of hazardous situations, which subsequently influences behavior like motivating individuals to take action to mitigate, avoid, adapt to, or even ignore risks (Slovic, 2000; Wachinger et al., 2013). There is a higher likelihood that individuals and communities who have experienced hazards/disaster and perceive themselves to be vulnerable to climate risks are more likely to act, heed to warnings, undertake protective and/or risk reduction measures, and/or engage with disaster management policies and processes (Michael and Fazil, 2001; Slovic, 2000).

Nonetheless, due to the changing and unpredictable nature of climate risks, personal experience may lead to future risks being misjudged. Hence, past experience of hazardous events can have both positive and negative impacts on the response of individuals or communities (Slovic, 2000). This implies that the link between risk perception, readiness to take action, and risk reduction/preparedness is still not clear (Wachinger et al., 2013), but cannot be undermined especially in the context of FRP.

The conceptualisation of FRP in the article relates to how the public understand contemporary flood threats/risks to their lives, livelihoods and/or well-being in the short/long-term including CRM strategies and responses. Studies have revealed that FRP is influenced by the following: proximity to flood hazard (Adelekan and Asiyanbi, 2016); exposure to frequent occurrence of flood hazard (Adelekan and Asiyanbi, 2016); changes in flood frequency and timing (Cai et al., 2016); level of self-protection from a flood hazard (Lindell and Perry, 2012; Bourque et al., 2012); educational attainment (Reynaud et al., 2013); house ownership (Adelekan and

Table 1
Major flooding in England from 1900 to February 2020

Month/Year	Cause	Area/Location	Properties flooded (Other Impacts)
January 1928	Combination of tides, rainfall, and snow	Thames valley, London	Thousands (14 deaths, disruption of transport/ services, damages to Tate Gallery, Houses of Parliament and the Tower of London when swamped, thousands rendered homeless, gas works damaged)
March 1947	Heavy winter snow	Midlands and Yorkshire	(Wide disruptions of energy supply, starvation and death of animal herds, thousands suffered from hypothermia,
August 1952	Storms-Heavy rainfall	Lynton and Lynmouth	100 (34 fatalities, home evacuations, trees uprooted, damage to property)
January 1953	Tides and sea surge	East Coast (Lincolnshire, Norfolk, Suffolk, and Essex)	24,000 (307 deaths, extensive damage on coastline, sea defences bridged in 1,200 places, 30,000 people displaced, economic damage of £ 1.2 billion at 2013 prices)
September 1968	Storms	South East (East Grinstead, Horley, Lewisham, Tilbury, Crawley, Petersfield, Redhill, Tonbridge.	14,000 (bridges destroyed, disruption to transportation services and businesses, temporary displacement of people when homes flooded)
January 1978	Storm surge	East Coast (Essex, Humberside, Essex Lincolnshire, Kent)	1,000 (Considerable beach and dune erosion, damage to property and infrastructure, disruption to businesses)
April 1998	Heavy rainfall	South East/ Midlands (Evesham, Leamington Spa, Stratford-on-Avon, Bedford, Northampton Huntingdon.	4,000 (5 deaths, 41 flooded locations around River Rea catchment hindering local transport and services, thousands evacuated from homes)
October and November 2000	Heavy rainfall	Large Areas (Sussex, Kent, Worcestershire, Shropshire, Yorkshire,	10,000 (Caused landslips, immensely affected transport, railways, and roads were frequently closed, significant cascading effects)
April 2001	Groundwater, heavy rainfall	Thames Region, Dulwich	480 (walkways and roads near River Thames and Dulwich flooded)
April and August 2002	Heavy rainfall and ground water	Thames area, Camberwell district	700 (Walkways, roads, parks and nearby properties near River Thames and Camberwell flooded, disruption of local transportation)
April and August 2004	Heavy rainfall and storms	Boscastle, Cornwall, Dulwich, East Dulwich, Herne Hill	100 (Disruption to schools, transportation, damage of flood defences)
January 2005	Heavy rainfall	Cumbria (Carlisle, Appleby, Keswick Cockermouth,	3000 (3 deaths, schools closed, widespread transport disruption, temporal relocation of people)
December 2006	Tornado	North West London, Thames area	190 (Few injuries, people left homeless, damage caused worth £10 million)
June 2007	Heavy rainfall	Midlands, Northern and South Eastern England	55,000 (13 deaths, major infrastructural damage, £3.2 billion economic damage, flood defences overwhelmed)
September 2008	Heavy rainfall	Northumberland (Morpeth)	1,250 (River flood defences overwhelmed, enormous damage worth about £40 m)
November 2009	Heavy rainfall	Cumbria/South	1,500 (4 deaths, local transport disrupted, psychological impact to hundreds of residents, caused £276 million worth of damage)
November 2010	Heavy rainfall	Cornwall (Blazey, Austell, Mevagissey, Lostwithiel)	250 (138 deaths, transportation, and school disruption, 1.3 million people left homeless)
April to December 2012	Heavy rainfall	Nationwide	7,900 (18,000 people affected, £277million property damage, £600 million crop losses, major disruptions to services)
December 2013	Heavy rainfall, storm, coastal surge	South East England (Dorset, Hampshire, Kent, Surrey)	11,000 (£ 1.3billion worth of economic damage, 6,000 people affected, transport disruption, 4,500 ha of coastal conservation sites affected, damage to seaside peers)
January-February 2014	Heavy rain, storms	East Coast (Somerset, Cornwell, Dorset, Devon)	870 (7,000 people affected, £19 million in agricultural losses, interruptions to critical infrastructure, disruption to transportation and emergency services, insurance losses of £1.5 billion yearly)
December to January 2015/16	Winter storms-Storm Desmond	Northern England (Wales, Bangor, Anglesey, Swansea)	20,900 (£ 1.6 billion economic damages, 36,000 people affected, £15.5 million agricultural losses, major infrastructural disruption, 70 sewage treatment works inundated)
July-August 2017	Heavy rainfall	Eastern/South Eastern England (Berkshire, Kent, Cornwall, Norfolk, Wiltshire, Hertfordshire, Leconfield)	23 (Transport disruption in many towns due to flooded roads, localised damage to residential and commercial buildings)
May 2018	Heavy rainfall	East/West Midlands (Walsall, Lapworth, Hockley, Rugby)	900 (One death, extensive transport chaos, disruption of businesses/services, damage to properties)
March, June November 2019	Heavy rainfall (Storm Ciara)		

(*continued on next page*)

Table 1 (*continued*)

Month/Year	Cause	Area/Location	Properties flooded (Other Impacts)
		North, East, Midlands, South/South East (Lincolnshire, Skegness, Boston Yorkshire, Fishlake, Doncaster, Worksop)	1,100 (One death, extensive destruction of property, disrupted transport and services, hundreds displaced from their homes,)
February, August, November, December 2020	Storms (Dennis, Francis, Bella)	Large swathes of England (Worcester, Telford, Shrewsbury, East Yorkshire, Cornwall, Shropshire, Bewdley, Lancashire, Cheshire, Oxfordshire, Northamptonshire	3,650 (5 fatalities, transport disruption, homes evacuated, flood defences overtopped, downed trees/ power lines, thousands of houses without electricity, landslip, closure of caravan parks, huge insurance pay-outs)
January, February 2021	Storms (Christoph, Darcy-snow)	South East, Cumbria, Rochdale, Preston, Lancaster, Cornwall, Warrington, Northwich, East Anglia,	More than 3,000 families evacuated, heavy snow disrupted transportation services and businesses, landslide, thousands of homes left without power.

Source: Authors, compiled from many sources especially from the online publications of the UK governments' Department for the Environment, Food and Rural Affairs (DEFRA), Environment Agency (EA), Met Office, and Centre for Ecology and Hydrology including Floodlist publications.

Asiyanbi, 2016); trust in authorities (Wachinger et al., 2013); knowledge of flood hazard (Roder et al., 2016; Lin et al., 2008); and previous flood experience (Lindell and Perry, 2012). These risk attributes have implications for effective FRM.

FRM is conceptualised in this article as: "*the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses*" (UNISDR, 2017; p.15).

Structural (hard) or non-structural (soft) engineering solutions/actions are considered when making FRM decisions. Structural measures are: "*any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems*", while non-structural measures are "*measures not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education*" (UNISDR, 2017, p.23). Non-structural measures are arguably, more sustainable and depends on good knowledge of early warning systems/forecasting and self-help—whereby the vulnerable populations take preparatory actions themselves (Curtin, 2017).

The successful application of these measures, including other operational FRM strategies are underpinned by contemporary understandings of FRP (Porter and Demeritt, 2012). Hence, FRP is important to public administrators since understanding how individuals/communities perceive risks can influence the design and operational aspects of disaster risk management (Michael and Fazil, 2001), implying FRP can be used to envisage natural hazard preferences, judgments, preparedness, and behaviours (Paton et al., 2001). This is relevant considering most of the characteristics that influence public FRP are often omitted during scientific risk analysis/assessments, leading to reduced public trust in institutional risk management measures (Slovic, 2000). Therefore, understanding public risk perception is crucial in determining the relevant policies that will increase public confidence in authorities and enable them heed to the prescribed risk reduction measures. This is the empirical focus of this research that examines FRP in England on account of the predicted climate/population changes exogenous to CRM and influences that are endogenous to CRM (Lindley et al. 2011).

3. Brief review of flood risk in England

3.1. Vulnerability of the UK to flood risks

The UK has experienced major flooding (sea, rainfall, storms, snow) dating back thousands of years with serious flooding occurring in the past three decades, especially in 1998, 2000, 2007, 2013/14 and 2015/16 (Table 1). Since 1998, the UK have been in a relatively "flood rich" period (Munchan, 2019). There were 70% more floods from 1998 to 2009 (Penning-Rowsell, 2021) and a significantly wetter than average period that continued to the protracted 2013/14 flooding, and the record 2015/16 intensive rainfall and flooding that affected several areas and caused damages and disruption to services and businesses with huge economic costs (Marsh et al., 2016).

Of the different types of flooding affecting the UK, more than 50% is surface water flooding (Penning-Rowsell, 2021). According to the Joseph Rowntree Foundation, coastal flooding is 40% of the total UK risk. Some authors considered 40% to be high. Penning-Rowsell (2020) argues that the percentage for coastal flooding should be much lower since very little evidence exists to show that coastal flooding is that high. The UK has experienced serious coastal flooding just three times (the East Coast in 1953; Towyn in 1990 and over a large area in 2013/14) in almost a century compared to at least eight incidents of serious fluvial flooding, notably in 1947; 1968; 1998; 2000; 2007; 2012; 2013/14; 2015/16. Furthermore, coastal flooding has very low annual probabilities (less than 0.1%) of serious events leading to huge flood damage costing billions of pounds (Penning-Rowsell, 2021).

The human and economic consequences of flooding in England have been considerable—deaths, displacement, damage to property, prevalence of water-borne diseases and post-traumatic psychological and mental health disorders (Ozger, 2017; EA, 2018). Flooding has caused annual damages of around £1 billion to around 2.4 million properties in the UK (EA, 2009; ASC, 2014). The estimated annual average economic damages from flood risk in England is £277 million (Sayers et al., 2018; EA, 2019) or £0.664 billion, representing a decrease of 26% from £0.900 billion that was estimated in 2017. In the last 126 years, only the 1894, 1947, 1953 and 2007 floods caused damage that might match or exceed the £0.664 billion average (Penning-Rowsell, 2021). These costs have huge implications for the insurance industry.

Flood insurance claims from the Association of British Insurers reveals that flood damages from the 2007, 2013/14 and 2015/16 floods accounted for £3.863 billions of flood damage with 55.6% from residential properties. Indeed, insurance claims for surface water flooding from the major 2007 floods outnumbered claims for tidal and river flooding by 6:1 (Penning-Rowsell, 2021). Nevertheless, not all flood prone households are insured. 21.79% of households in the UK (minus Scotland) had not bought structural flood insurance in 2014 (ONS, 2016) and the number of households not seeking flood insurance protection seems to be increasing. Recently, an independent review of flood insurance in Doncaster found that "…*majority of tenants were poorly protected…a worrying proportion of insurance policies held by Doncaster residents did not cover floods…there were signs of a lack of confidence in insurance as the best way to protect residents or businesses*" (Blanc, 2020, p.5). Yet, more households would be expected to transfer flood risks to insurers as predicted increases in climate risks implies more properties will be vulnerable to flooding.

In England, floods threaten 3.6 million properties with 1 in 6 at risk of inundation from rivers and the sea (Sayers et al., 2018). According to the latest CC Risk Assessment for the UK CC Committee, surface water flooding amounted to over 19.26% of damage from flooding in the UK (Sayers et al., 2018). During the 2007 floods, surface water flooding affected around 35,000 properties compared to 55,000 properties flooded from all sources (EA, 2019). The 2018 report on the State of the Nation project that informed a new country-wide picture of flood risk from rivers and the sea in England revealed that 2,590,616 properties (1,936,716 residential and 293,247 non-residential) are at risk to flooding. This represents an overall increase of 12% from 2006 to 2018 (Penning-Rowsell, 2021). This trend is set to continue as climate change exacerbates vulnerability to flooding in several areas of the country.

The Environment Agency has identified 116 areas/communities at risk of flooding in England and have also assessed the impact of flooding on human health, the economy, environment, and cultural heritage (Sayers et al., 2018; EA, 2019). Between 2008 and 2011, 650 of the 3500 houses constructed in significant flood prone areas in England were located in the 20% most disadvantaged communities, which have the least capacity to prepare, respond and recover from flood events (Lindley et al., 2011).

Floods affect around 5.2 million people in the UK's urban areas, with estimated annual damages of £264 million, albeit 30% of the population exposed to flood risks are in socially vulnerable rural neighbourhoods and accounting for 45% of the total £47 millions of estimated annual damages (Sayers et al., 2018). In England, 5% of the total population exposed to frequent flooding are in the most vulnerable communities and less than one-quarter of the properties located on flood plains have registered for the EA's Flood Early Warning System. High social vulnerabilities could be the main drivers of low flood risk awareness risk (ASC, 2014; Miller and Hutchins, 2017). Consequently, understanding FRP is a prerequisite to prioritise and enhance CRM efforts in socially vulnerable neighbourhoods (Sayers et al., 2018), an objective that has been pursued in this research.

3.2. Flood risk and climate change

An increasing number of communities are being inundated with flood waters and CC and its effects (rainfall, sea level rise, warmer temperatures, snowmelt) are increasingly to blame. Arguably, CC is the paramount driving force for increased flood risk in the UK, and its impact have been increasing faster than anticipated. Several unprecedented rainfall incidents during the last decade led to exceptionally high, record-breaking fluvial flooding like the 2015/16 winter flooding in northern England (Sayers et al., 2018). O'Donnell and Thorne (2020) reassessed and updated drivers of future UK flood risks and concluded that CC-induced rainfall is the leading source driver of future urban flood risk. Contemporary UK Climate projections indicate periods of warmer, drier summers and milder, wetter winters including increases in the intensity and frequency of extreme weather events, with intense rainfall (Table 2) that would result in more flash flooding in England (EA, 2019; ELDC, 2017).

The UK has gotten warmer since 2002 and from 2009 to 2018 by on average, 0.3 °C warmer than the 1982–2010 average (Kendon et al., 2019). Climate projections reveal that in this century, annual average temperatures in the UK will rise by 0.5 and 5.7 °C above the 1981–2000 baseline. Furthermore, relative sea-level rise (Table 3) could be a future driver of flood risk in coastal and other areas subject to subsidence (ELDC, 2017; O'Donnell and Thorne, 2020). For instance, UK climate projections indicate sea-level in the Thames Estuary could rise between 29 and 70 cm by 2100, aggravating flood risk to London.

The 2017 UK CC Risk Assessment states that one of the top six areas of CC risks is flooding and coastal change risks to businesses, infrastructure, and communities (CCC, 2017). CC projection in England and the study area (Fig. 1) show that under a 4 °C warming scenario, between 630,000 and 1.2 million properties will be affected by river and coastal flooding by 2080 with associated damage costs projected to increase between £1.8– £5.6 billion per year by the 2080 s (ELDC, 2017; Cabinet Office and DEFRA, 2016).

Directly linking climate change to increasing flood risks is a delicate endeavour. While it is likely that CC-induced increases in storminess could result to a rise in the frequency and magnitude of rainfall/storm surges, there is high uncertainty on how CC will influence the position and intensity of storm tracks (Murphy et al., 2018; ELDC, 2017). Although several publications are suggesting

Table 2
Peak rainfall intensity allowance in small and urban catchments in England

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039) to 2025	Total potential change anticipated for the '2050s' (2040 to 2069) 2026 to 2055	2056 to 2085 Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

Source: ELDC (2017)

Table 3
Predicted Sea level allowance for net sea level rises between 1990 and 2115 in some parts of England.

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
East, East Midlands, London, South East	4 mm p.a (140 mm)	8.5 mm p.a. (255 mm)	12 mm p.a (360 mm)	15 mm p.a. (450 mm)	1.21 m

Note: Sea level allowance for each epoch is in millimeters (mm) per year with cumulative sea level rise for each epoch is in brackets. Source: ELDC (2017)

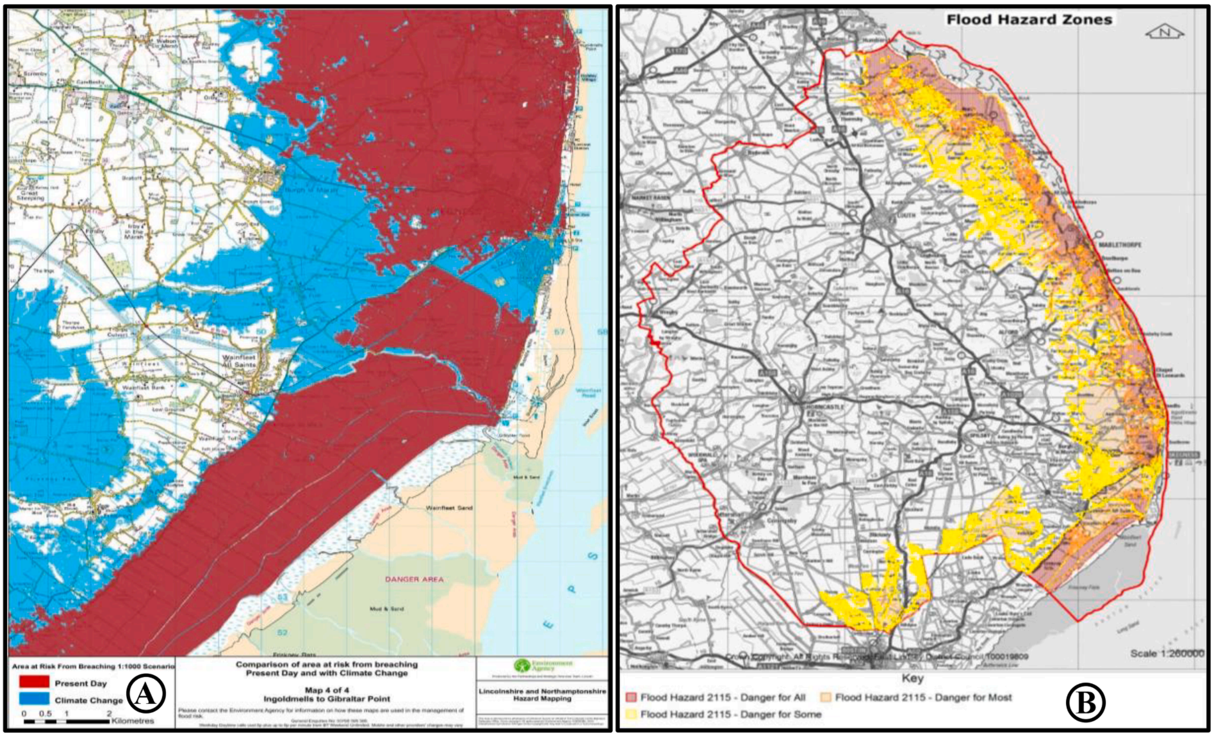

Fig. 1. (A) Contemporary and predicted flood risk due to CC in the study area in East Lindsey District from Ingoldmells to Friskney. (B) Areas at risk of flooding from breaching of sea defenses in East Lindsey District due to a 1 in 200-year event. Source: ELDC (2017).

large-scale projections of changes in the frequency, severity, and intensity of floods in Europe, discrepancies in projections have raised questions on the paramount research route on future climate risks. For instance, Kundzewick et al. (2017) identified and interpreted differences in flood hazard projections for several regions of Europe and argued that the observed records/trends do not demonstrate a vigorous and widespread increase in the amplitude and frequency of high river flows throughout Europe. Regardless of any inherent uncertainties to determine the range of possible future flood, storm and temperature projections are important to inform CRM decision making processes.

CC pose several challenges for CRM including increasing disaster relief funds and adaptation costs to extreme/severe events; rising costs of maintaining/improving structural defenses and increased demand for land as a consequence for restricting development in flood-prone areas (ELDC, 2017; EA, 2019). This will require more innovative CRM solutions because the current command-and-control measures may become obsolete. In fact, market-based instruments are increasingly regarded as more efficient/effective risk reduction strategies in view of CC (Tatiana, 2014).

Consequently, to help all stakeholders improve standards of protection against flood risks, the EA published a national Flood and Coastal Erosion Risk Management strategy for England that aimed to ensure fast/effective responses to and recovery from flood events and prioritise investment that benefit communities facing the greatest risk. The Flood and Water Management Act of 2010 clarified FRM responsibilities and attributed more local powers for handling local flood risk (EA, 2019). Essentially, England's national CRM strategy strives to inspire cooperation between all stakeholders; sets out current and future CRM strategies and enhance community resilience to flood risks (DEFRA and EA, 2011). The UK government's most recent strategy to mitigate the impact of climate risks is the 2019 version of the National Planning Policy Framework, which explains the Government's proactive planning policies for England. The policy framework sets out the requirements for dealing with flood risk from CC and is explicit on how the planning system should reduce vulnerability and enhance resilience to developments from the impacts of CC (ELDC, 2017; EA, 2019).

This has been reiterated at the regional level. Fears that flood risks could undermine the European Union's sustainable development goals led to a European Framework approach to FRM (European Flood Directive 2007/60/EC). The framework underlines the desire to increase societal resilience to flooding in six countries including England (Priest et al., 2016) where there is increasing call for the government to mainstream climate and environmental considerations into existing and future development programmes (Price, 2019).

Developers and investors have been urged to consider climate risks, especially that of flooding during the early stages of design, planning and investment process to help inform the decision-making process of the EA and local authorities. Early consideration of CC, from a flood risk perspective, will ensure the design of developments take into consideration viable and cost beneficial mitigation measures (IEA, 2019). Primarily, stakeholders have been urged to: encourage mixed use developments of land in urban and rural areas; consider flood and coastal change; mitigate the vulnerability of new developments due to impacts from CC; promote the use of suitable adaptation measures where new development in vulnerable areas is inevitable, and ensure development is risk-free in flood prone areas without increasing flood risk elsewhere (ELDC, 2017; EA, 2019).

4. Methodology

4.1. Research design-case study strategy

This is a principally qualitative case study research (draws on primary/empirical and secondary techniques) in Lincolnshire County (Fig. 2) where the Lincolnshire County Council has local FRM oversight. The empirical focus is flood prone communities in Wainfleet All Saints (hereinafter referred to as "Wainfleet") in East Lindsey District (Figs. 3 and 4). Wainfleet is located in a low-lying eastern coastal flood plain that stretches for up to 15 km inland containing salt and fresh-water wetlands fringing an open and extensive seacoast. Hence its protection by the Linc shore coastal defenses that extends for up to 24 km (ELDC, 2017; LCC, 2019). The inquiry involves an up-close, in-depth, and detailed investigation providing the researchers the opportunity to explore and construct theories (Bhattacherjee, 2012).

4.1.1. Background of study area

Despite its relatively large physical area (6959 km^2), Lincolnshire has a comparatively small population of 751,171 (2017) and 95% live in large rural areas with a sparse population. The region is drained by West-East flowing rivers dominated by the Rivers Witham and Steeping. These rivers, their tributaries (Fig. 3), along with a much wider network of drains, including the East/West Fen catchment drains have influenced surface flooding in the area since the 13th century (ELDC, 2017; LCC, 2019). Breaching of the coastal defenses in 1953 caused extensive flooding in Lincolnshire while in June 2007, Wainfleet was flooded when the flood defenses along the River Steeping were breached. (Table 1; ELDC, 2017; LCC, 2019). East Lindsey District host around 48% of all businesses in the county, dominated by the hospitality, tourism, and agricultural industries. Indeed, agriculture is vital to the thriving Lincolnshire economy, relying on the provision of water and the drainage of land that is at risk of flooding.

Fig. 2. Lincolnshire County district map showing Wainfleet All Saints. Source: Adapted from Lincolnshire_outline_map_with_UK.png.

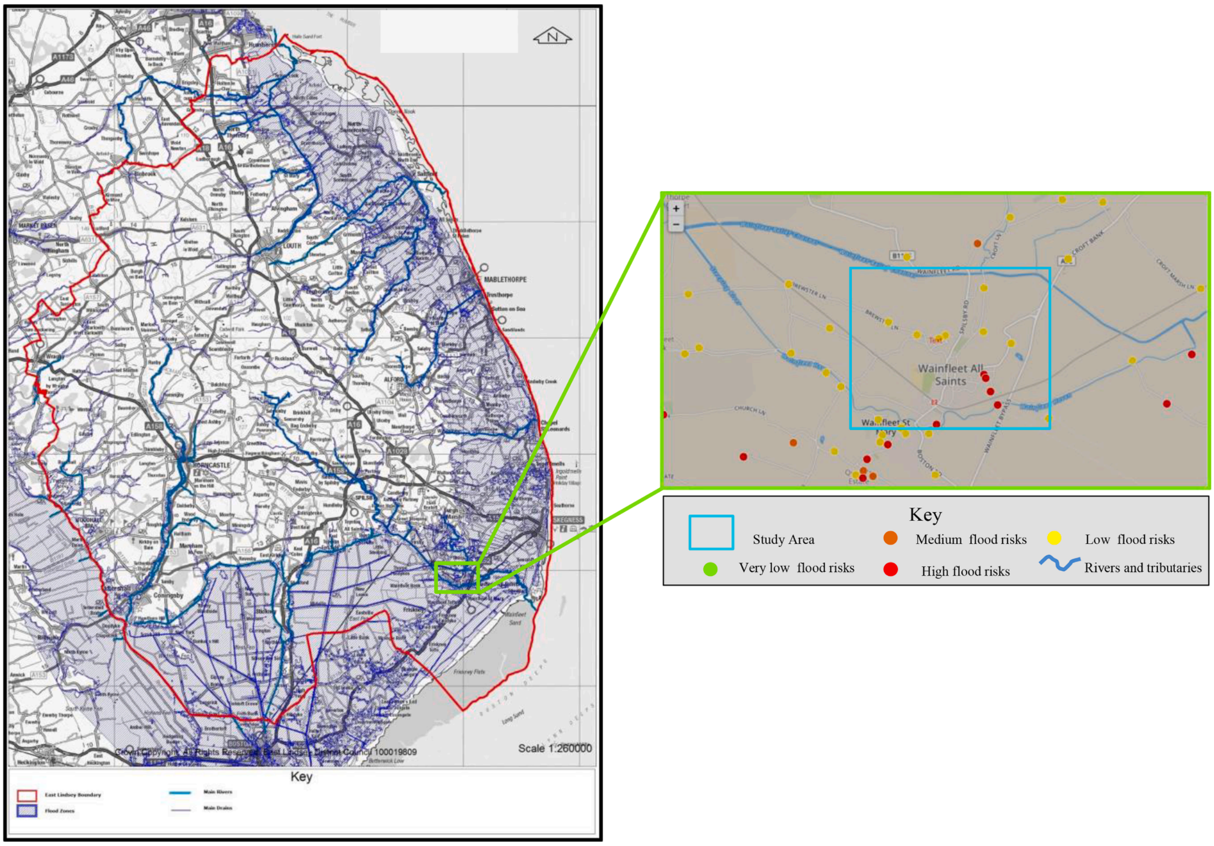

Fig. 3. Drainage map of East Lindsey District showing the location of the study site. Source: Adapted from ELDC (2017).

Fig. 4. Flooded areas in Wainfleet. Source: Sun Reporter (2019).

4.1.2. The June 2019 Wainfleet floods

Wainfleet received a prolonged and unprecedented amount of rainfall in June 2019. The equivalence of two and a half month rain (132 mm) fell between 10 and 12 June, continuing into 13 June. This caused the River Steeping and its relief channel to burst their banks (Fig. 10) inundating several properties in and around Wainfleet and Thorpe St Peters (Fig. 4). As a result, the Lincolnshire Police responded to a flood warning from the EA and facilitated the evacuation of 580 homes in Wainfleet and the surrounding area. By Monday 17 June, water levels on the River Steeping and its relief channel were significantly reduced. However, heavy rainfall continued to 19 June and by Friday 21 June, the evacuated population started returning home just to realise that 59 properties were inundated (Met Office, 2019; Sun Reporter, 2019).

4.2. Data collection and analysis

This research employed a principally qualitative strategy that draws upon multiple sources of evidence to enhance validity of the results (Yin, 2003; Creswell, 2003). Primary data was collected through semi-structured interviews enabling the researcher to engage with two categories of respondents from (1) the Wainfleet flood-affected community and (2) professional/experienced FRM stakeholders (hereinafter referred to as "flood managers") from various bodies/agencies in the study area to explore their opinions, perceptions, feelings, ideas, and experiences and recommendations on flood/climate risks (Bhattacherjee, 2012).

Through simple random sampling, 15 Wainfleet community members were interviewed, 10 via telephone for between 25 and 65 min and 5 via written questionnaire. Purposive sampling was used to select the flood managers. Attempts to interview flood managers in some agencies like the Lincolnshire Police, Environment Aagency and Lindsey Internal Marsh Drainage Board was futile. Finally, 7 mid-senior officials across different FRM agencies/organisations in the region (2 from the Lincolnshire County Council), 1 each from the East Lindsley and Witham Fourth Internal Drainage Boards, 2 from the East Lindsley District Council and 1 from Anglian Water) were interviewed (6 via telephone and 1 through a written questionnaire guide) for between 40 and 80 min.

Eventually, 22 semi-structured interviews were conducted with bespoke and generic enquiries.

Ethical considerations were built into the research process with voluntary participation, confidentiality/anonymity of participants and informed consent for interviews of vital importance. Interviews were digitally recorded only with the permission of respondents.

Specific question themes for the community respondents focused on: effects/impacts of the 2019 floods, perception of flood risks in Lincolnshire, greatest worries/concern about flooding in Lincolnshire, preparedness for the 2019 floods, flood early warning, multiagency response to the 2019 flooding, responsibility for FRM in locality, response capacity of flood management agencies and suggestions on improving local FRM. Enquiries for the flood managers centred on: perception of flooding in Lincolnshire, key FRM measures in Lincolnshire, perception of flood risk in England, capacity/ability of their agencies to effectively manage flood risks, contemporary and future FRM challenges in Lincolnshire, measures taken to effectively respond to flood risks, what local communities or their members can do by themselves to mitigate flood risks or enhance resilience to flood risks, the extent to which their organisations was incorporating proactive or risk reduction measures, and suggestions/recommendations on improving FRM.

Secondary data sources included published research articles; Climate/FRM documents (reports, guidance, resource, policy, planning etc.) from stakeholder government and private organisations, agencies and bodies that were either culled from their websites or sent to the researchers (Newman and Robson, 2015; Bhattacherjee, 2012).

Multiple techniques like thematic analysis, systematic description of events and verbatim quotations were used to analyse the data qualitatively. The thematic analysis approach involved a process where the interviews were transcribed, anonymised, coded, and similar themes, emerging themes and/or categories identified. This was then fused/aligned with the secondary data and used to analyse the main findings of the research in a triangulation technique. The analysis were enhanced with charts. The identified themes/categories in the data provided orientation to the structure of the research findings (Newman and Robson, 2015; Bazeley and Jackson, 2013).

A potential limitation of this research is the number of flood managers interviewed. As hinted earlier, effort was made to interview more flood managers but was constrained due to limited time since the research had to be presented as a dissertation. Nevertheless, the breadth and depth of the interviews with both groups generated very rich data that have informed the results.

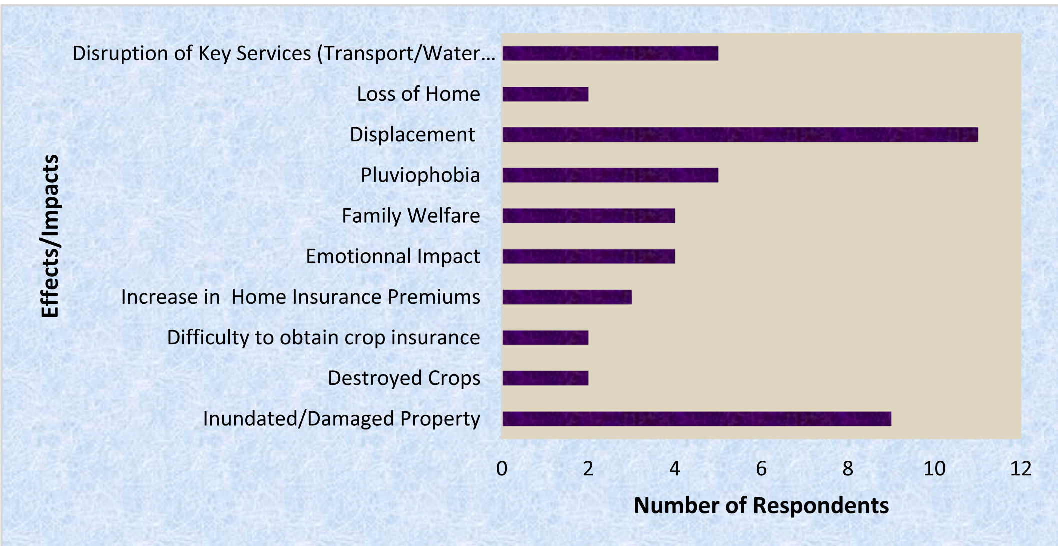

Fig. 5. Effects/impacts and concerns of flooding in the Wainfleet community. Source: Authors.

5. Results

The results have been grouped into various themes based primarily on empirical/primary data albeit complemented with secondary information in some instances.

5.1. Effects/impact of the June 2019 Wainfleet floods

The flooding has various impact/effects to the Wainfleet community (Fig. 5). The research gathered that most of the respondents' houses were inundated and some experienced varying degrees of water damages. Interviewee farmers mentioned widespread crop destruction. According to one farmer, "*I lost 95% of my Brussel sprouts and 80% of my cauliflower…the financial knock on effects of that are huge, and also the emotional stress of it all is just so draining. The loss is probably over £30,000, we're going to struggle to recover from this*". Another said,"*… we had about 160 acres under water at one point"*. The farmers were frustrated for not being able to obtain crop, pastures and farmland insurance. Other respondents were worried about the potential rise of future insurance premiums for their properties. Many said the floods had affected them emotionally, and parents expressed concerns over the welfare of their children regarding recurrent and future flood risks. Interview transcripts reveal feelings of worry and apprehension in the community even with minimal levels of rainfall making them to continuously check weather forecasts. Temporary displacement was also documented. Some respondents were evacuated from their homes and/or places of work while others refused to leave their homes against official advice. During data collection, some respondents were still in temporary accommodation whilst damage assessments/repairs were conducted in their houses. Most had returned to their homes within 2–8 days of the flood incident while a few were not certain of when they would return to their houses. The research also gathered that the flooding caused local disruption of one or more services in the area including blocked road access to houses and work premises. Poor health issues related to drinking water quality was also mentioned.

5.2. Perceptions of flood risk

This section addresses community and disaster managers' FRP. All community respondents were unequivocal that floods are their worst natural hazard. Most think flooding is increasing and attribute it to CC, and a mixture of CC and poor FRM measures. One respondent substantiated, "…*the weather is becoming more extreme*…*we are getting more periods of sustained heavy rainfall*…". In addition, the community respondents have the conviction that CC will exacerbate flood risks (Fig. 6A).

All flood managers also affirmed that floods were the UK's major and worst natural hazard and that the coastline and heavy rainfall were the major source of flood risks. Perception of an increase in flood risk revealed mixed responses. Most respondents felt flood risk is increasing in the region and attributed it to CC as a major contributing factor, highlighting weather extremes and an increase in frequency and intensity of rainfall in recent years. A senior respondent was explicit, "…*I have seen the hottest summer, the coldest winter and the worst rainfall we have had in 40 years*". Another commented, "…*now we pretty much have droughts across winter and then we have to brace ourselves for biblical rain in the summer*". A few argued there was insufficient data to state categorically that flood risk is increasing and caused by CC. The interviewees also discussed current and projected rises in sea levels and its potential to increase risk of coastal flooding (Fig. 6B). The perception of both study groups aligns with contemporary research that predicts heightened and more extensive flood risk due to CC (ASC, 2014; Cabinet Office and DEFRA 2016).

5.3. Flood risk management

This section addresses perceptions of the main FRM stakeholders and community preparedness for the June 2019 floods.

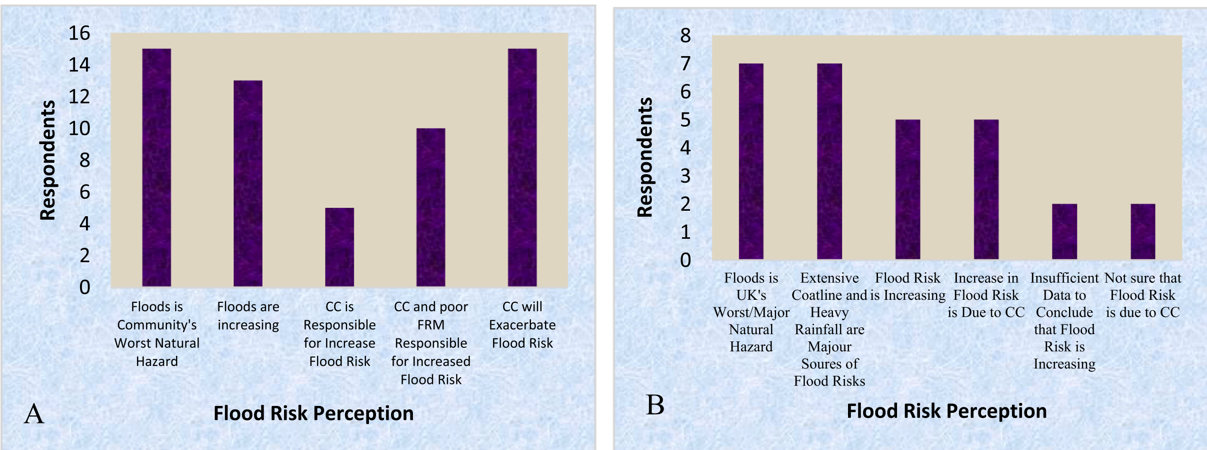

Fig. 6. (A) Community perception of flood risk (B) Flood risk managers' perception of flood risk. Source: Authors.

5.3.1. Key FRM stakeholders

The findings show that community perception of FRM stakeholders vary. Analysis of the responses reveal one, two, three or more agencies/organisations with responsibility for FRM. According to the respondents, the FRM stakeholder are the council, emergency services, internal drainage boards, central government, district/county council and the EA (Fig. 7).

The analysis in Fig. 8 shows perception of agencies/organizations with the greatest responsibility for FRM. The EA is considered to have the most responsibilities, followed by the central government and district councils, respectively. Interestingly, very few respondents felt the community has responsibility for FRM.

5.3.2. Community preparedness for the June 2019 floods

Interview transcripts reveal that most of the respondents were not prepared for the June 2019 floods for the following reasons: they did not anticipate the flooding; did not think they would be affected in case of flooding and have not been flooded before. The only respondent (a farmer) who claimed to be somewhat prepared had always maintained drains on his farmland, albeit still inundated when River Steeping burst its banks. Home insurance was mentioned as a preparedness measure although some respondents were wary this could rise with repeated flooding. Most community informants claimed not to have received warning of impending flooding. Nevertheless, a few confirmed they received warning indirectly via weather forecasts through radio, television, text message from the EA and when the flooding had started through police visits to their houses. The respondents were also clear that the rapid onset of the flash floods left very little time to protect their properties from the hazard.

5.4. Flood managers' role/capacity in FRM

Results show that the role and/or capacity of flood managers varies and aligns with the main activity of their agencies. The informants were keen to identify their agencies/themselves with successfully implementing structural and non-structural FRM measures. Examples of successfully implemented FRM projects mentioned were the Louth and Horncastle Flood Elevation Schemes (mitigated flood risks to around 350 properties); the Wrangle Sea Bank Raising Project (involved re-profiling, reinforcing, and raising old sea defenses); Sand replenishment projects (mitigated against coastal flooding and erosion) and the Bacton to Walcott Coastal Management Scheme. The Linc shore and Mablethorpe Flood Defense Schemes were amongst the most noteworthy discussed. A respondent stressed the importance of the pumping capability of the Witham Fourth Internal Drainage Board in removing flood waters. Hear him, "…*we had every pump running in the Wainfleet event and we were moving 58 tons of water a second*…". They emphasized the importance of a continuous/annual maintenance program to keep all the existing flood mitigation structures to their design standards.

5.5. Contemporary FRM measures

Community and flood managers' perception of FRM are addressed in this section. Most community respondents criticised the Environment Agency for poor maintenance and in their words "*dereliction of duty*" in regard to structural FRM measures. They mentioned inadequate/poor maintenance of flood control structures such as siltation and buildup of organic matter in River Steeping and its relief channel, which they argue, exacerbates flood risk in the area. One landowner described the lack of maintenance as "*a disappointment*" whilst another stated "*the big failure is that the Environment Agency hasn't done anything to maintain the river*". Indeed, the community respondents were concerned that without improvements in structural FRM measures, flooding would get worse in the region.

All the flood managers felt FRM should be a shared responsibility between the local, regional, and national agencies, managed

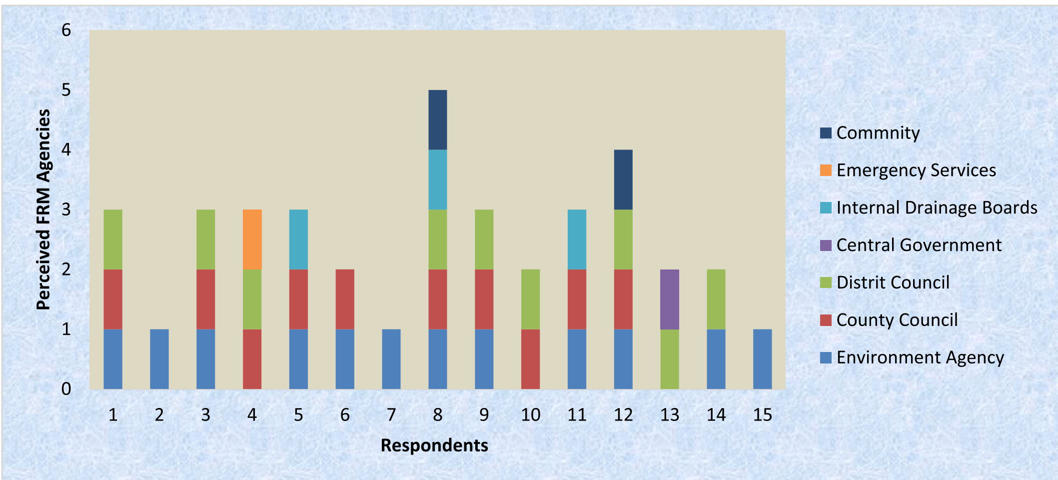

Fig. 7. Perceived multi-agency involvement in FRM. Source: Authors.

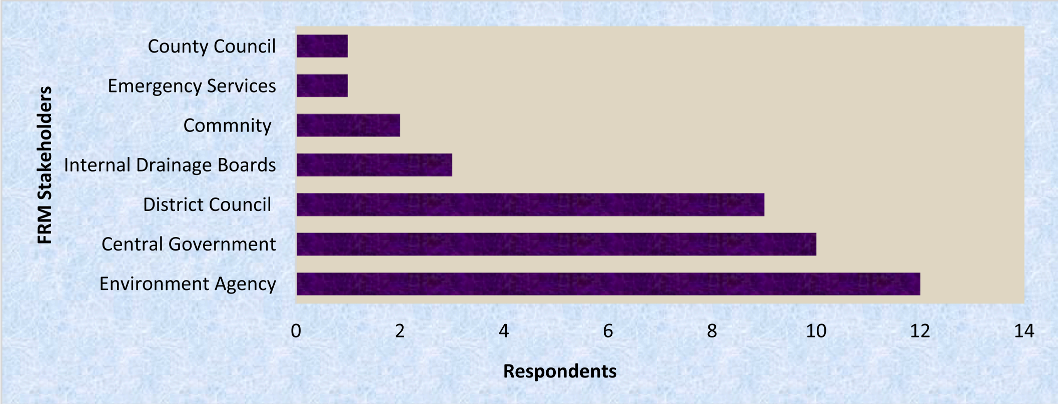

Fig. 8. Perception of greatest responsibility for FRM. Source: Authors.

through a comprehensive partnership and strategy. They endorsed the current FRM structure/strategy in Lincolnshire, which they argued is significant in mitigating flood risks. Furthermore, the entire respondents were confident of their agency/organizations' competence and ability to manage flood risk within their remit.

The flood managers revealed challenges in FRM including limited funding for FRM agencies; low relief/topography of the region; CC's potential to exacerbate flood risks ; community sensitization on FRM issues, ageing public/private infrastructure; managing psychological flood effects; unpredictable future weather; vulnerable population due to more older people; dwindling trust in FRM agencies, and the ageing/single line of flood defenses along the coast (Fig. 9). The greatest challenges are in funding and the physical geography of the area.

5.6. Flood incident response

This portion presents perspectives from the two sets of informants on the response to the 12 June Wainfleet floods and generally, about institutional flood capacity. Most community informants spoke positively about the multi-agency response to the 2019 flooding while some had mixed feelings. The respondents praised the professionalism of the East Lindsey District Council and the police and fire services throughout the response. The research was informed that the Fire Service complemented the services of pumping stations and the Environment Agency mobilized ultra-high-volume water pumps, albeit criticized for its slow response. The British Army and Royal Air Force helicopters also assisted to strengthen bridged flood defences along River Steeping (Fig. 10; RAF, 2019).

Regarding institutional flood response capacity, around half of the community respondents said FRM agencies in England have the capacity to effectively respond to major flood incidents. Some had mixed feelings while a few were negative. The main reasons for the expressed reservations were that the Environment Agency lacks sufficient physical and financial resources. A respondent perceived the Environment Agency to be "*too big and too slow*". A few said the response capacity depends on the scale of the incident and that more attention and resources for flood response targeted urban areas to the detriment of rural areas.

Overall, the flood managers have a positive perspective of institutional capacity and highlighted the following factors that have enhanced their FRM ability/capacity: Local Resilience Forums, communication and information management systems, expertise of

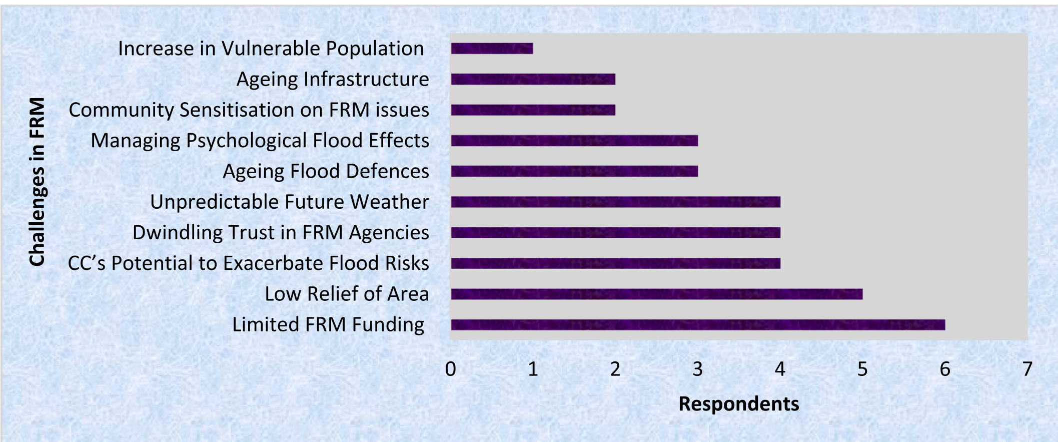

Fig. 9. Flood risk managers perception of challenges in FRM. Source: Authors.

Fig. 10. An RAF Chinook helicopter dropping sandbags to contain flood waters from the relief channel of River Steeping. Sources: ITV report (2019) and RAF (2019).

emergency planners, the incident command model, cooperation/partnership with stakeholder agency groups, and a 24/7 emergency response hotline.

5.7. Recommendation for improving FRM

Perspectives on how to improve FRM was gauged from both study groups. The community respondents suggested the following: regular dredging of the River Steeping, regular maintenance/reinforcement of River Steeping's flood defenses, building more dykes/embankments along River Steeping, increased community sensitization/knowledge and responsibility for FRM that can enhance preparedness for and respond to major flood events, providing more powerful water pumps, more funding for FRM, enhanced flood early warning system, prioritise FRM strategies for rural/local communities, more community/local level involvement in FRM, and more proactiveness in flood risk reduction than response and recovery (Fig. 11).

The flood managers made the following recommendations: a catchment approach to FRM stressing it would better protect rural communities as opposed to the existing '*numbers of households protected*' funds allocation model; more community sensitization on flood resilience measures; flexible local level FRM funding that reflects contemporary risk; better collaboration/partnership between national and local FRM agencies/organisations; enhanced response capability for local FRM agencies; and more hands-on FRM at the national level; flood managers should be given more access to flood modelling information; all households in flood prone areas should sign up to the EA flood alerts and retrofit their homes with flood resilience (Fig. 12).

6. Discussion

The findings reveal significant flood effects with implications for cascading consequences. Worthy of note is the psychological impact to the Wainfleet community with potentially dire health consequences. As a result, the community is now exceedingly wary, nervous, excited, and apprehensive with even minimal rainfall leading them to continuously check weather forecasts. While this could be seen as having a positive influence on community preparedness, being hypervigilant can have negative impact on people's physical and mental health, lifestyle, and relationships.

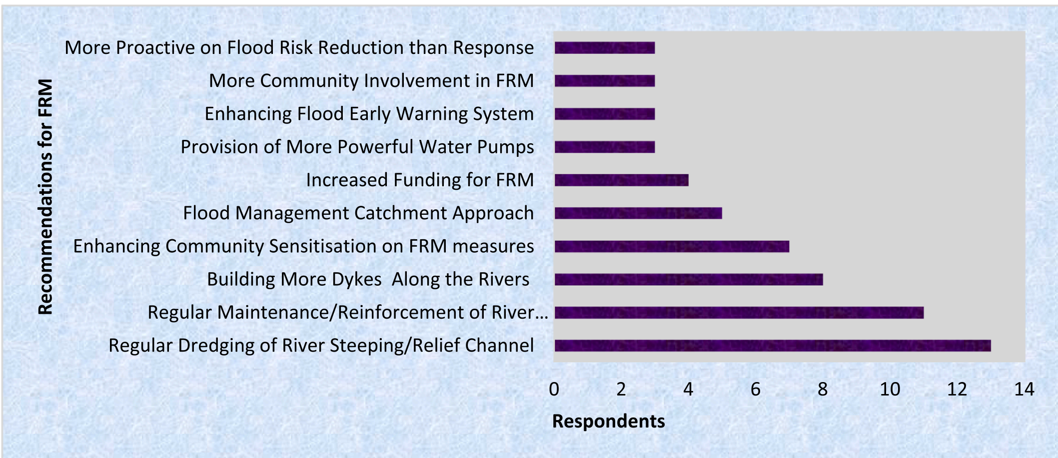

Fig. 11. Community recommendations for improving FRM. Source: Authors.

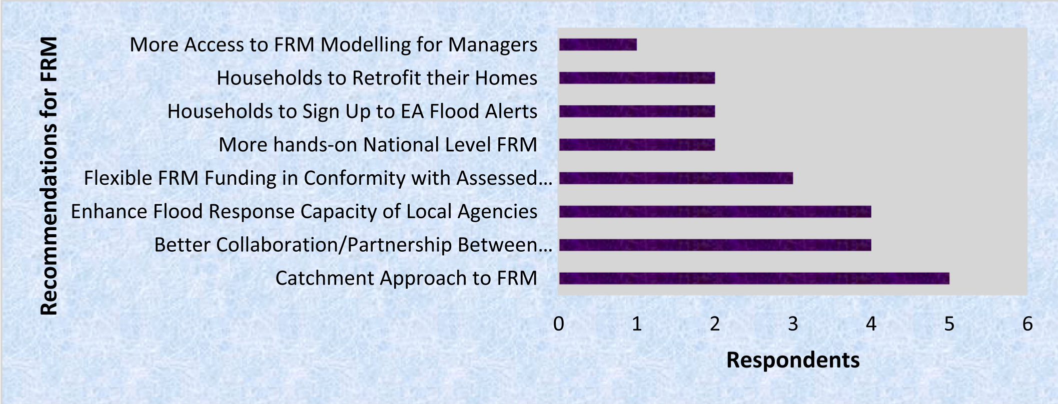

Fig. 12. Flood manager's recommendations for improving FRM. Source: Authors.

The results highlighted issues with obtaining domestic insurance in flood-risk areas. Flood insurance coverage in the UK (obligatory when obtaining mortgage but not legally compulsory) is guaranteed only for properties with flood probability less than 0.5% per year (Treby et al., 2006) implying many properties might not be covered for actuarial risk. Perhaps compulsory insurance with premiums proportional to social and private/business cost of occupancy of flood-risk areas would enable more rational decisions. Indeed, more sustainable insurance policies will serve as a risk communication device to help people rationalize land-use decisions in flood prone areas.

The June 2019 floods has caused a huge perception shift amongst the Wainfleet community. Many respondents who were not prepared for the floods are now wary of flooding. This reveals severe localized flooding can drastically change people's FRP, aligning with theories that associate FRP with past flood experience/knowledge (Lindell and Perry, 2012; Roder et al., 2016).

By overwhelmingly underlining the poor management of rivers (lack of dredging, poor maintenance of embankments) and raising concerns regarding delay in employing high capacity flood pumps, the community has undermined contemporary FRM and some response measures. This has implications for trust and confidence in the Environment Agency. Perhaps the community needs to understand that risk can only be temporarily reduced and cannot be completely eliminated. Hence, the need to be cautious irrespective of strategies employed. Nevertheless, community perception showed strong relationships with local authorities and positive widespread views of the Environment Agency and their facilitation of the flood response, indicating that residual trust in the Environment Agency still exists.

Although the Wainfleet community perceive flood risk to be high, their perception of community FRM is low. Minimal risk perception suggests low acceptance level of FRM policies that results to lack of disaster preparedness (Tatiana, 2014). Ironically, the UK's National strategy for FRM aims to empower communities to have key stakes in their own risks (DEFRA and EA, 2011). Therefore, creating awareness of their responsibility by urging the community to integrate environmental risks in private decision making will improve preparedness.

Concerns about limited funding are genuine considering some projects in the region like the Louth and Horncastle Flood Elevation Scheme received a significant amount of European Union funding. This raises uncertainties around funding future projects especially with the exit of the UK from the European Union. To mitigate against funding shortfall, the national FRM budget should be adjusted in accordance with actual and increasing risk. Similarly, public property-level protection may require financial assistance or grants from the government as incentive in less populated areas where structural defences may be expensive. According to the ASC (2014), around £4000 worth of low-cost measures per property is capable of reducing flood damages in England with a greater than 1 in 50 chance of flooding.

The perception from both sets of informants of increased FRM responsibility for local stakeholders aligns with the recommended catchment approach to FRM. Arguably, this will better protect local flood prone communities while providing more autonomy and responsibility to local FRM agencies/organizations. That would create more local flood risk awareness, enhancing flood risk reduction; a policy enshrined in the Flood and Water Management Act 2010.

The clear view amongst both groups of interviewees that floods are the UK's major natural hazard and is increasing as a consequence of CC has implications for the recommendations. Unsurprisingly, the informants underscored the importance of strong public and private partnership for effective FRM especially in view of CC, also strongly supported by the local authorities (LCC, 2019). On account of CC induced flooding, institutional arrangements that foster cooperation between local communities and public institutions would be invaluable to enhance FRM resilience.

Local concerns about protecting the vital economic assets in the area that are vulnerable to flood risks are well founded. Whilst age-old flood defence structures have periodically countered sea and river rises, this is not seen as sustainable. Finding innovative ways of managing future flood risk is vital to contemporary FRM operations. Related concerns about the fragile and ageing infrastructure in the area gives clear room for enhancing resilience by improving structural mitigation measures through a risk-based approach. This could entail having a pre-defined acceptable risk and ensuring flood defence schemes are designated according to the protected values with better prioritization of expenditure.

Nevertheless, such command-and-control measures that set a uniform standard for everyone may not be appropriate since people are heterogenous in their risk perception, locational preferences, and financial abilities. Indeed, this approach neglects externalities such as the wider socio-economic impacts of flood risks to vulnerable communities (Sayers et al., 2018). Market-based instruments may be preferable for economic actors since they facilitate risk communication, stimulate innovation, and promote cost-effective solutions for businesses (Tatiana, 2014).

The review of FRM reveals its primarily command and control in nature involving policy formulation and spatial planning influenced by structural mitigation measures. Therefore, the government should be conscious of spatial externalities and path-dependencies that can foster flood risks and provide stimuli for autonomous adaptation in flood-prone areas in consideration of risk perceptions. We argue for the need to incorporate flood prone community's risk perception into FRM policies/plans/strategies to encourage autonomous adaptation measures where people can make land-use choices that mitigate flood risks. However, this may require that such communities/people be provided with the appropriate resources, knowledge, information, and incentives.

7. Conclusion and recommendation

This research set out to examine contemporary FRP in Britain via a case study in Wainfleet that experienced unprecedented flooding in June 2019 and have achieved its objectives. The key findings are that: flooding had varied consequences to the community members with key concerns about getting crop insurance and the potential rise of insurance premiums for properties; both study groups believe flood risk is increasing in the region and will be exacerbated by CC; the Environment Agency is the most popular agency

Table 4
Recommendations

Theme	Recommendation/Suggestion
Provision of Resources	• Consider a catchment-based approach to FRM funding and operations. • Give Internal Drainage Boards increased funding and responsibility for managing flood risk within their catchments. • Develop schemes and initiatives that allows and encourages local communities to invest in FRM measures (i.e. local flood action groups). • The Environment Agency should have mobile ultra-high-capacity pumps permanently available in high flood risk regions. • The allocation of funding for FRM should target the most socially vulnerable communities at greater flood risk. • Significant investment in existing/new flood defenses is needed. • The government should review its funding strategy and seek funds for FRM from the private sector and local communities/authorities.
Reducing Vulnerability	• Regulatory policy restrictions on infrastructural development in high flood risk areas should be instituted and enforced. • Insurance policy and building regulations should encompass notions of "build-back-better" to ensure new or refurbished buildings are resilient to flooding. • Compulsory insurance with premiums proportional to social and private/business cost of occupancy of flood-risk areas will enable people to make rational decisions. • Local FRM agencies should proactively tackle local flood-related problems by working with all relevant parties particularly the local public to establish ownership and legal responsibility. • There should be an increased emphasis on protecting critical infrastructure in rural regions particularly to protect the agricultural and tourism industries. • The Government should establish a program to support and encourage communities to be better prepared and more self-reliant in the event of a flood emergency, allowing emergency managers to focus on those areas and people in greatest need. • The Met Office and Environment Agency should continue to develop Early Warning Systems to ensure warnings land with vulnerable populations.
Educational Policy	• The government should integrate water and flooding into the national curriculum to ensure children are educated on flood risks and their responsibilities within FRM. • Understanding local flood risk should be made a mandatory requirement when people buy or rent property. • The public should have an emergency flood kit—including personal documents, insurance policy, emergency contact numbers, medication etc. • Internal Drainage Boards should be classified as category 1 responders as written into the Civil Contingencies Act 2004.
Increased Flood Risk	• The government should prioritise both adaptation (promoting development of safe areas rather than risky ones) and mitigation in its programs to help the UK cope with CC. • Key adaptation measures should focus on protecting existing properties and the location/design of new infrastructural developments. • Planned adaptation pursued by the government should include both command-and-control and market-based instruments. • The Environment Agency should liaise with other stakeholders to urgently develop tools and techniques for modelling in flood waters. • With some uncertainties on the role of CC in flood risk, more research is required to assess uncertainty and ensure decision-makers are conscious of any uncertainties in information, data, and knowledge.

Source: Authors

perceived to be responsible for FRM while the community has a very low perception of their own responsibility; the community was not prepared for the June 2019 flooding; limited funding is believed to be a handicap to FRM in the region; overall, the respondents were pleased with the response of the local emergency services to the June 2019 flooding albeit critical of the Environment Agency for slow response and negligence in structural FRM measures; prominent amongst community and flood manager's perspectives on how to improve FRM were regular maintenance of rivers (dredging/repairing embankments) and a catchment approach to FRM respectively.

Table 4 is a summary themed recommendation (also see Section 5.7) on how to improve FRM based on the findings/analysis in this article.

This research enriches the literature on climate risk management, especially on contemporary community/flood administrators' climate/FRP and mitigation strategies. The findings also have the potential to inform local and national policy on CRM. By understanding how local communities and the responsible administrators perceive contemporary and potentially future climate risks, the UK government can enact legislation and policies that would facilitate both community and stakeholder risk reduction measures in view of CC. Hence, this article underscores the relevance to embrace contemporary FRP into CRM policies and strategies in England since this is not often captured by scientific risk analysis/assessment leading to low trust in institutional FRM (Slovic, 2000). Of utmost importance, are policies and practical measures that would enhance community participation/involvement in mitigating their own risks.

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.

Acknowledgement

This research was undertaken to write an MSc dissertation in Disaster Management under the supervision of the first author. We gratefully acknowledge the assistance provided by the members of the case study site who responded to the research enquiries although not yet recovered from the impacts/effects of the flooding. Furthermore, we would like to thank the climate/flood risk management administrators who were able to squeeze some time from their hectic schedules to inform the research through interviews and contemporary documents.

References

Adaptation Sub Committee (ASC), (2014). Managing climate change risks to well-being and the economy. Committee on Climate Change. Progress report 2014. London.Website (accessed on August, 23rd 2019): https://www.theccc.org.uk/wp-content/uploads/2014/07/Final_ASC-2014_web-version.pdf.

Adelekan, I.O., Asiyanbi, A.P., 2016. Flood risk perception in flood-affected communities in Lagos, Nigeria. Nat. Hazards 80 (1), 445–469. https://doi.org/10.1007/s11069-015-1977-2.

Balica, F., Popescu, I., Beevers, L., Wright, G., 2013. Parametric and physically based modelling technique for flood risk and vunerability assessment: a comparison. Environ. Model. Softw. 41, 84–92. https://doi.org/10.1016/j.envsoft.2012.11.002.

Bazeley, P., Jackson, K., 2013. Qualitative Data Analysis with NVivo, 2nd ed. Sage, London.

Bhattacherjee, A., 2012. Social science research: principles, methods, and principles (2nded.). Create Space Independent Publishing Platform, Tampa, Florida.

Birkholz, S., Muro, M., Jeffrey, P., Smith, H., 2014. Rethinking the relationship between flood risk perception and flood management. Sci. Total Environ. 478, 12–20. https://doi.org/10.1016/j.scitotenv.2014.01.061.

Blanc, A., 2020. Independent review of flood insurance in Doncaster. Website (accessed on March 30th, 2021): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932523/review-flood-insurance-doncaster.pdf.

Bourque, B., Regan, R., Kelly, M., Wood, M., Kano, M., Mileti, S., 2012. An examination of the effects of perceived risk on preparedness behavior. Environ. Behav., 45 (5), 615-649. DOI:10.1177%2F0013916512437596.

Cabinet Office and Department of Environment Food and Rural Affairs (DEFRA), 2016. National Flood Resilience Review. London. Website (accessed on July 22nd, 2019): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf.

Cai, X., Haile, T., Magidi, J., Mapedza, E., Nhamo, L., 2016. Living with floods - household perception and satellite observations in the Barotse floodplain, Zambia. Phys. Chem. Earth 100, 278–286. https://doi.org/10.1016/j.pce.2016.10.011.

Committee on Climate Change (CCC), 2017. UK climate change risk assessment 2017. Synthesis report: priorities for the next five years. Website (accessed on January 06th, 2020): https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Synthesis-Report-Committee-on-Climate-Change.pdf.

Curtin, J., 2017. Flood risk management 10 years on – A journey of high and low tech improvements. Website (accessed on May 25th, 2019): https://environmentagency.blog.gov.uk/2017/06/27/flood-risk-management-10-years-on-a-journey-of-high-and-low-tech-improvements/.

Denchak, M., 2019. Flooding and climate change. Natural Resources Defense Council. Website (accessed on August 25th, 2019): https://www.nrdc.org/stories/flooding-and-climate-change-everything-you-need-know.

Department for Environment, Food and Rural Affairs (DEFRA) and Environment Agency (EA) The national flood and coastal erosion risk management strategy for England, London Website 2011 accessed on March 03rd, 2019): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/920944/023_15482_Environment_agency_digitalAW_Strategy.pdf.

Environment Agency (EA), 2009. Flooding in England: A national assessment of flood risk, Bristol. Website (accessed on September 12th, 2018): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292928/geho0609bqds-e-e.pdf.

Environment Agency (EA), 2018. Preliminary flood risk assessment for England. Bristol. Website (accessed on August 09th, 2019): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/960159/English_PFRA_Feb_2021_PDFA.pdf.

Environment Agency (EA), 2019. National flood and coastal erosion risk management strategy for England. London: Cabinet Office. Website (accessed on December 02nd, 2019): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/920944/023_15482_Environment_agency_digitalAW_Strategy.pdf.

East Lindsey District Council (ELDC), 2017. East Lindsey strategic flood risk assessment. Website (accessed on 26th July, 2019): https://www.e-lindsey.gov.uk/media/5974/CD54-SFRA-2017-Part-1/pdf/CD54_SFRA_2017_Part_1.pdf?m=636413249442670000.

European Environment Agency (EEA) Floods: Catastrophic floods cause human tragedy, endanger lives and bring heavy economic losses Website 2018 accessed on June 24th, 2019): https://www.eea.europa.eu/archived/archived-content-water-topic/water-resources/floods.

Inogen Environmental Alliance (IEA) Flood risk and climate change: England flood planners must prepare for the worst? GRESB Website 2019 accessed on March 22nd, 2021): https://gresb.com/flood-risk-climate-change-england-flood-planners-must-prepare-worst/.
Inouye, J., 2014. Risk perception: theories, strategies, and next steps; Campbell Institute National Safety Council: Itasca, IL, USA. Website (accessed on March 23rd, 2021): https://www.thecampbellinstitute.org/wp-content/uploads/2017/07/Campbell-Institute-Risk-Perception-WP.pdf.
Kellens, W., Terpstra, T., Maeyer, P., 2013. Perception and communication of flood risks: a systematic review of empirical research. Risk Anal. 33 (1), 24–49. https://doi.org/10.1111/j.1539-6924.2012.01844.x.
Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Legg, T., 2019. State of the UK climate 2019. Int. J. Climatol. 39, 1–55. https://doi.org/10.1002/joc.6213.
Kundzewick, Z., Krysanova, V., Dankers, R., Hirabayashi, Y., Kanae, S., et al., 2017. Differences in flood hazard projections in Europe – their causes and consequences for decision making. Hydrol. Sci. 62, 1. https://doi.org/10.1080/02626667.2016.1241398.
Kundzewicz, W., Hegger, D., Matczak, P., Driessen, J., 2018. Opinion: flood-risk reduction: structural measures and diverse strategies. PNAS 115 (49), 12321–12325. https://doi.org/10.1073/pnas.1818227115.
Lady, J., Kondolf, M., 2012. Flood risk perception in lands protected by 100-year levees. Nat. Hazards 61 (2), 829–842. https://doi.org/10.1007/s11069-011-0072-6.
Lazrus, H., Morss, R., Demuth, J., Lazo, J., 2016. Know what to do if you encounter a flood hazard: mental models analysis for improving flash flood risk communication and public decision making. Risk Anal. 36 (2), 411–427. https://doi.org/10.1111/risa.12480.
Lin, S., Shaw, D., Ho, M., 2008. Why are floods and landslides victims less willing to take mitigation measures than the public? Nat. Hazards 44, 305–314. https://doi.org/10.1007/s11069-007-9136-z.
Lincolnshire County Council (LCC) Joint Lincolnshire flood risk and water management strategy 2019–2050 Website 2019 accessed on 29th November, 2019): https://www.lincolnshire.gov.uk/downloads/file/3390/joint-flood-risk-and-water-management-strategy-2019-2050-strategic-visio-.
Lindell, K., Perry, W., 2012. The protective action decision model: theoretical modifications and additional evidence. Risk Anal. 32 (4), 616–632. https://doi.org/10.1111/j.1539-6924.2011.01647.x.
Lindley, S., O'Neill, J., Kandeh, J., Lawson, N., Christian, R., O'Neill, M., 2011. Climate change, justice and vulnerability. Website (accessed on June 25th, 2019): http://www.jrf.org.uk/publications/climate-change-justice-and-vulnerability.
Marsh, T.J., Kirby, C., Muchan, K., Barker, L., Henderson, E., Hannaford, J., 2016. The winter floods of 2015/2016 in the UK—A review. Centre for Ecology and Hydrology, Wallingford, England.
Met Office. 2019. Wainfleet Climate. Website (accessed on June 17th, 2019): https://www.metoffice.gov.uk/public/weather/climate/u12nn0rs0#?region=uk.
Michael, B., Fazil, A., 2001. Worldwide public perception of flood risk in urban areas and its consequences for hydrological design in Ireland. Website (accessed on 22nd September, 2019): https://www.researchgate.net/publication/255646250_WORLDWIDE_PUBLIC_PERCEPTION_OF_FLOOD_RISK_IN_URBAN_AREAS_AND_IT%27S_CONSEQUENCES_FOR_HYDROLOGICAL_DESIGN_IN_IRELAND.
Miller, D., Hutchins, M., 2017. The impacts of urbanisation and climate change on urban flooding and urban water quality: a review of the evidence concerning the United Kingdom. J. Hydrol.: Reg. Stud. 12 (C), 345–362. https://doi.org/10.1016/j.ejrh.2017.06.006.
Murphy, J., Harris, G., Sexton, D., Kendon, E., Bett, Pl Clark, R. et al., 2018. UKCP18 Land projections: science overview report. Exeter, UK: Met Office Hadley Centre. https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Land-report.pdf.
Office for National Statistics (ONS), 2016. Living costs and food survey, 2014 (2nd ed.). London: UK Data Service, SN. DOI:10.5255/UKDA-SN-7992-3.
Ozger, M., 2017. Assessment of flood damage behaviour in connection with large-scale climate indices. J. Flood Risk Manag. 10, 79–86. DOI:10.1111/jfr3.12158.
Paton, D., Millar, M., Johnston, D., 2001. Community resilience to volcanic hazard consequences. Nat. Hazards 24, 157–169. https://doi.org/10.1111/jfr3.12685.
Penning-Rowsell, Edmund C., 2021. Comparing the scale of modelled and recorded current flood risk: Results from England. J. Flood Risk Manag. 14 (1) https://doi.org/10.1111/jfr3.v14.110.1111/jfr3.12685.
Porter, J., Demeritt, D., 2012. Flood-risk management, mapping, and planning: The institutional politics of decision support in England. Environ. Plan A, 44, 2359–2378. DOI:10.1068%2Fa44660.
Price, R., 2019. Mainstreaming climate and environmental considerations into existing development programmes. Website (accessed March 30th, 2021): https://assets.publishing.service.gov.uk/media/5c8645a7ed915d07cb04cf80/541_Mainstreaming_Climate_Change_into_Development.pdf.
Priest, S., Suykens, C., Van Rijswick, H., Schellenberger, T., Goytia, S., Kundzewicz, W., Van Doorn-Hoekveld, W., Beyers, J., Homewood, S., 2016. The European Union approach to flood risk management and improving societal resilience: lessons from the implementation of the Floods Directive in six European countries. Ecol. Soc. 21 (4), 50. https://doi.org/10.5751/ES-08913-210450.
Reynaud, A., Aubert, C., Tarolli, P., 2013. Living with floods:protective behaviours and risk perception of Vietnamese households. Geneva Pap. Risk Insur. Issues Pract. 38, 547–579. https://doi.org/10.1057/gpp.2013.16.
Roder, G., Ruljigaljig, T., Lin, C.-W., Tarolli, P., 2016. Natural hazards knowledge and risk perception of Wujie indigenous community in Taiwan. Nat. Hazards 81, 641–662. https://doi.org/10.1007/s11069-015-2100-4.
Rural Air Force (RAF) RAF News: RAF Chinook aids emergency repairs to UK flood defences Website 2019 accessed on June 18th, 2019):https://www.raf.mod.uk/news/articles/raf-chinook-aids-emergency-repairs-to-uk-flood-defences/.
Sayers, P., Penning-Rowsell, E., Horritt, M., 2018. Flood vulnerability, risk, and social disadvantage: current and future patterns in the UK. Reg. Environ. Change 18, 339–352. https://doi.org/10.1007/s10113-017-1252-z.
Slovic, P., 2000. The Perception of Risk. Earthscan, Publications, London.
Sun Reporter, 2019. Wainfleet floods – where is it flooding in Lincolnshire and how many homes have been evacuated since the River Steeping broke its banks? Website (accessed on August 28th, 2019): https://www.thesun.co.uk/news/9307094/wainfleet-floods-river-steeping-lincolnshire/.
Tatiana, F., 2014. Market-based instruments for flood risk management: a review of theory, practice and perspectives for climate adaptation policy. Environ. Sci. Policy 37, 227–242. https://doi.org/10.1016/j.envsci.2013.09.005.
Terpstra, T., Lindell, K., 2012. Citizens' perceptions of flood hazards adjustments: An application of the protective action decision model. Environ. and Behav., 45(8), 993-1018. DOI:10.1177%2F0013916512452427.
Treby, J., Clark, M., Priest, J., 2006. Confronting flood risk: implications for insurance and risk transfer. J. Environ. Manage. 81 (4), 351–359. https://doi.org/10.1016/j.jenvman.2005.11.010.
United Nationis International Strategy for Disaster Reduction (UNISDR), 2015. Sendai framework for disaster risk reduction 2015 – 2030. Website (accessed on February 23rd, 2018): http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf.
United Nationis International Strategy for Disaster Reduction (UNISDR), 2017. Terminology. UN Office forf Disaster Risk Reduction. Website (accessed July 14th, 2020): https://www.unisdr.org/we/inform/terminology.
Wachinger, G., Renn, O., Begg, C., Kuhlicke, C., 2013. The risk perception paradox – implications for governance and communication of natural hazards. Risk Anal. 33 (6), 1049–1065. https://doi.org/10.1111/j.1539-6924.2012.01942.x.
Wing, E., Bates, D., Smith, M., Sampson, C., Johnson, A., Fargione, J., Morefield, P., 2018. Estimates of present and future flood risk in the conterminous United States. Environ. Res. Lett. 13 (3), 1–7. https://doi.org/10.1088/1748-9326/aaac65.