Response to WP1 (UK)

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Work package	Title
1	Analysis of natural disasters needed to be managed in Western Balkan region
Activity	Title
1.2	Survey of established practices in EU countries for NDRM

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1 Introduction

Information about established practices for natural disasters risk management in EU countries is indispensable for developing master curricula for risk management in Western Balkan regions. In work package 1.2 (WP 1.2) a collaboration between BOKU and all partners from EU countries is foreseen to dose the knowledge gap concerning natural disaster risk management. In the following chapters information about natural disasters, analysis of risk management, survey of responsible institutes and analysis of education possibilities are documented for different EU countries.

2 Identification of natural disasters

The United Kingdom (UK) is a decentralised unitary state which is composed of England and three other countries (Scotland, Northern Ireland and Wales) which have differing degrees of devolved responsibilities. Some aspects of managing natural risks are therefore managed separately by the fours nations and as such the UK has a very complex mix of agencies, laws and policies. For example, the Floods Directive was transposed into legislation separately for England and Wales, Scotland and Northern Ireland (e.g. see Flood Risk Regulations 2009(E and W); Flood Risk Management (Scotland) Act 2009; The Water Environment (Floods Directive) Regulations (Northern Ireland) 2009). Due to these differences, the sections in this report will primarily focus on the circumstances related to England, however where the discussion is focussing more generally on the UK, this will be indicated.

Two key approaches are utilised herein to identify and select the key natural risks affecting the United Kingdom; governmental-led risk assessments which aim to identity and plan for current and future risks and also examples of past events. The UK government have produced a *National Risk Register of Civil Emergencies* (Cabinet Office, 2015) which assesses the risks in the UK over the next five years with the aim of providing information to assist the public and other authorities with managing them. One risk category that is defined is that of 'natural risks', however this has a very broad definition and importantly considers the impact of any natural event on the country, not only those which originate from within the UK. Principally, this 'natural risk' category includes Human Diseases (e.g. Pandemic Flu), Flooding (divided here into coastal and inland, Poor Air Quality events, Volcanic hazards (e.g. examining the impacts of overseas eruptions), severe space weather (e.g. solar flares, radiation storms), Severe weather (including storms and gales, low temperatures and heavy snow, heatwaves, drought), Severe Wildfires and Animal diseases (e.g. foot and mouth disease, rabies etc). This risk assessment then identifies those risks which it considers to be most significant on two risk matrices which consider the scale of the impact and the probability of occurrence. The matrix related to 'other risks' (i.e. non-terrorism/malicious attack) is presented in Figure 1. This figure highlights the key concern of coastal flooding, with inland flooding, heatwaves and low temperatures/heavy snow having a medium risk concern.

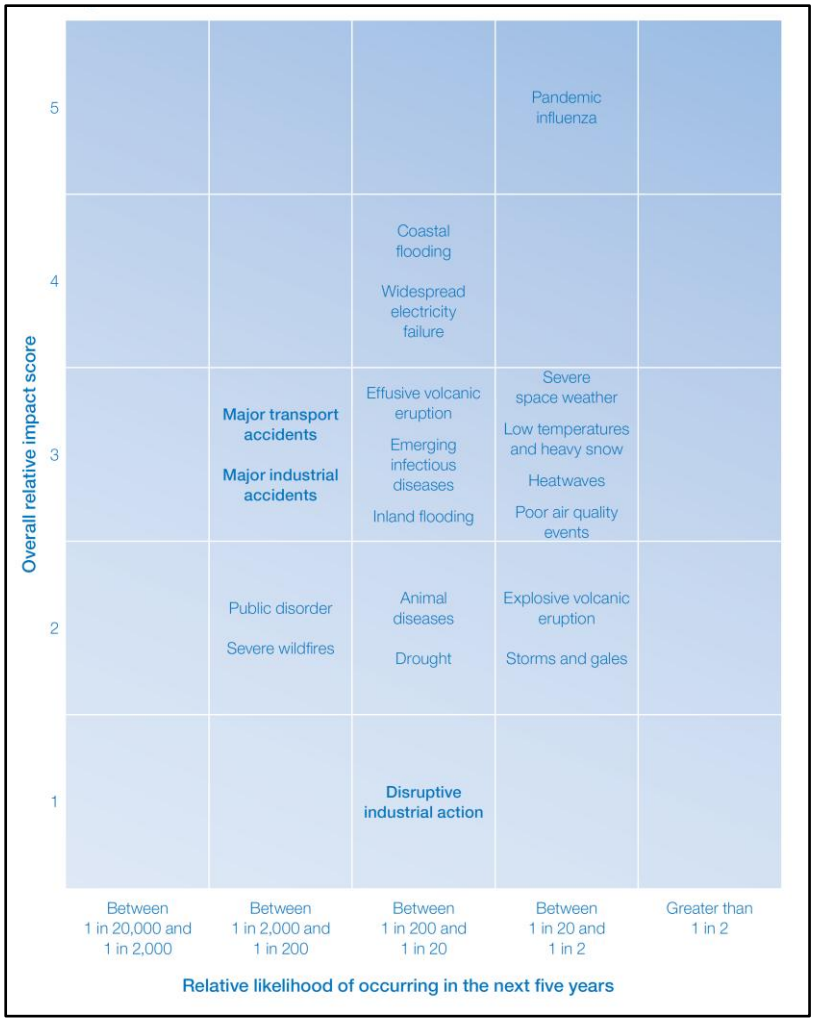

Figure 1: Risk matrix of 'other risks' to the UK (Cabinet Office, 2015; 13).

Another body of work that has contributed to the UK debate in this area is the Climate Change Risk Assessment 2017 which aims to provide evidence for and "assess the urgency of further action to tackle current and future risks, and realise opportunities, arising for the UK from climate change." (CCC, 2017). This report also emphasises that the greatest increase in risk magnitude are in the areas of flooding and coastal risks and the risks to health and well-being and productivity from high temperatures (CCC, 2017).

Data from the EM-DAT database[1] can provide some indication of the scale of events which have affected the UK in past years. Although the dataset has some limitations if the absolute values are presented[2] (i.e. there are questions about how deaths or damages are attributed to specific events) and the resolution of the data, it is very useful in providing some indication of the relative importance of different type of natural risks in the UK. Table 1 highlights the ten most

[1]D. Guha-Sapir, R. Below, Ph. Hoyois - EM-DAT: The CRED/OFDA International Disaster Database – www.emdat.be – Université Catholique de Louvain – Brussels – Belgium.

[2] This database enters a record in the database if any of the following criteria are are present: 10 or more people killed, 100 or more people affected/injured/homeless, significant disaster, e.g. 'worst disaster in the decade', significant damage, e.g. 'most costly disaster'.

severe natural events experienced in the last 30 years (i.e. 1986-2016). Events in these cases have been ranked based on the different types of impact that have been experienced: numbers of fatalities, numbers of people affected and an estimate of the economic damages.

Table 1: Top ten natural disasters in the UK ranked by fatalities, total number of people affected and total damages sustained

Total Fatalities				
Ranking	Disaster No	Type	Date	Totals deaths
1	2013-0549	Extreme temperature	Jul-13	760
2	2003-0391	Extreme temperature	Jul-03	301
3	1991-0004	Storm	05/01/1991	48
4	1990-0717	Storm	25/01/1990	47
5	1987-0191	Storm	15/10/1987	20
6	1990-0722	Storm	25/02/1990	18
7	1990-0723	Storm	28/02/1990	18
8	1998-0007	Storm	01/01/1998	15
9	1997-0004	Extreme temperature	04/12/1997	14
10	2007-0019	Storm	18/01/2007	13

Total People Affected				
Ranking	Disaster No	Type	Date	Total affected
1	2007-0278	Flood	20/07/2007	340000
2	1998-0419	Storm	24/12/1998	250000
3	2015-0561	Flood	26/12/2015	48000
4	2007-0247	Flood	25/06/2007	30000
5	2000-0714	Storm	28/10/2000	19504
6	2014-0067	Storm	14/02/2014	18000
7	2015-0525	Storm	04/12/2015	15600
8	1996-0252	Storm	27/10/1996	12000
9	2007-0692	Earthquake	28/04/2007	4501
10	2013-0517	Storm	06/12/2013	4200

Total Damages				
Ranking	Disaster No	Type	Date	Total damage ('000 US$)
1	2000-0662	Flood	11/10/2000	5900000
2	2007-0247	Flood	25/06/2007	4000000
3	2007-0278	Flood	20/07/2007	4000000
4	1990-0717	Storm	25/01/1990	3400000
5	2012-0552	Flood	21/11/2012	1630000
6	1987-0191	Storm	15/10/1987	1565000
7	2000-0714	Storm	28/10/2000	1500000
8	2013-0572	Flood	27/12/2013	1500000
9	2015-0561	Flood	26/12/2015	1200000
10	2007-0019	Storm	18/01/2007	1200000

When considering fatalities three of the most severe events relate to deaths from extreme temperature, whilst the remaining seven relate to storm events. However, what also is important is a consideration of the difference in magnitude of the deaths experienced with 760 fatalities being attributed to the effects of extreme temperature in July 2013 and 301 in July 2003, whilst the fatalities from storm events only reaching a maximum of 48. By comparison, when considering the other ways of ranking the most severe impacts (e.g. total numbers affected and economic damages) principally floods and storms dominate.

Although the UK is potentially subject to awide range of natural risks if a broad definition is considered, the following sections will concentrate on a more narrow focus of natural risks as understood in the NatRisk project (i.e. concentrating principally on hydro-meteorological events). Furthermore, although there may be natural risks which will have locally important impacts (e.g. landslides), the following sections will also focus on those risks which had higher impacts in recent years and which are identified as being more nationally significant.

2.1 Flooding

England is at risk form a wide range of different types of flood risks from different sources (the sea, fluvial, surface water, groundwater, reservoirs),which have differing characteristics (slow rise, rapid flash flooding) and are caused by meteorological events of different types (e.g. summer convectional storms, winter storms). Importantly, the geographical and topographical nature of England means that quite often these different types of flooding occur in combination and also in combination with other severe weather impacts such as high winds. There is evidence to suggest that flood risks will increase in the future due to increased and changed precipitation patterns and sea level rise which both relate to climate change. These changes will affect the likelihood and impact of fluvial, surface water and coastal flooding (CCC, 2017, Evans et al., 2004; 2008). The Environment Agency (2009a) estimates that around one in six residential and commercial properties (5.2 million) are at risk from flooding. Of these, 2.4 million properties are susceptible to fluvial and coastal flooding of which one million of these are also at risk from surface water flooding. The remaining 2.8 million properties are at risk from only surface water flooding (EA, 2009a) (see Figure 2).Of those 2.4 million properties at risk of fluvial and coastal flooding, almost 500,000 properties are at significant flood risk (greater than a 1 in 75 chance of flooding in any one year) (EA, 2009a). Figure 3provides an indication of the numbers of properties at risk from flooding coastal and fluvial flooding and their location. However, importantly there have been many efforts made to manage flooding and so not all of these risks remain unprotected (see Section 3.2).

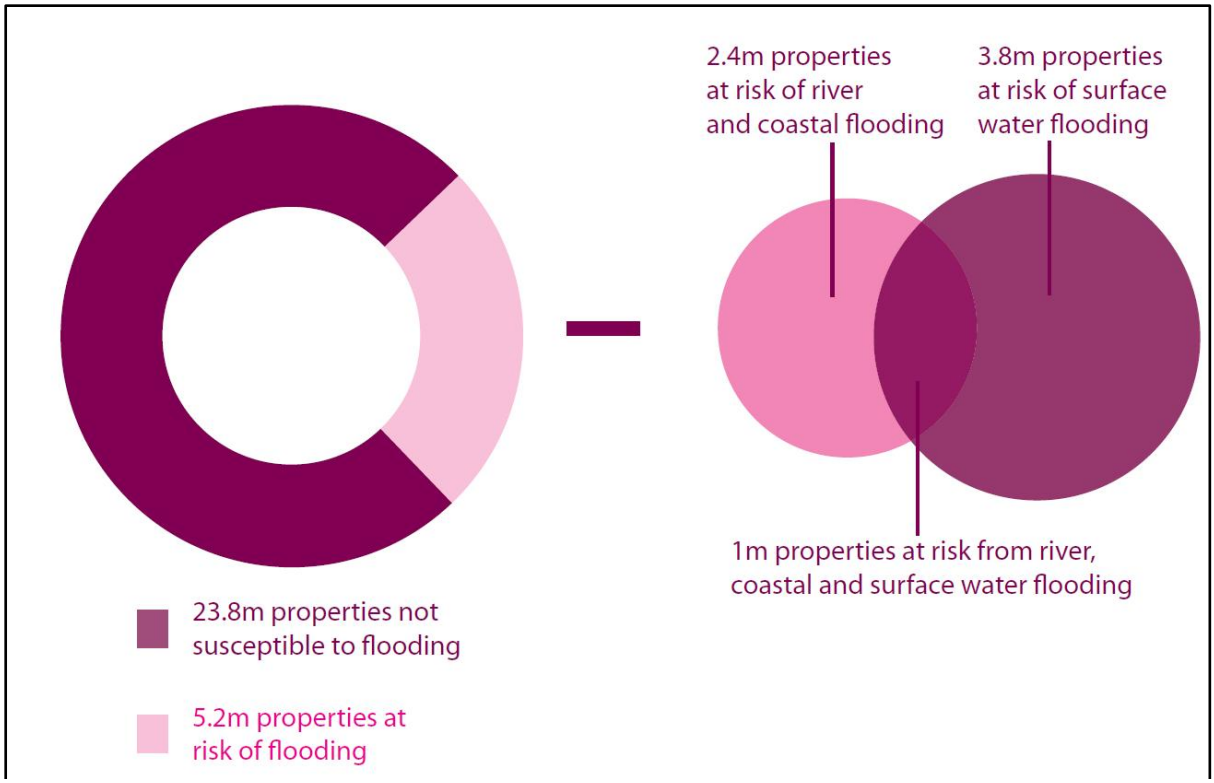

Figure 2: Properties at risk of flooding in England (Environment Agency, 2009b; p6)

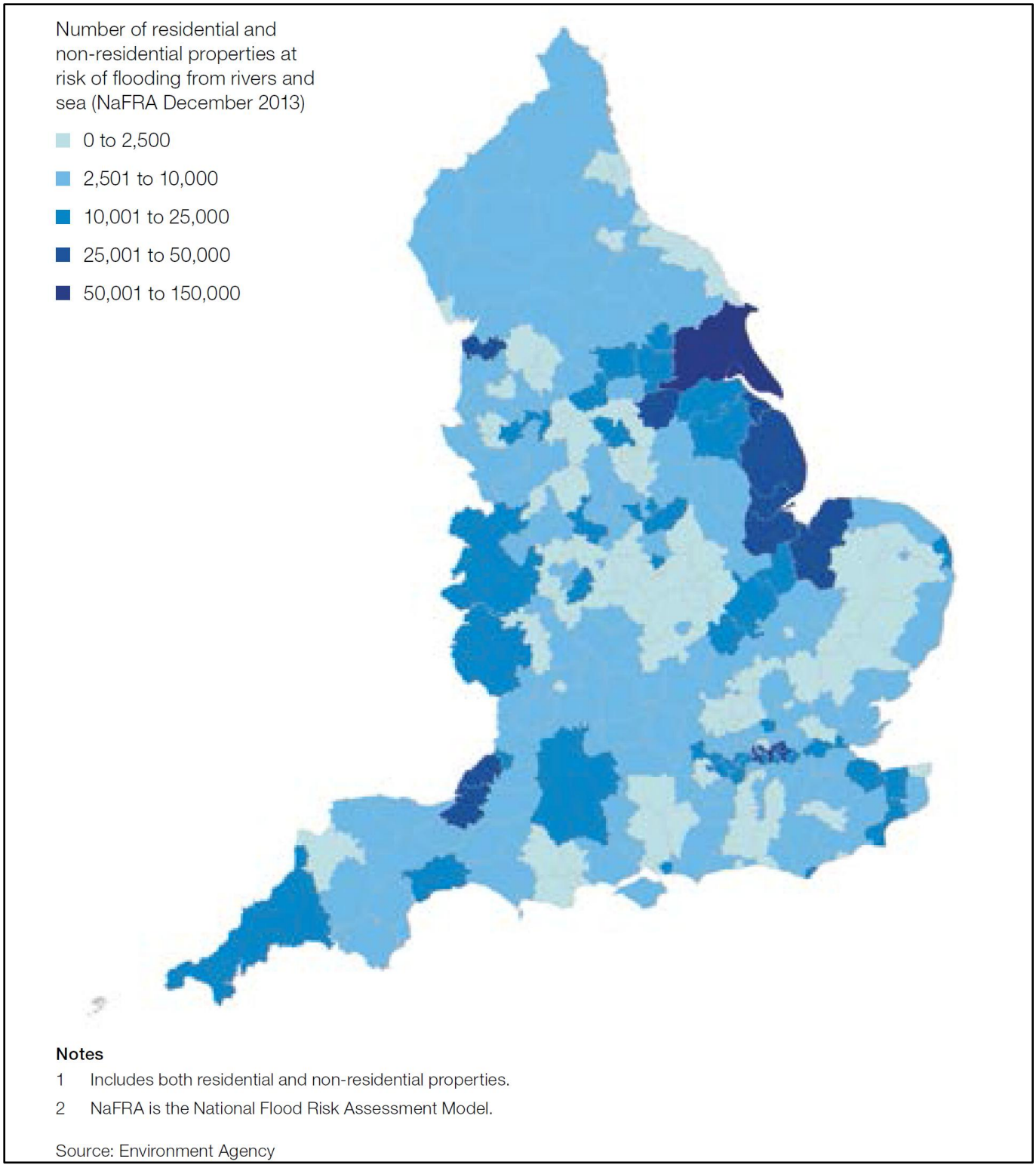

Figure 3: Properties at risk from flooding (National Audit Office, 2014, p13)

Coastal flooding is recognised by the National Risk Register as having the potential to have the greatest single event impact and in particular related to a combination storm surge event to the East coast of England (Cabinet Office, 2015). Importantly, there is recognition that this type of flooding has the highest potential for flood fatalities related to the expected depths and

velocities of water. This recognition, as well as pervading memories of the worst loss of life experienced from a flood event with 307 fatalities caused by east coast floods in 1953 (Baxter, 2005) has provided a clear impetus for management. Much effort has been made to mitigate coastal flood risks in different ways, particularly on the east coast, however despite these efforts coastal flooding still occurs with more recent cases being discussed below.

Various types of fluvial flood risk are experienced including rapid onset flash flooding within steeper catchments as well as slow rise flooding from smaller or larger rivers. The Cabinet Office (2015) suggests that the frequency of inland flooding is increasing with significant floods occurring in 2007, 2009, 2010, 2012, 2013 and 2014. Although efforts have been made to manage flooding (see Section 3) not all of these measures are oriented towards preventing flooding or flood protection and therefore it is expected that some residual risk will remain and will need to be managed in different ways. Recent flooding, and initiatives to assess risk following these events, has highlighted the significance of surface water flooding (see Figure 2) and increasing addition has been paid to managing these risks. Surface water flooding includes inundation from run-off, but is also related to inadequate drainage, and this type of flooding has been present in all of the recent events discussed below.

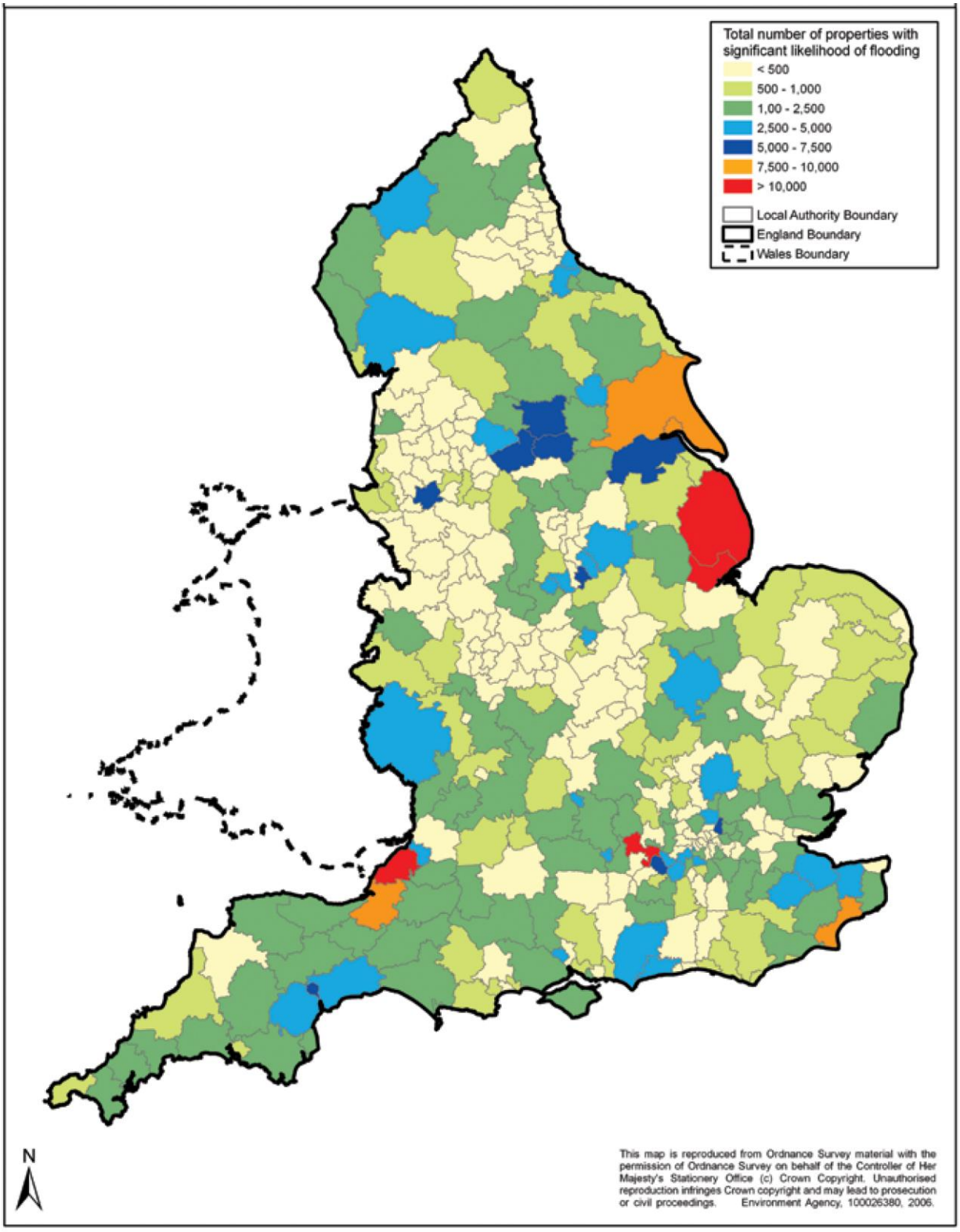

Figure 4: Number of properties located in areas at significant risk of flooding by Local Authority boundary (Environment Agency, 2009a; 27).

2007 Summerfloods

The floods experienced in Summer 2007 is one of the most widespread and nationally significant flood events of recent years.England and Wales experienced extremely wet weatherwith a cumulative rainfall total of 395.1mm[3] for May to July 2007 which is more than twice the average amount of rainfall (Pitt, 2008). Fluvial and surface water flooding were the principal sources of flooding with the numbers of properties flooded from surface water considered to be higher[4]. It is important to recognise that the flooding did not just occur on one occasion and extended over a considerable period of time, but that there were two key distinct flood events. The north of England was affected by heavy thunderstorm rainfall in mid-June and led to flooding across many counties (Yorkshire, Humberside, Lincolnshire, Derbyshire and Worcestershire) with the cities of Hull and Sheffield being particularly severely affected (Chatterton et al., 2010). Further flooding was experienced in late July caused by heavy rainfall from a depression slowly moving from south-east England northwards falling on already saturated ground (Pitt, 2008). There were thirteen fatalities in the floods and a total around 48,000 homes and 7,300 business properties were flooded. Additionally, the event caused widespread disruption to transport and utility networks (Pitt, 2008). Indeed, in Gloucestershire, c. 140,000 properties lost access to a clean water supply for up to 17 days (Chatterton et al., 2010). The total economic costs of the flooding were estimated to be around £3.2 billion at 2007 prices (Chatterton et al., 2010). The widespread scale and types of impacts (i.e. significant amount of disruption to critical infrastructure) led the government to commission an independent review into the floods conducted by Sir Michael Pitt (Pitt, 2008) which made 92 recommendations for changes to all areas of flood risk management (e.g. see Defra, 2008; 2009; 2012). These recommendations, in combination with other initiatives and requirements (such as the Floods Directive) have seen recent clarifications and changes to English flood risk management (see sections 3 and 4).

Winter 2013/14 storms and floods

In contrast to the summer 2007 event, the 2013/14 floods occurred during winder and originated from a period of stormy weather which affected all of the UK during the four months from October 2013 to February 2014. Various areas of the country experienced flooding from a series of different weather events. Coastal flooding occurred in a variety of different areas. The east coast of England suffered from the highest tidal surge in 60 years in early December 2013 which caused an evacuation of thousands of residents and to the inundation of 2,800 houses (Cabinet Office, 2015; Chatterton et al., 2016). Storms around Christmas in December 2013 caused inland flooding across southern England, travel disruption to roads, rail and Heathrow airport and an extensive loss of power. Both Wales and the south-west of England (Devon and Cornwall) were affected by storms in early January as well as February 2014. Many roads to this region were cut (the A631 being shut for 12 weeks) (Chatterton et al., 2016) and the nature of the infrastructure in this part of England means this results in severe disruption and lengthy detours. Furthermore, a 100 metre stretch of railway near Dawlish in Cornwall was destroyed, completely shutting the line for a number of weeks and leading to thousands of train cancellations (Chatterton et al., 2016). This period of flooding was also unusual due to the

[3]This total is for both England and Wales as both experienced flooding within this event.

[4]Initially the Environment Agency suggested that the split was one third fluvial or a mix of fluvial and surface water and the remaining two thirds being surface water, but the Pitt review (Pitt, 2008) suggests that these estimates cannot be fully substantiated.

duration of the impacts being experienced. The Somerset Levels, in the south of England, suffered significant flooding throughout this period, with areas and a small number of properties being inundated for many weeks during the floods (DCLG, 2014).

In total it was estimated that 8,342 homes and 4,459 businesses were directly flooded, with a further 7,000 properties suffering from a loss of water or other essential services (DCLG, 2014).The total economic damages of the eventwere in the region of £1,300 million in England and Wales (Chatterton et al., 2016). Not all of the disruption, however, was caused directly by flooding, but also by high winds associated with the severe weather with roads being affected by fallen trees and electricity being affected by fallen power lines. However, despite the losses and disruption experienced, the event also served to highlight the effectiveness of many of the existing flood management responses. It was estimated by the Environment Agency that flood defences prevented the inundation of around 1.4 million properties (DCLG, 2014).

Winter 2015/16 storms and floods

Similar to the events of winter 2013/14, the floods in winter 2015/16 are characterised by a series of severe weather eventssome of which were linked to named storm events (e.g. Storms Desmond, Eva and Frank; Priestley, 2016) and rainfall that was considered to be the highest since records began (Marsh et al., 2016). Unlike the floods in 2013/14 which affected many different parts of the country in winter 2015/16 the floods were primarily concentrated in the north and west of England where the rainfall was highest, the catchments affected were steep and had relatively thin soil cover so that insufficient rainfall was absorbed (Marsh et al., 2016). Areas significantly affected by flooding included Cumbria, and in particular the city of Carlisle, as well as Manchester, Lancashire and Yorkshire.

Investigations into the 2015/16 floods remain ongoing and the Environment Agency official report about the total costs of the floods is yet to be published. However, estimates suggest that there are insured flood losses of £1.3 billion (ABI, 2016) although the total costs of Storm Desmond on all of the UK are estimated to be around £5 billion (EFRA, 2016). Similarly, there are multiple estimates of the numbers of properties impacted and are complicated by the fact that some properties flooded multiple times. The Association of British Insurers(2016) estimated a total of 22,000 flood claims of which c. 5600 were for businesses and 6700 were motor claims. However, the government also estimated that flood defences helped to protect over 11,000 properties and provided time to evacuate both people and property (UK Government website[5], January 2016).

Part of the significance of the winter 2015/16 floods on flood risk management was that it affected areas such as Cumbria which had previously been flooded (notably in 2005 and 2009: Cowen and Mallinson, 2009; Cumbria Resilience, 2011) and had received considerable investment in flood defence infrastructure which many thought would prevent future flooding. Following assessment of the causes of flooding it was considered that the defences did not 'fail' but significant amount of rainfall experienced caused flooding was above the design standard for the defences. It has also reignited the debate about whether natural flood management might be used in certain areas to reduce flooding (Environment Agency, 2016; HM

[5]https://www.gov.uk/government/news/north-west-england-floods-2015-government-response

Government, 2016). The floods also reinforced existing concerns about risks to infrastructure and led to a major review to consider these aspects (HM Government, 2016); whereby actions from the recommendations remain ongoing.

2.2 High temperatures and heatwaves

Public Health England (PHE) (2015a) have analysed the risk of the health impacts and an increased number of deaths associated with high temperatures and heatwaves in England and are responsible for setting out a plan for managing them. PHE (2015a; 3) report that in England in Summer 2006 "a linear relationship between temperature and weekly mortality was observed…with an estimated 75 extra deaths per week for each degree of increased temperature." Concern is growing that these extreme weather events may become more common and/or severe under climate change (CCRA, 2017) and thus a greater emphasis is being placed on preparing and managing these events (PHE 2015a; 2015b).

3 Analysis ofestablished risk management strategies

Disaster management has a long tradition in England and has developed in an iterative and piecemeal way over considerable centuries. As in many countries the first priority is to address issues which impact public safety and adopts principally a cost-benefit approach (CBA) to managing risks, whereby investment is targeted to those situations which can provide most economic benefits, although these are often adjusted to account for other factors (e.g. environmental benefits, recognising social vulnerabilities).

Importantly, there is a mix of public and private responsibility for managing disasters and although the government leads the management of many risks, individuals are also expected to take responsibility for managing their own risk. An example of this is demonstrated within the case of flood risk, whereby despite government interventions and investment, the legal responsibility for managing flood risk continues to rest with the land/property owner (Environment Agency, 2013). This has been reinforced more recently with the politically and resource driven move towards Localismand a shift towards increasing the proportion of funding (Partnership Funding; Defra, 2012) for flood risk management which comes from local sources (Thaler and Priest, 2014).

Furthermore, due to the extent and complexity of the flood risks experienced in England it has long been recognised that it is impossible to protect all properties from all floods. Therefore, over the past 60 years or more a highly diversified strategy of risk management has developed (Alexander et al., 2016) which is highlighted in the many different categories described below. This approach recognises that in areas with a lower flood risk it may be more appropriate to live with flooding and develop other approaches to management including increasing community resilience and facilitating ways to absorb impact and recover. Figure 5 presented by the Environment Agency (2009a; 8) illustrates the ways in which they expect flood likelihood and impacts to both increase and decrease through management actions and future scenarios.

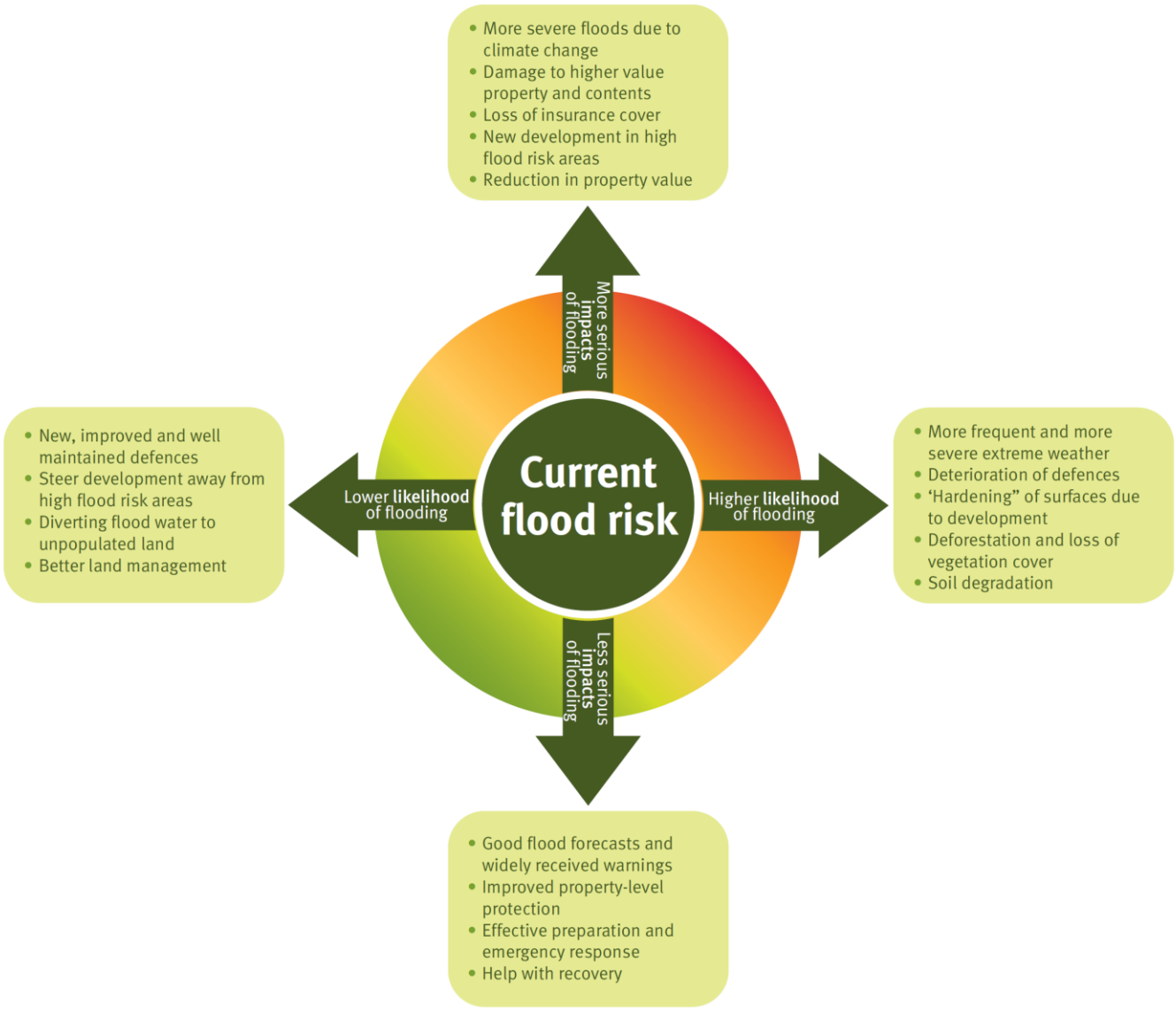

Figure 5: Managing flood risk – addressing likelihoods and impacts (Environment Agency, 2009a; 8)

3.1 Prevention: Spatial planning and development control

England has a long-standing and well-developed approach to spatial planning and development control which aims to minimise the exposure of people by prohibiting or discouraging inappropriate development in areas susceptible to flooding. This approach was strengthened in 2001 with the first iteration of the indicative flood map (Priest et al., 2008) which provided a means for spatial planners to identify flood risk. The 'Flood Map for Planning' is still a product offered by the Environment Agency (seeFigure 6).

Principally, England has a non-zoning discursive approach to spatial planning and any (re)developments are required to submit a planning application locally and receive planning consent prior to their construction. Therefore, spatial planning is primarily undertaken at local levels, although decisions are required to be consistent with national planning policy. The National Planning Policy Framework (NPPF) (DCLG, 2012) includes flood risk as a material

consideration which means that it has to be taken into account when judging planning applications and requires Local Planning Authorities to prepare Strategic Flood Risk Assessments (SFRAs) which are used to guide planning decision-making and provides the basis on which to permit or deny development.

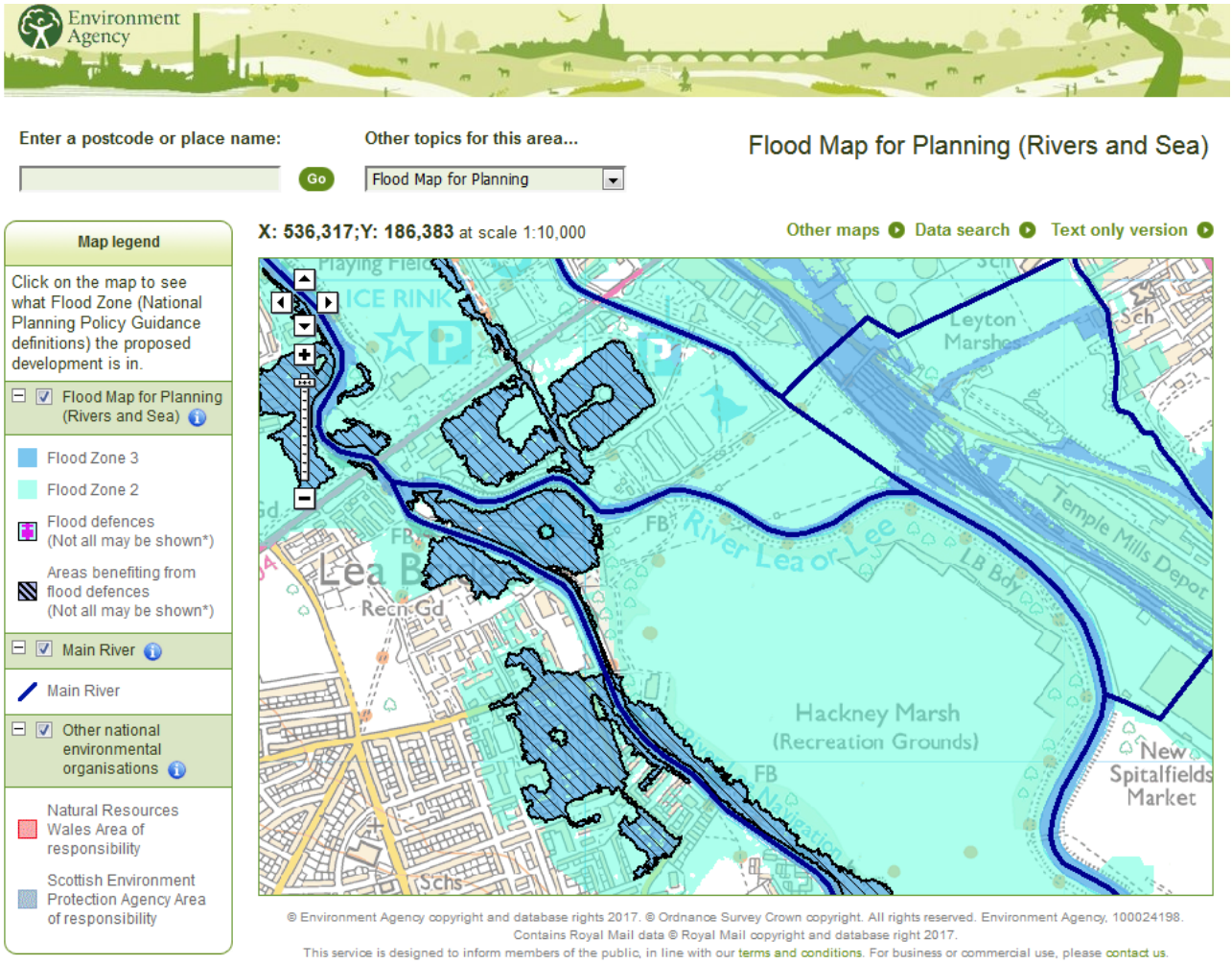

Figure 6: Example of the Environment Agency's Flood Map for Planning (see http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e)

If a proposed (re)development is within an area susceptible to flood risk it is required to have a Flood Risk Assessment (FRA) to detail the risk, explain how the development will not increase the risk to others and also any proposed measures to mitigate that risk. Local Planning Authorities have a duty to seek technical advice from the key flood risk management organisation (Environment Agency) about the risk and whether they consider an application should go ahead. Of course Local Planning Authorities are balancing many different pressures and so may choose to go against the Environment Agency advice, but in these cases they are required to report this and the Secretary of State may 'call in the decision' for additional scrutiny (see Figure 7). This figure highlights that overall less than 4% of applications went ahead against EA advice, but this is still considered to be too many, especially in the case of the 15 major developments (Environment Agency, 2009a). Although it is recognised that the

Environment Agency are now objecting to fewer developments, a concern remains a lack of knowledge of the outcomes of many (up to 40%) of planning decisions that they did object to and therefore it is unknown how much development is actually occurring (CCC, 2014). The CCC (2012) estimates that on average 13% of development each year is still in the floodplain.

Where possible, the aim is that development avoids areas at flood risk, however the policy is that 'inappropriate' development be avoided, not *all* development. Thereby if (re)development is to go ahead developers are required to ensure that development is flood resilient and resistant, safe for its users for the development's lifetime, and will not increase flood risk overall (DCLG, 2012; 23-25).

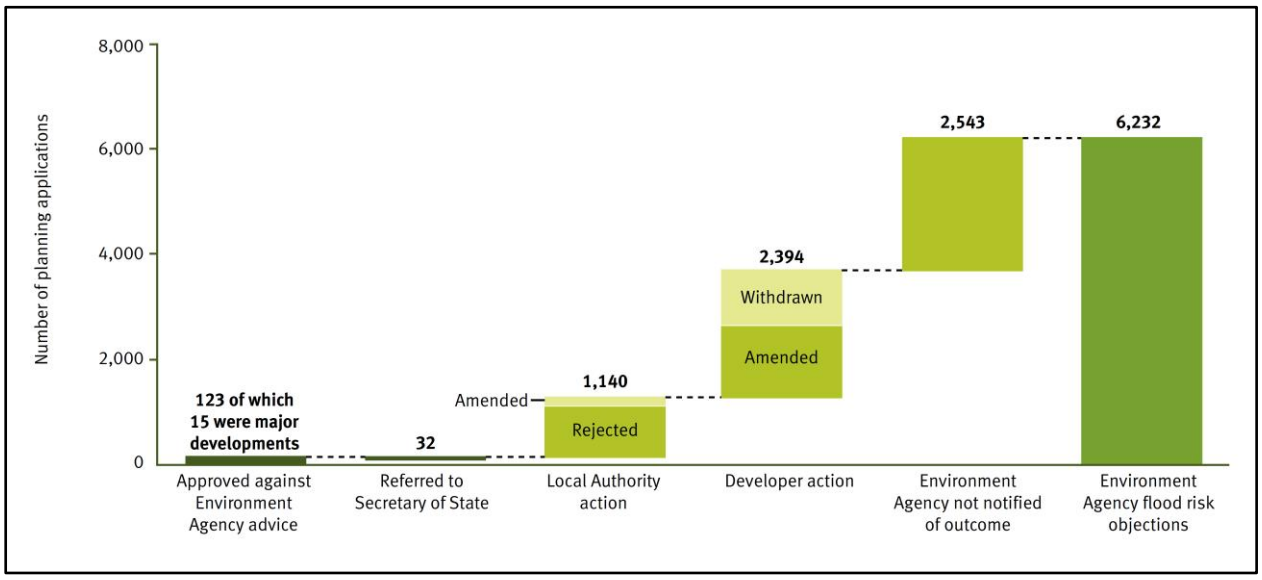

Figure 7: Resolution of Environment Agency flood risk planning objections in England (2007-2008) (Environment Agency, 2009a;14).

3.2 Protection measures: Flood defence and mitigation

Flooding is one of the key risks whereby management action can be taken to reduce the likelihood and severity of impacts. Flood management in England for many years was dominated by an approach of land drainage which focused on ensuring that agricultural land was not flooded in order to maintain food production and security. However, following the decline in dependency on domestic food production focus turned to the importance of defending properties in urban areas where the concentration of assets was highest. Significant investment has been undertaken over the years and many of the significant risks in England are now protected by flood defences. A major example of this was the building of the Thames Barrier and its associated defences (opening in 1984) which aims to protect London from tidal flooding and is estimated to prevent flooding to 500,000 homes, 1.25 million people and assets worth £200 billion (London Assembly, 2014). The Environment Agency (2009a) has estimated that investments between 2003-2004 and 2007-2008 reduced the risk of flooding to over 176,000 properties of which 156,000 were attributable directly to flood defence improvements (see Figure 8).

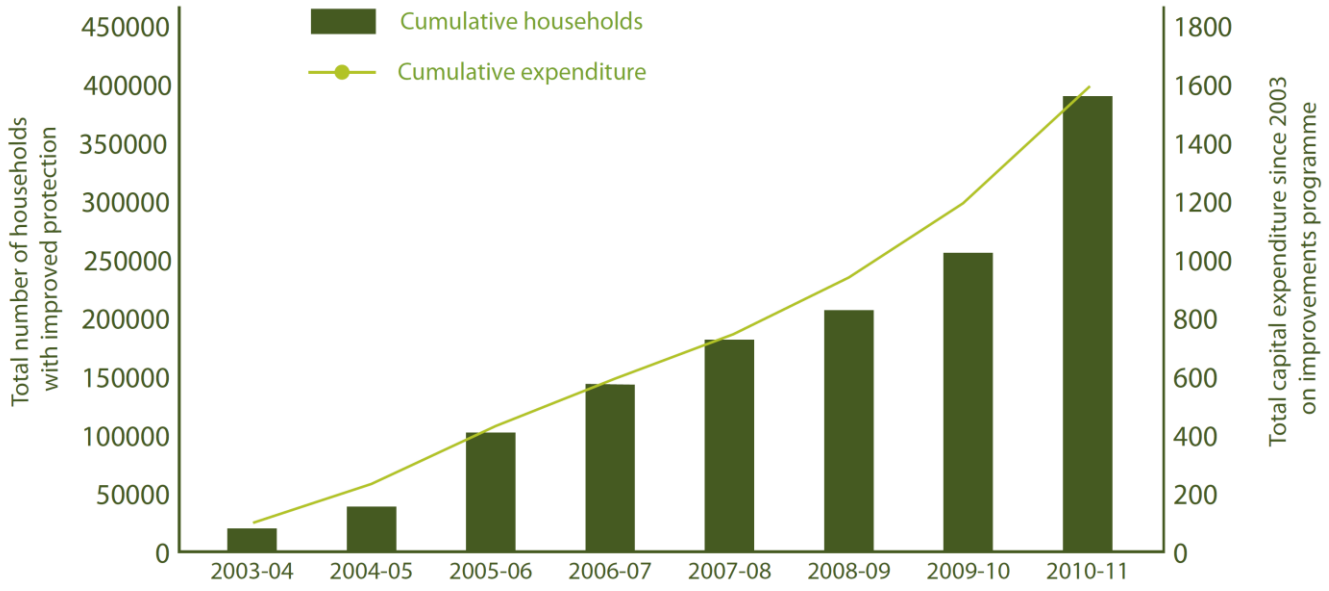

Figure 8: Cumulative number of households benefiting from reduced likelihood of flooding since 2003-2004 (Environment Agency, 2009a; 15).

In more recent years the focus has broadened from measures solely considered to be defence towards the inclusion of other types of flood mitigation which reduce the likelihood or frequency of flooding. This includes measures such as flood retention basins, property level resilience and resistance measures and other types of sustainable urban drainage systems.

3.3 Preparation, awareness-raising and resilience

Great efforts have been made to increase the awareness of individuals and communities from all kinds of risks, both natural and man-made. As part of the National Resilience Capabilities Programme (NRCP), the Cabinet Office adopts a supportive role in helping responders to meet their statutory duty to raise public awareness of risk (Cabinet Office, 2015).Local Resilience Fora (a requirement of the Civil Contingencies Act 2004) are partnerships made up of multiple agencies and include representatives from local public authorities, including: emergency services, NHS, local authorities, Environment Agencies and others. These organisations are core members of this organisation and are known as Category 1 responders (Civil Contingencies Act 2004). Category 2 responders (such as utility companies) support these organisation and have requirements to share data and respond during emergencies. There are over 40 Local Resilience Fora in the UK and are principally aligned with the boundaries or police areas.

For over 15 years, flood maps have been available online to the public (see http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e) and recent developments have increased the amount and type of information provided. For

instance, maps are now available for inland flooding, coastal flooding and erosion, surface water flood risk, groundwater flooding and the risk of flooding from reservoir. As discussed in Section 3,not all flood risks are able to be protected and therefore there is need for individuals and communities to make preparations to be more resilient. In the flood sphere, local communities have long been involved in decision-making. A more recent key development are the creation of community flood plans (Environment Agency, 2012) which aim to get local flood professionals and communities working together to prepare for flooding and recognition of those measures that local people can take before or during flooding.

Emergency response planning is another area which encourages preparation and is a fundamental pre-requisite to emergency response and crisis management. The Civil Contingencies Act (2004) requires responders at all levels to identify, assess and plan for managing different risks. Similar to the National Risk Register discussed in Section 2 emergency responders are required to develop and maintain a Community Risk Register (CRR) and utilise a risk-based matrix to prioritise responses, the allocation of resources and develop appropriate responses (CCA Regulations 2005). Various plans are produced at different scales and for different purposes and Figure 9 illustrates how these plans may align. Specifically for flooding, emergency responders are required to work together (via, and under oversight, ofthe Local Resilience Forum) to create Multi-Agency Flood Plans (MAFP). These can be of various scales and be targeted towards strategic or operational response decision-making (Defra, 2014).

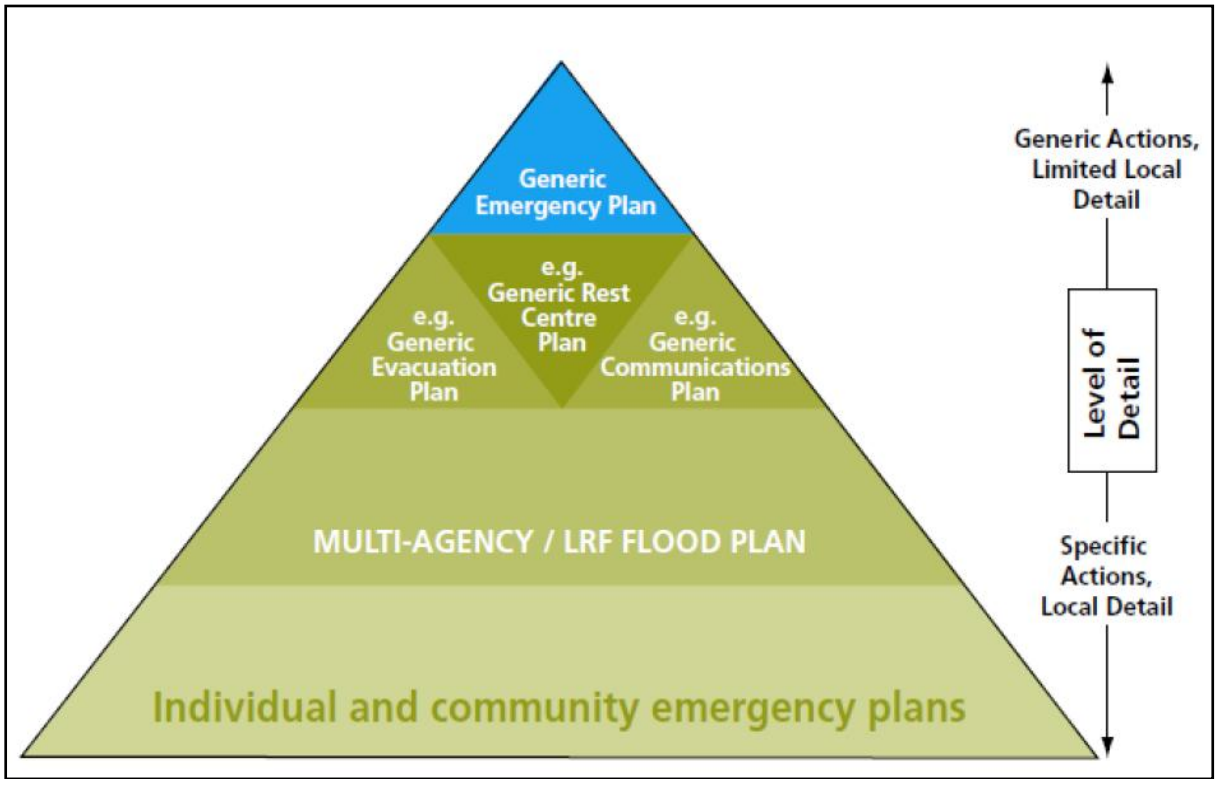

Figure 9: How a Multi-Agency Flood Plan fits with other plans, Defra (2011; 3)

Greater emphasis is being placed on heatwave planning with the production of a number of plans which set out the approaches and responsibilities (PHE, 2015a;2015b). Certain groups (including the very young, elderly, those with chronic illnesses, homeless) are considered to be

most at risk from the health impacts of heat and therefore the greatest emphasis is placed on targeting these groups, whilst also ensuring that the general population are informed and warned of the dangers. The plans also aims to encourage community responses and for neighbours to assist each other (and in particular vulnerable groups) during times of high temperature (PHE, 2015b).

3.4 Response and crisis management

The Civil Contingencies Act 2004 is the fundamental legislation which governs crisis management and response during disasters. As described in Section 3.3 this principally requires a whole range of different authorities planning and working together to respond. Like most countries, the principal of subsidiarity pervades this area and the response and crisis management responsibilities and actionsvary depending on the severity of the event and its scale. Across all types of emergency events, integrated emergency response is key and is coordinated through a tiered command structure, convened at *operational* (hands on response), *tactical* (Tactical Co-ordinating Group (TCG)) and *strategic* (for emergencies with high severity or geographical spread a Strategic Co-ordinating Group (SCG)) levels. Strategic decision-making is essentially concerned with the "bigger picture" and involve difficult decisions about the allocation and prioritisation of response resources. Often, the SCG (and TCG) is often chaired by a representative from the Police or LA Chief Executive and will be attended by representatives for all Category 1 Responders. Crucially, within these multi-agency coordinating groups, no single responding agency has command control (HM Government, 2012).

In the UK, emergencies are categorised into 3 levels indicating different levels of Government involvement. Figure 10 illustrates these trigger levels and some examples of natural and other events which fit into each category. For levels 2 (significant) and 3 (catastrophic) the government plays a strategic coordinating role and COBR (Cabinet Office Briefing Room) would be established and there will be a higher degree of reporting to government. For Level 3 the Civil Contingencies Secretariat (CCS) coordinates a centralised response.

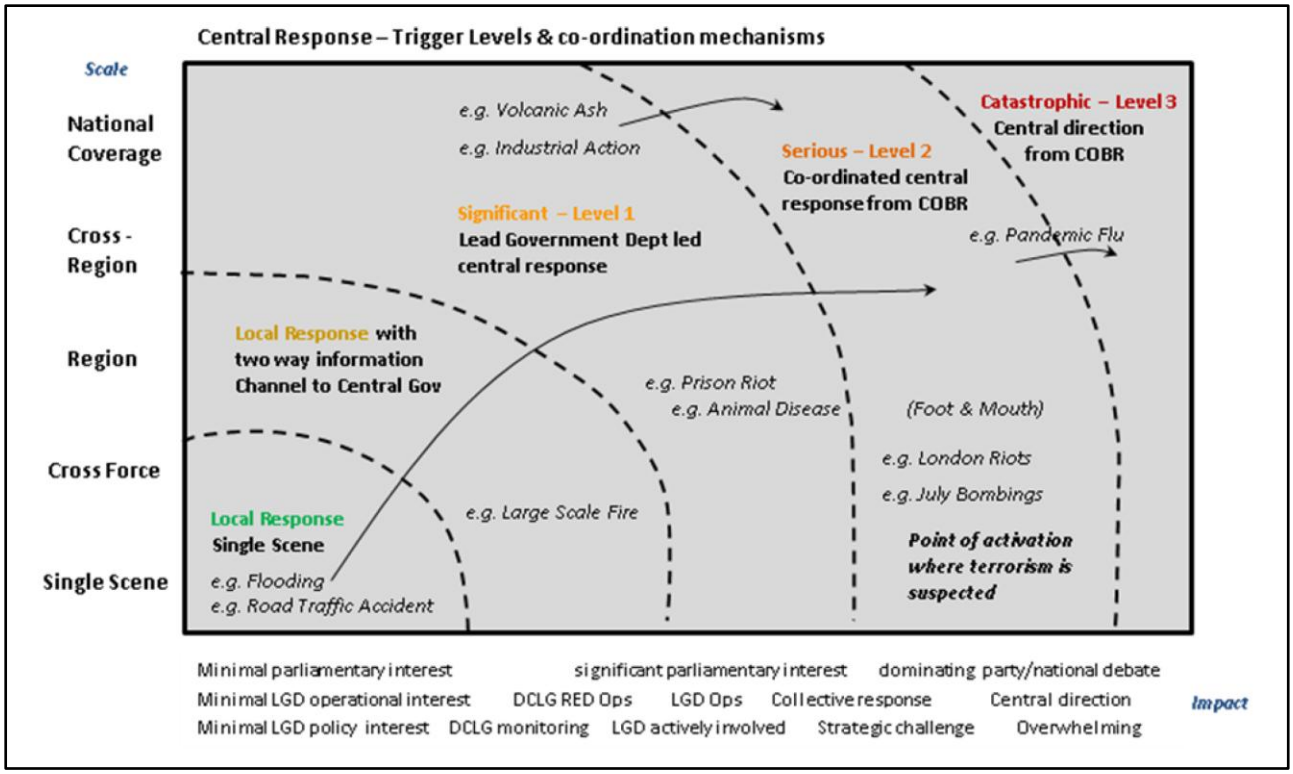

Figure 10: UK emergency levels and their trigger levels (Defra, 2014; 10)

Other resources and approaches are often required to enable response and crisis management. A critical one in the context of floods is flood forecasting and warning. These warnings and responses are critical to having sufficient lead time and information about flood extent andseverity to trigger specific responses and where to put resources. Flood forecasting and warning are a well-developed and considered a strength of the English system. Under the responsibility of the Environment Agency (along with other partners such as the Meteorological Office) coverage for flood warnings is high and the system is constantly being improved to offer warnings to floods of different types and also many different dissemination mechanisms (e.g. telephone, internet, digital application, siren, SMS) and in different formats (e.g. text, mapped). This allows both professional organisations and the public the opportunity to take action prior to a flood in many situations.

A new heat-health watch alert system was established in 2015 and runs from 1 June to 15 September each year and has five main alert levels (Figure 11). The threshold temperatures for these levels are regionally variable, however in all cases the first level instigates a planning programme whilst, levels 2 and 3[6] are linked to more concerted action and readiness by local authorities and others. Importantly, the lower thresholds are recognised as being very important as there is often a surge of deaths initially when temperatures increase. Level 4 is enacted when the high temperatures are considered to be sufficiently severe to require national cross-governmental working.

[6]Average thresholds are 30°C for daytime and 15°C for night time temperatures (PHE, 2015b).

Level 0	**Long-term planning -** All year
Level 1	**Heatwave and Summer preparedness programme -** 1 June – 15 September
Level 2	**Heatwave is forecast – Alert and readiness -** 60% risk of heatwave in the next 2 to 3 days
Level 3	**Heatwave Action -** temperature reached in one or more Met Office National Severe Weather Warning Service regions
Level 4	**Major incident – Emergency response -** central government will declare a Level 4 alert in the event of severe or prolonged heatwave affecting sectors other than health

Figure 11: Heatwave alert levels (PHE, 2015b; 14)

3.5 Recovery and reconstruction

Recovery is a core strategy for managing natural risks in England. Private market insurance is a key approach and natural perils (including flooding, storm etc) have been included in standard household policies for almost a century. Generally, insurance penetration is high with around three quarters being insured for property contents and two thirds covered for structural damage (Association of British Insurers, 2014). Importantly, when the total damages of previous events are considered, a good proportion of the damages are insured. This means that although the residual risk within England is quite high, the extent to which the government or an individual is exposed is limited to some extent by the presence of insurance.

When other types of reconstruction are considered, it is the local level that is important. Local Authorities are generally required to lead much of the reconstruction of, for example roads, schools and other public assets. However, they do not do this without support from national government. Although Local Authorities are required to show that they have budgeted for these types of losses and are encouraged to take out insurance to cover any losses, they are permitted to recover some of the uninsurable costs for some events from national government. Under the Bellwin Scheme (DCLG, 2013) the government can designate an event and open the scheme to claims for funding assistance from Local Authorities, police and fire authorities according to set criteria.

Furthermore, there are often other organisations are involved within reconstruction following a natural risk, depending upon the damages which are faced. This may include damage to major roads (Highways Agency), rail (Network rail), hospitals (NHS trusts), water companies or other private organisations.

4 Analysis of responsible institutes

The management and response to natural risks in England has developed in quite a piecemeal way over many decades. It displays various modes of governance ranging from functions which are highly centralised and controlled by central government, right though to encouraging individuals to take responsibility for their own risks (Alexander et al., 2016). In many cases, there has been a pulling back of centralised control of central government and a move towards encouraging responsibilities at the local level. This recognises that although a

consistent national policy may be desirable and necessary, often decisions need to recognise local conditions and involve local experts. As previously mentioned, the principle of subsidiarity is important (especially in crisis management) with responsibility resting with those closest to relevant scale of the event that is occurring. The role of the private market in managing risks is long established in England with the role of the insurance industry, however the privatisation of water companies in the 1980s and a desire to enhance public-private partnerships has meant a greater role for private actors and the greater inclusion of market principles within risk management.

The piecemeal development of roles and responsibilities and the broadening of the number of actors identified as having a stake and expertise in natural risk management have led to a complex mix of organisations at different levels with varying roles and responsibilities. Alexander et al. (2016) summarise this complexity and the administrative structure that exists for English flood risk management.

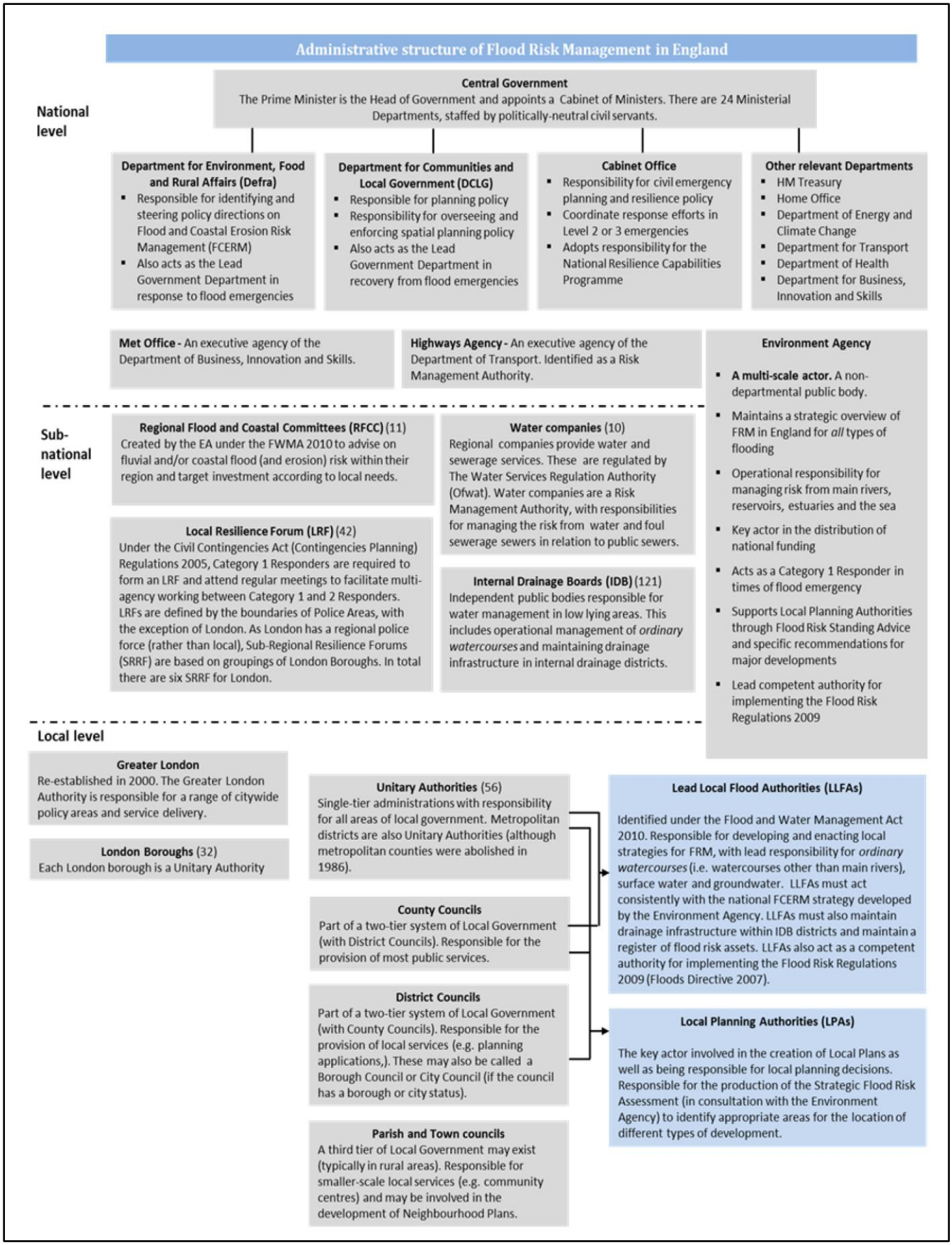

Figure 12: Administrative Structure for flood risk management in England (Alexander et al., 2016; 13)

The responsibilities of managing the effectives of high temperatures and heatwaves are also very complex and involve a large number of actors. Although Figure 13 is illustrating the cascade of heatwave alerts, rather than depicting responsibilities, it highlights some of the key agencies and individuals involved in heatwave management.

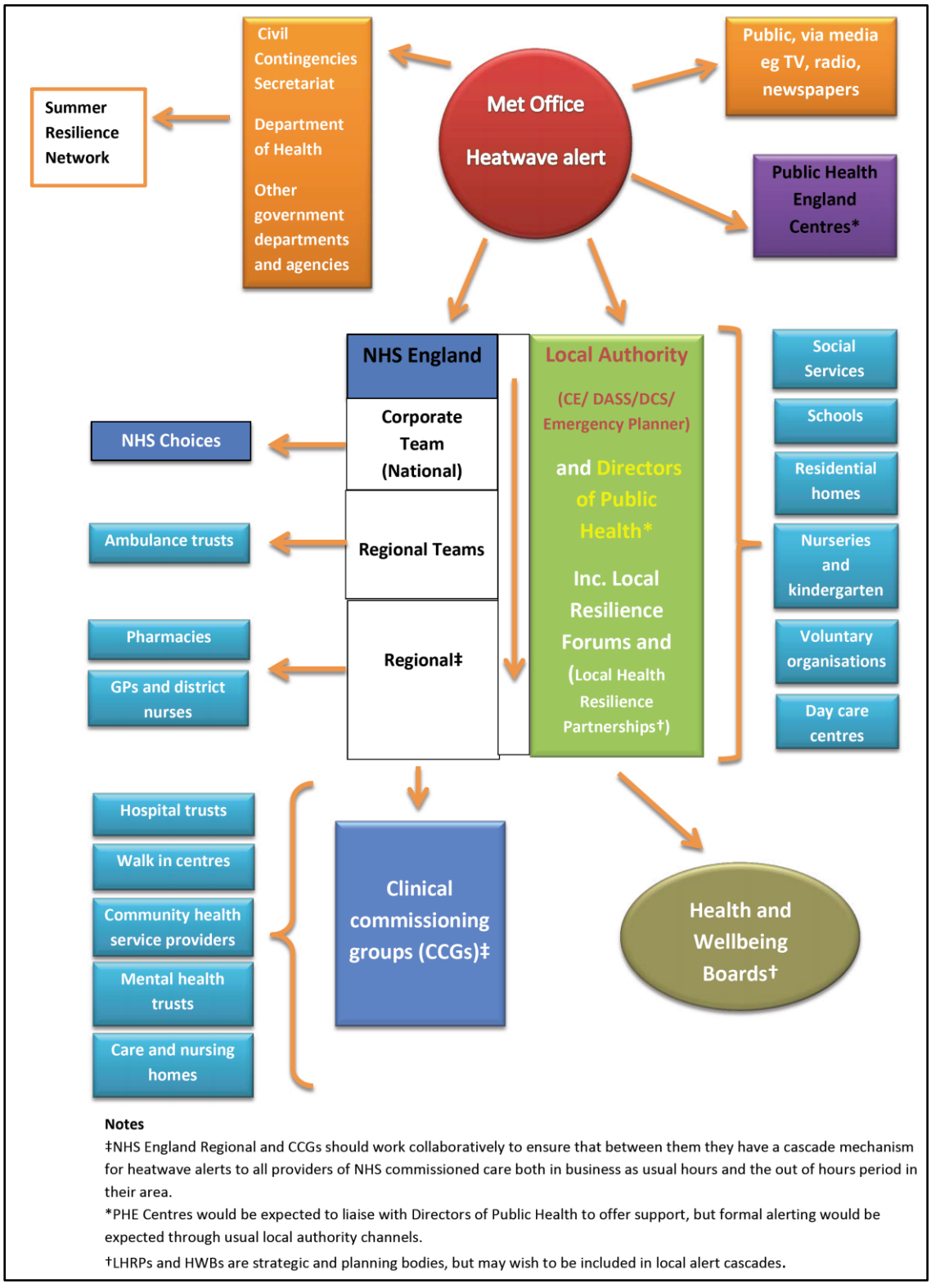

Figure 13: Typical cascade of heatwave alerts (PHE, 2015b; 17).

4.1 National management

A wide range of different government agencies have responsibilities for the management of different aspects of natural risks. They are required to enact and have different responsibilities under a whole host of different pieces of legislation and/or their associated regulations and policies. This includes (but is in no way limited to) the Reservoirs Act 1975, Town and Country Planning Act 1990, Land Drainage Act 1991, Civil Contingencies Act 2004, Flood Risk Regulations 2009, Flood and Water Management Act 2010[7]. The lead governmental agencies vary depending upon the type of management (i.e. crisis management, planning, proactive response) and may vary depending upon the specific natural risk. Principally, but not exclusively, the national level is responsible for setting policies, whereas operational actions are more often undertaken at more local levels.

Key governmental ministries/Agencies with responsibilities for some aspects of natural risk management:

- Department for Environment, Food and Rural Affairs (Defra) – Lead government department for flooding: flood, coastal erosion risk, response to flood emergencies;
- Department for Communities and Local Government (DCLG) – Planning policy, Recovery (administers the Bellwin Scheme), co-ordinates fire service assets;
- Cabinet Office – civil emergency planning, response co-ordination for Level 2 and 3 emergencies. The Civil Contingencies Secretariat – the department of the Cabinet Office responsible for emergency planning;
- HM Treasury – set rules of funding and investment;
- Department for Transport – would be responsible for elements of disaster planning and response related to transport networks;
- Department of Health – policy and planning related to health-related impacts (e.g. heatwaves etc.), initiate and direct the government health response and ensure that resources are available;
- Department for Business, Energy and Industrial Strategy (BEIS) – oversees the Meteorological Office and Climate change policy and also will liaise with certain sectors (e.g. telecommunications) to ensure their preparation;
- Ministry of Defence – there are no official duties and responsibilities but they may be called upon during an emergency to provide assistance;

Related public-sector organisations

- Highways Agency – identified as a risk management authority under the Civil Contingencies Act (2004);
- Public Health England – an executive agency of the department for health which assesses health risks and provides guidance on preventing the health impacts of flood and heatwaves;

[7]The legislation which principally transposed the Floods Directive in England (along with the Flood Risk Regulations 2009).

Key role of the Environment Agency

The Environment Agency (EA) is a non-departmental public organisation which works under the supervision of the Department for Environment, Food and Rural Affairs (Defra) and is the competent authority for many of the Floods Directive functions. It has many permissive powers (but not statutory obligations) and is the key operating agency as well as having the strategic overview for flood risk management. It has responsibilities for managing 'main rivers' and also a supervisory role for overseeing others (such as internal drainage boards and local authorities) who manage watercourses. The EA also has responsibilities for flood forecasting and warning, to responding during flooding, for mapping flood risk, raising public awareness of flooding and assisting communities to be more resilient.

Importantly, in the context of flood risk management, the EA work at both the national level (more strategic roles) and the local level (more operational roles) and herein will appear under both headings. Since their inception in 1996 the Environment Agency have become the lead experts in flood risk management,have assumed more permissive powers and have undertaken to adopt a more holistic approach to managing flooding.

Another national-level organisation that plays a role is the Meteorological Office which is the national weather service and is an executive agency of the Department for Business, Energy and Industrial Strategy. This organisation will provide valuable forecasting information about many natural risks (e.g. floods, storms, heatwaves etc) and guidance and warnings are based on these predictions. In particular in recent years there has been much a much closer working relationship between the Met Office and the Environment Agency with the creation in 2009 of a jointly–run Flood Forecasting Centre (Defra, 2014).

4.2 Local-level management

Local level management is a key area for the management of natural risks in England and herein the term local means anything that is not considered to be a national-level agency. Significantly, however this includes organisations and agencies with differing geographical boundaries and of different sizes (i.e. there are various types of Local Authority (municipality) for historical reasons: see Figure 12). Furthermore, this level is characterised by the presence of actors which have been specifically created/designated for natural risk management functions and others where the management of natural risks is only part of their role and responsibilities.

The enactment of the Flood and Water Management Act (FWMA) 2010, following the implementation of the Floods Directive and the recommendation of the independent review of the 2007 floods (Pitt, 2008), clarified management responsibilities particularly at the local level. These responsibilities reflect the view presented above that local actors have a greater role to play in both the decision-making and funding of flood risk management. The FWMA 2010 established Lead Local Flood Authorities[8] (LLFAs) which comprise one or more Local Authority (see Figure 12) and who are now responsible for planning and implementing local strategies for manging flooding from surface water, groundwater and also from 'ordinary watercourses' (i.e. those which are not considered to be 'main rivers').

[8]The competent authority for some functions under the Floods Directive

Local Authorities under their roles as Local Planning Authorities also have a critical role at the local level in spatial planning and development control. These responsibilities include the creation of Local Plans and undertaking a Strategic Flood Risk Assessment (SFRA, see Section3.1), but also providing evidence to planning committees (elected local members) who make planning decisions about (re)development. Finally, Local Authorities are a Category 1 responder to emergencies and therefore are required to be involved as part of the Local Resilience Fora in the planning and preparation, as well as taking actions before, during and after a crisis.

However, the FWMA 2010 also recognised that there were many more agencies acting at the local level and so it introduced reference to a collective group referred to as English Risk Management Authorities (RMAs) and imposed a duty on them to cooperate and share data.

Those identified as being within Risk Management Authorities (RMAs) include:

- Environment Agency (EA)
- Lead Local Flood Authorities (LLFAs)
- Internal Drainage Boards (IDBs) (where they exist)
- District Councils
- Highways Agency
- Water Companies

At the sub-national level there are another two flood-specific organisations that have responsibilities and stakes in managing flood risk. Internal Drainage Boards (IDBs) do not exist in all areas (they are a legacy of past flood risk management systems) but have responsibilities for water management in low lying areas (Alexander et al., 2016) as well as within the designated internal drainage district that they serve they have responsibility for the maintenance of ordinary watercourses. Regional Flood and Coastal Committees (RFCCs) were established under the FWMA 2010 and replaced the pre-existing Regional Flood and Coastal Defence Committees. These organisations principally provide advice and direction setting about where investment or management should be targeted.

The final group of organisations at the sub-national/local level are Local Resilience Fora which facilitates the multi-agency working of Category 1 and 2 responders (see Section3.4). These are princpally designated according to the boundaries of police areas – except in London; see Figure 12 and The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005).

According to the Civil Contingencies Act 2004:-

Category 1 responders include:	Category 2 responders include:
• Local authorities; • Environment Agency; • Police; • Fire Authorities;	• Utilities (including electricity, gas and water, communcation providers); • Water company; • Transport for London; • Railway operators;

• National Health Service trusts; • Public Health England;	• Airport operators; • Highways Authorities; • Harbour Authorities; • Health and Safety Executive;

In the context of heatwaves, alongside the responsibilities of the Local Resilience Fora and the Category 1 and 2 responders, there are multi-agency Local Health Resilience Partnerships (LHRPs) which have been established for strategic planning purposes and to bring together local health sector organisations (e.g. NHS Trusts, Ambulance Trusts etc) (PHE, 2015b). Furthermore, Health and Wellbeing Boards (which act as forums for commissioners across health, social care and public health providers) are also involved in the strategic planning and preparation for heatwaves and other health-related risks.

4.3 General public

Many responsibilities for managing natural risk remain with the general public and the individual affected. As introduced in Section 3the legal responsibility for managing flood risk rests with the land or property owner and there is not statutory duty on the government to manage flood risks (Environment Agency, 2013). However, the government and local authorities have adopted certain permissive powers and this has made the situation more confusing for individuals, many of whom are unaware that; firstly that they are at flood risk and; secondly, that ultimately they are responsible for managing it. This confusion has led to a disparity between responsibilities and expectations of flood risk management. Therefore, in recent years there has been a concerted effort to try to inform and encourage local communities (in particular those living in unprotected areas and where residual risk is quite high) about their risk and enhance resilience. Pilot schemes (e.g. Flood Resilience Community Pathfinder; Twigger-Ross et al., 2015) have examined and evaluated different ways to engage the community better in flood risk management.

4.4 Private market actors: Insurance companies and water companies

Private market insurance-based recovery is a key element of managing some natural risks (flood, windstorm) in England. From April 2016 a new flood insurance scheme, Flood RE, was initiated which is a private market initiative under the regulation and scrutiny of central government (Penning-Rowsell and Priest, 2015). The scheme has established a pool which has formalised existing cross-subsidies which caps premium insurance costs in high flood risk areas. The pool is funded via those insurance premiums from the properties entered and a levy on all domestic insurance policies and pays for any claims of those properties in high risk areas which are entered into the pool. The scheme is a transition arrangement for 25 years which aims to maintain the availability and affordability of flood insurance to high risk properties whilst hoping to encourage homeowners to reduce their risk. As such, the insurance industry acts as a buffer for flood risk management and in managing residual risk (Penning-Rowsell et al., 2014; Alexander et al., 2016).

Water companies in England were privatised in the 1980s and therefore are classified as being a private market actor although they are heavily regulated by the government and have

commercial restrictions. The nine water companies in England are designated RMAs under the FWMA 2010 and have responsibilities for manging the risks of flooding from water and foul and/or combined sewers systems which provide drainage to buildings and yards.

4.5 Media

The broadcast media have an important role to play during natural events through the warning and dissemination of information to both professional partners and, in particular, the public. These relationships to broadcast messages have been formalised through the establishment of contractual agreements (Alexander et al., 2016).

However, in England the media are also recognised as potentially influencing management and decision-making following events. Often media criticism of floods has been both severe and wide-reaching and has fuelled the increased politicisation of events. Following recent past events, the media have been critical of the performance and lack of defences, planning decisions, management decisions (such as the failure to dredge) and the response to flooding; some criticisms have been justified and others less so. These reports have often been followed by principally politically-driven knee-jerk reactions to respond to these very public negative criticisms and either the offer of increased assistance or the implementation of new management measures, sometimes with little scientific basis or without financial justification, have resulted (Alexander et al., 2016).

4.6 Other organisations

Some organisations within England can have an influence on the management of natural risks, in particular flood risk and coastal erosion. Organisations of this nature tend to be those which own large amounts of land such as the National Trust (an organisation which aims to purchase land or buildings to protect cultural/natural heritage) which are able to have a say about how their land is managed or enable opportunities such as natural flood management to be exploited.

Other organisations have a particular interest such as the RSPB (Royal Society for the Protection of Birds) which again lobbies government for actions which promote (or do not harm) the conservation of birds and their habitats. Other interest groups and organisations, such as the National Farmers Union, also lobby government in order to represent their members' interests.

5 Assessment of risk management aspects

Alexander et al. (2016) in their analysis of the governance of English Flood risk management highlighted a number of key strengths and weaknesses of the system. Many of these are pertinent to this discussion and are summarised and presented below.

5.1 Advantages

Long-established, integrated and diverse approach to management

Flood risk management in England has evolved in a piecemeal and flexible way which means that it is well-placed to respond quickly to emerging challenges. The diverse approach to management can also be regarded as a strength as it adopts a more proportional and efficient approach to managing flooding.

Balance between national and local management

The approach presented in England aims to balance the guidance and steer from national government, whilst maintaining the responsibilities at the local and individual level. Alexander et al. (2016) highlighted the strong policy steer provided by national governments on a range of issues and a dedicated budget for investing in flood risk management measures. However, retaining legal responsibility with the land/property owner, the inception of Partnership Funding (Defra, 2012) which requires more local, as well as efforts to engage local stakeholders in flood risk management decision-making is reinforcing the message that responsibility and action rests with all those at risk. Public participation and awareness raising efforts are also recognised as key strengths (Alexander et al., 2016).

Private market recovery

The long-standing availability and penetration of insurance in England is a strength of the system and provides a key buffer to losses. The approach facilitates the diverse approach to risk management that has been adopted and means that a protectionist approach does not dominate.

Flood Forecasting and warning capabilities

Flood forecasting and warning are recognised strength of the English system. There is a clear framework for responsibilities for flood forecasting, warning and action exists which provides the best chance for effective action, in particular by professional responders and an established culture of multi-agency working and decision making.

5.2 Disadvantages

Funding

Although the push towards local level funding is beneficial and a recognised advantage of the English approach, it is debatable the extent to which these funds are bringing in new sources of funding. Many of the initial examples highlighted that the majority of the local funding was still coming from public finances that was being merely redistributed at the local level (Alexander et al., 2016). Furthermore, there were some concerns that Partnership Funding would interfere with the transparency and legitimacy of the process and allow some organisations to 'jump the funding queue' (Thaler and Priest, 2014). A further criticism of Alexander et al. (2016) relates to whether sufficient funding will be made available for flood asset maintenance. Concern is also raised about whether there is sufficient funding for Local Authorities to successfully fulfil their role as LLFAs as well as undertaking their responsibilities in planning and crisis planning and response. Government reductions in funding have seen the budgets of Local Authorities reduce

in recent years which are placing pressure on all services that they provide including flood risk and crisis management (CCC, 2014).

Enforcement of planning conditions and encroachment of new development on the floodplain

The policy for spatial planning is in England is well-regarded and it is thought that large-scale inappropriate development in high risk areas is being prevented. However, there is concern that smaller developments or redevelopments are being permitted to encroach into floodplain areas and as such increasing the risk in those locations (CCC, 2014). Furthermore, there is a lack of enforcement of conditions placed on planning applications and therefore the true extent of any increase of inappropriate development in flood risk is unknown.

Managing SWF and sustainable urban drainage

Alexander et al. (2016) report a lack of progress in promoting sustainable urban drainage systems (SUDs) and ensuring their effectiveness. Provisions to strengthen the legal and policy framework in this area was included within the FWMA 2010, however opposition from developers (and others) meant that these provisions were not able to be implemented. The promotion of SUDs is still prominent within the spatial planning system and is required to be considered during (re)development, however it is not really clear if this is resulting in better urban drainage outcomes.

6 Analysis of EU master curricula

The overarching topic is very broad and therefore there may be many Masters level courses programmes which includes particular modules or units relating to assessing or managing natural risks. However, the analysis presented for the UK herein only focusses on those Masters Programmes which predominantly focus on natural disasters and/or their management. The following information is provided following an internet search of the relevant programmes and their curricula undertaken in February 2017.

6.1 Disasters, adaptation and development, Kings College London

This programme is offered as both MA and MSc and employs a pathway-led mode of teaching permitting students to specialise according to their interests. In general, the programme delivers a social development perspective to disaster risk reduction and provides a choice of many modules. The aim of the course is to "provide students with an in-depth and critical awareness of the politics and geographies of disaster risk reduction and its contribution to sustainable adaptation and disaster response[9]. "

Occupational fields

The course is suitable for those coming directly from an undergraduate degree as well as practitioners who wish to formalise their knowledge.

[9] http://www.kcl.ac.uk/study/postgraduate/taught-courses/disasters-adaptation-and-development-ma-msc.aspx

Scope and classification

In the scope of this master's degree programme courses in the extent of 90 ECTS Credits (180 UK credits) have to be taken. The courses are subdivided into the following classification:

- Core dissertation module: 30 ECTs equivalent;
- Both the MA/MSc programmes have compulsory modules of20 ECTS equivalent with the MSc having a further 10 ECTs;
- Optional modules: MA students take 40 ECT and MSc take 30 ECTS equivalent,

Table 2: Relevant courses for the MA/MSC in Disasters, adaptation and development, Kings College London

Title	Compulsory/optional	Lecturer	ECTS credits
Dissertation in Disasters, Adaptation and Development	Core (MA/MSc)	Pelling, M (lead), plus various	30
Practising Social Research	Compulsory (MA/MSc)	Various (not listed)	10
Disasters and Development	Compulsory (MA/MSc)	Pelling, M	10
Advanced Quantitative Spatial Methods in Human Geography	Compulsory (MSc)	Reades, J; Shiode , N.	10
Environmental Internship	Prescribed optional	Wiltshire, R.	10
Water Resources and Water Policy	Prescribed optional	Allan, T.; Mirumachi, N.	10
Environment, Livelihoods and Development in the 'South'	Prescribed optional	Potts, D.	10
Environmental GIS	Prescribed optional	Mulligan, M.	10
Risk Communication	Prescribed optional	Löfstedt, R.	10
Critical Geographies of Terrorism	Prescribed optional	Mustafa, D.; Schofield, R.	10
Community, Vulnerability and Disaster Risk	Prescribed optional	Cannon, T.	10
Water, Security and the Environment	Prescribed optional	Mirumachi, N.	10
Climate Change and Culture	Prescribed optional	Hulme, M.	10
Climate: Science and History	Prescribed optional	Adamson, G.	10
A Practical and Theoretical Evaluation of Sustainable Development	Prescribed optional	van den Berg, R.D.	10

NB: The table illustrates the "prescribed optional modules for the course" of which students are required to obtain 10 ECTS. However, are free to obtain the remaining credits from a longer list of optional modules of equivalent (e.g. Masters) level. This list is too lengthy to detail.

6.2 Risk and Disaster Science, Institute for Risk and Disaster Reduction, University College London (UCL)

This is a science-based programme whereby students will "learn how to assess and quantify risk, reduce disaster risks and manage emergencies for natural and anthropogenic hazards, humanitarian and health crises, conflict and climate change[10]"and centres around five key themes: Science of Earth and Space Hazards, Understanding Vulnerability, Statistical and Modelling Tools, Managing Disasters and Multidisciplinary Holistic Approaches

[10] http://www.ucl.ac.uk/rdr/teaching/msc-risk-disaster-science-brochure

Occupational fields

Graduates of the master's degree programme "Risk and disaster science" are prepared for employment in the following fields of activities: insurance, catastrophe modelling, risk management, public policy, humanitarian development, NGOs, business continuity, government, emergency services, consultancy and academic research.

Scope and classification

In the scope of this master's degree programme courses in the extent of 90 ECTS Credits (180 UK credits) have to be taken. The courses are subdivided into the following classification:

- Two compulsory core taught modules: 15 ECTS equivalent;
- Two compulsory taught skills modules: 15 ECTS equivalent;
- Two compulsory programme-specific core modules: 15 ECTS equivalent;
- Two optional taught modules: 15 ECTS equivalent;
- Independent Project: 30 ECTS equivalent.

Table 3: Relevant courses for the MSc in Risk and Disaster Science, Institute for Risk and Disaster Reduction, UCL

Title	Compulsory/optional	ECTS credits
Integrating Science into Risk and Disaster Reduction	Compulsory core	7.5
Emergency and Crisis Management	Compulsory core	7.5
Risk and Disaster Reduction Research Tools	Compulsory skills	7.5
Research Appraisal and Proposal	Compulsory skills	7.5
Earthquake Science and Seismic Risks	Compulsory programme specific	7.5
Space Weather Risks	Compulsory programme specific	7.5
Independent Project	Compulsory core	30
Catastrophe Risk Modelling	Optional	7.5
Digital Health: Epidemics and Emergencies	Optional	7.5
Decision and Risk Statistics	Optional	7.5
Conflict, Humanitarianism & Disaster Risk Reduction	Optional	7.5
Climate Risks to Hydro-ecological Systems	Optional	7.5
Seismic Risk Assessment	Optional	7.5

6.3 Risk and Disaster Resilience, Institute for Risk and Disaster Reduction, University College London (UCL)

This second programme from the Institute for Risk and Disaster Reduction (UCL) has a greater focus on how to manage disaster risk and aims to add to the professionalism of DRR. It suggests that "Through a multidisciplinary approach to risk and disaster reduction, you will learn to become a future leader driving policy change and innovation in order to preserve lives and sustain economies which could otherwise be destroyed or damaged by disaster...gain expertise in analysing complex challenges and providing sustainable solutions." Five key themes are studied: Physical and Social Science of Natural and Anthropogenic Hazards, Understanding Vulnerability, Quantifying Risk, Managing Disasters and Multidisciplinary Holistic Approaches.

Occupational fields

Graduates of the master's degree programme "Risk and Disaster Resilience" are prepared for employment in the following fields of activities: insurance, catastrophe modelling, risk management, public policy, humanitarian development, NGOs, business continuity, government, emergency services, consultancy and academic research.

Scope and classification

Similar to the previous MSc, in the scope of this master's degree programme courses in the extent of 90 ECTS Credits (180 UK credits) have to be taken. The courses are subdivided into the following classification:

- Two compulsory core taught modules: 15 ECTS equivalent;
- Two compulsory taught skills modules: 15 ECTS equivalent;
- Two compulsory programme-specific core modules: 15 ECTS equivalent;
- Two optional taught modules: 15 ECTS equivalent;
- Independent Project: 30 ECTS equivalent.

Table 4: Relevant courses for the MSc in Risk and Disaster Resilience Institute for Risk and Disaster Reduction, UCL

Title	Compulsory/optional	ECTS credits
Integrating Science into Risk and Disaster Reduction	Compulsory core	7.5
Emergency and Crisis Management	Compulsory core	7.5
Risk and Disaster Reduction Research Tools	Compulsory skills	7.5
Research Appraisal and Proposal	Compulsory skills	7.5
Natural and Anthropogenic Hazards and Vulnerability	Compulsory programme specific	7.5
Emergency and Crisis Planning	Compulsory programme specific	7.5
Independent Project	Compulsory core	30
Conflict, Humanitarianism & Disaster Risk Reduction	Optional	7.5
Decision and Risk Statistics	Optional	7.5
Risk, Power and Uncertainty	Optional	7.5
Disaster Risk Reduction in Cities	Optional	7.5
Post Disaster Recovery	Optional	7.5
Adapting Cities to Climate Change in the Global South	Optional	7.5
Space Weather Risks	Optional	7.5
Earthquake Science and Seismic Risks	Optional	7.5
Risk and Contingency Planning	Optional	7.5
Perspectives on Terrorism	Optional	7.5

6.4 Risk and Disaster Reduction, Institute for Risk and Disaster Reduction, University College London (UCL)

The third UCL programme offered by UCL is a research masters (MRes) which offers students the opportunity to undertake a greater degree of research. Specifically, the programme provides a multi-disciplinary perspective allows students to "acquire a broad overview of different hazards, how this affects decision-making, different approaches to implementing this information in decision-making and how to plan and manage emergency and crisis scenarios[11]."

[11] http://www.ucl.ac.uk/rdr/teaching/msc-risk-disaster-science-brochure

Scope and classification

As would be expected for an MRes programme two thirds of this (90 ECTS) programme focusses on more independent-led research. The courses are subdivided into the following classification:

- Two compulsory taught skills modules: 15 ECTS equivalent;
- Three optional taught modules: 22.5 ECTS equivalent;
- Independent Project: 52.5 ECTS equivalent.

Table 5: Relevant courses for the MRes in Risk and Disaster Reduction, Institute for Risk and Disaster Reduction, UCL

Title	Compulsory/optional	ECTS credits
Risk and Disaster Reduction Research Tools	Compulsory skills	7.5
Research Appraisal and Proposal	Compulsory skills	7.5
Independent Project	Compulsory core	52.5
Integrating Science into Risk and Disaster Reduction	Optional	7.5
Natural and Anthropogenic Hazards and Vulnerability	Optional	7.5
Emergency and Crisis Planning	Optional	7.5
Emergency and Crisis Management	Optional	7.5

6.5 Disaster Management and Sustainable Development, Northumbria University

The MSc in Disaster Management and Sustainable Development at Northumbria University focuses on real world problems and places an emphasis on students learning how to plan and respond to crises. A practical focus suggests that graduates "will develop the planning skills to help minimise impact ...and develop advanced knowledge, project management and analytical skills[12]".

Occupational fields

Graduates of the course have been employed in the following careers:

- UN;
- Governments;
- Development;
- Humanitarian aid organisations;
- Charities;
- Local authorities.

Scope and classification

Students are required to take both core and compulsory modules totalling 180 UK credits (90 ECTS). The courses are subdivided into the following classification:

- Five compulsory modules: 50 ECTS equivalent;

[12] https://www.northumbria.ac.uk/study-at-northumbria/courses/disaster-management-and-sustainable-development-msc-ft-dtfdsd6/#brief%20%20Student%20run%20society

- Three optional taught modules: 10 ECTS equivalent;
- Independent research or work dissertation: 30 ECTS equivalent.

Table 6: Relevant courses for the MSc in Disaster Management and Sustainable Development, Northumbria University

Title	Compulsory/optional	ECTS credits
Approaches to Project Management	Compulsory core	10
Themes in Sustainable Development	Compulsory core	10
Disaster Risk Reduction and Response	Compulsory core	10
Health and Well-being in Disaster and Development	Compulsory core	10
Postgraduate Research Methods	Compulsory core	10
Research or Work Related Dissertation	Compulsory core	30
Integrated Emergency Management	Optional	10
Subject Exploration in Disaster and Development	Optional	10

6.6 MA/MSc in Risk, Durham University

The MA[13] in Risk at Durham University focuses on the social dimensions of risk and resilience and includes various different types of risk including environmental and natural, climate and security risks. The MSc[14] focuses on physical hazards and scientific training for understanding and quantifying hazards.

Scope and classification

For both programmes, students are required to take both core and compulsory modules totalling 180 UK credits (90 ECTS). However the MA/MSc programmes have a different selection of optional and core modules as highlighted in the following tables. The courses are subdivided into the following classification:

- Three compulsory taught modules: 30 ECTS equivalent;
- Optional taught modules: totalling 30 ECTS equivalent;
- Dissertation by research or vocationaldissertation : 30 ECTS equivalent.

Table 7: Relevant courses for the MA/MSc in Risk, Durham University

Title	Compulsory/optional	ECTS credits
Understanding Risk	Compulsory core	15
Risk Frontiers	Compulsory core	7.5
Fundamentals of Risk Research	Compulsory core	7.5
Dissertation by Research (or) Vocational Dissertation	Compulsory core	30
Hydrological Hazards	Optional	15
Spatial and Temporal Dimensions of Hazard	Optional	15
Social Dimensions of Risk and Resilience	Optional	15
International Relations and Security in the Middle East	Optional	7.5
Strategic Asia: Policy and Analysis	Optional	7.5
European Security	Optional	7.5
Social Policy and Society	Optional	15

[13] https://www.dur.ac.uk/geography/postgraduate/riskmasters/ma-in-risk/
[14] https://www.dur.ac.uk/geography/postgraduate/riskmasters/msc-in-risk/

6.7 Crisis and disaster management, University of Portsmouth

The MSc in Crisis and disaster management at the University of Portsmouth[15] offers both theoretical grounding of disaster hazards, vulnerability and risk as well as focussing on planning and responding to emergencies. The course is endorsed by the UK Cabinet Office's Emergency Planning College (EPC) and as such the programme allows some exemptions for professionals who have previously attended EPC courses.

Occupational fields

The programme prepares graduates for careers in the sectors of emergency planning, crisis management or disaster response. Graduates of the master's degree programme "Crisis and disaster management" are therefore prepared for employment in the following fields of activities:

- Contingency planning;
- Humanitarian aid organisations;
- Community resilience;
- Flood management;
- Military-civilian emergency liaison;
- (Re)insurance and risk management.

Scope and classification

In the scope of this master's degree programme courses in the extent of 90 ECTS Credits (180 UK credits) have to be taken. The courses are subdivided into the following classification:

- Three compulsory taught modules: 45 ECTS equivalent;
- Optional taught modules: totalling:15 ECTS equivalent;
- Independent research project : 30 ECTS equivalent.

Table 8: Relevant courses for the MSc in Crisis and Disaster Management, University of Portsmouth

Title	Compulsory/optional	ECTS credits
Disasters: Hazard, vulnerability and risk	Compulsory Core	15
Emergency management and planning	Compulsory Core	15
Disaster management: techniques and study visits	Compulsory Core	15
Research Project	Compulsory Core	30
Crisis management and governance	Optional	15
Humanitarian emergency response and recovery	Optional	15

6.8 Disaster Management, Coventry University

"The course aims to provide students with the research skills, knowledge and management expertise to deal with future crises, emergencies and disasters in the developed and developing

[15] http://www.port.ac.uk/courses/geography-earth-and-environmental-sciences/msc-crisis-and-disaster-management/

world[16]". A holistic view of managing disasters is presented with graduates being able to identify, analysis, assess and manage risk and disaster issues and apply these from strategic perspectives within relevant policy and operational frameworks.

Occupational fields

Graduates of the master's degree programme "Disaster Management" are prepared for employments in the following fields of activities: disaster management, risk assessment, community development, humanitarian assistance and capacity building;

Scope and classification

Full details of the programme were not provided online. However, the information provided about the course suggests that the following topics will be studied:

- Disaster risk reduction and development;
- Humanitarian theory and practice in disasters;
- Communities - approaches to resilience and engagement;
- Risk, Crisis, and continuity management;
- management of natural and environmental hazards;
- Technology for disaster and emergency management;
- Research design and methods;
- Dissertation.

6.9 Emergency Planning and Management, Coventry University

A second MSc course at Coventry University concentrates more on the crisis management aspects of disasters and is aimed primarily at response professionals. In particular, it focusses on providing graduates with "the knowledge skills and competencies necessary to fulfil duties that fall on organisations arising from UK civil contingencies legislation[17]".

Occupational fields

Graduates of the master's degree programme "Emergency Planning and Management" are prepared for employment within organisations with emergency response duties, including local government, the uniformed services, health and other public sector agencies, as well as private sector companies.

Scope and classification

[16] http://www.coventry.ac.uk/course-structure/engineering-environment-and-computing/postgraduate/disaster-management-msc/

[17] http://www.coventry.ac.uk/course-structure/engineering-environment-and-computing/postgraduate/emergency-planning-and-management-msc/

Full details of the programme were not provided online. However, the information provided about the course suggests that the following topics will be studied:

- Disaster and emergency planning;
- Integrated emergency management, practice and issues;
- Communities - approaches to resilience and engagement;
- Risk, crisis and continuity management;
- Management of natural and environmental hazards;
- Technology for disaster and emergency management;
- Research design and methods;
- Dissertation.

6.10 Risk Disaster and Environmental Management, University of Huddersfield

This MSc has more of a business focus than some of the other Master's courses presented here and provides grounding in topics around natural, man-made and business risks[18]. Three themes of study are provided Risk (identify, assessment and management), Disaster (develop ability to analyse the consequences when disasters occur) and Environment (how human activity interacts with the natural environment and how to minimise any damage).

Scope and classification

Full details of the programme were not provided online. However, the information provided about the course suggests that the following topics will be studied:

- Disaster and Emergency Management;
- Forensic Aspects of Disaster Management;
- Principles of Environmental Management;
- Principles of Risk;
- Corporate Responsibility & Governance;
- Research Methods and Techniques;
- Sustainable Business: Environment Management in Practice;
- Business Continuity Management.

6.11 International Disaster Management, University of Manchester

This MSc provides an international perspective on disaster management in both the developing and developed context. It is "designed for participants who want to increase both theoretical and practical management skills in enhancing resilience to disasters through prevention,

[18] https://www.hud.ac.uk/courses/full-time/postgraduate/risk-disaster-and-environmental-management-msc/

preparedness, response and recovery from natural and man-made disaster events[19]." It adopts a very multi-disciplinary perspective drawing modules from history, politics, development studies, the arts and medicine.

Scope and classification

In the scope of this master's degree programme courses in the extent of 90 ECTS Credits (180 UK credits) have to be taken, including a research dissertation of 30ECTS credits. The programme is composed of core modules taught by the Humanitarian and Conflict Response Institute, whereas students can draw on optional modules from elsewhere including the School of Environment and Development, the School of Social Sciences and the School of Nursing. Full details of the programme were not provided online. However, the information provided about the course suggests that the following topics will be studied:

- Introduction to disaster management;
- Risk management;
- Research & evaluation methods;
- Reconstruction and development;
- Emergency humanitarian assistance;
- Water sanitation planning & policy in the developing world;

- Global health;
- Fundamentals of epidemiology;
- History of humanitarian aid;
- Climate change, poverty and disaster management;

6.12 Disaster Resilience and Management, University of Salford

The University of Salford's, University's Centre for Disaster Resilience offers an MRes in Disaster Resilience and Management. Few details are provided on the website about the pathways and requirements of MRescandidates, however as a research-oriented programme there will be a heavy focus on independent study. The following categories are identified as potential areas of study:

- capacity building for disaster mitigation and reconstruction;
- project management for post disaster reconstruction;
- disaster risk reduction ;
- risk management and sustainability;
- post-conflict reconstruction;
- stakeholder management and corporate social responsibility;
- community engagement and participation in reconstruction;
- social impact of reconstruction;
- protection and empowerment of women and other vulnerable groups;
- role of women in mitigating and managing disasters;

[19] http://www.manchester.ac.uk/study/masters/courses/list/09910/msc-international-disaster-management/all-content/

- livelihood development;
- micro finance and community co-operatives;
- knowledge management and integration;
- impact of culture towards disaster risk reduction;
- post disaster waste management;
- disaster management and theory building;
- extreme weather events and coping strategies;
- business continuity analysis and planning; and
- resilience and adaptive capacities of SMEs.

6.13 Disaster Management for Environmental Hazards, University of South Wales

This MSc offered by the University of South Wales provides a range of training from the concepts of environmental hazards and disasters management through to practical responses. There is an emphasis on skills and it offers a two-week summer school, and overseas residential field course and students the opportunity to take extended field or work placements as part of the course. The course aims to enable students to "critically assess the effectiveness of existing disaster risk management techniques, in order to evaluate good practice and apply it to new situations[20]."

Occupational fields

Graduates of the master's degree programme "Disaster Management for Environmental Hazards" are prepared for employment in the following fields of activities: governmental organisations, civil protection agencies, non-governmental organisations, industry, insurance companies, specialist consultancies, disaster and emergency planning, flood planning, disaster management and intervention, humanitarian aid and relief work, logistics, community development and capacity building, hazard and risk assessment, environmental monitoring, teaching or further academic research.

Scope and classification

Specific information about credits was not provided online, however it is likely that similar to the other UK Masters it will be 90 ECTS credits equivalent. Similarly, there is no information about the balance of credit between modules, but it appears students are required to take:

- Six compulsory core taught modules;
- One optional taught modules;
- Independent Project.

The University of South Wales also offers an online study course MSc in Disaster Healthcare[21].

[20] http://www.southwales.ac.uk/courses/msc-disaster-management-for-environmental-hazards/
[21] http://www.southwales.ac.uk/courses/msc-disaster-healthcare-online-delivery/

Table 9: Relevant courses for the MSc in Disaster Management for Environmental Hazards, University of South Wales

Title	Compulsory/optional
Principles and Concepts in Disasters	Compulsory
Management of Coastal and Hydrological Hazards	Compulsory
Management of Geological and Technological Hazards	Compulsory
Personal Preparedness for Disasters	Compulsory
Disaster Risk Management	Compulsory
Planning for Disasters and Civil Contingencies	Compulsory
Masters Dissertation Project	Compulsory
Applied Geospatial Analysis	Optional
Remote Sensing for Environmental Management	Optional

6.14 Crisis and Disaster Management, University of Lincoln

This MSc course focusses firmly on the management element of crises and in particular on preventing the impacts from disasters and has a key business dimension. "This programme brings together the areas of crisis management, risk management and disaster management enabling students to understand current approaches to crisis and disaster and the impact that such events may have on businesses, communities and nations. In particular, the Programme addresses the issues of interruption to business and the need for preparedness, from crises and disasters of both natural and human origins.[22]"

Occupational fields

Graduates of the master's degree programme "Crisis and Disaster Management" are prepared for employment in the following fields of activities: emergency planning, disaster response, and crisis communication. It provides for critical examination of contingency and business continuity plans and approaches crises and disaster recovery as 'windows of opportunity'.

Scope and classification

In the scope of this master's degree programme courses in the extent of 90 ECTS Credits (180 UK credits) have to be taken. The courses are subdivided into the following classification:

- Seven compulsory core taught modules: 52.5 ECTS equivalent;
- One optional taught modules: 7.5 ECTS equivalent;
- Independent study: 30 ECTS equivalent (from a choice of three different types).

Table 10: Relevant courses for the MSc in Crisis and Disaster Management, University of Lincoln

Title	Compulsory/optional	ECTS credits
Disaster management	Compulsory core	7.5
Crisis communication	Compulsory core	7.5
Humanitarian logistics	Compulsory core	7.5
Project planning and management	Compulsory core	7.5
Decision analysis for managers	Compulsory core	7.5
Finance and accounting	Compulsory core	7.5
Teams and leadership	Compulsory core	7.5

[22] http://www.lincoln.ac.uk/about/courses/cridisms_2017-18.pdf

Research dissertation	Optional independent study	30
Consultancy project	Optional independent study	30
Start-up venture	Optional independent study	30
Global supply strategies	Optional	7.5
Social entrepreneurship	Optional	7.5
Trade and development	Optional	7.5
Analysing fiction	Optional	7.5
Comparative Human Resource Management	Optional	7.5

6.15 Risk, Crisis and Disaster Management, University of Leicester

The University of Leicester offers a two year distance learning course in Risk, Crisis and Disaster Management. The course focusses on both the theory of risk management and how to apply it in practice[23].

Scope and classification

Specific information about credits was not provided online, however it is likely that similar to the other UK Masters it will be 90 ECTS credits equivalent. Similarly, there is no information about the balance of credit between modules, but it appears students are required to take six modules and a dissertation in order to complete the Master's degree.

Table 11: Relevant courses for the MSc in Risk, Crisis and Disaster Management, University of Leicester

Title	Compulsory/optional
Theories of Risk and Crisis	Compulsory
Managing Risk and Crisis	Compulsory
Research Methods	Compulsory
Case Studies of Crises and Disasters	Compulsory
Models of Risk, Crisis and Disaster	Compulsory
Emergency Planning Management	Compulsory
Research Dissertation	Compulsory

7 Literature

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[23]https://le.ac.uk/courses/risk-crisis-and-disaster-management-msc-dl

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