



# Social vulnerability and flood risk exposure

Analysis and conclusions largely drawn from the following reports:

Present and future flood vulnerability, risk and disadvantage: A UK Assessment  
(by Paul Sayers, Matt Horritt, Edmund Penning-Rowsell, and Jessie Fieth;  
Joseph Roundtree & Sayers and Partners; June 2017)

Targeting flood investment and policy to minimize flood disadvantage  
(by Kit England and Katharine Knox; Joseph Roundtree Foundation; June 2016)



Introduction: This paper presents the evidence base regarding the connection between social vulnerability and exposure to flood risk

Specifically, this paper seeks to answer the following questions:

- What contributes to social vulnerability and how is it measured?
- Where are socially vulnerable people exposed to high-risk flood areas?
- What types of flooding particularly impact socially vulnerable communities?
- What is the take-up of insurance among socially vulnerable communities?
- How will climate change impact socially vulnerable communities?

## Contents

Background: UK poverty, Flood risk, low income households and insurance

Flood model and disadvantage metrics

- Neighbourhood Flood Vulnerability Index (NFVI)
- Relative Economic Pain (REP)
- Social Flood Risk Index (SFRI)

Present day model results: floodplain population and flood disadvantage

Future model results: floodplain population and flood disadvantage

Summary

## Context: UK poverty, insurance expense and insurance take up

### UK poverty

- In 2017/18, more than 1 in 5 UK households were living in poverty<sup>1</sup>, defined as 60% below median income; for a couple with no children this was £13,260 per year after housing costs

### Insurance expense

- On average, UK households spent £17.60 per week on insurance in 2017/18, of which £4.60 was spent on household insurance (around £2.30 on building and £2.10 on contents insurance).<sup>3</sup>
- In a Defra study, the average median cost of home insurance amongst the at-risk group (1.3% or higher) for all income bands was £328 (mean £488), significantly higher than the Control group of £276 (mean £340).<sup>4</sup>

### Insurance take up

- For the **lowest income decile** of all households, 35% and 23% had contents and building insurance compared to 90% and 81% for contents and building insurance for the highest income decile in 2014.<sup>5</sup>
- In markets like insurance, there are often discounts for purchasing annual cover rather than spreading payments over a year, disadvantaging those that cannot pay a lump sum upfront.<sup>5</sup>
- According to Defra research on affordability, 18% of those in the ‘at risk of flooding’ group stated they did not have insurance because premiums were too high<sup>6</sup>
- In general, households that struggle to pay for essentials such as heating/eating, will not prioritise insurance

1. JRF Poverty Statistics [https://www.jrf.org.uk/Data?f%5B0%5D=field\\_taxonomy\\_poverty\\_indicator%3A867](https://www.jrf.org.uk/Data?f%5B0%5D=field_taxonomy_poverty_indicator%3A867); 2. JRF. 2018. UK Poverty <https://www.jrf.org.uk/report/uk-poverty-2018>

3. Office for National Statistics. 2018. [https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/bulletins/familyspendingintheuk/f\\_inancialyearending2018](https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/bulletins/familyspendingintheuk/f_inancialyearending2018). Other main items were vehicle and travel insurance. 4. Defra 2018. Availability and affordability of flood insurance.

<http://scienceresearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19990&FromSearch=Y&Publisher=1&SearchText=FD2705&SortString=ProjectCode&SortOrder=Asc&Paging=10> 5. JRF 2016. UK poverty: Causes, costs and solutions. <https://www.jrf.org.uk/report/uk-poverty-causes-costs-and-solutions>

6. Defra 2018. Availability and affordability of flood insurance.

<http://scienceresearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19990&FromSearch=Y&Publisher=1&SearchText=FD2705&SortString=ProjectCode&SortOrder=Asc&Paging=10>

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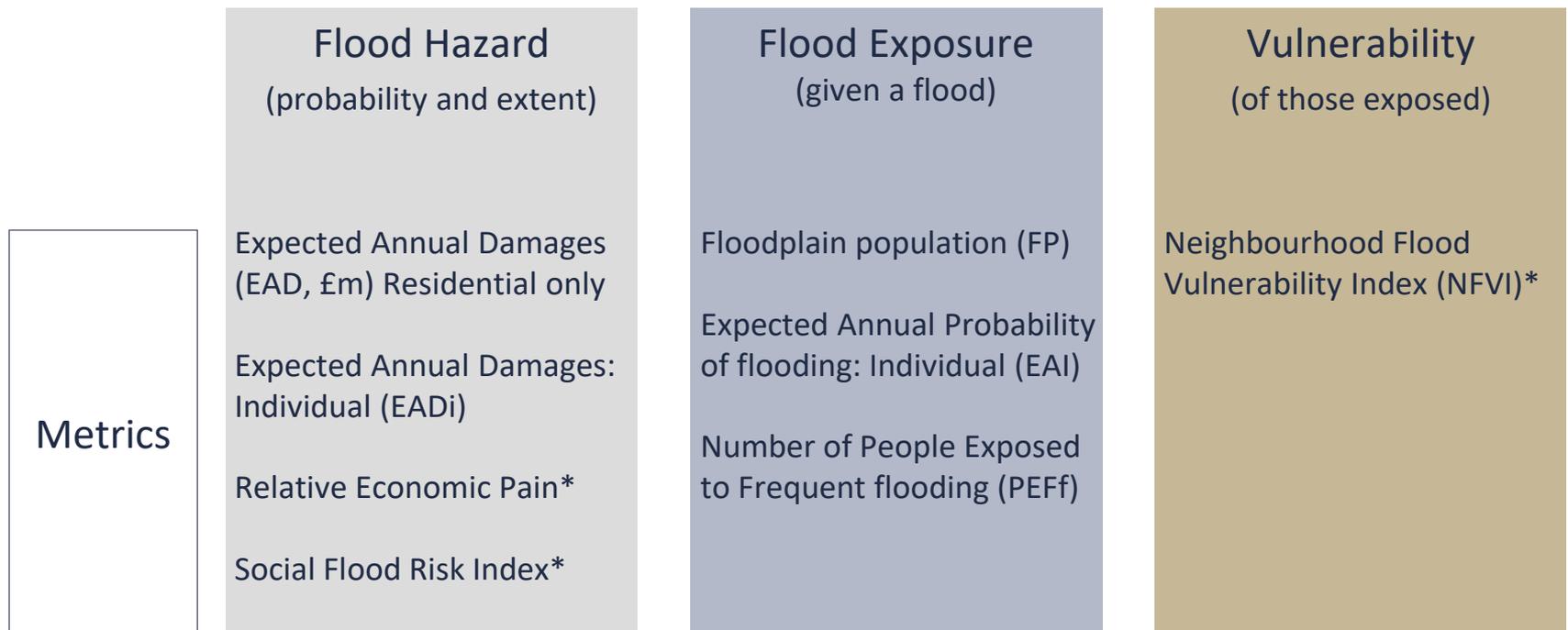
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The Future Flood Explorer (FFE) estimates present-day and future flood risk across the UK based on an assessment of the flood hazard, exposure and vulnerability



\* New metrics

New metrics of flood risk reflect vulnerability and anticipated reductions in well-being (in contrast to EAD which just considers direct economic damages irrespective of ability to respond to the damage)

## Existing metric

Hazard

**Expected Annual Damages (EAD):** The annual ‘average’ direct economic damages, in monetary terms, taking account of defences.

## Detail on new metrics

Vulnerability

**Neighbourhood Flood Vulnerability Index (NFVI):** The propensity of those living in a neighbourhood to suffer a loss of well-being should a flood occur.

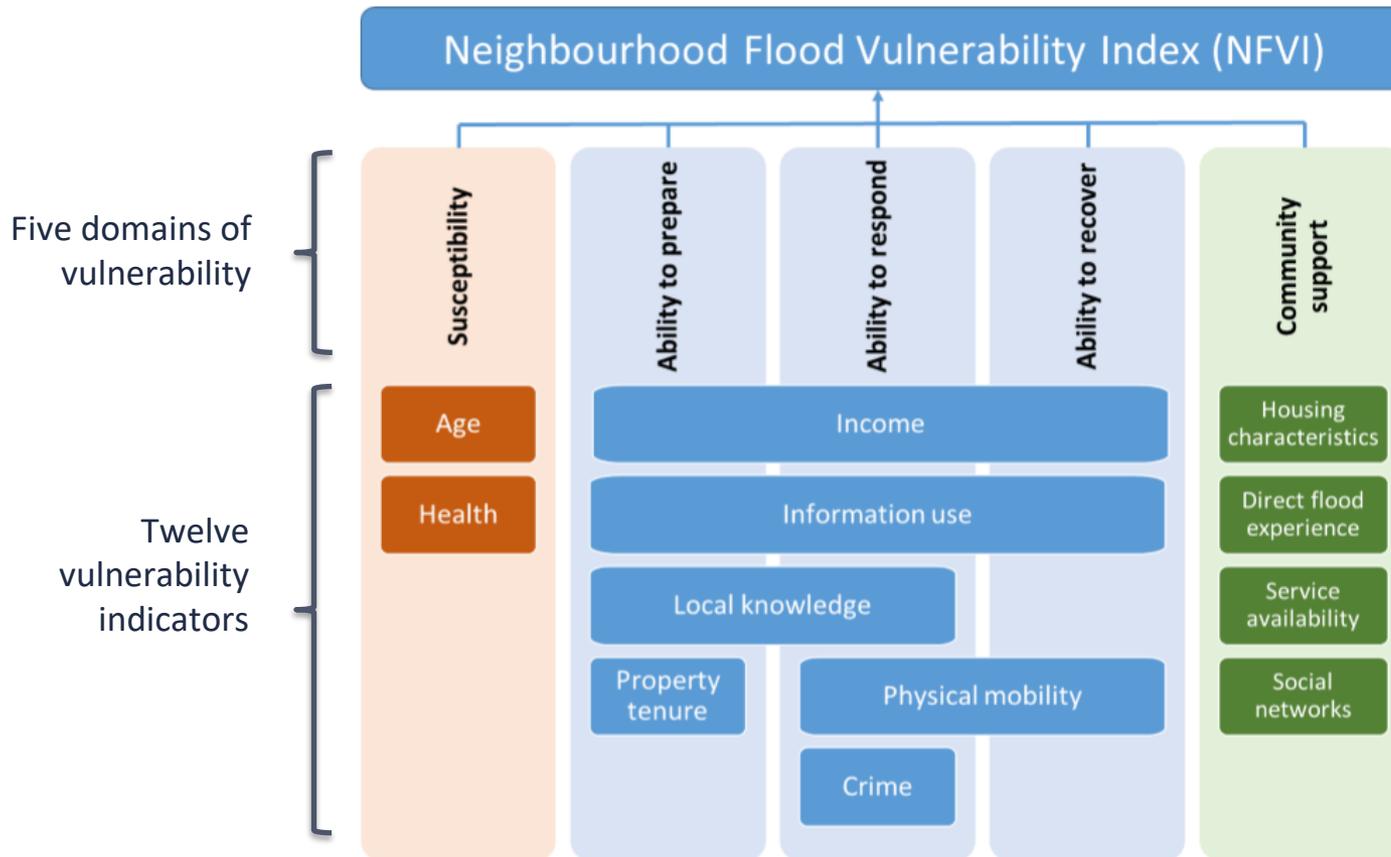
Hazard

**Relative Economic Pain (REP):** The ‘relative pain’ of the economic risks faced by those exposed to flooding (expressed as the ratio between uninsured economic damages and household income).

Hazard

**Social Flood Risk Index (SFRI):** The level of social flood risk (a combination of exposure, vulnerability and probability of flooding), at a neighbourhood scale (SFRI) and as an individual ‘average’ (iSFRI). The SFRI is used to identify those areas where the largest number of the most vulnerable people are exposed to frequent flooding.

Neighbourhood Flood Vulnerability Index (NFVI) combines five domains of vulnerability based upon twelve 'vulnerability indicators'



The highest concentration of vulnerability is referenced throughout this paper as the “Top 5% by NFVI” where the community is viewed as most susceptible on each of the twelve indicators.

### Neighbourhood Vulnerability Index: Indicators and supporting variables

Each is evaluated at a neighbourhood scale

Indicator	Supporting variables	
Age	a1	Young children (% people under 5 years)
	a2	Older people (% people over 75 years)
Health	h1	Disability / people in ill-health (% people whose day- to-day activities are limited)
	h2	Households with at least one person with long-term limiting illness (%)
Income	i1	Unemployed (% unemployed)
	i2	Long-term unemployed (% who are long-term unemployed or who have never worked)
	i3	Low income occupations (% in routine or semi-routine occupations)
	i4	Households with dependent children and no adults in employment (%)
	i5	People income deprived (%)
Information use	f1	Recent arrivals to UK (% people with <1-year residency coming from outside UK)
	f2	Level of proficiency in English
Local knowledge	k1	New migrants from outside the local area (%)
Tenure	t1	Private renters (% Households)
	t2	Social renters (% households renting from social landlords)
Physical mobility	m1	High levels of disability (% disabled)
	m2	People living in medical and care establishments (%)
	m3	Lack of private transport (% households with no car or van)
Crime	c1	High levels of crime
Housing characteristics	hc1	Caravan or other mobile or temporary structures in all households (%)
Direct flood experience	e1	No. of properties exposed to significant flood risk (%)
Service availability	s1	Emergency services exposed to flooding (%)
	s2	Care homes exposed to flooding (%)
	s3	GP surgeries exposed to flooding (%)
	s4	Schools exposed to flooding (%)
Social networks (non-flood)	n1	Single-pensioner households (%)
	n2	Lone-parent households with dependent children (%)
	n3	Children of primary school age (4-11) in the population (%)

Vulnerable communities also show reduced capacity to adapt to flood-risk

**Draining:** Anecdotal evidence suggests that in inner-city areas (where urban flooding and drainage is significant) take-up of retrofitting SUDS does not occur as much as in other locations

**Spatial planning and development control:** Percentage of new dwelling in the fluvial and coastal floodplain is around 14 percent in more vulnerable areas (top 20% of neighbourhoods by NFVI) compared to 11 percent in less vulnerable areas

**Property level measurers:** take-up by the most vulnerable in existing developments is likely to be significantly lower than the population as a whole due to:

- Expense of measures
- Cumbersome grant application processes
- Reduced ability and incentive to install property measures for tenants
- Transient nature of communities that are less aware of flood risk

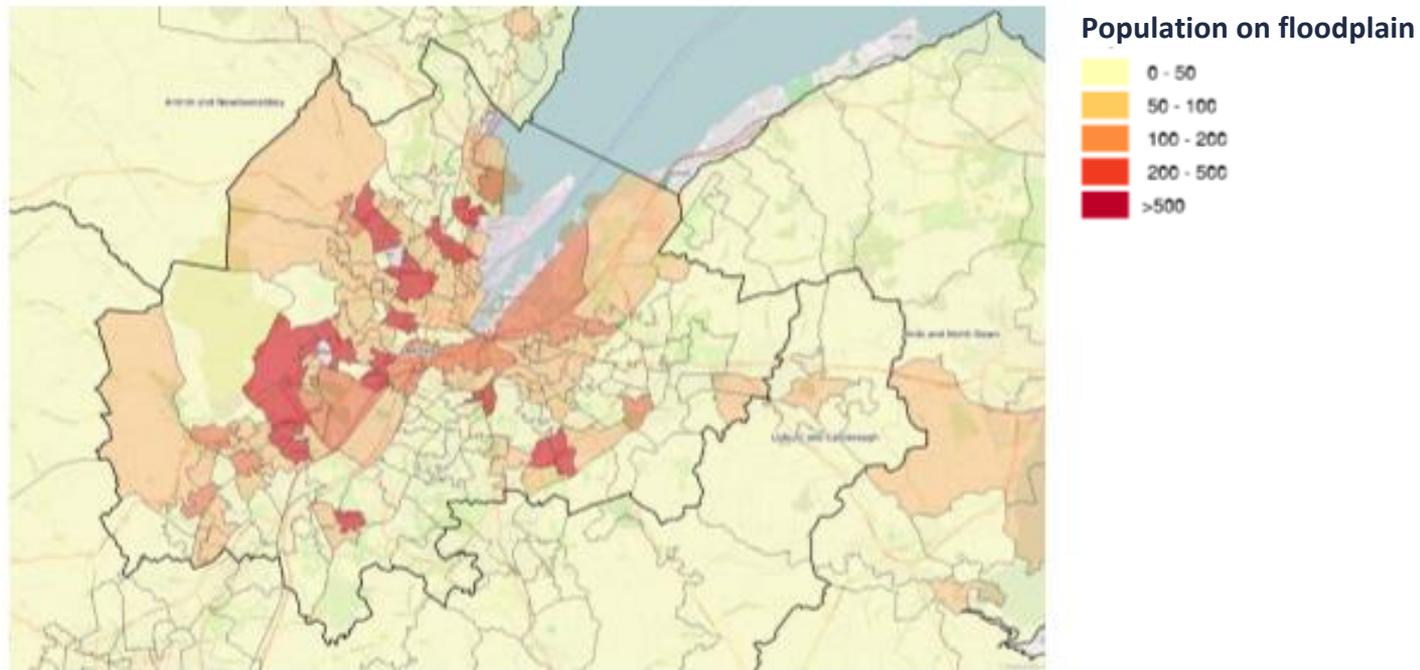
**Effectiveness of warnings:** Warnings may be less effective for the following reasons:

- Less ability to access the content of warnings due to language barriers
- Lack of flood awareness/previous flooding experience

In combination, individual adaptation and response to warnings is likely less effective among more vulnerable populations

Social vulnerability is determined at a neighbourhood scale

### Example: Belfast neighbourhoods



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Present day: Most vulnerable neighbourhoods are over-represented in areas prone to flooding for all sources and significantly over-represented in areas prone to coastal (and tidal) flooding

## UK population at risk

- 1.5 million people (23%) live in the 20% most vulnerable neighbourhoods (by NFVI)
- 0.45 million (23%) are exposed to frequent flooding (1:75 years or more frequent) live in the 20% most vulnerable neighbourhoods (by NFVI)
- 74,000 people in Northern Ireland (55%) live in the top 20% most vulnerable by NFVI

## Coastal flooding particularly notable

- 33% of people prone to frequent coastal floods live in the top 20% most vulnerable neighbourhoods
- Service availability key vulnerability driver (see next slide for more detail)

### Present day: Population of flood prone areas (1:1,000 years or more frequent)

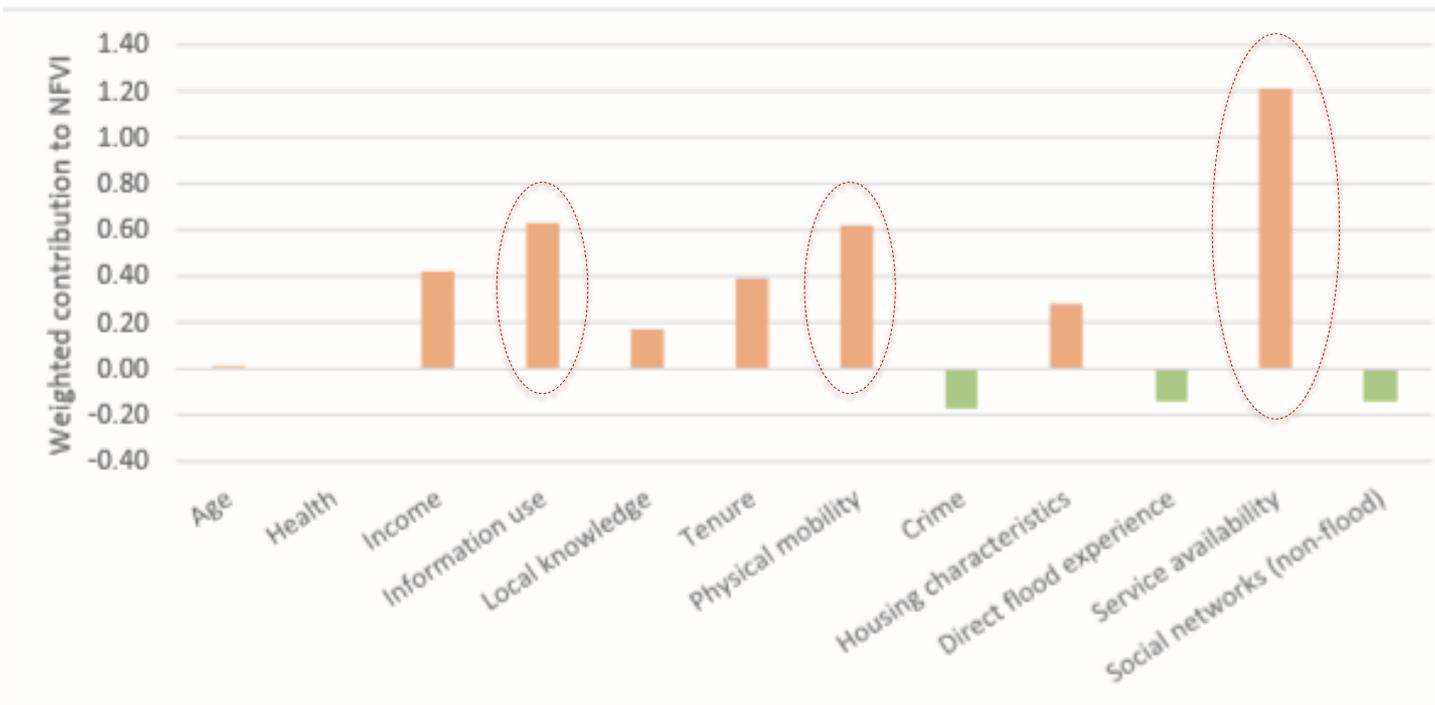
	All neighbourhoods (000s)	Vulnerable neighbourhoods (000s)					
		Top 20% by NFVI		Top 10% by NFVI		Top 5% by NFVI	
<b>By country</b>							
UK	6,398	1,497	23%	788	13%	397	6%
England	5,508	1,216	22%	635	12%	316	6%
Wales	378	107	28%	45	12%	13	3%
Scotland	376	99	26%	56	15%	32	8%
Northern Ireland	136	74	55%	52	38%	37	27%
<b>By flood source</b>							
All sources	6,398	1,497	23%	788	12%	397	6%
Coastal (and tidal)	1,809	604	33%	340	19%	179	10%
Surface water	2,869	594	21%	293	10%	148	5%
Fluvial	1,720	299	17%	155	9%	71	4%

### Present day: Population of flood prone areas (1:75 years or more frequent)

	All neighbourhoods (000s)	Vulnerable neighbourhoods (000s)					
		Top 20% by NFVI		Top 10% by NFVI		Top 5% by NFVI	
<b>By country</b>							
UK	1,985	451	23%	239	12%	122	6%
England	1,612	335	21%	174	11%	88	5%
Wales	117	36	30%	15	13%	4	3%
Scotland	200	51	26%	29	15%	17	9%
Northern Ireland	55	29	53%	20	35%	14	25%
<b>By flood source</b>							
All sources	1,985	451	23%	239	12%	122	6%
Coastal (and tidal)	489	164	33%	95	19%	50	10%
Surface water	870	103	21%	92	11%	48	5%
Fluvial	626	184	16%	52	8%	24	4%

Present day: Service availability, physical mobility and information use are most significant drivers of vulnerability at the coast

Drivers of neighbourhood vulnerability at the coast

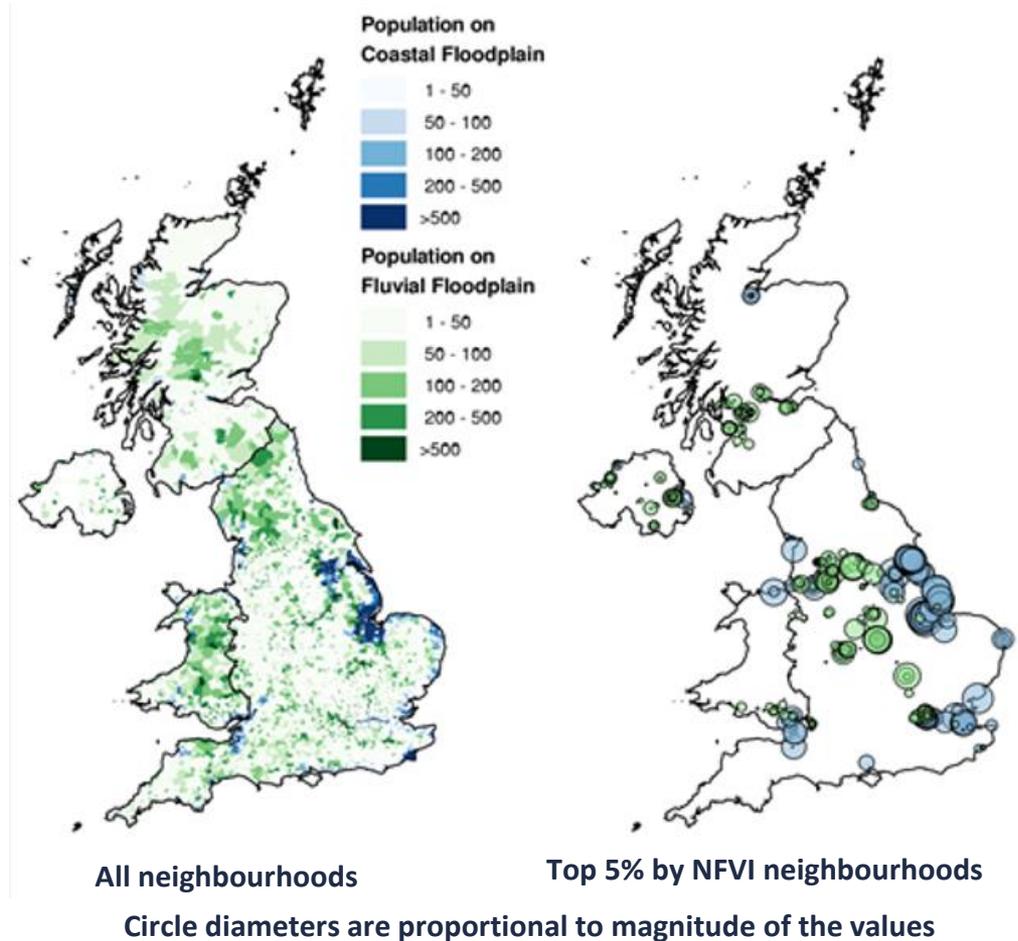


## Present day: Spatial distribution of the floodplain population, vulnerability (by NFVI) and exposure to frequent flooding

75 local authorities (~20% of the UK total) account for 50% of those living in flood prone areas

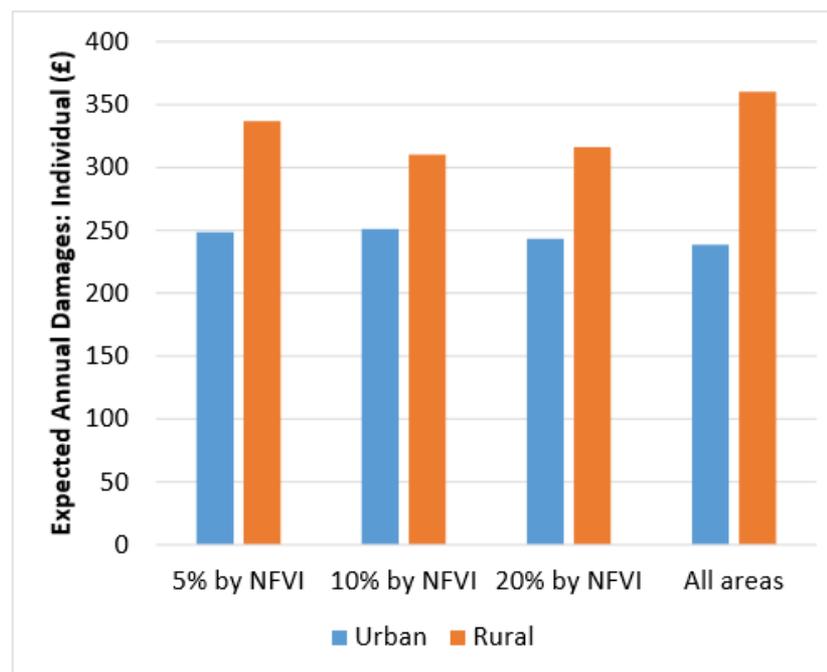
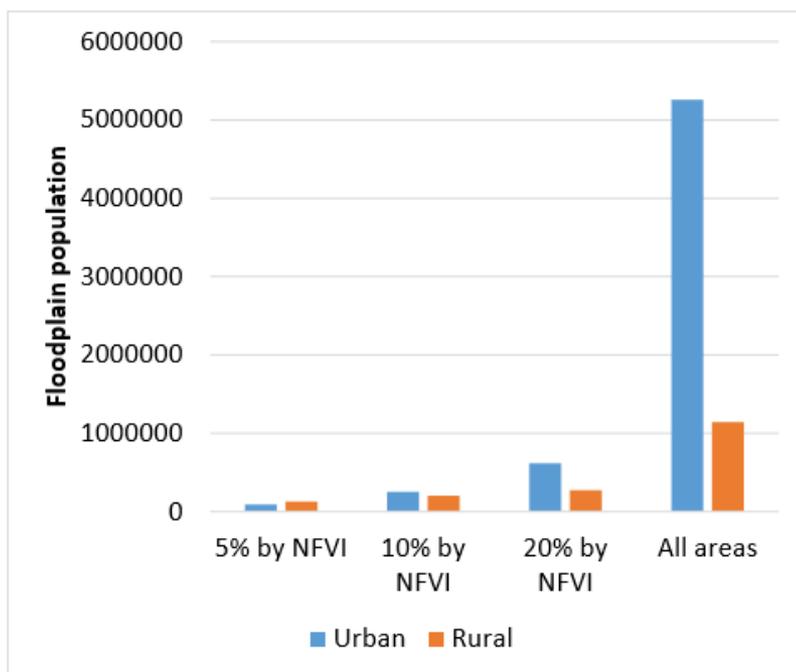
Considering vulnerable neighbourhoods (top 5% by NFVI), over 50% of the population are located in ten local authorities

- Hull
- Boston
- Belfast
- Birmingham
- East Lindsey
- Glasgow
- Leicester
- North East Lincolnshire
- Swale District
- Tower Hamlets



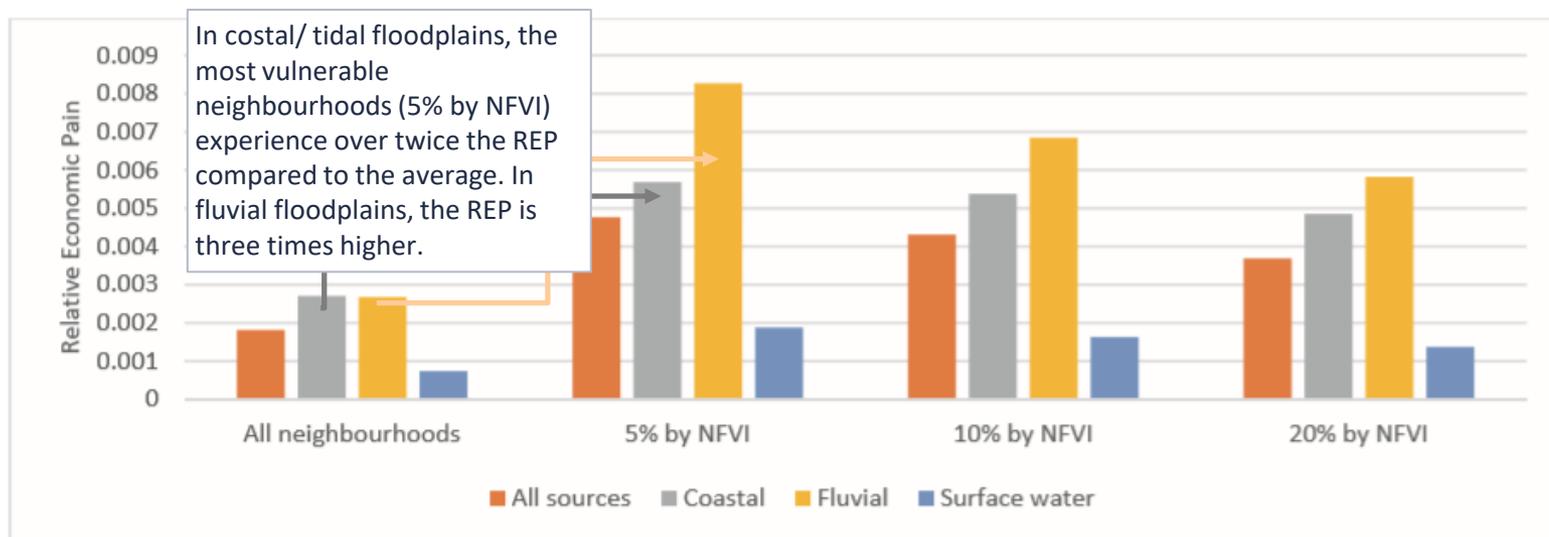
Urban areas (defined as where the majority of people live in settlements with population >10,000) have the largest number of socially vulnerable people; however, vulnerable people (by NFVI) living in rural settings are often exposed to more frequent flooding

**Present day: A comparison of flood risk in rural and urban settings** (Sayers et al, 2016)



Relative Economic Pain significantly higher in most vulnerable neighbourhoods (5% by NFVI) due to low incomes and low levels of insurance penetration

### Present day: Relative economic pain (ratio between uninsured economic damages and household income) – by flood source



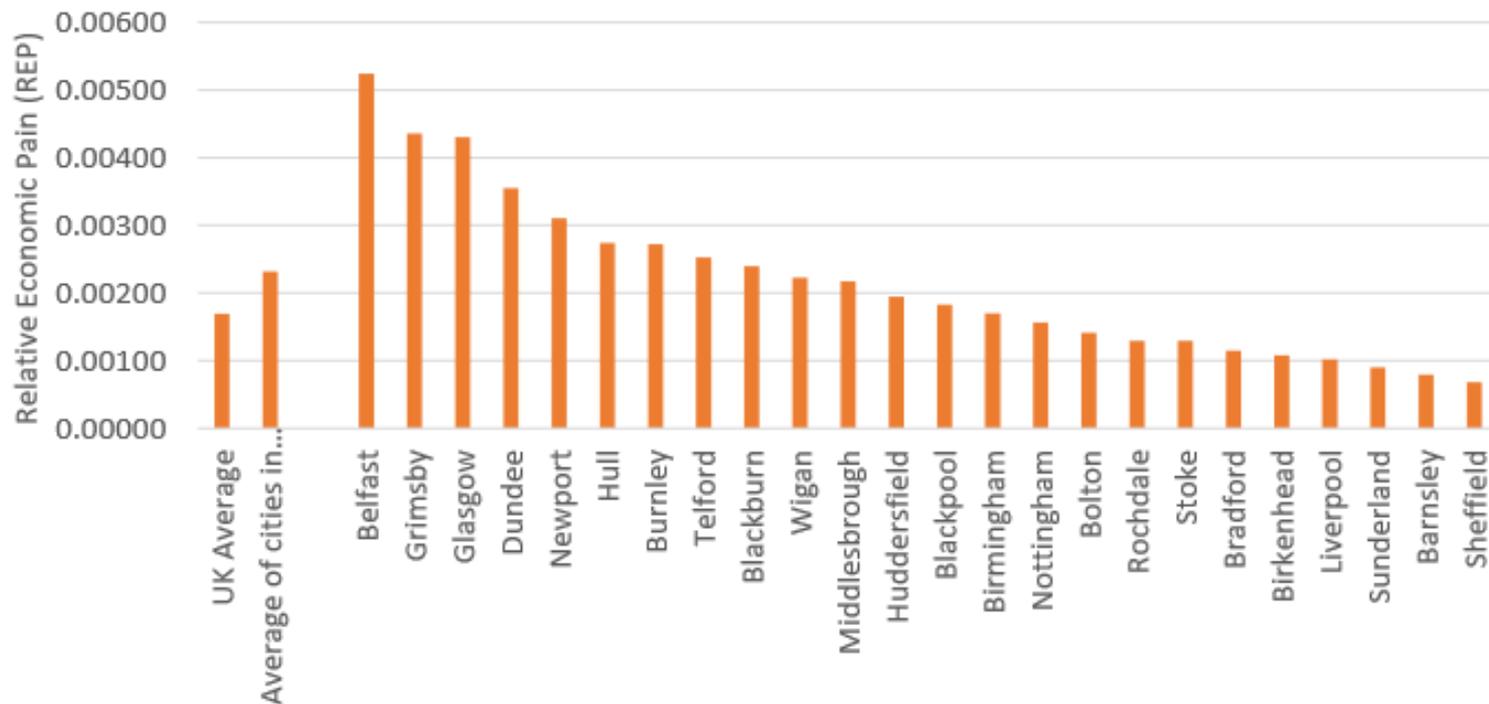
A value of '0' implies expected annual flood losses are fully covered by insurance. A value of '1' implies expected annual uninsured flood losses are equal annual income.

	Average neighbourhood	Vulnerable (5% by NFVI)
Avg income*	£10,500 / person	£7,500 / person
Insurance penetration	60-75%	20-40%

\*Avg income across all those living in a neighbourhood not just those of working age

Cities in relative economic decline tend to experience levels of flood disadvantage above UK average.... flood risk likely to undermine economic growth in areas that need it most

Relative Economic Pain (the economic risk faced by those exposed to flooding expressed as the ratio between uninsured economic damages and household income) of flooding



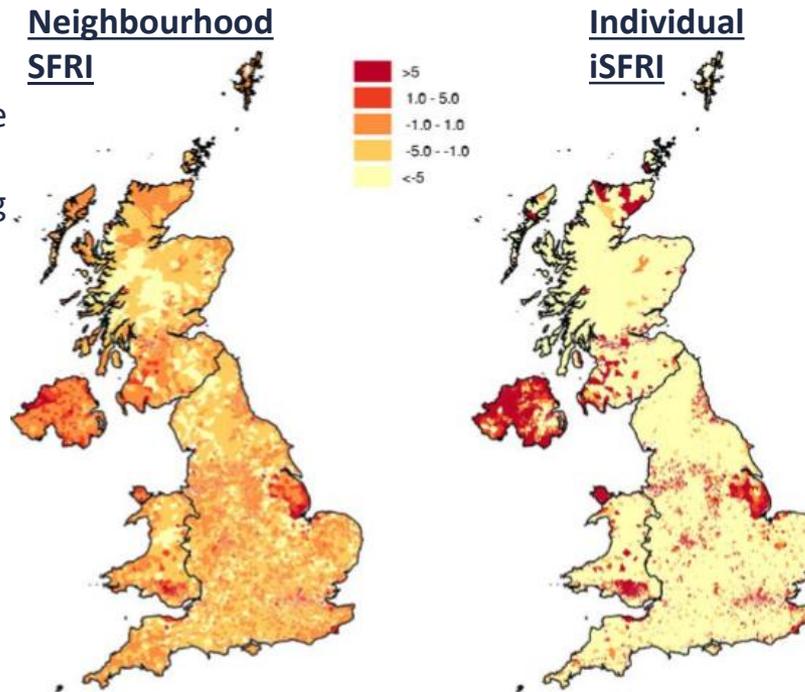
Different regions exhibit higher levels of flood disadvantage depending on whether you examine group or individual social flood risk

## Present day Social Flood Risk Index

(combination of exposure, vulnerability and probably of flooding at a neighbourhood scale and as an individual)

SFRI helps identify those areas where many vulnerable people, as defined by the NFVI, are exposed to flooding  
 $SFRI = \text{Expected Annual Probability of Flooding: Individual (EAI)} \times \text{Neighbourhood Flood Vulnerability Index (NFVI)}$

Hull has the greatest levels of social flood risk (SFRI) with highest floodplain population, people exposed to frequent flooding and EAD



iSFRI = helps identify those neighbourhoods where the vulnerability of those exposed is high (even when only a few people may be exposed) and is calculated simply by dividing the SFRI by the floodplain population

Highest individual social risk emerge in:

- Clusters in Northern Ireland
- Coastal areas from the Wash to the Humber
- North and South Wales
- Scotland lowlands

The impact of a flood on social well-being is fundamentally influenced by access to insurance

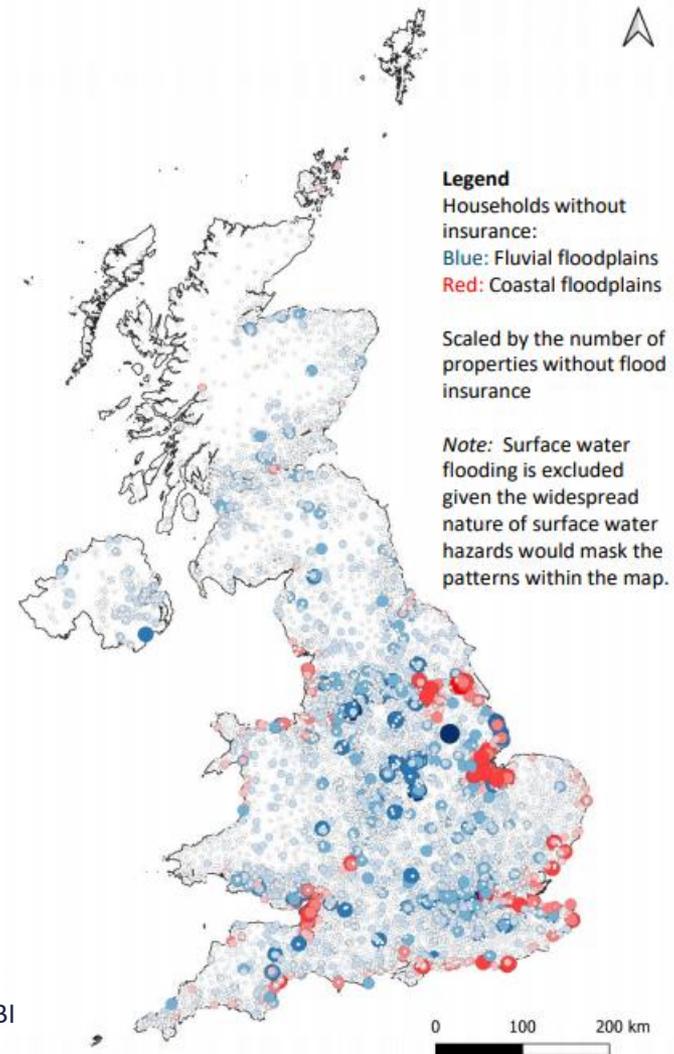
Insurance penetration is known to vary by:

- Income (those on lower incomes much less likely to have insurance)
- Tenure (those living in renter accommodations – particularly social housing – much less likely to have insurance)
- Experience of flooding (there is some limited evidence that direct experience of a flood increases the take-up of insurance)

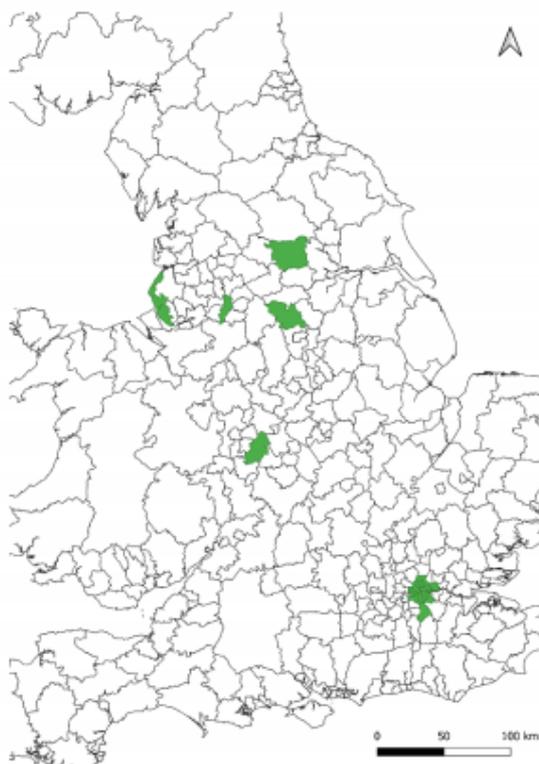
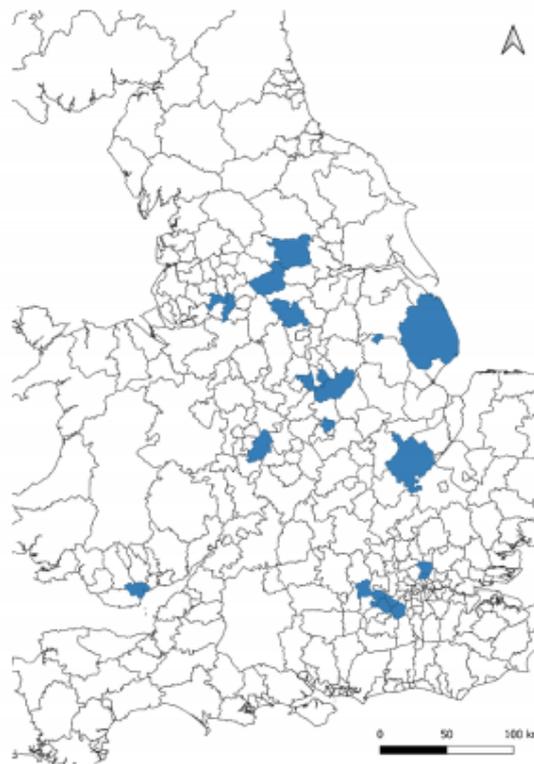
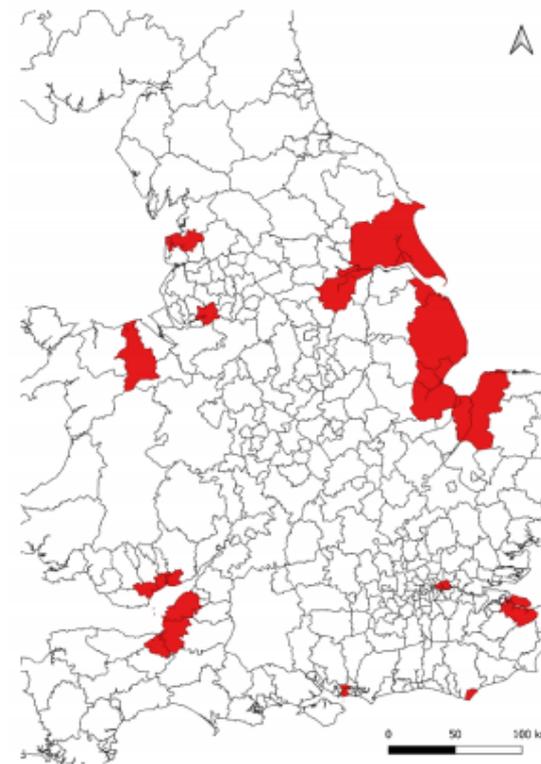
A basic estimate of those households living in the fluvial and coastal floodplain without insurance (structural and contents) is shown opposite:

- Households within the floodplain: 1.4m
- Households without insurance: 0.45m
- % households without insurance: 32%

Note: The modelled estimate here is broadly consistent with EA surveys post events (such as Chatterton et al, 2010) and take-up rates published by the ABI (2018); although neither of these publications provide an equivalent analysis.



An estimate of the Local Authorities with the largest number of uninsured households for each source of surface water, fluvial and coastal flooding is presented below. The maps highlights those Local Authorities with significant households exposed to surface water, fluvial and coastal flooding and high levels of social vulnerability (particularly rented and lower income households).

**Surface water****Fluvial****Coastal**

It is not social factors alone that differentiate the risks faced, but also geographic variation in physical flood hazards. Black, Asian and Minority Ethnic are more likely to be exposed to frequent flooding (surface water, fluvial and coastal). The disadvantage is most significant amongst Black ethnic groups.



Present Day:  
Local authorities ranked by Social Flood Risk Index and ranking against all other metrics

Doncaster has many people exposed to flooding but not as much vulnerability as Boston, for example

Local Authority (ranked top 25 by SFRI)	Metric							
	Social Flood Risk Index: Individual (SFRI)	Floodplain population	Expected Annual Probability of flooding: Individual (EAPI)*	Number of People Exposed to Frequent Flooding (PEFF) (per 1000 on the floodplain)	Expected Annual Damages (EAD, £m) - Residential only	Expected Annual Damages: Individual (EADI, £)*	Relative Economic Pain (REP)**	Neighbourhood Flood Vulnerability Index (NFVI)***
City of Kingston upon Hull (B)	31	1	1	1	1	1	38	20
Boston District (B)	6	12	109	9	7	73	71	1
Belfast	1	27	39	18	1	55	13	2
East Lindsey District	21	9	7	14	12	105	77	5
Glasgow City	14	15	29	4	6	48	25	50
Swale District (B)	7	49	51	32	9	54	14	10
Newham London Borough	46	3	188	17	2	124	65	15
City of Leicester (B)	19	20	116	12	16	25	32	13
Shepway District	9	65	38	28	14	15	36	16
North East Lincolnshire (B)	34	10	14	19	11	97	21	19
Birmingham District (B)	47	8	111	7	17	129	66	22
West Dunbartonshire	2	184	4	73	26	6	4	18
Doncaster District (B)	52	11	113	5	9	79	30	64
Rhondda Cynon Taf - Rhondda Cynon Taf	25	37	17	25	58	107	147	14
Derry City and Strabane	5	169	58	109	136	43	43	3
Slough (B)	20	67	47	30	19	50	49	60
West Lindsey District	12	96	86	40	39	61	34	7
Hammersmith and Fulham London Borough	84	4	69	8	8	51	250	84
East Ayrshire	4	231	26	131	66	20	8	9
Southwark London Borough	82	6	179	26	3	90	132	67
Casnewydd - Newport	54	25	25	36	20	4	53	59
Greenwich London Borough	65	16	194	48	36	147	189	43
City of Bristol (B)	44	56	36	11	21	67	59	65
Barking and Dagenham London Borough	36	78	172	162	103	122	95	8
Waltham Forest London Borough	48	60	68	35	71	99	168	37

\* The average value based on the population within the floodplain

\*\* The direct estimate of the Index.

Source:  
[http://www.sayersandpartners.co.uk/uploads/6/2/0/9/6209349/sayers\\_2017\\_-\\_present\\_and\\_future\\_flood\\_vulnerability\\_risk\\_and\\_disadvantage\\_-\\_final\\_report\\_-\\_uploaded\\_05june2017\\_printed\\_-\\_high\\_quality.pdf](http://www.sayersandpartners.co.uk/uploads/6/2/0/9/6209349/sayers_2017_-_present_and_future_flood_vulnerability_risk_and_disadvantage_-_final_report_-_uploaded_05june2017_printed_-_high_quality.pdf)

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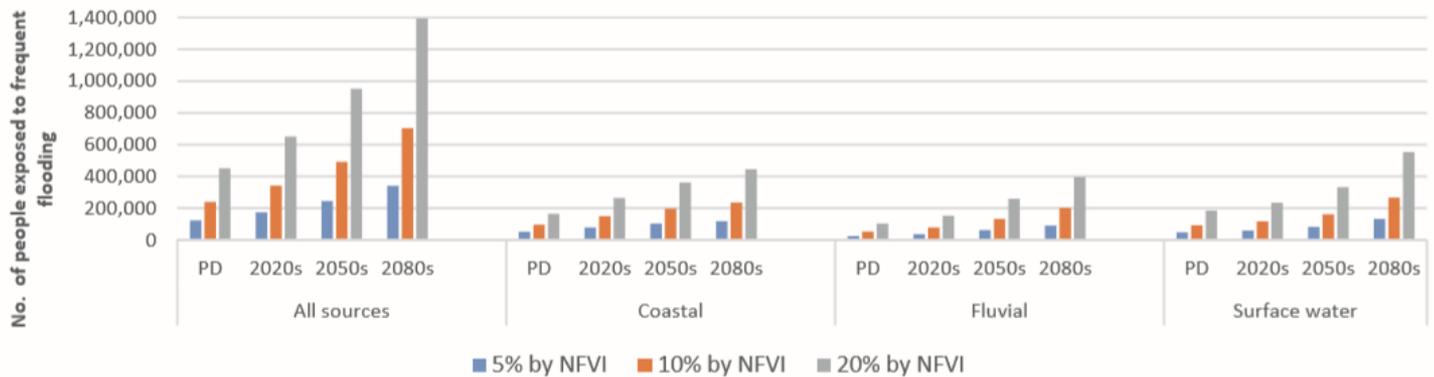
Future model results: floodplain population and flood disadvantage

Summary

Future change: In most vulnerable neighborhoods, risk increases from 451,000 to 1.4 million by 2080; the proportional increase of vulnerable neighbourhoods is similar to less vulnerable neighbourhoods

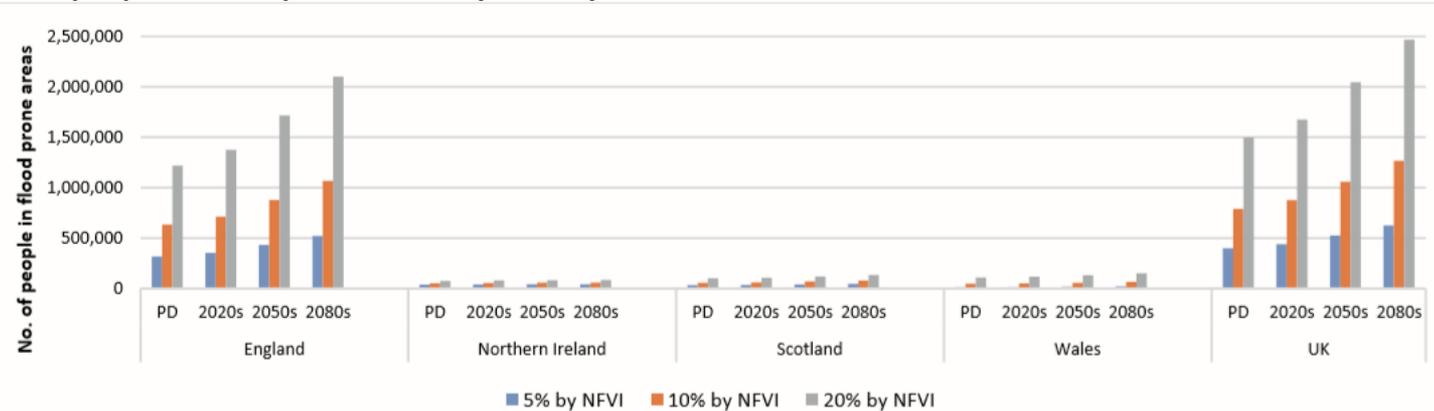
The greatest future increases in risk occur in England due to surface water and fluvial flooding

**No. of people in flood prone areas: By source**



In Wales, Scotland and Northern Ireland (and coastal settings) increases are just as significant in terms of relative increase from present day

**No. of people in flood prone areas: By country**



Assuming a continuation of current adaptation, +40C climate future and high population growth. PD= present day.

Future change: For the 25 highest ranked local authorities by SFRI most do not change from present day to the 2080s

A few local authorities where flood disadvantage does increase include the Highlands of Scotland, North Somerset, the London Boroughs of Enfield, Tower Hamlets and Haringey.

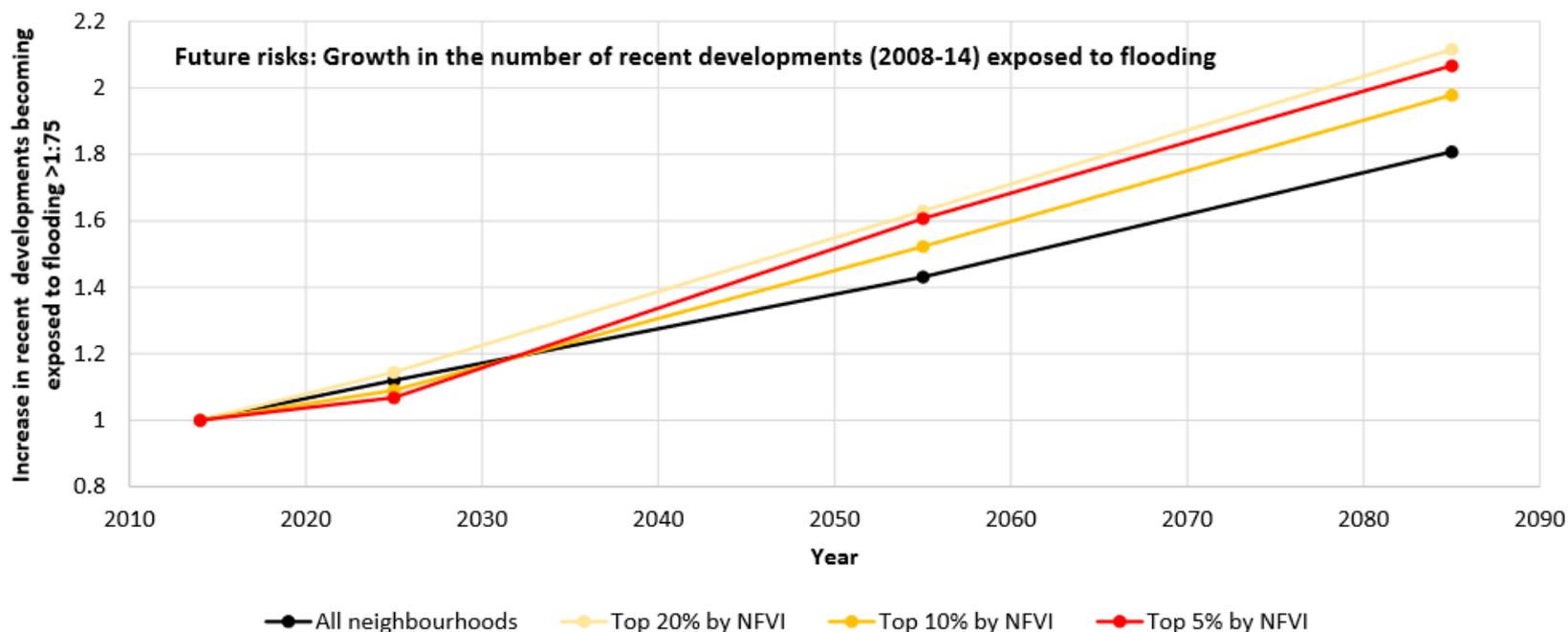
The underlying reasons for these changes are variation in climate influences and the assumed approach to adaptation.

		PD	2020s	2050s	2080s
Local Authority	Country	Ranking by SFRI			
Newham London	England	7	5	3	1
Boston	England	2	2	1	2
Hull	England	1	1	2	3
Glasgow	Scotland	5	4	9	4
Belfast	Northern Ireland	3	3	4	5
Highland	Scotland	72	15	5	6
East Lindsey	England	4	8	7	7
Leicester	England	8	6	8	8
Shepway	England	9	7	6	9
Birmingham	England	11	9	11	10
Swale	England	6	10	10	11
Barking and Dagenham, London	England	24	18	12	12
Enfield, London	England	48	30	17	13
Warrington	England	34	34	23	14
Southwark, London	England	20	17	13	15
North Somerset	England	372	359	276	16
Tower Hamlets, London	England	35	26	19	17
West Dunbartonshire	Scotland	12	12	15	18
Slough	England	16	13	16	19
Greenwich, London	England	22	20	18	20
Waltham Forest, London	England	25	22	21	21
Haringey, London	England	50	42	27	22
Salford	England	42	33	25	23
Rhondda Cynon Taf - Rhondda Cynon Taf	Wales	14	14	22	24
Caerdydd - Cardiff	Wales	33	25	20	25

\* Local authority boundaries from Ordnance Survey OpenData Boundary Line

Recent developments (2008-14) in high-risk areas (1-in75 years or more frequent) have disproportionately taken place in the most vulnerable neighbourhoods by NFVI

By the 2080s, all developments built between 2008-14 will experience a significant increase in exposure to flooding. Across all sources of flooding, the increase is greatest in those developments built in the most vulnerable neighbourhoods (but this is particularly the case in coastal floodplains).



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In summary, below are key points addressing each question posed at the outset of this paper

What contributes to social vulnerability and how is it measured?

- Neighbourhood Flood Vulnerability Index (NFVI) combines five domains of vulnerability (susceptibility, ability to prepare, ability to respond, ability to recover, and community support) based upon twelve vulnerability indicators
- Relative Economic Pain (REP) is the ratio between uninsured economic damages and household income
- Social flood risk combines exposure, vulnerability and probability of flooding at a neighbourhood scale (SFRI) and as an individual 'average' (iSFRI)

Where are socially vulnerable people exposed to high-risk flood areas? What types of flooding particularly impact socially vulnerable communities?

- Most vulnerable neighbourhoods are over-represented in areas prone to flooding for all sources of flooding and significantly over-represented in areas prone to coastal (and tidal) flooding
- For vulnerable neighbourhoods (top 5% by NFVI), over 50% of the population are located in ten local authorities
- Urban areas have the largest number of socially vulnerable people; however, vulnerable people (by NFVI) living in rural settings are often exposed to more frequent flooding

What is the take-up of insurance among socially vulnerable communities?

- For the lowest income decile of all households, 35% and 23% had contents and building insurance compared to 90% and 81% for contents and building insurance for the highest income decile in 2014
- Relative Economic Pain significantly higher in most vulnerable neighbourhoods (5% by NFVI) due to low incomes and low levels of insurance penetration

How will climate change impact socially vulnerable communities?

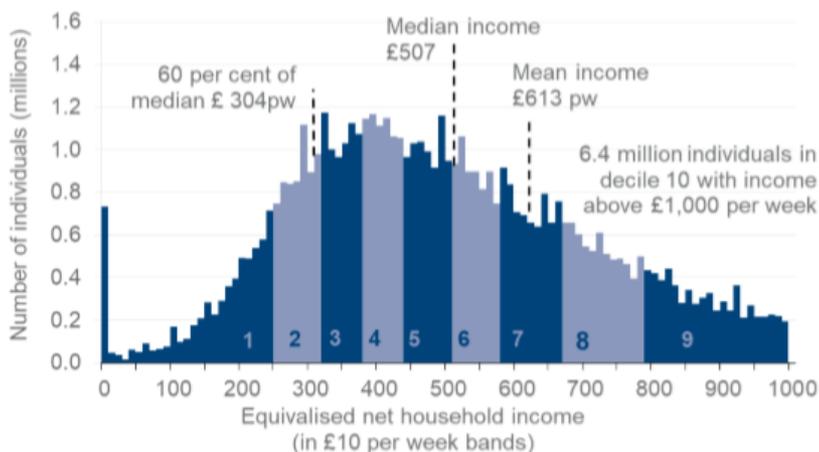
- In most vulnerable neighborhoods, risk increases from 451,000 to 1.4 million by 2080; the proportional increase of vulnerable neighbourhoods is similar to less vulnerable neighbourhoods

**FLOODRE**

ANY QUESTIONS?

Households below 60% of median income mark (£304 per week) are considered to have relative low income; insurance take up directly tracks income (as does internet access)

### Income distribution (BHC) for the total population, 2017/18



### Annual net equivalent household income BHC by household type at different percentiles of the 2017/18 UK distribution

Percentile	Single individual	Couple with no children	Couple with two children under 14
10th	£8,800	£13,100	£18,300
50th	£17,700	£26,400	£37,000
90th	£34,900	£52,000	£72,800
97th	£51,400	£76,700	£107,400

### Percentage of households with contents and buildings insurance by income decile 2014

Equivalent income decile (lower limit)	% with contents insurance	% with building insurance
Decile 1 (£0)	34.9%	22.5%
Decile 2 (£152)	55.1%	38.2%
Decile 3 (£203)	66.1%	50.8%
Decile 4 (£245)	72.7%	59.4%
Decile 5 (£287)	77.5%	63.1%
Decile 6 (£334)	82.5%	70.5%
Decile 7 (£386)	86.7%	74.9%
Decile 8 (£448)	85.0%	77.4%
Decile 9 (£536)	88.6%	79.1%
Decile 10 (£692)	90.4%	81.0%

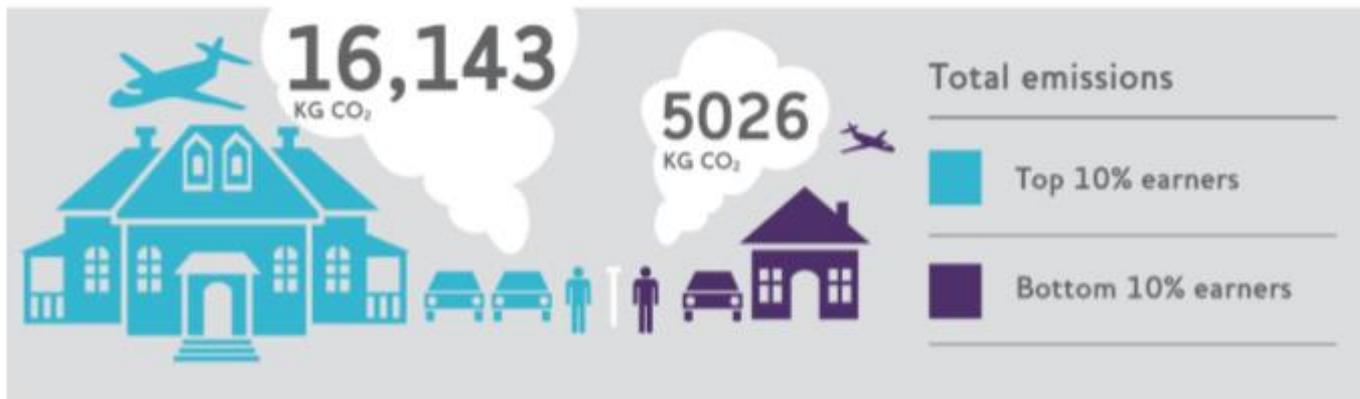
For lowest income quintile 35% have no internet access; compared to 11% and 3% for the middle and highest quintiles respectively.

\*BHC – Before Housing Costs

Source: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/789997/households-below-average-income-1994-1995-2017-2018.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/789997/households-below-average-income-1994-1995-2017-2018.pdf)  
 JRF 2016. UK poverty: Causes, costs and solutions. <https://www.jrf.org.uk/report/uk-poverty-causes-costs-and-solutions> (Table 9 and Table 7)

## Drivers of climate change: household carbon emissions in Great Britain are strongly related to income

The richest 10 per cent of households emit three times that of the poorest 10 per cent from energy use in the home and personal travel



Differences are particularly pronounced for private transport especially air travel compared to housing