

Building Public Health Resilience to Fluvial Flooding in Scotland



Policy Brief

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Recommendations

To enhance the overall resilience of communities:

- **Establish a cross-sectoral flood and public health resilience working group.**
- **Incorporate a public health perspective within flood risk management plans, focusing on health resilience alongside existing environmental, economic and property resilience.**
- **Increase awareness of, and discourse around the public health impacts of fluvial flooding and factors that influence people's resilience through communications and engagement, tailored to different vulnerable groups.**
- **Promote measures to protect and ensure continuity of public health services and health & social care facilities during floods.**
- **Greater emphasis on preparedness measures and establishing long-term community-based support networks, including training of professionals and key trusted members of communities to assist with secondary stressors and increase capacity to respond respectively.**

Introduction

Climate change is increasing our exposure to fluvial flooding in Scotland. Physical and mental health are negatively impacted by flooding, with the greatest health impacts in the UK and Scotland seen for mental health. This CREW Policy Brief reviews the literature on the public health impacts of fluvial flooding and identifies factors that influence health resilience to flooding. Key Scottish flood-related and public health policies are analysed and discussions with key stakeholders were held via a workshop to help to understand and identify knowledge gaps, and mechanisms to incorporate public health resilience to fluvial flooding in Scotland. Findings will support the development of Scotland's Flood Resilience Strategy.

How are Fluvial Flood Hazards affecting Scotland?

Scotland's climate has seen a warming trend, shifting rainfall patterns, more extreme weather events and rising sea levels. Projected changes for Scotland's climate include warmer, drier summers; milder, wetter winters; and increases in intense, heavy rainfall events in both

summer and winter¹, and these changes are happening faster than expected². Projected increases in intense heavy rainfall events will increase the risk of extensive and significant fluvial flooding³. UK-wide, fluvial flood exposure is the dominant source of flood exposure today (compared to coastal, groundwater and surface water) and remains so in the future⁴. Flooding poses a significant risk to people, communities and the built environment, with approximately 1.9 million people across the UK currently living in areas at significant exposure from either river, coastal or surface water flooding. The number of people at risk could double as early as the 2050s⁵. Flooding is therefore one of the most important climate change challenges facing the UK, with more people at high risk of flood exposure in the future due to changing rainfall patterns.

The Third UK Climate Change Risk Assessment (UKCCRA3) identified that despite action in this area flood exposure to people, communities and buildings remains a severe risk for Scotland and is the costliest hazard to businesses. The last few years have seen numerous, widespread and significant flood events in Scotland. High river flow runoff has increased by over 20% and winter river runoff by nearly 45% over the last 4 decades^{9,10}. Under a high emission scenario, peak river flows for some Scottish river catchments could increase by more than 50% by the 2080s¹¹. The storms of early 2016 were estimated to have cost the Scottish economy £700 million¹².

Box 1: Definitions

Fluvial flooding: occurs when rivers, streams or burns overflow their banks into surrounding areas.

Vulnerability: *'The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards'*⁶.

Vulnerability is complex and vulnerable groups are non-static. The impacts of an emergency change over time and are influenced by other wider concurrent and contextual factors⁷.

Resilience: *'The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management'*⁶.

Mental health: WHO defines mental health as *"a state of well-being in which every individual realizes his or her own potential, can cope with the stresses of life, can work productively and fruitfully and is able to make a contribution to her or his community"*⁸.

Box 2: Physical Health Impacts of Flooding

- Drowning
- Electrocution
- Water-borne pathogens or chemical and/or biological contaminants arising from floods
- Skin and gut infections from exposure to contaminated flood water
- Vector-borne and zoonotic disease including rodent-borne disease
- Respiratory disease from mould and damp
- Cardiovascular events
- Non-fatal injuries
- Risk of carbon monoxide poisoning in clean-up phase from inappropriate use of generators

What are the Public Health Impacts of Fluvial Flooding?

A rapid evidence assessment was undertaken to gather evidence on the physical and mental health impacts of fluvial flooding, as reported in Scotland, UK and internationally. Globally impacts of floods are substantial, not just in terms of economic loss, but detrimental short-, medium- and long-term effects on wellbeing, relationships and physical and mental health are common^{13,14,15}. Flooding adversely impacts on both physical (Box 2) and mental (Box 3) health¹³. Floodwater can contain a range of items that can be hazardous to physical health, such as human and livestock waste; sewage; household, medical and industrial hazardous waste (chemical, biological, and radiological); physical objects (e.g. wood, vehicle debris, rubbish); wild or stray animals (e.g. rodents, birds); petrol or oil spillages¹⁶.

The greatest health impacts of flooding in the UK are on mental health (Box 3). People who experience flooding are at higher risk of depression, anxiety and post-traumatic stress disorder¹⁷. There is also a link between mental and physical health via stress-related pathways, as stress can lower immune system responses, increasing vulnerability to water-borne diseases. Chronic stress is linked to sleep disorders which can influence physical illness and worsen mental health and psychosocial well-being. Stress can also increase risks of developing cardiovascular and autoimmune diseases and potentially some cancers⁸. However, the longer-term impacts of flooding on mental health have been less well described with limited evidence available to fully understand the impacts (Box 4). A small number of Scottish-based studies have investigated the impacts of flooding on people and communities. One of the earliest studies found that flooding impacts directly on both physical and psychological health, with a strong interaction between the two¹⁸. Similarly, a more recent CREW study demonstrated long-term (>3 years after the flood) negative impacts on physical and emotional wellbeing¹⁹.

Box 3: Mental Health Impacts of Flooding

- Anxiety and stress-related disorders
- Mood disorders including depression
- Post-traumatic stress disorder (PTSD)
- Strained social relationships, domestic violence
- Sleep disturbances
- Helplessness
- Fear and grief
- Suicidal thoughts and behaviours
- Alcohol and substance use
- Increase in psychotropic medication use
- Decrease in sense of self and identity via loss of place and grief reactions
- Emerging concepts such as ecological grief, eco-anxiety, solastalgia
- Exacerbation of pre-existing mental disorders

What Factors Influence Flood Vulnerability?

Climate change affects everyone, but not equally. Climate change heightens existing social and economic inequalities. Exposure to floods interacts with demographic, socio-economic and environmental factors, as well as access to and quality of health care, to affect the magnitude and pattern of risks²⁰. These health risks are unevenly distributed around the world, within countries and within populations, with any pre-existing health issues and inequalities likely to be exacerbated during and after the flood event²⁰. Some groups are at greater risk of health effects due to flooding than others (Box 5). This may be due to specific vulnerabilities, but multiple risk factors may also intersect. It should also not be assumed that having a risk factor or factors automatically implies vulnerability – a person with a risk factor may also have resilience if they are prepared and have the appropriate support. Meanwhile, people without a risk factor may also experience health impacts²¹. In Scotland certain groups – children, older people, those living alone, with pre-existing chronic illness or disability and stressful life circumstances, place-based occupations, low incomes, rural and remote areas – are all more vulnerable to flooding and to extremes of heat and cold^{18,22,19}.

Box 4: English Case Study

A 3-year UK-based study was established to identify the duration of psychological impacts of flooding, to help inform preventive and follow-up actions and to reduce harm from future floods¹⁶. The main findings were that the percentage of people with probable depression, anxiety or PTSD was highest among people whose homes were flooded (depression 20.1%, anxiety 28.3% and PTSD 36.2%, compared to depression 5.8%, anxiety 6.5% and PTSD 7.9% among people whose homes were not flooded), with the risk of having these mental health issues approximately six times higher in the affected group than in those who were unaffected. Mental health problems were also observed for people who did not have floodwater enter the liveable part of their homes, but whose lives were otherwise disrupted by the flood, emphasising the importance of acknowledging both direct and indirect impacts.

Box 5: Factors Influencing Vulnerability^{8,24}

- **Health** – chronic diseases, physical, sensory or cognitive impairment/disability, pre-existing mental health conditions (for people living in the community or in care facilities); people with complex healthcare needs at home.
- **Socio-economic** – poverty; financial insecurity; precarious housing; rental accommodation; homelessness; individuals exposed to abuse or violence; lack of education; poor literacy; language and cultural vulnerabilities; transient communities.
- **Demographic** – age (older adults, children, adolescents, university students); sex (pregnant and recently postpartum women); minority ethnic groups; indigenous status.
- **Geographic** – conflict zones; remote and dispersed communities; areas prone to extreme weather events; declining urban cities.
- **Sociopolitical** – gender; political instability; displaced populations and migrants; discriminated or socially-isolated individuals and groups; individuals with less knowledge/experience related to specific risks.
- **Occupational** – healthcare and other frontline workers; place-based occupations; migrant workers; informal insecure work; self-employed.

Particular public health-related challenges exist for Scotland and certain factors make Scotland's population more vulnerable to the health impacts of climate change and flooding than other parts of the UK and Europe. Scotland's population is ageing; the proportion of the population of pensionable age is expected to increase from about 20% to 25% by 2033. Scotland also has areas of greater deprivation and the lowest life expectancy than the rest of the UK. Health is poorest in the most deprived areas, with a difference in life expectancy of 13.7 years between men living in the most and least deprived areas of Scotland. 98% of Scotland's landmass is classed as rural with a dispersed and ageing population²³.

Secondary stressors are factors indirectly associated with flooding that often have negative mental health consequences, but where potential action can be taken to reduce their impact²⁴. Multiple secondary stressors have been identified in many studies, shown in Box 6.

Box 6: Secondary Stressors

- Lack of warning, not enough time to respond
- Greater flood water depth and duration
- Extent of flood damage
- Structural damage, costs of rebuilding or repair
- Upheaval, financial implications of clean-up
- Distress and financial implications of displacement or evacuation from home (temporary or permanent)
- Loss of domestic utilities
- Loss of/damage to possessions, sentimental items and burden on household costs
- Insurance-related issues e.g. dealing with insurance claims
- Disrupted access: employment, education, and wider facilities, health & social care services
- Separation from friends and family
- Feelings of loss of control and fear of recurrence of another extreme event
- Stress arising from exposure to media
- Damage to agriculture or livestock, leading to loss of food supplies

Scotland's Policy Landscape on Public Health Resilience to Fluvial Flooding

Key Scottish flood risk management and public health policies were examined to evaluate the 'policy-readiness' of Scotland's health and environment sectors to support public health resilience to fluvial flooding (See Appendix for list of policies).

Flood risk management policies: Whilst a range of useful flood risk management policies and strategies exist, which focus on increasing resilience, what is missing is the incorporation of a public health perspective, and a focus on health resilience, alongside other forms of resilience. Unified policies linking flooding and public health impacts (both physical and mental health) directly are lacking. There is a need for greater awareness, from the public, Government, local authorities, SEPA, and Public Health Scotland, of the public health impacts of fluvial flooding and the factors that influence people's resilience. It will be key to acknowledge that pre-existing vulnerabilities influence people's capacity for resilience. Previous research has highlighted a lack of joined-up policies and that Scottish communities are not engaging effectively with messages about their flood exposure and risk²⁵. Integrated policies should target communication around improving people's awareness and access to information, in terms of impacts on physical and mental health from fluvial flooding, tailoring information to specific vulnerable groups.

Public health policies: Within Scotland a number of recent public health strategies have been developed to respond to the challenges related to climate change and sustainability. Flooding is often recognised as having a significant impact on people's health and wellbeing, with the most adverse effects on mental health and among disadvantaged groups. Very few policies distinguish the specific effects resulting from health impacts. There is a need for further evidence and guidance for vulnerable groups (e.g. children, people with disabilities). Research on the health effects, communication and timing of interventions needed for compound and cumulative flooding is also lacking. Future research and policy would benefit from engagement with affected communities and those identified as most vulnerable to flooding to fully understand how their needs and concerns in relation to fluvial flooding can be best supported. Better integration of climate and flood policy into public health policy and in particular, mental health policy is needed to help support individual and community resilience to fluvial flooding in Scotland.

Future Research Perspectives

The Scottish population is becoming increasingly vulnerable to the health impacts of fluvial flooding. Knowledge gaps and mechanisms for building health resilience were identified from a literature review, policy analyses and workshop with key stakeholders from the health, environment and water industry sectors. By addressing knowledge gaps and barriers to implementation through directed research we can increase public health resilience to fluvial flooding in Scotland. Stakeholders at the workshop indicated we should be addressing this now. There is an urgent need for further research of the physical and mental health impacts of flooding in Scotland, with a focus on understanding impacts on certain vulnerable groups and the subsequent implementation of this knowledge into localised flood emergency management, as a public health priority.

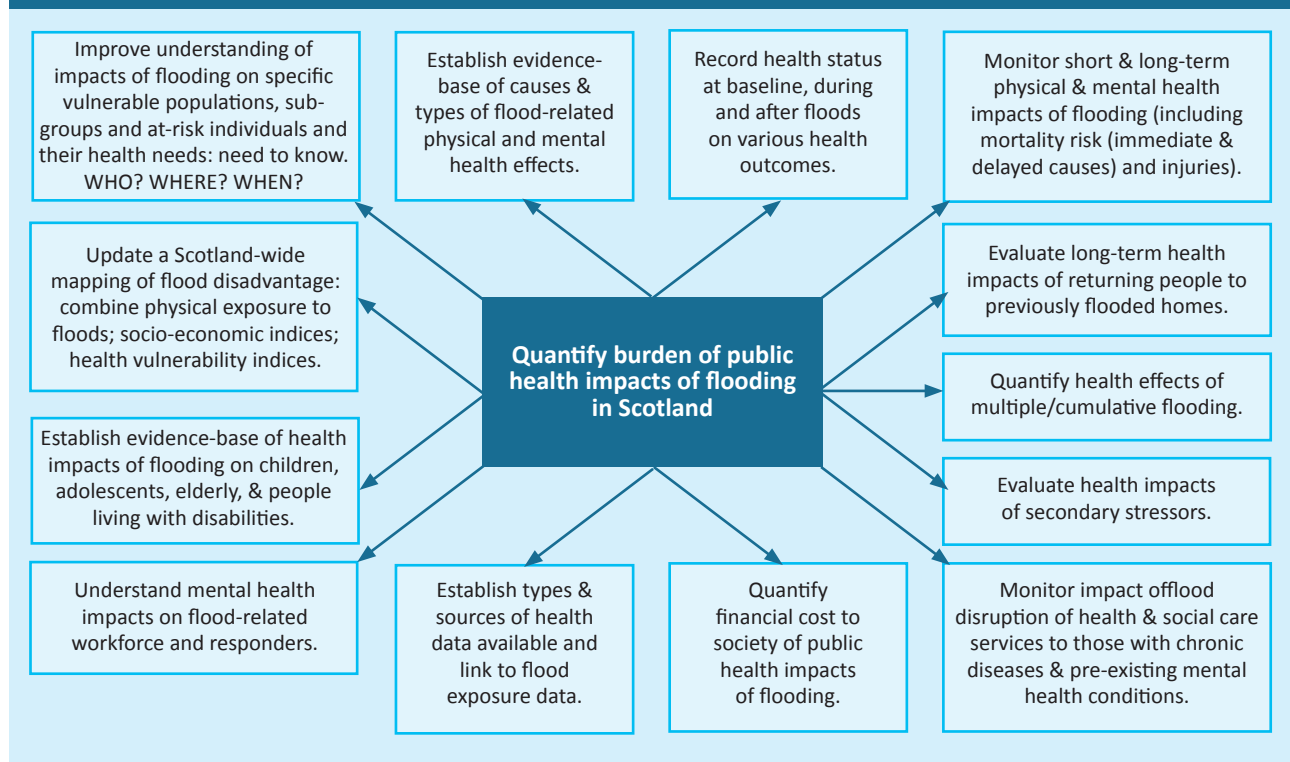
Specific knowledge gaps include:

Quantifying the burden of public health impacts of flooding in Scotland: Box 7 highlights key areas in need of further research. Future research and policy would benefit from engagement with affected communities and those most vulnerable, to fully understand how their needs and concerns in relation to fluvial flooding

can be appropriately supported. This was a key knowledge gap identified by workshop participants. Studies on the impacts relating to some vulnerable groups, e.g. elderly, are contradictory²⁶. Future research should revise and update a Scotland-wide mapping of flood disadvantage^{27,28,29}. This could use up-to-date data combining physical exposure/risk of flooding; socio-economic deprivation indices; population structure; and the addition of physical and mental health vulnerability indices (e.g. % of population accessing mental health services; prescription rates of antidepressants; hospital admission rates, etc). This could include developing a mental health risk index that incorporates indices on population health, exposure to risk, and health and general infrastructure resilience.

High-quality evidence on the impacts of floods on the physical and mental wellbeing of specific groups is crucial for policy makers and practitioners – knowing who, where and when. There is a need to understand the most effective mechanisms for communication immediately before, during and after a flood, especially during and after flood events if there is a loss of power/ internet in high flood exposure areas. The secondary stressors associated with floods (i.e. dealing with insurance; disrupted access to social and health care) are important issues to investigate further in terms of health

Box 7: Research required to quantify the burden of public health impacts of flooding in Scotland



impacts. Understanding health impacts of evacuation/relocation, temporary or otherwise, and how can this be minimised is crucial. However, understanding the implications and longer-term health impacts of returning people to previously flooded homes and impacts from disruptions to children’s education were highlighted in the workshop.

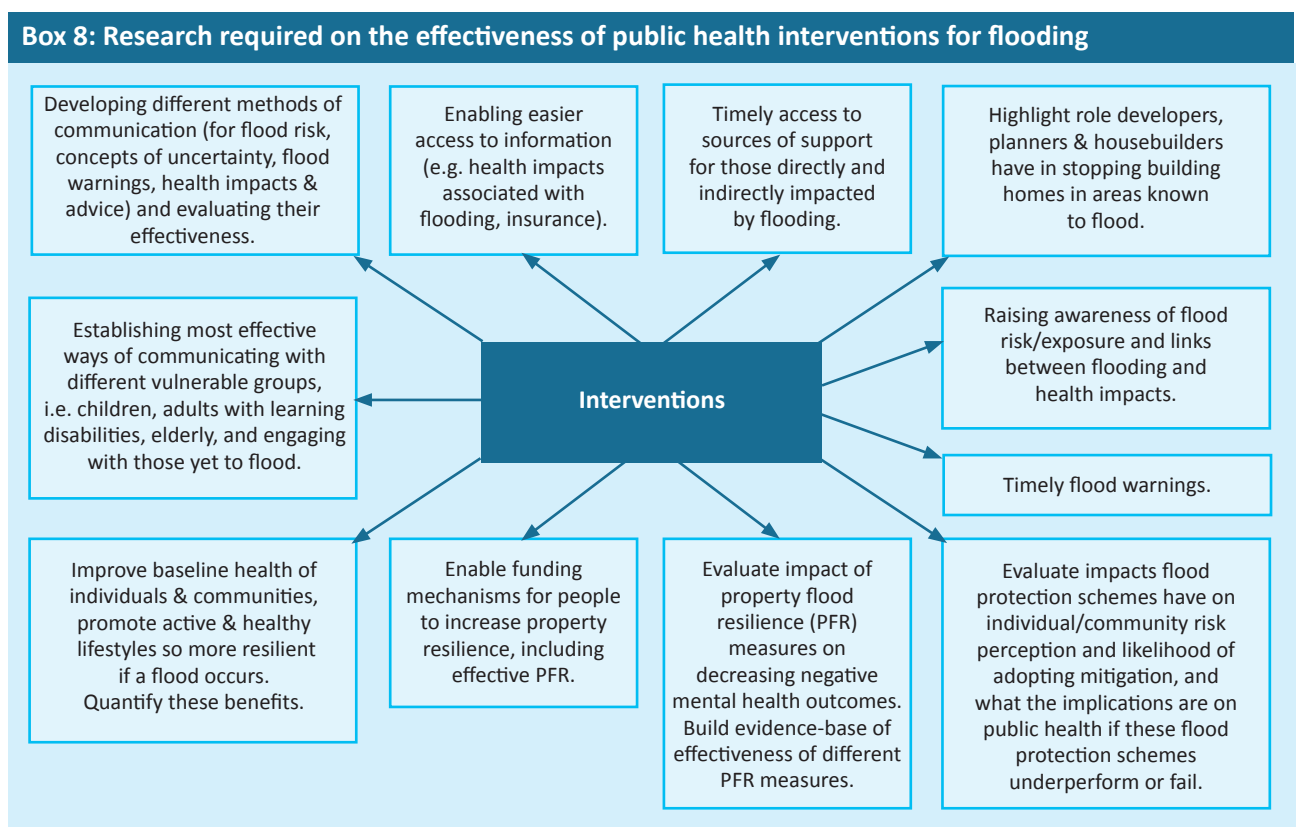
We need to develop a standardised methodology to support health surveillance of flood impacts on mortality, injuries and mental health, both in real-time and retrospectively to subsequently better understand the health impacts of flooding. A further key outcome from the workshop was a need to better understand the financial costs of physical and mental health impacts from flooding in Scotland. This could include a cost-benefit analysis of effectiveness of various interventions.

Interventions: There is an urgent need to design, develop, implement and evaluate the effectiveness of different public health and flood exposure intervention strategies (Box 8). This is currently lacking^{30,31,32}, for individuals and communities that are i) first-time flooded, ii) experienced multiple floods, iii) those yet to experience floods but are likely to in the future. This includes interventions before, during and for a sustained period after a flood which help protect and improve health and wellbeing, increasing resilience and improving mental health outcomes. Understanding the most appropriate interventions for specific vulnerable groups is crucial. Interdisciplinary research will be

most effective. Flood warnings are a crucial aspect in reducing flood-related health burdens. We need to understand their effectiveness, in terms of public health impacts (positive and negative), and links between flood warnings and how people perceive and respond to them, including understanding what motivates people to take action. Evaluating benefits of timely flood warnings, but also potential health risks of false alarms and warnings with not enough time to respond effectively, is key. Previous studies have suggested that longer warning times had a small but significant effect on protecting mental health^{33,34}. More broadly, research is required into behavioural contexts underpinning individual exposure/risk and barriers to behavioural change or uptake of interventions.

Co-benefits: We need to evaluate the wider costs and benefits (and risks), to physical and mental health, of nature-based flood interventions, such as natural flood risk management measures and implementing blue/green infrastructure.

Role of Community: Disaster mental health literature indicates that community resilience and social cohesion are powerful protective factors for communities’ mental health^{35,36}. However, a more critical assessment is needed to determine which factors make communities more resilient^{37,38,39,40}. Further research is required to quantify the positive public health impacts of addressing flood resilience through empowering and working with communities and implementing holistic interventions.



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Visual minutes from project workshop.
Graphic Artist: Jenny Capon.

Restoring social cohesion of communities/families immediately after a flood event is crucial to reduce suffering and promote effective recovery^{41,42}, but this needs to be evaluated. We need to better understand ways of improving social connectedness in communities and recognise potential negative health impacts of loss of community and loss due to temporary/permanent evacuation/relocation. Workshop stakeholders highlighted a strong emphasis on developing community/individual resilience plans, with targeted advice so people know what to do before, during and after a flood, the safe places to go, and encourage people to sign-up to flood alerts. This could include assisting with creation and updating local registers of at-risk individuals for first responders to prioritise.

Addressing barriers to implementation: We need to understand the range and severity of physical and mental health impacts of flooding to support policy and resource prioritisation. Currently, the resources required are unknown. Addressing flood resilience is one of many challenges people and places face, and in a cost-of-living crisis with multiple socio-economic and health implications, building resilience to flooding may not be everyone's top priority, so flood resilience cannot be viewed in isolation. Misunderstandings of responsibility for flood protection also exist which can act to decrease people's resilience. Siloed thinking and budgets act as barriers to co-design and co-production of policies and strategies that embed health resilience into flood risk management.

Conclusions

The future success of Scotland's Flood Resilience Strategy is dependent on improving the evidence-base by conducting targeted research as identified in the Future Research Perspectives section; by better integration of policy areas; addressing implementation barriers and following suggested recommendations. Whilst this policy brief suggests it is key for the environment and public health sectors to work together, the stakeholder workshop also recognised the need to include other key stakeholders, such as engagement specialists to ensure communication is as effective and reaches as many people as possible; local authorities; GPs; social and health care systems; schools; faith-based organisations; utilities including Scottish Water and transport; Category 1 and 2 responders including emergency services; engineers; builders, trades and skills bodies; insurers; community planning partnerships and householders.

References

- 1 Scottish Climate Change Adaptation Programme: Progress Report. 2023. Fourth annual progress report on the "Climate Ready Scotland: Scotland's Climate Change Adaptation Programme 2019 to 2024. May 2023
- 2 Rivington M, Jabloun M. 2022. Climate Trends and Future Projections in Scotland. Deliverable D2.1a for the Project D5-2 Climate Change Impacts on Natural Capital. The James Hutton Institute, Aberdeen. DOI: 10.5281/zenodo.7657945
- 3 Climate Projections for Scotland Summary. 2021. Scottish Government, Sniffer
- 4 Sayers PB, Horritt M, Carr S, Kay A, Mauz J, Lamb R, Penning-Rowsell E. 2020. Third UK Climate Change Risk Assessment (CCRA3): Future Flood Risk. Research undertaken by Sayers and Partners for the Committee on Climate Change. Published by Committee on Climate Change, London
- 5 Flooding and Coastal Change Briefing, Findings from the third UK Climate Change Risk Assessment (CCRA3) Evidence Report 2021. ukclimaterisk.org
- 6 United Nations Office for Disaster Risk Reduction 2019
- 7 UK National Risk Register 2023. HM Government
- 8 Mental health and climate change: policy brief. 2022. World Health Organisation
- 9 Hannaford J. 2015. Climate-driven changes in UK river flows: a review of the evidence. *Progress in Physical Geography*, 39(1): 29–48
- 10 Hannaford J, Mastrantonas N, Vesuvioano G, Turner S. 2021. An updated national-scale assessment of trends in UK peak river flow data: how robust are observed increases in flooding? *Hydrology Research*. DOI: 10.2166/nh.2021.156
- 11 Kay AL, Rudd AC, Fry M, Nash G, Allen S. 2021. Climate change impacts on peak river flows: combining national-scale hydrological modelling and probabilistic projections. *Climate Risk Management* 31 100263
- 12 Evidence for the third UK Climate Change Risk Assessment (CCRA3) Technical Report: Summary for Scotland, Sniffer

- 13 Fernandez A, Black J, Jones M, Wilson L, Salvador-Carulla L, Astell-Burt T, Black D. 2015. Flooding and mental health: a systematic mapping review. *PLoS One*, 10 (4), e0119929.-1-e0119929.-20
- 14 Alderman K, Turner LR, Tong S. 2012. Floods and human health: A systematic review. *Environment International* 47: 37–47
- 15 Stanke C, Murray V, Amlot R, Nurse J, Williams R. 2012. The effects of flooding on mental health: Outcomes and recommendations from a review of the literature. *PLoS Curr*. 30: 4 DOI: 10.1371/4f9f1fa9c3cae
- 16 English National Cohort Study of Flooding and Health, Public Health England 17 UKHSA Health effects of climate change (HECC) in the UK. State of the evidence 2023
- 18 Werritty A, Houston D, Ball T, Tavendale A, Black A. 2007. Exploring the Social Impacts of Flood Risk and Flooding in Scotland. Scottish Executive Social Research. Edinburgh. <http://www.gov.scot/Publications/2007/04/02121350/0>
- 19 Philip, L., Dowds, G. and Currie, M. 2020. Long-term impacts of flooding following the winter 2015/16 flooding in North East Scotland: Comprehensive Report. CREW
- 20 Nilsson M, Sie A, Muindi K et al. 2021. Weather, climate, and climate change research to protect human health in sub-Saharan Africa and South Asia. *Global Health Action* 14:sup1, 1984014, DOI: 10.1080/16549716.2021.1984014
- 21 UKHSA UK Government Guidance Flooding and health: an overview. December 2023.
- 22 Brisley R, Welstead J, Hindle R, Paavola J. 2012. *Socially Just Adaptation to Climate Change*. [Online]. York: Joseph Rowntree Foundation. Available from: <https://www.jrf.org.uk/report/socially-just-adaptation-climate-change>
- 23 National Records of Scotland. 2022. Life expectancy in Scotland 2019-2021.
- 24 UKHSA Guidance Flooding and health: assessment and management of public mental health. July 2022. Gov.UK
- 25 Henderson F, Helwig K, Teedon, P. 2022. Effective future communication of flood risk in Scotland. CREW
- 26 Cherniack EP. 2008. The impact of natural disasters on the elderly. *American Journal of Disaster Medicine*; 3(3):133–9
- 27 Lindley SJ, O’Neill, J, Kandeh J, Lawson N, Christian R, O’Neill M. 2011. Climate change, justice and vulnerability. Joseph Rowntree Foundation, www.jrf.org.uk
- 28 Lindley S, O’Neill J. 2013. Flood disadvantage in Scotland: mapping the potential losses in well-being. Scottish Government social research
- 29 Kazmierczak A, Cavan G, Connelly A, Lindley, S. 2015 Mapping Flood Disadvantage in Scotland 2015: Main Report to Scottish Government
- 30 Bouzid M, Hooper L, Hunter PR. 2013. The Effectiveness of Public Health Interventions to Reduce the Health Impact of Climate Change: A Systematic Review of Systematic Reviews. *PLoS ONE* 8(4): e62041. doi:10.1371/journal.pone.0062041
- 31 Mulchandani R, Armstrong B, Beck CR *et al.*, 2020. The English National Cohort Study of Flooding & Health: psychological morbidity at three years of follow up. *BMC Public Health* 20:321
- 32 North CS, Pfefferbaum B. 2013. Mental Health Response to Community Disasters A Systematic Review. *Jama-J Am Med Assoc*; 310(5):507–18
- 33 Tunstall S, Tapsell S, Green C, Floyd P, George C. 2006. The health effects of flooding: Social research results from England and Wales. *J Water Health*; 4(3):365–80. PMID: 17036844
- 34 Parker D, Tapsell S, McCarthy S. 2007. Enhancing the human benefits of flood warnings. *Natural Hazards*; 43(3):397–414
- 35 Charlson F, Ali S, Augustinavicius J *et al.*, 2022. Global priorities for climate change and mental health research. *Environment International* 158 106984
- 36 Bonanno GA, Brewin CR, Kaniasty K, La Greca AM. 2010. Weighing the Costs of Disaster: Consequences, Risks, and Resilience in Individuals, Families, and Communities. *Psychological Science in the Public Interest* 11(1): 1–49
- 37 Boon HJ. 2014. Disaster resilience in a flood-impacted rural Australian town. *Nat Hazards*; 71(1):683– 701
- 38 Crabtree A. 2013. Questioning Psychosocial Resilience After Flooding and the Consequences for Disaster Risk Reduction. *Soc Indic Res.*; 113(2):711–28

- 39** Keogh DU, Apan A, Mushtaq S, King D, Thomas M. 2011. Resilience, vulnerability and adaptive capacity of an inland rural town prone to flooding: a climate change adaptation case study of Charleville, Queensland, Australia. *Nat Hazards.*; 59(2):699–723
- 40** Norris FH, Tracy M, Galea S. 2009. Looking for resilience: Understanding the longitudinal trajectories of responses to stress. *Soc Sci Med.*; 68(12):2190–8. doi: 10.1016/j.socscimed.2009.03.043 PMID: 19403217
- 41** Tapsell S. 2001. The hidden impacts of flooding: experiences from two English communities. *Iahs-Aish P.* 272:319–24
- 42** Cianconi P, Betro S, Janiri L. 2020. The impact of climate change on mental health: a systematic descriptive review. *Frontiers in Psychiatry* 11:74. doi:10.3389

Appendix

Scotland's Policy Landscape on Public Health Resilience to Fluvial Flooding

Key Scottish flood risk management policies and public health policies were examined to evaluate the 'policy-readiness' of Scotland's health and environment sectors to support public health resilience to fluvial flooding.

Flood risk management/environment policy review:

The Climate Change Committee (CCC) published its **third Independent Assessment of UK Climate Risk** in 2021 and found that action to improve resilience across all UK nations is generally failing to keep pace with the increasing risks associated with the impacts of climate change. CCC also assessed the **second Scottish Climate Change Adaptation Programme (SCCAP2)**, designed to integrate action on adaptation into wider Scottish government policy and service delivery. Its assessment concluded that "more needs to be done to translate ambition into actions that are commensurate with the scale of the challenge." Scottish Ministers' assessment of SCCAP2 is that "more needs to be done to build resilience in Scotland...". The CCC highlighted that Scotland's progress in delivering its adaptation aims had stalled across most sectors and it emphasised the need to raise the level of adaptation response (Is Scotland climate ready? 2022 Report to Scottish Parliament, CCC).

Scotland's key Flood Risk Management policies and programmes include the **National Flood Risk Assessment (NFRA) 2018**. SEPA published the second NFRA in 2018 to indicate flood risk in Scotland that embeds climate change and a range of social, environmental and economic impacts into a single assessment. The assessment enables identification of locations with the greatest flood risk and these areas are designated as Potentially Vulnerable Areas. Areas may be vulnerable due to current or future flood risk to people, the environment, cultural heritage and economic activity. The 2018 NFRA assesses flood risk to different receptors. Receptors are 'things' that are impacted by flooding and include: Agriculture; Buildings; Community facilities; Cultural heritage; Environment; Transport; Utilities. There is no mention of people here. Receptors are assessed against the SEPA flood hazard maps to identify those at potential risk of flooding, however the focus appears to be on economic impact assessment. Community facilities are recognised to have

social impacts based on the type of facility impacted and how this would negatively affect the community if the use of the facility were disrupted. Residential homes are however only assessed for economic impacts. A new community scale element is also incorporated into the 2018 NFRA where the proportion of flooded homes and businesses and services in a community was assessed. If a large proportion of homes and businesses within a community is flooded, this can cause significant disruption. Remote and rural communities are also considered more explicitly. Overall it is not clear how exactly social factors are taken into account and if/how social vulnerabilities are incorporated into the Potentially Vulnerable Areas identification.

The **Flood Risk Management (Scotland) Act 2009** Delivering sustainable flood risk management (Feb 2019) lays out a structure and plan for integrated flood risk management and partnership working to deliver flood risk management. Including Public Health Scotland as one of those partners would be an effective way to include more specific public health information, as the report does acknowledge human health as an impact of flooding, both immediate and consequential. Two of the outcomes particularly lend themselves to incorporating public health information: 1. A well informed public who understands flood risk and adopts actions to protect themselves, their property and businesses. To do this they must be supported through improved awareness and access to information on flood risk. 2. Flood management actions undertaken that stand the test of time and be adaptable to future changes in climate. Non-structural actions to manage flood risk such as flood warning, public awareness raising campaigns, planning decisions, emergency response, relocation, flood insurance, compensation, and flood proofing buildings, could easily include public health information. An integrated approach to flood risk management is one of seven key topics. Including Public Health Scotland as a key partner and public health related policies linked alongside other environmental and economic policies is recommended. Various groups are referred to, including a National Flood Management Advisory Group (NFMAG) to advise on the key deliverables outlined in the FRM act. Professional advice is provided through the Scottish Advisory and Implementation forum for flooding (SAIFF). A National Prioritisation Advisory Group, with representatives from the Scottish Government, COSLA, Scottish Water and local authorities, provides guidance to SEPA on the priority of flood risk management actions.

Multiple groups exist, so clarity over the purpose and functioning of each group is needed to avoid confusion and duplication.

The Flood Risk Management (Scotland) Act 2009 introduced a plan-led approach to flood risk management in Scotland with the aim of reducing flood risk in the most sustainable manner. This requires SEPA to produce **Flood Risk Management (FRM) Plans** for each of Scotland's 14 districts, along with **Local Authority Flood Risk Management Plans** to supplement SEPA's plans. The first set of FRM plans were published by SEPA in 2015, with local FRM plans produced in 2016. The second set of Flood Risk Management Plans 2021-27 were published in 2021, and the Strategic Environment Assessment summarises the environmental report for the 14 Flood risk management plans that set the direction and priorities for flood risk management in Scotland. The plans acknowledge that flood risk has implications for physical and mental health and wellbeing, and state that the FRM plans will address risk to human health from flooding and will therefore contribute to improving human health and wellbeing. However, there are no specific actions outlined related to this. One objective is to protect and improve human health and wellbeing through improved environmental quality. There is, however, no mention of improving health and wellbeing through raising awareness of public health impacts of flooding, or by providing advice or support.

The report uses language such as 'Significant beneficial effects were identified in terms of population and health and material assets as a result of reduced flood risk to homes, businesses and infrastructure; with benefits in terms of wellbeing', however there is no specific detail. In addition, reduction of flood risk is framed around actions such as flood schemes, works design and implementation, such as river defences, run off reduction, property flood resilience, river and floodplain restoration, storage conveyance and control. No reference to public health advice or policies or health resilience are evident. The Plans state that SEPA will monitor the effects that the flood risk management plans are having on the environment. A key gap is the lack of monitoring of the effect of FRM plans on the public health of individuals/communities at risk of, or having experienced flooding.

In the Local Flood Risk Management Plans it is evident that plans are co-produced by the relevant councils involved, SEPA, Scottish Water, Forestry & Land Scotland, Scottish Forestry, and at times National Park Authorities, the Scottish Flood Forum and local advisory groups. There appears to be no public health bodies/organisations involved, which is a clear gap. Plans contain a link of who to contact in the event of flooding,

and lists SEPA, local authority and Scottish Water and their main roles and sources of support, such as flood maps, signing up to Floodline but there is no information about public health advice and sources of support, which is a clear knowledge gap that could be addressed by including public organisations such as Public Health Scotland in the co-production of FRM plans and links to Public Health Scotland advice and support.

The **Mapping flood disadvantage report and tool** (Kazmierczak *et al.*, 2015), commissioned by the Scottish Government in 2015 is a dataset showing the most flood disadvantaged neighbourhoods and their underlying flood vulnerability to help better understand the social impacts of flooding. It includes 34 vulnerability indicators, social vulnerability to flooding, percentage of households exposed to flooding, flood disadvantage and geographical location. Outputs are embedded in the **National Flood Risk Assessment** and inform the flood risk management strategies and local flood risk management plans. The tool is intended to support cross-departmental working, identifying priority areas for emergency services and communicating flood risk issues to local communities, and targeting flood risk management actions including community engagement and awareness raising. This is a useful tool that would benefit from updating with the most recent datasets and the inclusion of a public health perspective. An updated assessment of the characteristics of vulnerability and adaptive capacity across Scotland would be beneficial, as stated in *Is Scotland climate ready? 2022 Report*, as much of the knowledge base needed to understand distributional consequences of climate impacts and adaptation actions remains at an early stage.

The **Scottish Flood Forum** supports flood risk communities by raising community awareness, promoting self-help, developing community groups and establishing recovery support programmes after a flood. These measures should contribute to increased understanding and awareness of flood risk, raising awareness of actions that prepare individuals, homes and businesses for flooding thereby reducing the overall impact of flooding. The Scottish Flood Forum is a key support organisation and would be an obvious channel for including public health advice and sources of support.

The **River Basin Management Plan for Scotland 2021-2027**, produced in Dec 2021, sets out a framework for protecting and improving the benefits provided by the water environment across Scotland. The Scottish Government, SEPA, responsible authorities and all of Scotland's public bodies are responsible for developing and delivering RBMP actions. One of the four main themes is "action to create healthier and more resilient

communities” and refers to river restoration, blue-green river corridors, active travel and recreation to improve health. It refers to restoring the water environment to help communities adapt to climate change, by building resilience to increased frequency of flooding. The focus therefore is on physical and/or environmental resilience, rather than public health resilience related to the negative impacts of flooding. The RBMP refers to strong and effective links between RBMP, flood risk management and land use planning but no inclusion of public health. Similarly, **Scottish Water’s Route map** includes no mention of public health impacts. An aim is to provide more public information, therefore this could incorporate information on the physical and mental health impacts of flooding due to disrupted/damaged water supplies.

In the **Scottish Climate Change Adaptation Programme (SCCAP2)** progress report, it provides examples of progress towards the SCCAP2 policies across the seven high-level outcomes since May 2022. The only example related to public health is the NHS Scotland climate emergency and sustainability strategy: 2022-2026. SCCAP2 Outcome 2 is the people in Scotland who are most vulnerable to climate change are able to adapt and climate justice is embedded in climate change adaptation policy. This acknowledges that everyone’s health can be affected by climate change but that those who are socially disadvantaged, older, very young or experiencing chronic health problems are less able to cope. SCCAP2 acknowledges more extreme weather will increase the risk of flooding which can lead to negative health effects, and population health in Scotland can be affected both directly and indirectly. Recognition that flooding can become a health hazard and may result in an increase in mental ill health due to distress of displacement, loss of personal possessions and financial losses.

Adaptation Scotland Programme published a **Community Climate Adaptation Routemap** in March 2023. It provides practical actions communities can take to build resilience and prepare for climate change. There are some actions included that address secondary stressors that can result in physical and mental health impacts, such as checking people in your community have appropriate insurance, installing property level flood protection measures, reducing dampness in homes, and establishing a community resilience team. However, there is no mention of public health impacts of climate change or flooding specifically, or mention of health resilience. This potentially is because no public health body was involved as a contributor. Community Adaptation Actions do not refer directly to actions related to public health impacts of flooding but includes

some indirect actions including advice for addressing some of the secondary stressors, so actions involving insurance, and property flood resilience measures.

Place Standard Tool with a climate lens (PST CL): co-creating local climate solutions is a joint-led project by Sniffer and Sustainable Scotland Network, together with and funded by Public Health Scotland and Scottish Government. It aims to support integrating climate action into placemaking. A working version of PST CL has been updated to allow consideration of climate change alongside health, wellbeing and other significant aspects shaped by places. The focus appears to be on benefits to health and wellbeing from green spaces (i.e. Edinburgh’s thriving green places) and addressing inequalities (e.g. Greater Pollok placemaking), with no specific mention of public health impacts of flooding.

The **Fourth National Planning Framework (NPF4)** addresses risks from climate change including flooding. A Position Statement on Scotland’s NPF4 highlights the need for a fresh approach to address climate change. Issues that need to be addressed to achieve this ambition are identified as: reducing communities’ exposure to flooding by future-proofing the design of the built environment and investing in natural infrastructure; promoting natural flood risk management and strengthening policies on the water environment and drainage infrastructure; restricting development in flood risk areas; adapting existing infrastructure where climate change may increase vulnerability to flooding; and placing greater importance on flood risk management and coastal protection and the interface between planning on land and at sea. There is no mention here of public health impacts of flooding or health-related policies and support which is a key gap.

The **‘Is Scotland climate ready? 2022 Report to Scottish Parliament Recommendations’** includes health recommendations that refer to resilience of the population to changes in temperature, resilience of people to pathogens and air quality. There is a clear gap linking flooding to public health impacts. A clear recommendation is therefore to include consideration of resilience of population to flooding as a priority area and a SEPA and Public Health Scotland partnership should assess the changing risks to people from flooding, considering areas for future monitoring and surveillance, and evaluating effectiveness of interventions.

Flood warning development framework 2022–2028 includes no mention of public health impacts of flooding. However within Aim 2 Upgrade capabilities through development and innovation, there is Theme 2.4 – Scoping an impact-based forecasting capability, which could link to broader vulnerability factors to

evaluate risk. Also, within Aim 3 Deliver enhanced digital communications and an engaged and customer focused service, all themes (Theme 3.1 – Communication including digital enhancements; Theme 3.2 – Working with partners; Theme 3.3 – Working with communities) could include public health messaging and links to Public Health Scotland or NHS Scotland, and more general awareness raising of links between flooding and public health impacts and sources of advice/support.

Ready Scotland's aim is to make Scotland more resilient to emergencies. The website has three main categories of support – prepare, respond and get involved. There is nothing substantial related to public health with the exception of some mental health advice in the prepare section and there is some information on first aid.

In the response section there is a page on coping with trauma which points to some sources of support such as GP, NHS24 and two websites on PTSD. There is also specific information on supporting children after a traumatic event. In the recovery from flooding section it highlights to: be aware of the health effects caused by a flood, wear appropriate clothing and protection as flood water can be contaminated with harmful bacteria and be mindful of how the stress and traumatic feelings of loss can have an impact on your own and the mental wellbeing of others.

Public health policy review:

Scottish Government

NHS Scotland Climate Emergency & Sustainability Strategy 2022-26 recognises that climate change is a major threat to public health and accordingly, NHS Scotland is aiming to become a net-zero health service by 2040. The potential impacts on mental health from climate-related events, such as flooding are acknowledged. The need to take urgent action to protect sites, services and communities is highlighted. Flooding and overheating are the climate risks most likely to have the biggest effect on the estate and operations of NHS Scotland as well as increasing patient demand. This is already having an impact on health services. An example is provided when a flood event in Perthshire resulted in patients being cut-off for a week. Over 400 health and social care assets in Scotland are at risk of frequent flooding and this number is expected to rise, but risks specific to fluvial flooding are not identified. Overall impacts on buildings include excessive moisture due to flooding. Detail is lacking on how to prevent and address the anticipated increased mental health demand, particularly for vulnerable groups.

In the **Chief Medical Officer for Scotland Annual Report 2022-2023 'Realistic Medicine: Doing the Right Thing'**, climate change is included as one of four major challenges to public health in Scotland and is highlighted as already impacting Scotland's health and wellbeing, with those who are living with existing disadvantages most affected. Direct impacts of climate change on health, including flooding and related economic disruption, are mentioned and the mental health effects due to unexpected costs, business disruption and temporary housing highlighted. Different types of flooding are recognised, including coastal and riverbank overflow, and landslides highlighted as a related risk that are problematic to manage. Secondary impacts on health include the potential for water contamination, increased risk of damp in housing, and interruption of water supplies which can increase risk of disease, such as cholera. Links between the climate emergency and socioeconomic inequalities are emphasised, with flood disadvantage greater in coastal areas, declining urban cities and dispersed rural communities. However, detail is lacking on how communities can reduce these impacts and increase public health resilience. The main measure mentioned was in relation to NHS estates where green infrastructure like rain gardens may help to mitigate flood risk, as well as overheating.

The 2022 Scottish Government document '**Delivering Value Based Health & Care: A Vision For Scotland**' does not mention flooding specifically but one of its six commitments is to *"support the delivery of sustainable care in line with the NHS Scotland climate emergency and sustainability strategy by reducing waste and harm"*. The related 'Value Based Health & Care Action Plan' published in 2023 outlines actions to achieve this, but the focus is mainly on integrating issues of sustainability into clinical guidelines, reducing low value interventions and over-prescribing.

The **Scottish Government's 2023 Mental Health and Wellbeing Strategy** highlights that more effective cross-policy action is needed to address the multifaceted factors that impact mental health and wellbeing, with climate change highlighted as a policy priority. Flooding is not addressed specifically. In the related Delivery Plan 2023-2025 and Workforce Action Plan 2023-2025, climate change is not mentioned specifically.

Creating Hope Together Scotland's Suicide Prevention Strategy 2022-2032 and associated Action Plan 2022-2025 by the Scottish Government do not mention potential impacts of climate change, although a 'Whole of Government and society approach' is recognised as a key action area. Further integration of environmental and flood policy may be beneficial. Similarly, the added challenge of climate change is not mentioned in

‘Scotland’s Self-Harm Strategy and Action Plan (2023-27)’ or ‘A CONNECTED SCOTLAND: Our strategy for tackling social isolation and loneliness and building stronger social connections’, published in 2018 by the Scottish Government. Reducing social isolation and loneliness and increasing community social cohesion could play a role in enhancing community resilience to flooding and other climate-related events. A number of other policies developed by the Scottish Government were consulted but included no mention of climate change or flooding, including the 2016 “Health and Social Care Delivery Plan” and “A National Clinical Strategy for Scotland”.

Public Health Scotland (PHS)

In 2023 Public Health Scotland published “**Working together to build climate-resilient, healthy and equitable places: A briefing for local government and partners**” developed alongside Adaptation Scotland and the Improvement Service. It aimed to enhance awareness of how climate change and adaptation responses can affect health and health inequalities. Increased challenges as a result of flooding are acknowledged, with consequences for both physical and mental health. The risks resulting from flooding are recognised to be unequally distributed, with vulnerabilities in terms of who is most exposed (e.g. residents and businesses in flood risk areas), most sensitive (e.g. elderly, people with health conditions) with the least capacity to adapt (e.g. those with low incomes). It is emphasised that upstream and downstream actions are needed to reduce inequalities in climate risk and related health inequalities. Examples of downstream interventions mentioned in relation to flooding include the provision of grants for property-level flood protection, but the potential to increase inequalities is highlighted as a risk if these are not targeted to the most socially disadvantaged. Nature-based solutions are provided as an example that may bring health and wellbeing co-benefits and climate resilience, via contributing to flood risk management and other benefits, such as temperature moderation.

In PHS’s “**Road space reallocation in Scotland: A health impact assessment**”, increasing greenspace was highlighted to have potential benefits both in terms of preventing flooding and reducing its severity, which can have significant and long-term impacts on mental health. Similarly, in “**Healthy housing for Scotland: A briefing paper setting out the fundamental link between housing and public health**” the provision of quality green infrastructure is also highlighted to reduce the risk of flooding and overheating of the built environment. They highlight that one in eight homes in Scotland is at risk of flooding, but that mental health impacts extend to those

who may not be flooded themselves but may otherwise experience disruption. In the briefing developed by The Improvement Service and Public Health Scotland “**Place and Wellbeing: integrating land use planning and public health in Scotland**”, they provide practical guidance for land use planners, public health practitioners and policy makers to work together, using a whole systems approach to enhance health and wellbeing and minimise reduce health inequalities. Under the place and wellbeing outcomes relating to natural spaces, a key outcome mentioned is that everyone can be “*protected from environmental hazards including air/water/soil pollution or the risk of flooding*”.

The “**PHS climate change and sustainability strategic approach 2023–2026**” adapts the framework set out in the World Health Organization’s (WHO) “COP26 special report on climate change and health: the health argument for climate action”. The PHS document outlines a number of actions to achieve their goals, one of which is in relation to population health to “*play a lead role in delivering transformational societal change through a just transition to a net-zero, nature-positive, climate-resilient Scotland, maximising population health, wellbeing and equity co-benefits and minimising health harms.*” Most actions stated are expressed in general terms and do not address flooding specifically, although recognised as an impact of climate change that is already affecting the Scottish population. A key outcome measure, however, is to develop “*an adverse weather (heat, cold and flooding) health protection plan for Scotland*”.

In “**A Scotland where everybody thrives Public Health Scotland’s three-year plan: 2022–25**” climate change is highlighted as a significant long-term challenge, especially for Scotland’s poorest areas. The development of a PHS climate emergency and sustainability action plan is mentioned as part of 2022/23 milestones, as well as a review of its impact in 2024/25. Flooding is not mentioned specifically.

In 2022 PHS also produced sets of Mental Health Indicators for children and young people and adults to assist with public health surveillance on population mental health and wellbeing. Within the adult indicator set, an indicator related to climate change has been included under the physical environment construct, but it is noted that more development work is required. Similarly, within the children and young people indicator set there is an indicator relating to optimism about society’s future (including aspects relating to anxieties around climate change) under the social optimism construct, but developmental work is noted to be required.

In the 2020 document “**Management of Public Health Incidents: Guidance on the Roles and Responsibilities of NHS Led Incident Management Teams, Scottish Health Protection Network Scottish Guidance, 12.1 interim update**” extreme weather events including flooding are identified as potential hazards to health. It is mentioned that the Scottish Ambulance Service has developed several Special Operations Response Teams (SORT) which have training in water rescue techniques so that ambulance staff can assist in flooding incidents. Three SORTs have been developed in Edinburgh, Glasgow and Aberdeen comprising 206 specially trained paramedics and ambulance technicians. PHS (Health Protection Scotland at the time) also published “Communicating with the Public About Health Risks: Health Protection Network Scottish Guidance” which was developed to assist public service organisations to effectively and accurately communicate risk to the public. It has a particular focus on working with the media, through which many risk communication messages reach the public. It does not include specific mention of particular hazards. Consideration of aspects specific to climate change and fluvial flooding may be needed.

UK Health Security Agency (UKHSA) Several documents from the UKHSA that were particularly relevant were also consulted. The 2023 “**Adverse Weather and Health Plan Protecting health from weather related harm: 2023 to 2024**” aims to safeguard individuals and communities from the health effects (including mental health) of adverse weather (including flooding) and to build community resilience and support local and national organisations to prepare, build and respond to severe weather events whilst protecting and promoting health and wellbeing. The plan is organised around nine objectives: service delivery; capacity building; organisational arrangements; communication; risk management; early warning systems; data analysis; quality assurance; policy development and accountability. It is notable that multi-agency action is highlighted as being required to address wider determinants of health, such as socioeconomic inequalities, as certain groups are more vulnerable to severe weather events than others. In the Appendix several guidance documents are referred to relating to flooding specifically, most notably: “**Flooding and health: assessment and management of public mental health**”.

Flooding and health: assessment and management of public mental health aims to provide guidance about ways to minimise the mental health effects of flooding in England, so that people are able to optimally prepare and respond. It is prepared for public health and local authorities, emergency services, frontline

health professionals and other public agencies. Fluvial flooding, in particular, is recognised to cause the greatest damages. Interventions to reduce the impact of flooding on mental health are highlighted to be needed during preparation, response and recovery phases of a flooding event. Community-wide action, as well as individual interventions targeted at the most vulnerable are needed. Identification of factors that increase vulnerability to the mental health impacts of flooding is key and this document recognises a wide range of individual (e.g. children, elderly, pre-existing mental health condition) and community-level (level of deprivation, social cohesion, proportion of population who speak English as a second language) risk factors, that also may co-occur and affect capacity to prepare for, respond and recover from flooding. A four-tiered intervention approach, illustrated below (see Figure 1), for providing support in response to flood events is recommended that can be implemented by public agencies and local resilience groups. 1 (immediate response); 2 (short-term recovery); 3 (short-medium term); and 4 (long-term recovery).

Gaps and priorities are outlined in UKHSA document “**Health Effects of Climate Change (HECC) in the UK: 2023 report**” within the third chapter which addresses “**Climate change, flooding, coastal change and public health**” and considers the whole of the UK. This report recognises different types of flooding and that fluvial flooding has been the leading form in terms of burden of health (high risk of mortality) and social effects (due to water depths and velocities involved), although surface water flooding affects a greater number of properties. Under different climate scenarios, the number of people at risk of fluvial flooding will increase in the UK as whole (with significant increases in Scotland under a 4°C temperature increase scenario (see Figure 2)).

Research priorities (to adapt from UKHSA 2023 to be more Scotland focused/fluvial flooding specific):

- Improve understanding of causes and types of flood-related adverse health effects with improved understanding of the longer-term health effects of flooding. Particularly on mortality risk, mental health care for flooded populations and for vulnerable groups.
- More epidemiological studies are needed with novel methods for the linkage of health data to flood exposures.
- Research is required on implications for persons with chronic diseases affected by the disruption to health services and infrastructure following a flood.

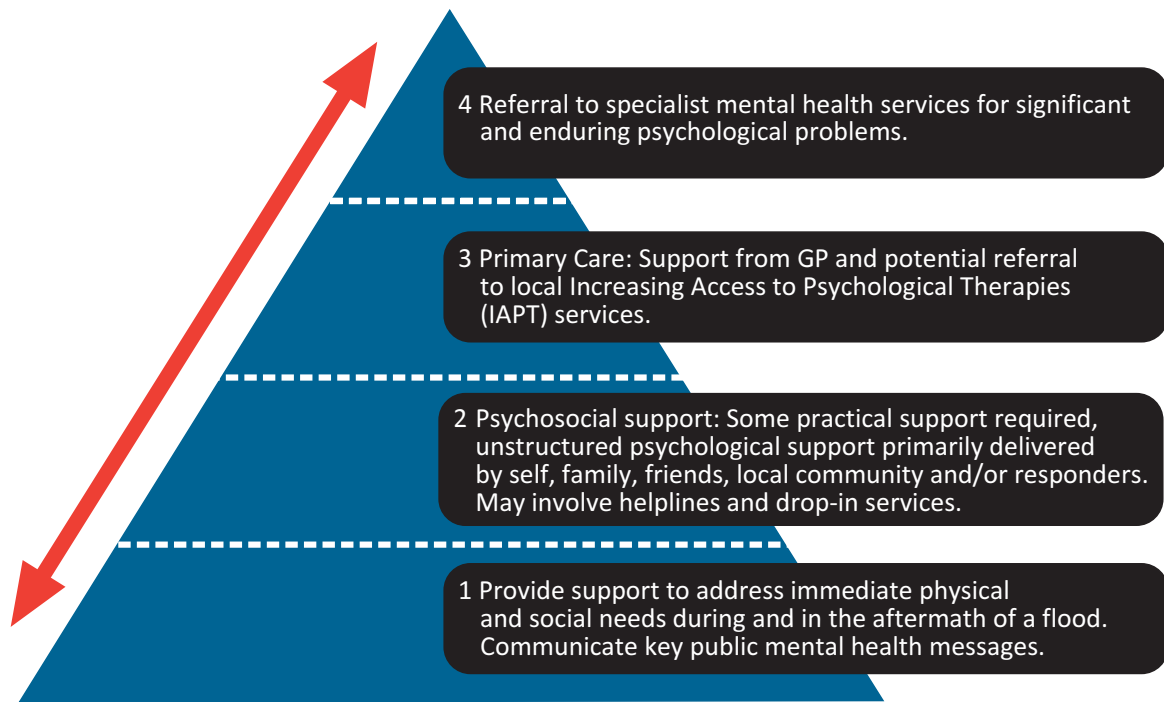


Figure 1: 4-tiered pyramid for flood response. Source: Gov.UK, UKHSA, Flooding and public mental health: assessment and management.

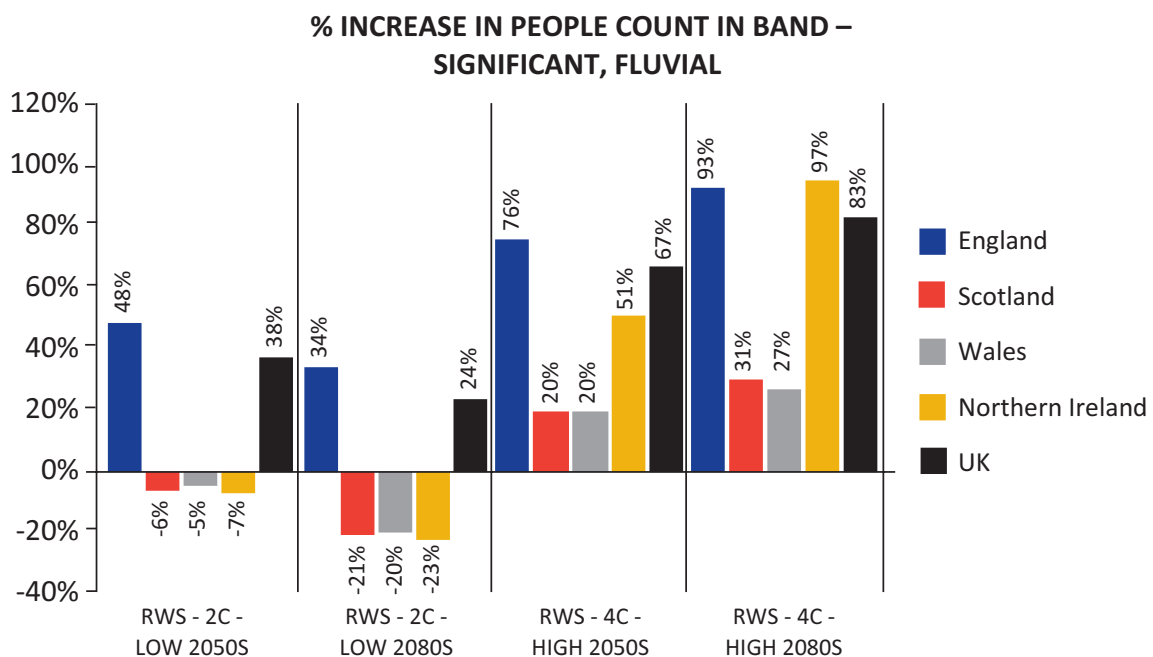


Figure 2. Projected increases in the population at significant risk of fluvial flooding for the 2050s and 2080s by country. The Reduced Whole System (RWS) scenario, for low population growth and a pathway to 2°C and 4°C temperature increases. Source UKHSA 2023.

- Research is required on the causes and outcomes of population displacement via evacuation and relocation, including long-term follow up of flooded households.
- Standardised systematic methodology (such as the use of routine clinical health records) needs to be developed to understand mental health impacts associated with flooding.
- Improve understanding of the mental health and physical health impacts of the potential loss of communities as a result of coastal change.
- Improve understanding of vulnerable or at-risk individuals and sub-groups and their health needs.
- The impacts of flooding on mental and physical health of children and effective response measures.

- Wider benefits, including health benefits and risks. of natural flood risk management measures.
- Evaluation of the effectiveness of related health policy and practice interventions as at present, there is a paucity of evidence, which hinders comparative learning.
- Impact of storm runoff and floods on water treatment efficiency, mobilisation and transport of pathogens. and potential to negatively affect quality of water supply and sanitation infrastructure.

Public health implications (UKHSA)

- Ensure that flood emergency plans are coordinated with relevant local partners and public health agencies are involved in flood recovery.
- Ensure local flood planning has robust measures to identify individuals at risk, with consideration of the various types of barriers to warnings and evacuation, and the range of health and social needs. Improve planning to identify at risk individuals for flood events.
- Improve the targeted advice for high-risk persons on how they should prepare for flooding.
- Invest in information systems to support health surveillance of flood impacts on mortality, injuries and mental health, both in real time or to allow for research and evaluation retrospectively, including:
 - o Improved CO poisoning surveillance.
 - o Record health status at baseline, during and after floods on various health outcomes, including deaths and injuries.
 - o Development of clear definitions for deaths from flooding, including immediate and delayed causes.
 - o Development of clear definitions for the attribution of injuries to flooding, including complete information on the causes and types.
 - o A comprehensive information system needs to record factors that are known to effect health, including population displacement (timing, duration and places) and support for flood recovery.
- Realise co-benefits of flood risk management: for example, nature-based solution such as implementing green infrastructure also has potential positive benefits for physical and mental health.
- Promote measures to ensure the continuity of the NHS services and health care facilities including residential care homes during floods.

Other organisations

A few other notable documents published by third sector and professional organisations were consulted including the Mental Health Foundation’s 2022 “**Climate change and mental health: Report from a COP-26 public participation event**”. Although flooding was recognised as a threat to people’s mental health, it was only indirectly addressed. For example, several participants mentioned that more trauma-informed health professionals are needed to respond to the direct and indirect impacts of climate change. The UK’s **Faculty of Public Health Climate and Health Strategy 2021-25** acknowledges flooding as a risk to public health, particularly among vulnerable groups in terms of both their ability to prepare for and recover from severe weather events. In the Academy of Medical Sciences and The Royal Society’s “**A healthy future – tackling climate change mitigation and human health together**”, the health impacts from flooding are acknowledged and nature-based solutions and green infrastructure (e.g. parks and urban woodlands) highlighted as having potential to increase community resilience to flooding in lower-lying areas, whilst helping to reduce the impact of other climate related hazards like heat and noise pollution. They also highlight the £5.2bn investment into a six-year programme for flood and coastal defences, supporting 20,000 green jobs by 2030, bringing benefits to mental health and wellbeing. The Faculty of Public Health in Scotland’s priority document “**Healthy Lives, Fairer Futures**” mentions climate change in passing, but does not address flooding specifically. The UK Health Alliance on Climate Change has also produced “**Biodiversity, climate change and health: A policy report from the UK Health Alliance on Climate Change**” which acknowledges flooding as a risk to health and wellbeing through physical injuries, drowning, increased incidences of food and water-borne infections and poor mental health, in addition to recognising risks relating to loss of livelihoods, infrastructure, and food and water security.

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