Climate and inequality

Megan Pearce, Met Office

Islam and Winkel (2017) identify that there are three main channels in which disadvantaged groups suffer disproportionately from the effects of climate change, and these can result in greater subsequent inequality. These channels are:

a) increase in the exposure of the disadvantaged groups to the adverse effects of climate change;
b) increase in their susceptibility to damage caused by climate change; and
c) decrease in their ability to cope and recover from the damage suffered

This has also been referred to by the Climate Change Committee (2021), who highlight the negative cyclical relationship between climate and inequality (Figure 1).

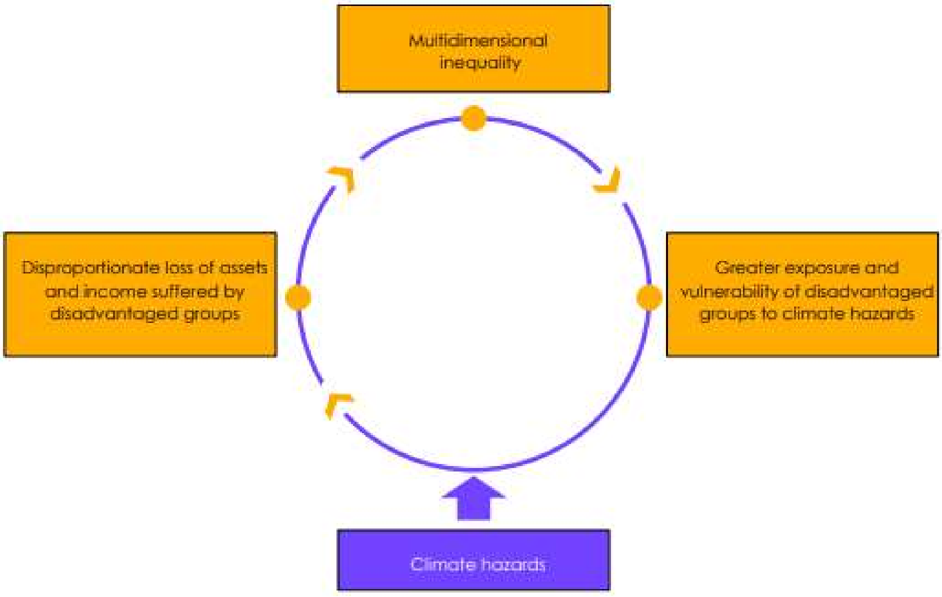

Figure 1: Cyclical relationship between climate hazards and inequality (Climate Change Committee, 2021)

The distributional effects of climate change, and therefore subsequent risks, can vary, with three particular factors highlighted; location, income and assets, and demographics (Climate Change Committee, 2021). Location is important as this has direct link to exposure of climate hazards, with regions across the United Kingdom experiencing a different range and magnitude, both currently and in the future. For example, coastal areas are, and will continue to be, more susceptible to sea level rise and extreme water levels – with increased risk to coastal flooding and erosion. The status of an individual, household or region in terms of their income and assets correlates with the adaptive capacity i.e. available fund and resource to protect against risk with insurance, recover from an climate event such as flooding, and/or enhance and implement adaptation and mitigation strategies to improve climate resilience. Certain demographics such as age, gender, ethnicity, and health status can also increase vulnerability to individual risks, as well as compound those associated with location and income. This has been evidenced by the Relative Economic Pain measure (an ratio index linking uninsured loss to income) which shows that a vulnerable community will have a significantly higher Relative Economic Pain and therefore an overall increased vulnerability to climate risk (Climate Change Committee, 2021).

It is worth highlighting that the UK Climate Change Risk Assessment[1] also highlights a number of opportunities, particular with regards to health and wellbeing in a warmer climate. However, even these opportunities are recognised as unlikely to recognised equitably, such as access to outdoor space being diminished for lower income and ethnic minority groups, as well as a general decline of green space in urban areas.

Another interesting angle, is the relationship between inequality and per capita greenhouse gas emissions. Islam and Winkel (2017) produced Figure 2, highlighting a mild correlation.

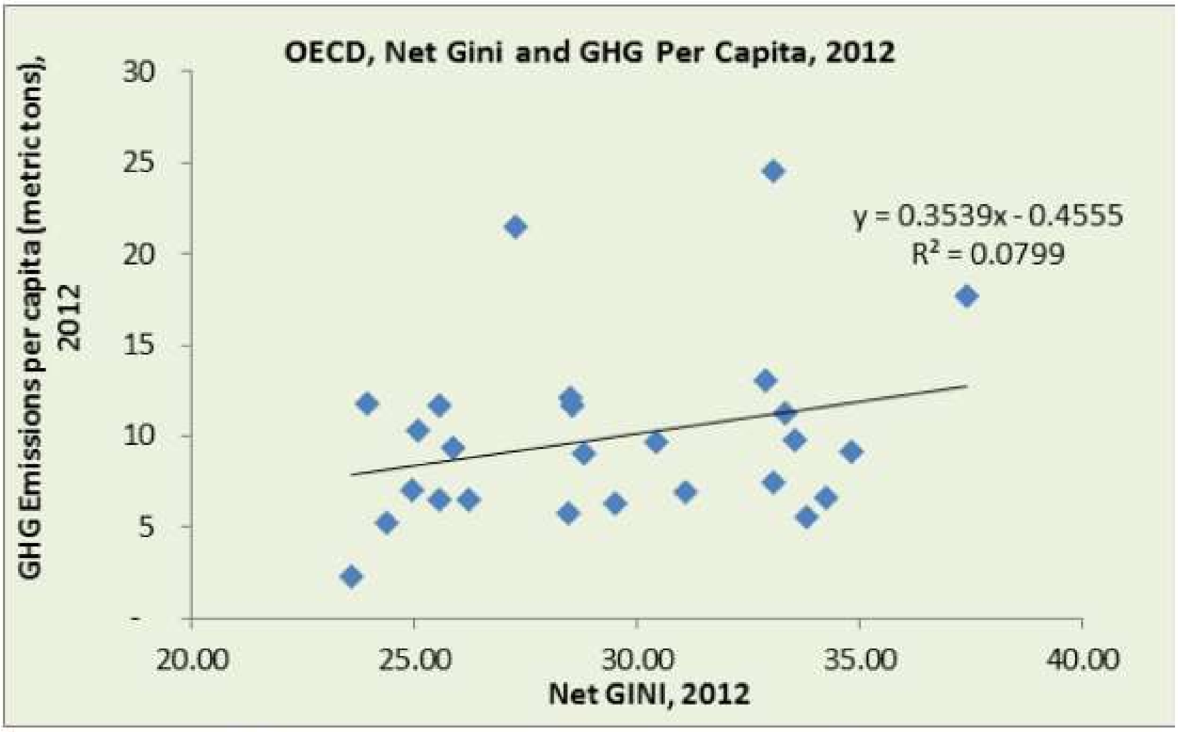

Figure 2: Positive relationship between inequality and per capita GHG emission among OECD countries (Islam and Winkel, 2017)

This is linked to the concept of inequality resulting to an increase in environmental deterioration. Islam and Winkel (2017) present evidence that highlights that among OECD countries, those with higher inequality tend to have increased resource consumption and waste generation. It also noted that the relationship between greenhouse gas emissions and inequality can become part of the cyclical process presented in Figure 1, where policy can greatly impact both greenhouse gas production and inequality status, both individually and with compounding effects.

Islam and Winkel (2017) discusses the three channels as an analytical framework for considering the relationship between climate and social inequality, with examples at a continent or country level. This work focuses on two of the three channels (location and income) and considers these from a UK perspective. In terms of location, and therefore exposure, the subsequent section will present an high level analysis of climate change projections over the UK for a number of key risks. The report by Rushby, Singh and Moore (2022) aims to summarise the existing literature linking social inequality

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1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

with crime, supported by an analysis of income related deprivation indexes and levels of crime in 2018, at a UK administrative region level.

Climate change overview

Climate Change Committee (2021) present a number of climate risks that can vary with the three distributional effects (location, income and assets, and demographics) (Figure 3.3, Climate Change Committee, 2021, not shown here). Particular of note are risks to sectors which are widespread across the UK, such as transport, energy, agriculture and infrastructure, as well as general business operations (Table 1).

Table 1: Risks and opportunities for different sectors. (Information from Table 2.2, Climate Change Committee, 2021)

Transport	Risks to transport networks from slope and embankment failure Risks to transport from high and low temperatures, high winds, lightning
Energy	Risks and opportunities from summer and winter household energy demand Risks to hydroelectric generation from low or high river flows Risks to energy generation from reduced water availability Risks to energy from high and low temperatures, high winds, lightning
Agriculture	Risks to and opportunities for agricultural and forestry productivity Risks to agriculture from pests, pathogens and INNS
Infrastructure	Risks to infrastructure networks from cascading failures Risks to infrastructure services from river and surface water flooding Risks to infrastructure services from coastal flooding and erosion Risks to bridges and pipelines from flooding and erosion Risks to subterranean and surface infrastructure from subsidence
Business	Risks to business sites from flooding Risks to business locations and infrastructure from coastal change Risks to business from disruption to supply chains and distribution networks Risks from climate change on international trade routes Risks to businesses from water scarcity Risks to business from reduced employee productivity – infrastructure disruption and higher temperatures Opportunities for business - changing demand for goods and services

These risks can be linked back to a number of main climate drivers and hazards, for which WSP et al. (2020) have summarised in terms of cascading impacts and how the magnitude of risk will change in future based on the impact and probability of the drivers occurring (Figure 3).

Hazardous events	Main impact cascades		2020	2080
Climate driver: Increase in summer temperatures and reduction in summer mean rainfall				
Heatwaves and very hot days	Building overheating leading to building productivity loss		Medium	High
	Transport infrastructure overheating, or disruption to IT and comms services	Travel and freight delays	Low	Medium
		Transport infrastructure damage	Medium	Medium
Low summer river flows, and increase in river water temperatures	Environmental water shortages, more algal	Habitat degradation	Medium	High
	Reduction in water quality		N/A	Medium
Increase in soil desiccation	Soil condition and quality impact			Medium
Climate driver: Extreme winter rainfall events and increase in winter mean rainfall				
River, surface and groundwater flooding	Power supply disrupting		Low	Low
	Water/sewerage infrastructure flooded, reduced water quality or power supply disrupted	Water supply disrupted	Low	Medium
		Sewer flooding	Low	Medium
	Transport hubs or infrastructure flooded or damaged, or power supply disrupted	Travel and freight delayed	Medium	High
	Damaging water flows, slope or embankment failure	Transport infrastructure damaged	Medium	High
	Building flooded	Building productivity loss	Medium	High
		Building damaged	Medium	High
	Increase in run-off	Reduced water quality	Low	Low
Climate driver: Sea level rise and storms				
Coastal flooding and erosion damage	Loss of natural flood defence		N/A	Medium
	Coastal squeeze		N/A	High
	Saline intrusion		N/A	High
	Near shore environmental impact		N/A	High
	Coastal building flooded/eroded	Coastal building productivity loss	N/A	Medium
		Coastal building damage	N/A	High

Figure 3: Interacting risks in infrastructure and the built and natural environments: research in support of the UK's third Climate Change (WSP et al., 2020)

Secondly, there are climate risks which have more societal impacts, such as risk to health and wellbeing, or increasing risks driven by societal and political actions, such as migration; such as:

- Risks to health and wellbeing from high temperatures
- Opportunities for health and wellbeing from higher temperatures
- Risks to health and wellbeing from changes in air quality
- Risks to health from poor water quality and household water supply interruptions
- Risks to people, communities and buildings from flooding

- Risks to people, communities and buildings from sea level rise
- Risks to health from vector-borne diseases
- Risks to health and social care delivery
- Risks to education and prison services
- Risks to UK food availability, safety, and quality from climate change overseas
- Risk to UK public health from climate change overseas

Particular climate drivers common to the physical, natural and societal risks outlined in Table 1, Figure 3 and mentioned above are flooding and high temperatures, which are also related to a number of impacts that will increase in risk magnitude in the future. As such, further detail on the climate projections of these hazards in particular are provided below, using UKCP18.

UKCP18 is the latest assessment of how the climate will change in the future, based on the most up to date climate science and models available. It was funded by UK Government, delivered and released in 2018 by Met Office in partnership with the Environment Agency. Further information, including reports, factsheets and guidance on caveats and limitations of the climate projections, can be found on the UKCP18 website.

<u>Flooding</u>

The heavy rainfall during July 2007 caused widespread flooding and transport disruption, particularly across the South Midlands, with record breaking rainfall events recorded across a number of weather stations and river flooding leaving thousands of homes with damage and lack of drinking water[2]. The most recent UK Climate Change Risk Assessment found that following these floods, those on the lowest incomes were eight times more likely to report severe mental health deterioration than those on the highest incomes, thus leading to poor health and compounding existing inequalities (HM Government, 2022).

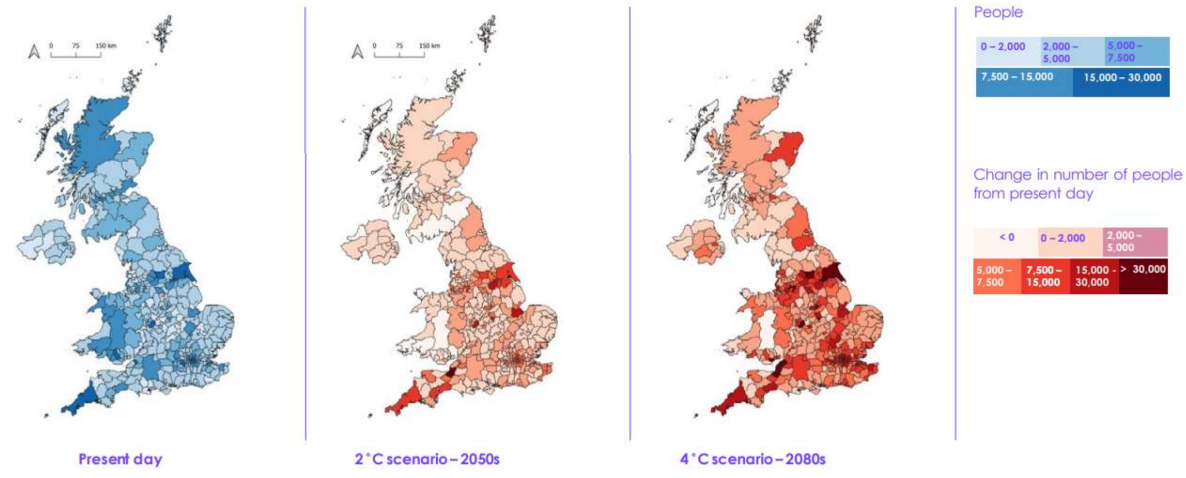

Figure 4: Present day number of people exposed to significant flood risk (river, coastal and surface water flooding combined), and then the absolute change in number of people from the present day for 2050 (2C scenario) and 2080 (4C scenario) (Climate Change Committee, 2021)

Figure 4 shows the present day number of people exposed to a significant flood risk and how this will change in the future. In the present day, the greatest risk is in Cornwall, coastal and central

[2] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2007/heavy-rainfall_flooding---july-2007---met-office.pdf

areas of Yorkshire and the Humber, and central London. In the 2050s, under a 2°C warming scenario, the number of people exposed increases in these already impacted areas, as well the North East, west of West Midlands and most significantly around Weston-Super-Mare. The most increase in exposure is largely in coastal regions. In the 2080s, the spread of increasing exposure continues to grow, both around the coast but in land for much of England. Most notably between Weston-Super-Mare and Bristol, Yorkshire and the Humber and around London. There is particularly interesting band running from the Great Ouse River, starting at the coastal boundary between East of England and East Midlands, down towards the Thames, with a trend of increasing risk from present day through to 2080s.

High temperature

The summer of 2018 was the UK's warmest summer since 2006, the driest since 2003 and the sunniest since 1995[3]. Interestingly, an attribution study at the Met Office as shown that the intensity of the 2018 heatwaves was around thirty times more likely than would have been the case without climate change[4]. The heatwaves had a number of impacts across different sectors and for society. For example, Farming UK reported that there was a soar in wheat prices, which notably suffered following the earlier cold spell (Beast from the East) in the year with overall crop yields down by around 20%[5]. This has implications for the supply chain to supermarkets and directly impacts the cost of living. From a public health perspective, heatwaves can have significant impacts, with a particular rise in excess mortality in vulnerable populations. The four heatwaves during summer 2018 were reported to result in an estimated 863 excess death in England (Public Health England, 2018).

In a changing climate, the Climate Change Committee (2021) note that, at the UK-wide scale, the chance of a summer as hot as in 2018 rises to around one in every two years by 2050 from up to one in every four today – i.e. 50% more likely. Figure 5 highlights projected extreme high temperatures during a 1 in 50 year event (return period[6]) in summer in 2070, given a high greenhouse gas emissions scenario. The hottest values projected (return level[7] - median values in the range of 38-40°C, 90th percentile reaching 45°C) for a 1 in 50-year event in 2070, are in the southeast of England, with lower values in the north, west and across Scotland.

[3] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2018/summer-2018---met-office.pdf
[4] https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2018/2018-uk-summer-heatwave
[5] https://www.farmdiversity.co.uk/crops/summer-heatwave-impact
[6] Return period - an estimate of the time interval between events of a similar severity
[7] Return level – the severity of the event expected to occur within a given return period

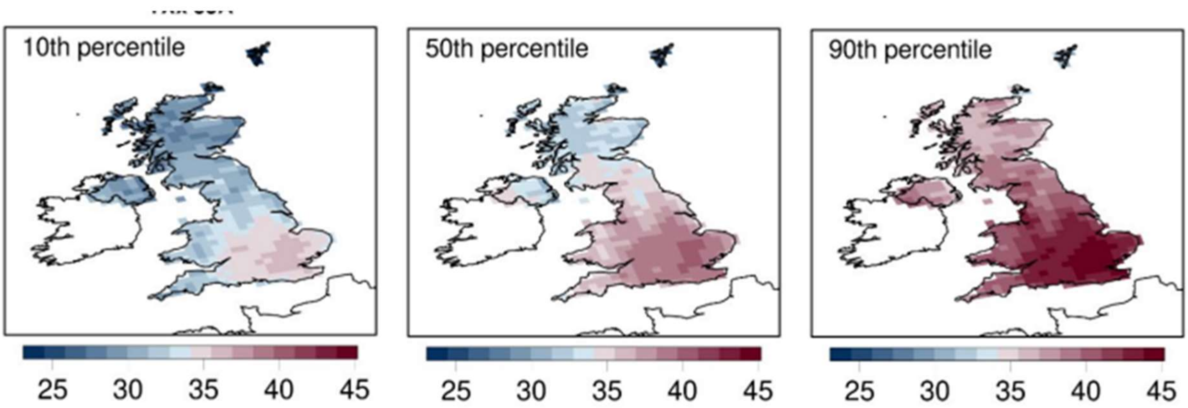

Figure 5: Maps of the 50-year return levels of maximum summer temperature, associated with the 10th, 50th and 90th percentiles of the pdfs in 2070, for the RCP8.5 scenario. From Murphy et al., 2020.

The UK, on average, would exceed temperatures between 30.4-32.5°C for a 1 in 50-year event in 1990 (Table 2, Murphy et al., 2020), highlighting that return levels associated with maximum summer temperatures are projected to increase, with the south east most at risk. For context, temperatures exceeded during July and August in 2018 were reported as above average, with 30°C exceeded fairly widely[4]. This indicates that the impacts associated during the summer 2018 heatwaves are likely to be as bad, if not more severe, to those experienced during future extreme summers.

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