Climate Change & Child Poverty in OECD Countries

Prepared for the Organisation for Economic Co-operation and Development

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List of Abbreviations

ACEEE	American Council for an Energy-Efficient Economy
CO2	Carbon Dioxide
COPD	Chronic Obstructive Pulmonary Disease
D-SNAP	Disaster Supplemental Nutrition Assistance Program
EU	European Union
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
HI	Heat Index
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
MPA	Master of Public Affairs
MIPA	Master of International Public Affairs
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NETs	Negative Emission Technologies
NTDs	Neglected Tropical Diseases
OECD	Organisation for Economic Co-operation and Development
PTSD	Post-Traumatic Stress Disorder
SBA	Small Business Administration
SNAP	Supplemental Nutrition Assistance Program
TANF	Temporary Assistance for Needy Families
UI	Unemployment Insurance
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
USGCRP	United States Global Change Research Program
WHO	World Health Organization
WMO	World Meteorological Organization

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Foreword

This report is the result of collaboration between the La Follette School of Public Affairs at the University of Wisconsin–Madison, and Olivier Thévenon, representing the Social Policy Division of the Organisation of Economic Co-operation and Development (OECD), Paris, France. The objective of our program is to provide graduate students at La Follette the opportunity to improve their policy analysis skills while providing the client an analysis to identify the main aspects of childhood climate poverty and to inform the OECD on how to meaningfully engage in the climate change policy debate from the perspective of disadvantaged children.

The La Follette School offers a two-year graduate program leading to a Master's degree in domestic Public Affairs (MPA) or International Public Affairs (MIPA). Students study policy analysis and public management, and they can choose to pursue a concentration in a policy focus area. They spend the first year and a half of the program taking courses in which they develop the expertise needed to analyze public policies. The authors of this report are all in their final semester of their degree program and are enrolled in Public Affairs 860/869, the Workshop in Public Affairs. Although acquiring a set of policy analysis skills is important, there is no substitute for actually doing policy analysis as a means of experiential learning. Public Affairs 860/869 gives graduate students that opportunity.

The OECD seeks to address the imminent effects of climate change on vulnerable children and their families. The team was asked to chronicle the economic or material effects of climate change; the socio-economic effects of climate change on poverty, inequality, educational attainment, unstable housing, and environmental migration in families with at risk children; and the effects of climate change on mental and physical health. The team was also asked to consider the distributional effects of climate policy mitigation effects on families with children. This report provides the first comprehensive review of these topics.

The report identified high-vulnerability areas that are most at risk of climate change-induced extreme weather events, natural disasters, and disease burden on children. They recommended that countries address the direct effects of climate change by investing in resilient infrastructures and expanding welfare and social services to support those most disadvantaged by climate change.

They also suggested that countries consider the distributional effects of policies aimed at mitigating climate change, especially by emphasizing the health benefits of mitigating climate change and considering the employment and distribution effects of changing from a carbon based economy to one with renewable sources of energy.

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Executive Summary

In this report for the Organisation of Economic Co-operation and Development (OECD), we survey the severe and wide-ranging ramifications of climate change and demonstrate how they harm poor children in OECD nations – a population uniquely vulnerable to the consequences of this destructive global phenomenon. In the following pages, we aim to: (1) conduct a thorough literature review of the most recent research on childhood climate poverty to help the OECD meaningfully engage in the climate change debate; (2) identify the main social, urban, and environmental policy challenges facing impoverished children in member states so the OECD can advocate for innovative solutions; and (3) delineate avenues of future inquiry to bridge research and action gaps.

To illuminate the relationship between climate change and child poverty, we explore four dimensions of climate change-related consequences on poor children. First, we discuss how an increase in natural disasters – such as wildfires, flooding, and drought – disproportionately harms poor children's material conditions by damaging the built environment and vital infrastructure. Second, we investigate how climate change exacerbates existing socioeconomic disparities in impoverished communities by impeding educational attainment, increasing poverty rates, and reducing income stability. We also find that climate change increases social tensions and strains social services. Third, we illustrate how climate change impairs the physical and mental health of children. In the aftermath of climate change-related events, low-income children are more likely to suffer from malnutrition, vector-borne diseases, stress-induced mental illnesses, and diseases stemming from air pollution and extreme heat. Fourth, we analyze climate policy within OECD nations and its impact on poor children. We find that, while mitigation measures designed to reduce greenhouse gas emissions can benefit poor children by improving health, boosting economic activity, and creating jobs, other measures can result in regressive distributional effects that disproportionately harm poor children and low-income communities.

Finally, after synthesizing the vast body of literature and reviewing the available evidence of how climate change affects child poverty, we recommend that the OECD focus on four main areas for policy consideration and future research. Policymakers and researchers should:

1. Identify high-vulnerability areas by developing comprehensive and high-resolution vulnerability maps to determine which countries, regions, cities, and communities are most at risk of extreme weather events and natural disasters – with specific attention to children in poverty.

2. Invest in resilient infrastructure by fortifying essential utility services, using policy levers to incentivize climate-resilient construction, avoiding new development in high-risk areas, implementing surveillance systems to monitor natural disaster risk, and creating comprehensive contingency plans for inevitable emergencies.

3. Increase low-income families' access to welfare and social services by bolstering and expanding child allowances, unemployment insurance, direct cash transfers, health care, legal services, public housing initiatives, and rehousing programs.

4. Consider the distributional effects of climate mitigation policies by incorporating the substantial, yet often neglected, health co-benefits of mitigation in cost-benefit analyses in order to more accurately weigh the pros and cons of mitigation measures. Carbon pricing schemes must also involve revenue recycling to offset any regressive effects on families with poor children. Further research must be conducted to understand and quantify how the renewable energy sector can promote economic activity and job creation.

I. Introduction

Hurricane Harvey, the strongest storm to hit Texas in fifty years, made landfall on the state's southeast coast on August 25, 2017, and began ravaging the region with severe winds, record-shattering rainfall, and extreme flooding (Kimball et al. 2018). Although it dissipated about a week later, the storm left behind lasting damage on the region's infrastructure, economy, and inhabitants. It was especially devastating for the state's low-income residents and children; even the staggering statistics released in the disaster's aftermath fail to capture the grim reality confronted by the area's poor children. While the storm displaced 1 million people, 8,500 children were among the 34,000 people forced into local shelters. Of the 1.4 million children who missed at least a week of school, 60 percent were from poor households (Kimball et al. 2018), and one county saw 14 percent of its students miss at least six weeks of school that year (Sanborn et al. 2019). The hurricane devastated affordable housing supplies, with nearly half of the damaged homes owned by households earning less than $50,000 per year (Kimball et al. 2018). Even three months later, over 22,000 students in the area were still homeless, with one school district reporting a full 10 percent of its students without housing (Noll and Kuzydym 2017). Experts were not surprised by this disproportionate damage to poor households; the majority of these households in the United States reside within a 100-year floodplain, but barely a quarter are insured accordingly (Sanborn et al. 2019). These figures, while stark, likely underestimate the destruction wrought by this life-altering disaster, as its full impact will not be known for years.

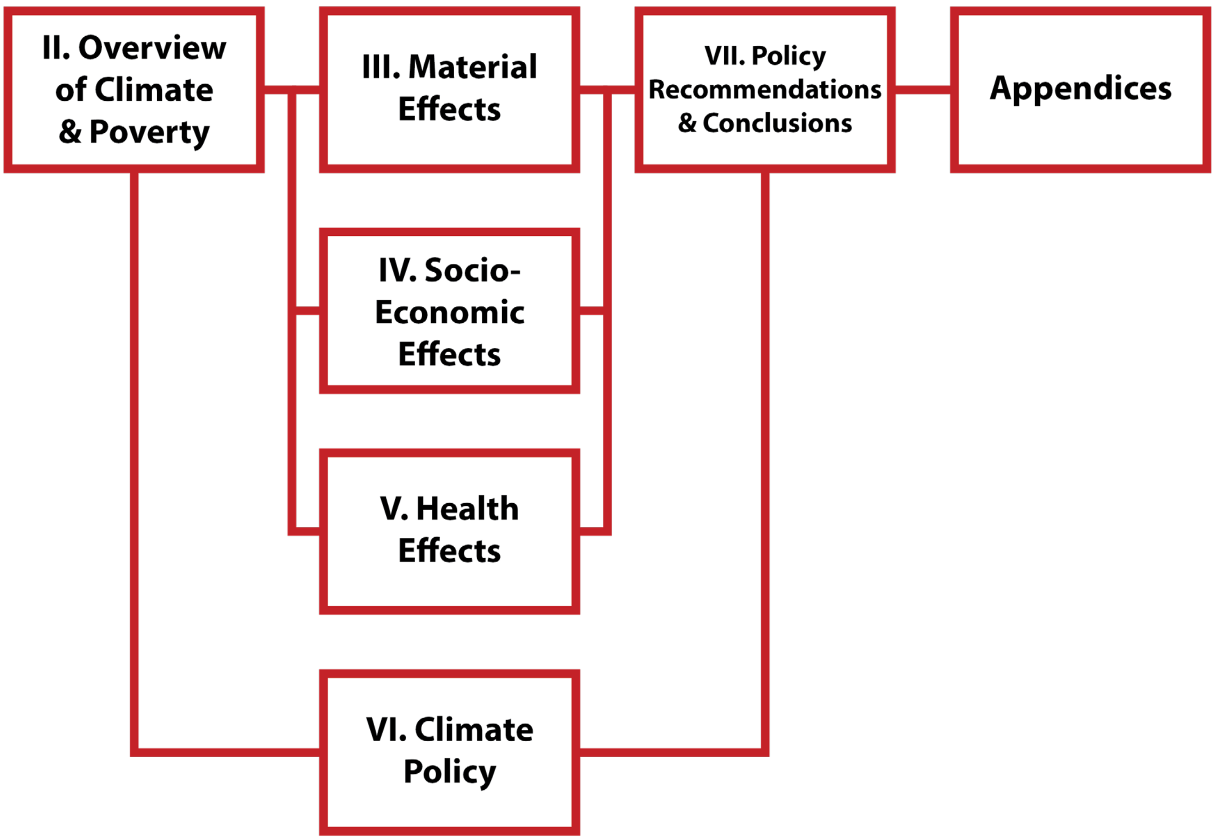
Hurricane Harvey and its aftermath exemplify how extreme weather events and natural disasters disproportionately harm poor children in OECD countries. Low-income families often lack the time and resources to prepare for and recover from these catastrophes, and government readiness to protect vulnerable populations has often been inadequate. In 2019, two record-breaking heat waves, the worst since 2003, killed over 1,400 people in France and proved particularly deadly to those in poverty and the elderly (BBC News 2019; Keller 2020). Thousands of miles away, Australia's hottest and driest year on record resulted in "catastrophic and unprecedented" wildfires that killed dozens, devastated cities and nature alike, and sent visible clouds of smoke as far as Antarctica and South America (WMO 2020). The weeks-long calamity brought chaos to the lives of children in affected regions, with 1,800 early childhood facilities and 1,400 schools disrupted. In the wake of this disaster, authorities and charities scrambled to provide counseling and mental health care for students, their families, and their teachers (Evins 2020). In both cases, government officials failed to enact policies to better prepare for these disasters and their aftermaths (Keller 2020; Economist 2020).

Across the world, perceived government inaction and poor policy responses to climate change have catalyzed civil unrest. In September, student-led awareness groups organized a week of protest events, which saw 6 million participants worldwide (M. Taylor, Watts, and Bartlett 2019). Climate activists have also found common cause with more local movements. During the wave of Chilean insurgence in October of 2019, impoverished rural families suffering from a climate change-exacerbated "megadrought" protested over increasingly scarce and privatized water reserves (NASA 2019). The protests led to Chile's government conceding its hosting duties for the United Nations' annual climate summit to Spain; as noted by one of the country's leading climate experts, environmental crisis had become social crisis, and rural Chileans had been denied the chance to make their voices heard before the world's leading forum for addressing the issues harming them (Rojas 2019).

Although research tends to focus on the developing countries expected to bear climate change's greatest burden, this report seeks to emphasize that OECD nations will not be spared burdens of their own. The assumption that wealthier nations will be better able to handle climate change masks the enormous threat to the most vulnerable groups within these countries; even as international inequality has decreased, inequality within nations has soared (Verbeek and Osorio Rodarte 2015). Beyond the worsening of Chile's drought, 2019 saw deadly heat waves across Europe and Japan, devastating wildfires across Australia and the American West, historic storm seasons in the Atlantic and Pacific, and widespread flooding in Turkey (BBC News 2019; Japan Times 2019; Butler 2020; Cal Fire 2020; NOAA 2019; Cappucci 2019; Daily Sabah 2019). Even rare positive examples came with caveats, such as a beneficially long rainy season in Israel that only occurred after five years of rainfall shortages had strained aquifers and freshwater supplies (Rinat 2019). In every OECD region, extreme climatic events dominated headlines.

Structure of the Report

In the pages that follow, we survey the wide-ranging ramifications of climate change and demonstrate how they affect poor children in OECD nations – a population uniquely vulnerable to the consequences of this destructive global phenomenon. We aim to make one conclusion clear: climate change exacerbates child poverty by raising poverty rates and worsening the conditions that children in poverty must endure. Governments and organizations around the world need to redress this disproportionate harm that climate change will inflict on poor children by preparing for acute calamities and preventing long-term declines in social and environmental conditions.



Following a brief summary of research into climate change and child poverty in OECD nations, we investigate the relationship between these two topics from four different angles. First, we explore the most visible effects of climate change – the damage it causes to infrastructure and the built environment and how these material effects harm poor children. We then discuss the socioeconomic effects of climate change, illuminating how climate change can increase poverty rates, magnify levels of inequality, and strain social service systems – all of which exacerbate child poverty. Third, we discuss the acute and long-term he
alth effects of climate change, demonstrating how this devastating global phenomenon contributes to elevated levels of morbidity and mortality among poor children. Finally, we consider how climate policy generates both positive and negative effects on children in poverty. Overall, we seek to emphasize that climate change compounds the hazards that poor children in OECD countries, already a vulnerable population, face in their daily lives.

After synthesizing the vast body of literature and reviewing the available evidence of how climate change affects child poverty – in terms of material conditions, socioeconomic effects, and health impacts – we will turn toward identifying key priorities for researchers and policymakers in order to guide both future research and policy development. This final section integrates and condenses the numerous policy priorities from the preceding sections into four concise recommendations. Despite the scarcity of research directly tying climate change to poor outcomes for children in poverty, we hope this report will act to garner attention and persuade policymakers of the severity of the issue, the urgent necessity for further research, and the need to deploy swift mitigation and adaptation measures to protect poor children.

Key Findings

In each of the four perspectives on climate change's effects on children in poverty, we found substantial threats to acute and long-term wellbeing, and we consider potential policy solutions for each.

- Material Conditions – Climate change increases the severity and frequency of environmental disasters and extreme weather patterns, resulting in damage to vital infrastructure and buildings. These changes lead to property damage, displacement, homelessness, school disruption, food insecurity, and limited access to health care, utilities, and other essential services. To address these issues, policymakers must invest in climate-resilient infrastructure, improve access to subsidized loss insurance, and implement policies to combat hunger.

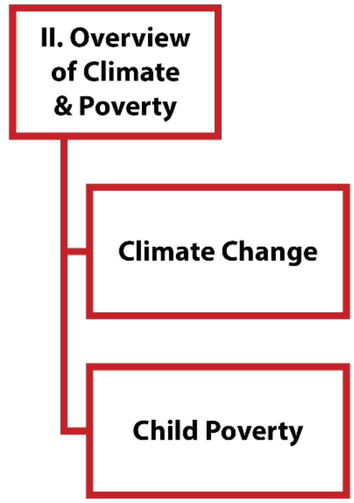
- Socioeconomic Conditions – Climate change destabilizes communities and economies, exacerbating existing disparities. This results in increased poverty rates, magnified levels of inequality, widened gaps in educational attainment, reduced employment and income stability, increased demand on social services, and heightened social tensions. Governments should institute targeted cash transfer programs for households in poverty, strengthen social programs before and after disasters, enact protections for workers such as public employment and retraining programs, and construct flexible public housing options.

- Health Conditions – The effects of climate change also pose wide-ranging risks to the physical and mental well-being of children and families. This threat may manifest as malnutrition due to unstable food systems, health complications from exposure to extreme heat and flooding, cardiovascular and respiratory disease caused by air pollution, heightened potential for vector-borne illnesses, mental health disorders, and the secondary effects of parental stress and illness on their children. Policymakers must expand epidemiological detection systems, strengthen food security, improve the resiliency of health-care infrastructure, and increase access to mental health services and resources.

- Climate Policy – Government interventions to address climate change engender both positive and negative impacts for children in poverty. Mitigation measures improve health outcomes by reducing air pollution through decarbonization efforts, fostering economic growth and net job creation through green energy and energy efficiency initiatives, and improving mobility for low-income children and families through public transit investment. Problems arise with the regressive distributional effects of some carbon pricing schemes, renewable energy subsidies, and the localized unemployment in communities reliant on carbon-intensive industries. To address these potential harmful effects, governments should consider the health benefits of mitigation, incorporate progressive distributional mechanisms into various taxation schemes, and target financial support and retraining initiatives to affected communities.

II. Climate Change & Child Poverty

Climate Change



Recent data and research have revealed the dire state of the world's climate. 2019 ended as the second hottest year ever reported, coming just shy of the record set three years prior. In fact, the five hottest years since measurement began in the late 1800s all fell within the past five years (NOAA 2020). Substantiating this alarming trend, the World Meteorological Organization's most recent semi-decadal report indicates that nearly every crucial climate metric continues to worsen: atmospheric greenhouse gas concentrations, global temperatures, and sea levels keep rising, while polar sea ice coverage continues to decline (WMO 2019). The report also attributes the increased severity of natural disasters, particularly heat waves, to anthropogenic causes.

Scientists and policymakers have long argued that it is imperative to reduce greenhouse gas emissions, but recent findings have prompted an additional message: it is too late to entirely avoid the effects of climate change, and governments must now consider adaptation policy alongside mitigation efforts. Even if all emissions were halted immediately, the planet would continue to warm for decades to come because of climate inertia. Researchers also fear the presence of tipping points – thresholds after which change cannot be reversed and may even accelerate (NASA 2020). Compounding these issues, carbon-driven economies built around fossil fuels and supported by governments and social norms provide barriers to emissions reductions, a phenomenon known as carbon lock-in (Brown et al. 2008). International efforts to address climate change have sought to engage public and private stakeholders at all levels in the planning process to respond to the predicted damage. For example, Article 7 of the Paris Agreement is devoted to the issue of adaptation (UNFCCC 2020). Acknowledging that the harmful effects of climate change are already upon us and will only continue to worsen, this report emphasizes that adaptation strategies need to go beyond the built environment.

Figure 1. Annual Rates of Sea Rise by Source of Rise

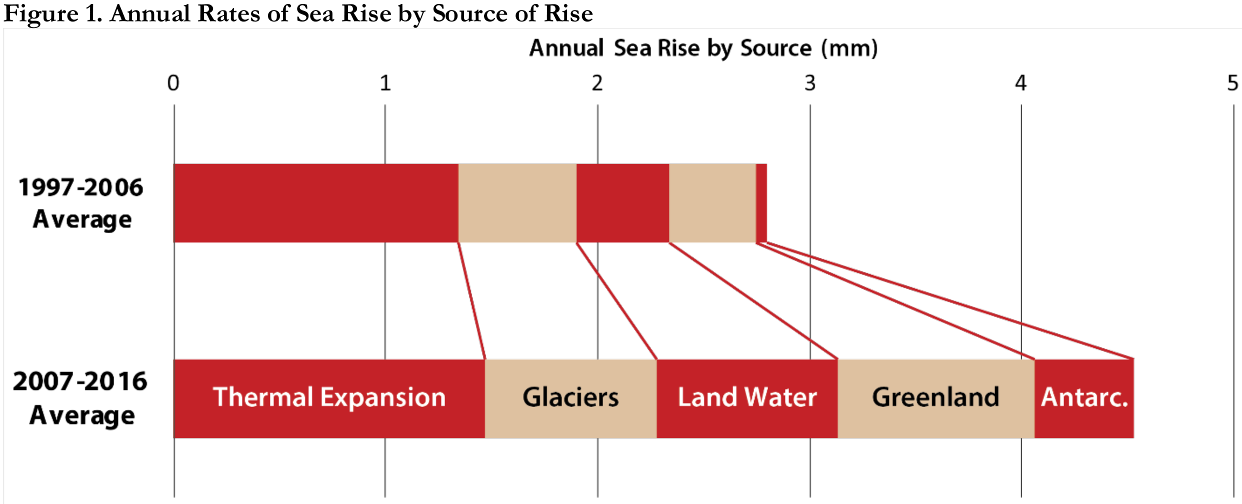


Figure 1: The annual rate of sea rise has been increasing in total, with this chart showing the average annual increase between 1997-2006 versus 2007-2016. While thermal expansion—the increase in volume due to warming waters—continues to be the largest contributor, glacial melt and inland water remain significant sources, and the melting of ice in Greenland and Antarctic are becoming alarming contributors as well (WMO 2019).

Child Poverty

Child poverty rates are one of the most common metrics of social well-being in the developed world, and for good reason. Growing up in impoverished households has detrimental long-term effects on children that can linger into adulthood, harming their health, well-being, educational outcomes, and future productivity levels. For example, poor children often lack essential resources, including food and quality housing, and they may grow up in an environment inconducive to healthy development (Madrick 2020; Thévenon et al. 2018; OECD 2018). These disparities can lead to higher rates of health issues, including malnutrition, obesity, chronic stress, and mental illness (Madrick 2020; Goosby 2013). These effects, in turn, can result in poor educational outcomes; children in poverty are likelier to have learning disabilities, to repeat grades, and to earn lower achievement scores (Brooks-Gunn and Duncan 1997b; S. B. Johnson et al. 2013). Experiencing deep poverty can even reduce children's IQs and lead to neurologic damage, and this cognitive impairment can persist into adulthood (Brooks-Gunn and Duncan 1997b; S. B. Johnson et al. 2013). In fact, being poor as a child can reduce earnings decades later (Corcoran and Adams 1997).

Figure 2. Child Poverty Rates for OECD Countries, Most Recent Year

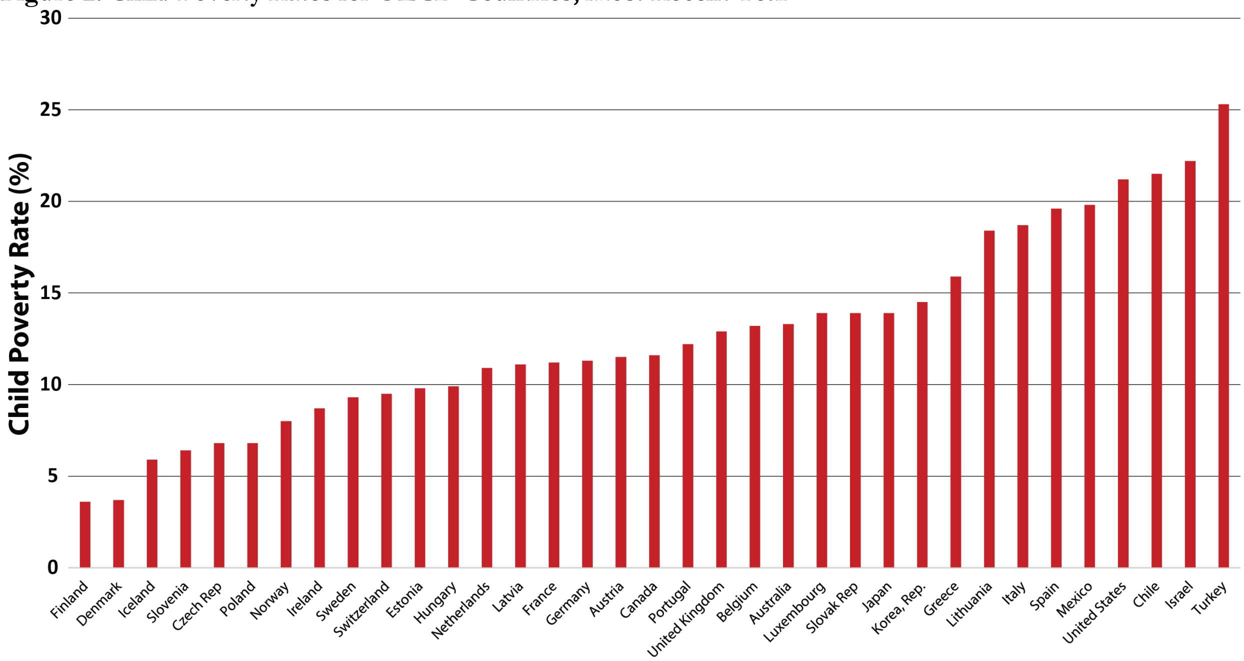


Figure 2: This graph depicts the child poverty rate in OECD countries for the most recent year available (2015-2019). The child poverty rate is defined as the percentage of children ages 0 through 17 living in households with incomes, after taxes and transfers, that are below 50 percent of the median household income (of all households). Rates range from under 5 percent for Denmark and Finland to over 25 percent for Turkey. (OECD 2019)

Child poverty also burdens society as a whole. For example, in the United States, it reduces GDP by an estimated $1 trillion annually (McLaughlin and Rank 2018). It lowers labor force participation and productivity, and it contributes to the homelessness epidemic (Corcoran and Adams 1997). Child poverty even leads to elevated rates of crime and incarceration (Madrick 2020). Worst of all, it is wholly avoidable in the developed world and is the direct result of meager social welfare systems that fail to prioritize children.

While researchers measure child poverty in different ways, we adopt the OECD's relative metric and broadly define child poverty as the percentage of children living in households with disposable incomes below 50 percent of a country's median income. Using this definition, roughly one in seven children in OECD countries lives in poverty, with rates in individual countries ranging widely – from well under 5 percent in Denmark and Finland up to over 20 percent in Chile, Israel, Spain, Turkey, and the United States. The economic turmoil and resulting government reforms of the Great Recession have made matters worse: roughly two-thirds of OECD member states still saw child poverty rates higher than pre-recession figures several years later. In many countries, this economic crisis disproportionately harmed the worst-off families, with percentage loss of household income greater for those in the bottom decile than the bottom quartile (OECD 2018).

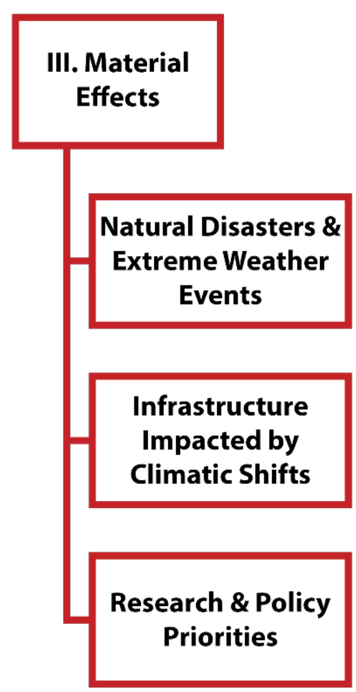
Unfortunately, many OECD countries have failed to adequately tackle child poverty in recent years. For example, austerity policies implemented in the wake of the Great Recession had detrimental effects on social spending that harmed poor children. Following initial efforts to meet the rising demand for social assistance amidst declining tax revenues, governments addressed growing deficits by making cuts to these programs (Maks-Solomon and Stoker 2019). In a review of forty-one developed countries in Europe and the OECD, twenty saw no growth in social spending as a portion of GDP from 2009 to 2013; in nine of those twenty, spending actually fell in that period. A majority of European countries reduced the portion of social spending allocated to family benefits from 2008 to 2013, and per capita spending on family programs decreased in a majority of these countries – even as other categories, such as old age programs, saw increases (Cantillon et al. 2017).

Poverty researchers are increasingly making use of non-monetary metrics in assessing populations by looking at whether an individual lacks basic needs and comforts in life that contribute to their overall well-being, a model referred to as material deprivation (Main and Bradshaw 2012). For child poverty, this approach may combine more universal needs such as adequate housing and nutrition with factors such as owning age-appropriate books or feeling comfortable inviting friends to their home. A review of poverty in France, Spain, and the United Kingdom found that around 85 percent of children in poverty were deprived of at least one of these measures, compared to 53 to 66 percent of children not in poverty. In France and Spain, 36 to 41 percent of impoverished children were deprived in at least four measures, versus 7 percent of children in non-impoverished households (Thévenon et al. 2018).

This research demonstrates that child poverty continues to be a pressing issue for OECD nations: prevalence rates have not recovered from the Great Recession, spending on programs to address it has waned, and it has tangible consequences on children's development, education, and overall well-being. This report suggests that climate change will exacerbate these issues facing poor children and will add further stress to already-strained welfare systems, necessitating an ambitious research agenda and a robust policy response to counteract these escalating harms.

III. Material Effects of Climate Change on Child Poverty

By the material effects of climate change, we refer to the damage it causes to the physical environment on which healthy childhood development depends. Because climate change contributes to the extreme weather events that damage homes, schools, infrastructure, and natural areas, it jeopardizes the ability of children to live, grow, and thrive. As they already face burdensome socioeconomic disparities, poor children are particularly susceptible to these harmful impacts, and these early life stressors can even lead to negative outcomes decades later. In the following section, we outline how climate change-induced natural disasters – such as wildfires, floods, and droughts – destroy communities, harm poor children, and foreclose their futures.



Natural Disasters & Extreme Weather Events

Climate change has increased the frequency and severity of natural disasters around the world (Pachauri et al. 2015). These extreme weather events can have indirect and direct impacts on children through home and vehicle loss, unaffordable insurance premiums, housing instability, homelessness, school destruction, and other types of property damage (Pachauri et al. 2015). To provide a holistic overview of how climate change can damage the physical environment of poor children, we first consider how wildfires, hurricanes, sea level rise, droughts, and food shortages harm poor children and families. This survey does not encompass every extreme weather event, but aims to highlight the most common and devastating.

Wildfires

Climate change has led to a surge in the global incidence of wildfires (B. J. Harvey 2016). By worsening droughts and raising temperatures, climate change creates the perfect conditions to fuel larger and more destructive fires that destroy property, decimate homes, and can lead to economic uncertainty for entire communities (Allen et al. 2018; Ruckstuhl, Johnson, and Miyanishi 2008).

Many regions within the OECD face added wildfire risk due to climate change, including countries in North America, Oceania, and Southern Europe (Y. Liu, Stanturf, and Goodrick 2010). For example, in the United States, 29 million Americans are at risk of extreme wildfire conditions, 12 million of which are considered especially vulnerable (Davies et al. 2018; Gaskin et al. 2017). This wildfire vulnerability, however, is unevenly spread across race and ethnicity in the United States; Black, Hispanic, and Native American populations are 50 percent more vulnerable to wildfires than other groups because these communities of color often do not have the social, economic, or legal support to recoup their losses (Davies et al. 2018).

The risk is also spread unevenly across income groups, as these fires harm poor households, and thus poor children, at disproportionate rates (IPCC 2014). For example, after a fire destroyed numerous housing complexes in 2018 in Shasta County, California, many low-income individuals lost their possessions and homes, and they often received no financial recuperation in the aftermath because they could not afford renters' insurance (Harnett 2018). Without insurance, many may never fully rebound financially, leading to wealth loss and family destabilization that could last for generations.

After a wildfire, impacted individuals often attempt to restore their communities by rebuilding as fast as possible due to pressures from residents, politicians, and others. This quick restoration can limit the ability of the community to prevent future wildfires, leaving children susceptible to future vulnerabilities (McGee, McCaffrey, and Tedim 2020)

Australian Wildfire Case Study

The 2019-2020 Australian bushfires, a disaster further exacerbated by climate change-related drought, adversely affected many Australians but especially harmed impoverished children (Yeung 2020). Researchers have found that one in seven Australian children live in poverty, but this is likely an underestimation due to the recent fires (Pollard 2020). Many Australian schools have been periodically suspended to ensure the safety of children. Not only have these children missed out on school days, but many low-income children who rely on supplementary meals and care from schools have experienced additional hardships due to the closures (Save the Children 2020). Numerous impoverished families have also struggled to maintain internet access for their children, which is a current necessity for schooling. This has led children to perform worse in the classroom and drop out of school prematurely (Pollard 2020).

Hurricanes, Sea Level Rise and Related Flooding

Climate change will lead to both rising sea levels and more intense hurricanes, resulting in increased flooding across the world (Bosello et al. 2012; IPCC 2014; see Appendix A for various IPCC models with estimated global mean sea level rise). This increased flooding may in turn lead to mass destruction, home loss, and economic devastation (Pilkey, Pilkey-Jarvis, and Pilkey 2016; Nordhaus 2010), which will disproportionately impact children in poverty through school disturbance, increased economic insecurity, and displacement (Curtis and Schneider 2011; Moser and Satterthwaite 2008). While each region's outcomes differ based on their heterogeneous levels of preparedness, the specificities of governmental assistance programs, and other contextual geographic factors, we can generalize results between OECD countries – as most are relatively wealthy nations that face the same environmental changes. Throughout OECD countries, research indicates that flooding disproportionately impacts low-income families and children due to their inability to relocate and lack of financial resources (see Appendix B for the estimated economic damage of climate change by 2100). Even when they are insured, low-income households often cannot afford to pay deductibles or repairs that are not covered by their policy (Arnone and Spriggs 2020). Flooding can also lead to declines in economic activity and damage to small businesses, starving local governments of much-needed tax revenues and forcing them to defund crucial welfare services – triggering a vicious cycle of disinvestment and poverty.

The frequent flooding in Venice exemplifies the hazards posed by rising sea levels due to climate change. Venice, a city of canals built on islands off the Italian mainland, is prone to flooding due to its coastal location and soft terrain; the mean sea level is now twenty centimeters higher than it was a century ago, and the city is sinking an average of one millimeter a year (Vagnoni 2019). In 2019, Venice experienced the highest peaks in flood waters in more than fifty years. Climate change will be especially devastating for low-lying coastal cities like Venice, as rising sea levels increase the destructive power of storms and floods, accelerate erosion, and threaten freshwater supplies (Bosello et al. 2012). Research has shown that these trends will be particularly harmful to children and poor households. While higher-income families can easily migrate out of the city, lower-income residents lack the resources to enable such a move. Poor children are even more susceptible to flooding due to their inability to relocate to less risky terrain and rebuild safe homes after extreme floods (Roder et al. 2017). Specifically, children have experienced school delays, home loss, and parental loss of income due to flooding (Roder et al. 2017).

Drought, Food Shortages, and Agricultural Insecurity

Agricultural development is highly vulnerable to both gradual climatic change and extreme weather events. Climate change can impact insect population levels, weed-infestation intensity, and plant pathogens (Houser et al. 2015). These changes in pests and diseases can decrease an agricultural harvest, driving up the costs of food. Additionally, extreme weather events can destroy crop fields and reduce water availability for plants (Houser et al. 2015). The IPCC has reported that projected changes in temperature and precipitation by 2050 are expected to increase food prices anywhere from 3 percent to 84 percent (Stocker et al. 2013). When food prices rise, many low-income individuals will be unable to afford the increasing costs, resulting in food insecurity and malnutrition (Tacoli et al. 2013). If low-income children are not properly fed, this can lead to numerous health problems and potential developmental difficulties, as discussed later in the health section of this report. Food insecurity is not a rare issue; in 2018, 7.1 percent of children in the United States were food insecure (USDA 2019). These insecure populations may increase as climate change continues to impact agriculture and food systems.

European Heat Wave Case Study

In recent years, climate change has increased the frequency of heat waves across the world (Sampson et al. 2013). Heat waves, such as those in 2003, 2018, or 2019 in Europe, put small children and infants at risk of overheating as their bodies are not able to regulate their body temperature (Watts et al. 2018). During the 2003 heat waves, climate change increased the risk of heat-related mortality by 70 percent in Central Paris and by 20 percent in London (Baccini et al. 2008). Impoverished children are more susceptible to heat wave stress for several reasons: their parents may not be informed about the danger of heat waves, they may be unable to afford air conditioning, and they may live in close quarters, increasing the likelihood of negative health outcomes due to heat (Singer 2017).

Droughts, another extreme weather event made more likely by climate change, harm poor children by increasing food insecurity and expanding areas susceptible to wildfires, leading to homelessness, insurance loss, and educational delays. Fueled by climate change, areas affected by droughts are projected to globally increase from 15 percent to 44 percent by 2100 (Y. Li et al. 2009). Droughts can dry out forests and make it easy for them to ignite, creating ideal conditions for a wildfire to spread quickly and destroy property (WMO 2018). These wildfires can also spike air pollution levels and lead to negative health outcomes for children (Davies et al. 2018). Moreover, droughts can further strain agricultural production and increase food insecurity. They even exact psychological costs; researchers found that an extended Australian drought had a negative impact on the mental health of farmers and farm workers (B. Edwards, Gray, and Hunter 2015).

Infrastructure Impacted by Climatic Shifts

Climate change can drastically damage a country's infrastructure and thus adversely affect poor children who rely on it. Buildings are vulnerable to short-term extreme weather events, including hurricanes and fires, and long-term impacts, such as soil erosion and extended heat waves (Canes 2019). In most countries, historical infrastructure is more vulnerable to a changing environment because it has not been adapted to new climatic conditions, and poor children are more likely to reside in these easily-damaged buildings and communities (USGCRP 2018). While coastal infrastructure is most at-risk from climate change, increased precipitation events will also impact inland infrastructure, such as access to roads, bridge viability, and pipeline safety. Extreme weather events like these may disproportionately destroy aging, poorly maintained structures, displacing low-income families and children from their homes.

When infrastructure improvements are made to prevent climate change-associated destruction, such as retrofitting homes to withstand flooding and erosion impacts, it can outprice certain individuals from an area – a process called "green gentrification" (Chappell 2018). Green gentrification makes housing unaffordable for many low-income families, forcing them to live in areas with greater risk for extreme weather events. These conditions leave poor children vulnerable to the destruction that climate change may wreak and may further exacerbate the socioeconomic divide as extreme weather events become more common.

Figure 3. Exposed Population and Asset Value in OECD Port Cities by 2070

	Amsterdam	Hamburg	Inchon	Istanbul	Lisbon	London
Exposed Pop. (Thousands)	1435	255	267	166	90	606
Exposed Assets ($ Billions)	834.7	127.3	92.3	46.8	33.4	306.0

	Melbourne	Miami	New Orleans	New York	Tokyo	Vancouver
Exposed Pop. (Thousands)	75	4795	1383	2931	2521	584
Exposed Assets ($ Billions)	40.3	3513.0	1013.0	2147.4	1207.1	303.0

Figure 3: Based on projections of population and construction growth, land subsidence, and climate change, this chart shows the number of people and the value of buildings and infrastructure expected to be vulnerable to high winds and storm surges by the 2070s in various port cities across the OECD. (OECD 2008)

Miami-Dade County, Florida, represents a prototypical example of green gentrification within the United States. In 2016, households in low-income communities within the county experienced flooding due to a massive tide. Generally, low-income communities tend to be less resilient to extreme weather events due to a lack of resources, government aid, and physical infrastructure (Delgadillo 2016). And even when affordable housing options were destroyed, they were often replaced with more resilient yet expensive residential developments, displacing low-income populations. This low-income Miami community has aging infrastructure and has received very little city aid compared to nearby luxury real estate, and these low-income residents were literally underwater for an extended period of time because of the lack of storm-water infrastructure – substantially harming the poor children residing in these communities.

Research & Policy Priorities

To prevent climate change-related damage to poor children's physical environments, OECD countries must implement adaptation policy. While each country faces its own unique mix of extreme weather events and thus must adopt individually-tailored prevention strategies (Pachauri et al. 2015), we identify research areas ripe for further inquiry to better inform policy, and we craft general policy priorities that may help guide policymakers as they work to alleviate child poverty and combat climate change.

- Conduct further empirical research and develop quantitative data on how socioeconomic status and natural disasters disproportionally impact a child's housing accommodations, school facilities, and familial income loss, both in the short and long-term.

- Analyze different communities that have experienced green gentrification in order to understand how infrastructure improvement, while beneficial, may negatively impact low-income families.

- Invest in climate-resilient infrastructure through "safe-to-fail" designs, updated redevelopment plans, and advanced predictive technologies to create safer environments, especially for low-income families (see Appendix C for further policy options to increase resilient infrastructure).

- Include climate variability and uncertainty in policy, accounting for a variety of potential scenarios. Policies should include risk prevention, contingency planning, and emergency relief for extreme weather events so that communities are prepared under most circumstance that may occur.

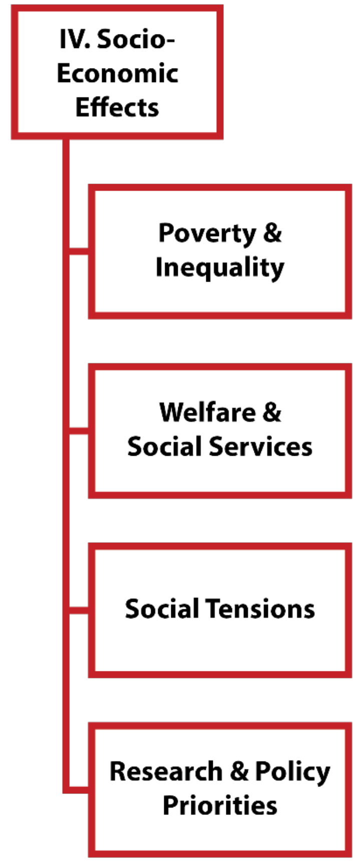
IV. Socioeconomic Effects of Climate Change on Child Poverty

While the consequences of climate change are widespread and affect various populations, its socioeconomic impacts will be especially devastating for the most vulnerable groups of society, particularly children living in poverty. As extreme temperatures and an increase in destructive natural disasters wreak havoc on communities around the world, they will disproportionately burden low-income families and their children – groups that are not financially resilient and lack the necessary resources to adapt to this changing environment. This section outlines the multitude of effects climate change has on socioeconomic spheres, such as poverty and inequality, welfare and social services, and social tensions.

Poverty & Inequality

Increased Poverty

One of the most alarming effects of climate change is an increase in poverty. Recent disasters have revealed that effects of climate change – such as droughts, forest fires, and land degradation – directly impact a region's economic livelihood (Skoufias et al. 2011). Countries that rely on environmental stability to sustain their economies are at the highest risk of negative impacts due to climate change (Reuveny 2007). This is especially true for regions that depend on agricultural production for survival and economic growth (Rosenzweig and Parry 1994). As crops die from reductions in rainfall and land degradation, poverty and income will consequently decline (Skoufias et al. 2011). Poverty can also increase in an area due to forced environmental migration or infrastructure devastation (Hugo 2008). Individuals will be forced to retreat from their homes in search of safety and resources elsewhere, further hurting a community's economy (Skoufias et al. 2011). Studies have also shown that climate change has long-lasting effects on an individual's income growth. Low-income individuals that live in regions that are more vulnerable to negative climate effects have seen slow rates of long-term growth in income (Skoufias et al. 2011). This can lead to a lifetime of increased poverty for themselves and their families. Children that suffer from poverty are likely to experience various adversities that stem from their family's financial hardship, such as learning disabilities, stunted growth, low school achievement, and a higher likelihood of emotional and behavioral problems (Brooks-Gunn and Duncan 1997a). These instances of poor development in adolescence have long-term effects on an individual's adult life; stunted growth, poor cognitive development, and low educational attainment will likely lead to lower economic achievement and productivity later in life (Dewey and Begum 2011).



Wealth & Income Inequality

The effects of climate change are particularly harmful to impoverished families and can exacerbate economic inequality. For example, using data from the Panel Study of Income Dynamics, researchers found that damage from hurricanes and other natural hazards was correlated with increased levels of wealth inequality (Howell and Elliott 2018). In fact, even areas receiving more FEMA aid saw increased inequality levels (Howell and Elliott 2018). These findings make intuitive sense; low-income households have fewer financial resources to protect themselves from the repercussions of environmental destruction and a lower adaptive capacity to cope with weather shocks. They also may live in areas that experience a higher incidence of natural disasters (Tol et al. 2004; Reuveny 2007). For instance, impoverished families will be unable to migrate to safer regions, thus putting them in danger of imminent natural disasters (Reuveny 2007). In other cases, impoverished families forced to flee their homes due to infrastructure destruction or economic decline from climate effects will have a much higher financial liability than others. Children whose families face income and wealth inequality have a higher likelihood of poor health outcomes, inadequate educational opportunities, and a higher probability of facing long-term social inequalities (Murali and Oyebode 2004).

Social & Demographic Inequality

Families living in poverty are not the only people at greater risk of extreme climate effects; inequality along social and demographic divides will also increase due to the negative consequences of climate change. Gender inequality has long been an indication of poverty rates (Christopher et al. 2001). Traditionally, women are more likely than men to face extreme poverty due to the disparities they experience in social, political, and economic spheres (Demetriades and Esplen 2010). Because of unequal representation and access in these areas, women must adapt to the same situations as men, but with fewer resources. In some industries and countries, women on average earn less money than men performing the same job (Carnevale, Smith, and Gulish 2018). Children of female-headed households are therefore more likely to live in poverty due to this income inequality (Tucker and Lowell 2016). This disparity makes women overall more susceptible to the economic consequences of climate change and their ability to adapt to its effects (Demetriades and Esplen 2010). In fact, women in poverty who must adapt to the effects of climate change have a higher risk of mental and physical health issues and an inability to find secure employment (Demetriades and Esplen 2010).

Just as gender inequality amplifies the risks women face due to climate change consequences, racial disparities also lead to socioeconomic and political inequality. Nations that have traditionally experienced racist rhetoric are more likely to see differences in allocation of resources between races (Newell 2005). Different ethnic and racial groups in countries that are systematically unequal have a higher probability of facing destructive climate effects, which further pushes them into extreme poverty (Raleigh 2010; Newell 2005). Disadvantaged socioeconomic groups who already face inequality in social, political, and economic spheres have a much higher chance of suffering from negative consequences of climate change, such as loss of employment, safe places to live, and health supplies (Newell 2005). Children whose families are affected by low socioeconomic status tend to suffer from poor developmental outcomes, which create long-lasting issues, such as lack of social skills and low educational attainment (Conger, Conger, and Martin 2010). Both developed and developing nations experience social inequality due to race or ethnicity, with social class also related to climate change adaptability (Newell 2005). This social inequality among disadvantaged groups plays a strong role in climate change susceptibility, and in these groups' capability to secure resources and support to endure destructive environmental changes.

Welfare & Social Services

Climate change can reduce access to and raise demand for social services. It will disrupt educational curricula, increase unemployment rates, reduce housing access, and trigger substantial amounts of property damage – straining the social service systems that provide basic needs to low-income households and children.

Education

Some OECD countries already face frequent natural disasters that affect children's access to education, and climate change will only intensify these challenges for schools (Sheffield et al. 2017). For example, studies in Texas and North Carolina found that hurricanes have led to temporary but lengthy school closures, creating learning difficulties for students and leading to missed school-days (C. Davis 2020). These harms were especially severe for low-income children and poor communities (C. Davis 2020). Environmental disasters may also force poor children to relocate or destroy school facilities, which adversely affects school attendance and performance. Evidence shows a positive relationship between school attendance and academic achievement (Gottfried 2010). As the effects of climate change accelerate, school disruptions may increase.

While there is a scarcity of literature specifically linking climate change to educational outcomes, some evidence demonstrates how trauma exposure in childhood impacts education. Studies show that trauma exposure, including from natural disasters, can lead to increased difficulty concentrating and learning – thereby harming academic performance (Wright and Ryan 2014). Research examining childhood trauma reveals that when triggered, children's stress response system will lead them to fight, freeze, or flee (van der Kolk 2005). In a school, this could result in a variety of maladaptive behaviors, including physical violence, disorganized thinking, and appearing inattentive (Wright and Ryan 2014).

Evidence shows that disruption in schooling can lead to lower academic achievement (Gibbs et al. 2019). A study from Australia tracks test scores of students attending schools severely harmed by bushfires (Gibbs et al. 2019). It found that, over an extended period of time, academic scores in affected schools were lower on average than the scores of students in less affected schools. Evidence also shows that prenatal exposure to a natural disaster can lead to lower test scores (Fuller 2014).

Because Australia endures frequent natural disasters, Australian schools use disaster education to raise awareness among students and to prepare them for action (Boon and Pagliano 2014). Research shows limited evidence regarding evaluation of school-based disaster education programs, for both Australia, and other OECD countries. Future research in this area, as well as establishing preparedness resources for children, will potentially help reduce vulnerabilities. Researchers warn, however, that poorly taught disaster education programs could have harmful effects on students' anxiety, including an exaggerated sense of vulnerability (Boon and Pagliano 2014).

The effects of parental education on adaptability and resilience also merit consideration. Evidence shows an association between education and higher levels of resilience over the long-term, including better psycho-social health (Frankenberg et al. 2013). In the period immediately after the 2004 Indian Ocean tsunami, better-educated people minimized dips in spending levels and were less likely than others to live in a camp or temporary housing. While this relationship is not necessarily causal, as the better educated people may have had greater resilience due to higher access to financial and social resources (Frankenberg et al. 2013), it suggests that families with less education may not cope as well in the aftermath of a natural disaster, increasing the vulnerability of their children.

Unemployment

Assessing the effect of climate change on unemployment can reveal potential impacts on family income levels and access to social insurance. Considering the significant risk of unemployment caused by climate change, examining the effects of unemployment on children's wellbeing deserves significant attention.

Evidence shows that climate change increases unemployment, especially in areas with a larger proportion of jobs relying on ecosystem services or the absence of environmental hazards (ILO 2018). With levels of unemployment varying across the OECD, it is difficult to calculate what percentage results from climate change. There is evidence, however, that investing in climate mitigation measures creates jobs in renewable energy and green construction, with the potential to reshape the labor market (OECD 2012; see Effects of Climate Policy section).

Figure 4. Employment Reliant on Ecosystem Products and Services

Country	Australia	Canada	EU	France	Germany	Italy
Jobs Dependent on Ecosystem (%)	9	7	16	8	6	11

Country	Japan	Korea	Mexico	Turkey	UK	USA
Jobs Dependent on Ecosystem (%)	9	11	23	32	5	7

Figure 4: This table shows the percentage of jobs in eleven countries and the European Union that are in industries reliant on ecosystem services and products. Major shifts in climate may leave these workers exposed. (ILO 2018)

Parent employment significantly impacts a child's well-being. Evidence shows that unemployment leads to poor outcomes, including a deterioration in psychological well-being, physical health, and economic situations, which often affect children of the unemployed (Ström 2003). Research also shows that parental job loss, which often leads to longer-term unemployment, has a negative effect on children's school performance – perhaps because parental job loss can cause economic and mental distress, both of which can affect a parent's ability to provide support for their children. (Rege, Telle, and Votruba 2011).

Homelessness & Reduced Housing

Natural disasters and displacement as a result of climate change may lead to unstable housing or homelessness, adversely affecting children. High-mobility families may experience homelessness, reduced housing, or school mobility (Fantuzzo et al. 2012). Homelessness causes severe residential instability and primarily occurs within low-income families. Homelessness can also disrupt healthy development in children and contribute to poor levels of academic achievement, as well as emotional and behavioral problems (Cutuli and Herbers 2014). In some cases, the increased personal and family stress from housing uncertainties can also exacerbate negative behaviors, such as child abuse (Kingsley, Smith, and Price 2009). Perlman and Fantuzzo (2010) identify that the developmental timing of homelessness can influence the risk. Their findings show that a child experiencing homelessness as a toddler faces a greater risk for poor achievement than when the child experiences homelessness later in development.

Residential stability influences a child's educational development. High residential mobility is associated with negative youth outcomes. Examples include low achievement and decreased rates of high school completion, especially among urban youth (Voight, Shinn, and Nation 2012). Research also shows that homeless and highly mobile students demonstrate reduced school achievement compared to children from low-income but nonmobile households (Obradovic et al. 2009). In addition to limiting a child's community resources, residential mobility may also impact a parent's well-being. Parents struggling financially with housing may consequently suffer from anxiety and stress (Kingsley, Smith, and Price 2009; Voight, Shinn, and Nation 2012). These financial hardships could affect parent's ability to support the educational development of their children.

Residential mobility does not necessarily indicate school mobility, although there is a correlation between the two. There is evidence that school mobility, especially while experiencing homelessness, leads to lower academic achievement as well as problems in classroom engagement (Fantuzzo et al. 2012). While there is a small body of research investigating the association between homelessness and educational outcomes of children in the United States, future research should be dedicated to this relationship in other OECD countries.

Subsidized Loss Insurance

As climate change continues to wreak damage on OECD nations, demands for subsidized insurance will escalate, making it important to strengthen the resilience of vulnerable groups and improve their adaptive capacity. Evidence shows that OECD nations can alleviate long-term poverty through vulnerability-targeted social protection (Carter and Janzen 2015). Findings demonstrate, however, that in the case of severe climate change, even robust social protection programs lose their ability to mitigate poverty and climate change risk. Climate change-fueled hurricanes and natural hazards can lead to tens of billions of dollars of damage, thereby overwhelming insurance programs (Arnone and Spriggs 2020). Insurance can also become unaffordable in response to these increasing risks of natural disasters and the concomitant rise in insurance prices (Zou 2020). For instance, the rise of premiums in the EU have led to unaffordable flood coverage rates and a decreased demand for flood insurance, which reduces financial resilience (Tesselaar, Botzen, and Aerts 2020). The United States has not been spared from insurance issues of its own; some officials even worry that rising U.S. flood insurance premiums could spiral into a mortgage crisis (Zou 2020). Private homeowner's insurance covers natural disasters, with the government intervening when private insurance markets fail (Brusentsev and Vroman 2017). Researchers suggest public reinsurers as a mechanism to reduce flood insurance premiums, as the government can borrow money at a lower rate (Tesselaar, Botzen, and Aerts 2020).

Lack of access to flood insurance exacerbates water-related disasters for low-income communities of color. In 2017, Hurricane Harvey caused mass destruction and flooding in Houston, Texas. While initial data indicated that hurricane victims only suffered short-term financial impacts, further analysis revealed that individuals who did not expect to receive flooding or who were in weak financial positions were most negatively impacted (Ricketts and Gallagher 2020). Flood insurance is the most significant form of assistance available following a catastrophic flood in the United States. Flood insurance is required in high-risk flood areas within the United States through the federal government, but most homeowners fail to purchase this insurance (Arnone and Spriggs 2020). Beyond flood insurance, there are three other forms of assistance in the United States: Federal Emergency Assistance Agency (FEMA) grants, Small Business Administration (SBA) disaster loans, and Internal Revenue Service disaster refunds (Ricketts and Gallagher 2020). These additional forms of assistance, however, are not evenly distributed. SBA disaster loans deny significantly more loans in areas with larger minority populations, more subprime borrowers, and higher levels of income inequality. Moreover, households with higher socioeconomic statuses disproportionately use government flood insurance (Begley et al. 2018).

Lack of insurance also affects housing and educational outcomes. Individuals outside the floodplain in Houston were less likely to purchase flood insurance; therefore, these populations declared bankruptcy at higher rates following Hurricane Harvey. Children experienced home and vehicle loss, school disruption, and temporary homelessness. Harvey hit Houston in August, very close to the beginning of the United States public school year, forcing many schools to start several weeks late due to a lack of sufficient facilities, teachers, and attending students (Isensee 2017; C. Davis 2020).

Social Tensions

Effects of Crime

Ample evidence supports the connection between climate change and social conflict across diverse regions globally. Conflicts can be exacerbated by crime and political tension and can result in forced migration and higher instances of xenophobia (Agnew 2011; Akresh 2016). As the effects of climate change continue to intensify, social tensions among citizens and their governments will surely escalate as well.

Researchers attempting to map the effects of climate change have recently taken an interest in how extreme temperature contributes to crime in different cities and countries (Akresh 2016). An economic review of fifty-five regions found that areas experiencing abnormally warm temperatures and longer periods of little rainfall saw an increase in the probability of conflict (Akresh 2016). Another study found a positive correlation between rising temperatures and increased criminal activity in United States counties (Akresh 2016). The study predicted that crime rates in the United States will likely increase by 1.5-5.5 percent by the year 2100 due to climate change, with estimates of an additional 1.2 million aggravated assaults and an estimated increase of 22,000 murders (Akresh 2016). Researchers who have conducted studies on the relationship between increased crime and climate change point to several factors explaining this correlation: higher temperatures can cause anger, irritation, aggression, and a rise in outdoor activities (Agnew 2011). Areas with a higher concentration of low-income households are more likely to be affected by climate change-triggered crime; perhaps due to a lack of air conditioning, hotter weather leads to increased outdoor activity and potentially criminal behavior (Agnew 2011). Climate change can also increase crime and social conflict through other mechanisms, including increased competition for social and economic resources, possible shortages of food and medical supplies, and an increase in poverty (Agnew 2011). Tensions between citizens and their government are likely to follow when their demands are not met, which can create further social conflict and crime (Akresh 2016). Studies on increased delinquency in communities have demonstrated the destructive effect that crime has on a child's educational growth and mental health; children raised in communities with high crime rates are more likely to have poorer school attendance and report more instances of distress and mental health issues (Bowen and Bowen 1999; Osypuk et al. 2012).

Environmental Migration & Social Consequences

The disastrous effects of climate change will not only shape the material conditions of a region but will also act as migration pressures. As countries fall victim to the destructive nature of climate change and become uninhabitable due to loss of economic and social resources and infrastructure decay, populations will be forced to find refuge in other regions. Environmental migration caused by rising sea levels, land erosion, and a shortage of food or freshwater supply will occur involuntarily, as families and individuals will no longer have the resources needed to sustain themselves (Reuveny 2007). Environmental migration is most common in areas that rely heavily on environmental dependency for their economic growth and citizen well-being, including countries that rely on agricultural production for food supply and economic support as well as access to freshwater sources (Naser 2011; Reuveny 2007). Rural Mexican and Central American farmers have been particularly devastated by climate change's impact on their land; droughts and long spells of little rainfall resulted in poor crop harvests (Spring 2009). This agricultural devastation has forced many Central Americans to seek environmental refuge in the United States in search of sustainable employment and an improved livelihood (S. Feng, Krueger, and Oppenheimer 2010). Individuals living in regions more susceptible to climate change-fueled natural disasters are likelier to become environmental refugees. Inquiry into this subject has just begun, but studies have shown that Latin America, sub-Saharan Africa, and Southeast Asian countries will experience the highest number of environmental refugees over the next thirty years (Rigaud et al. 2018). This issue, however, affects OECD countries as well; New Zealand has seen elevated migration levels from the Pacific Islands due to climate displacement, as migrants move from small islands to larger countries in response to natural disasters and rising sea levels (Nunn, Kohler, and Kumar 2017). The EU has also experienced a surge in immigration from distressed regions in the Middle East and North Africa, potentially spurred on by climate change. In fact, by the end of this century, the number of refugees seeking asylum in the EU could triple as a result of increased temperatures and extreme weather fluctuations (Missirian and Schlenker 2017). These preliminary studies indicate a growing need for more research into climate displacement and migration, particularly studying post-asylum patterns of migration.

Environmental migration produces negative consequences for both countries of origin and destination. These consequences come in many different forms, from economic strain to social tension. An increase in population leads to higher competition between individuals for resources such as employment, housing, and social services (Reuveny 2007). As competition arises among different groups of people, tensions among the merged populations can lead to conflict with each other and with governments. As environmental migrants seek refuge in foreign regions, the blend of ethnicities could lead to xenophobia and distrust among different nationalities. In effect, these tensions could lead to political instability, further inciting conflict (Reuveny 2007; Naser 2011). One study that explored the likelihood of conflict due to environmental migration, however, found that developed countries had a much lower probability of high intensity conflict compared with developing countries (Reuveny 2007).

Forced migration due to environmental calamities and conflict particularly harm children, as they are likely to face distress and health issues due to the consequences of environmental refuge. This distress stemming from forced migration results from unreliable access to school, poor housing, stigma coming from refugee status, and family instability (Wessells and Kostelny 2012). Children forced to migrate due to environmental destruction are also more susceptible to both physical and emotional health problems, such as post-traumatic stress disorder, malnutrition due to food shortages, and increased probability of communicable diseases (Bronstein and Montgomery 2011). These health problems arise from a lack of access to medical resources and immunizations (McMichael, Barnett, and McMichael 2012).

Research & Policy Priorities

Due to the severity of climate change's consequences, government administrations must begin taking steps toward risk management techniques and adaptation policies to curb negative social effects. Although the need for adaptation policy and the most effective strategies will vary based on the vulnerability of the region or country and their adaptive capacity, no country will be spared (Australian Greenhouse Office 2006). The following policy options provide a few examples of strategies for equitable social policies to stabilize family life (for additional priorities, see Appendix D). Their effectiveness and feasibility will vary based on available resources in each OECD country.

- Institute and expand universal child allowance to alleviate child poverty's burden. Like other income transfers targeted at children, reliable flexible cash subsidies reduce the cost of raising children and allow families to respond to needs and climate-related emergencies. Such supports may also further educational attainment, improve child health, reduce crime and homelessness, and increase labor market productivity (Garfinkel et al. 2016; Shaefer et al. 2018; Thévenon et al. 2018; Diffenbaugh and Burke 2019).

- Expand techniques for schools to engage traumatized children more meaningfully. Strategies include supporting children's inherent strengths by fostering positive relationships with teachers, supporting children's transition to school, and creating a supportive learning environment (Wright and Ryan 2014).

- Build rapid rehousing programs to transition families into permanent housing and reduce the risk from homelessness as a result of climate change. Programs that lead to residential stability can increase the likelihood of academic resilience, as well as allowing families to stay connected to needed resources and services (Cutuli and Herbers 2014).

- Expand affordable insurance policies to anticipate the potential for natural disasters. Strategies to reduce the burden on children by focusing on family well-being target improved finances after natural disasters by providing home repairs, temporary shelter expenses, or food loss. Some researchers have even proposed government-directed "planned relocation" programs to facilitate the transition of vulnerable populations to safer areas that are more protected from the harms of climate change (Ferris and Weerasinghe 2020).

- Offer humanitarian aid to environmental refugees through protective policies or social support. Due to the millions of people displaced by climate change effects, countries must be prepared to offer aid to migrants, depending on their available resources and economic ability (Renaud et al. 2007).

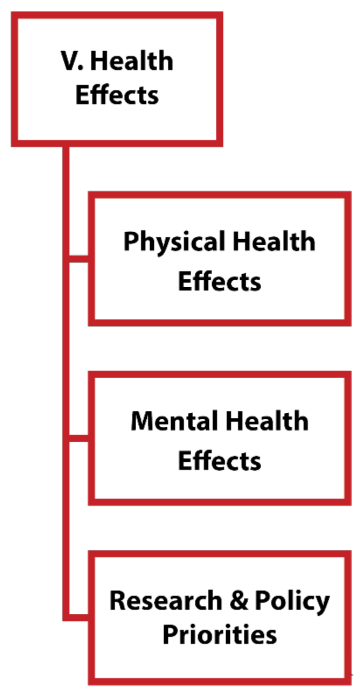
V. Health Effects of Climate Change on Child Poverty

Physical Health Effects

The effects of climate change, in the form of air pollution, heat waves, food insecurity, and vector-borne disease, contribute to worsened public health outcomes. These trends in impacts, exposures, and vulnerabilities continue to pose health hazards across OECD populations, as well as risks to core public health infrastructure and services. Children in poverty experience specific climate-related health vulnerabilities that place them at greater risk than adults. It is important to think about climate change effects as a pressing public health issue as well as a climatic, social, and technological issue.

Extreme Heat

Global temperatures have risen in the past three decades, and human vulnerability to the health effects of this increase has worsened as well. This extreme heat exposure increases morbidity and mortality from heat stress, cardiovascular disease, and renal disease, especially for those with underlying diabetes and chronic respiratory disease and those living in urban areas (Watts et al. 2018; Kenny et al. 2010; Kjellstrom et al. 2010; G. B. Anderson et al. 2013). The increased frequency and severity of extreme heat events pose a particular risk for children. Children have a small body-mass-to-surface-area ratio and higher susceptibility to dehydration than adults, which makes them more vulnerable to heat-related morbidity and mortality than healthy adults (Xu et al. 2012). Children under five and infants under one year old show evidence of higher mortality as daily temperatures increase (Basu and Ostro 2008). Extended exposure to high heat and lack of access to drinking water puts stress on kidney function and increases risk for chronic kidney disease (R. J. Johnson et al. 2019). Even so, epidemiologic analyses of heat waves in the past have not found a significant increase in mortality among children and infants compared to adults, but the predicted surge in extreme heat episodes in the future will



represent a pathway by which this population-specific vulnerability will become increasingly relevant (Kovats and Hajat 2008).

Additional non-biological factors that can impact heat-related morbidity and mortality in children include caregiver resources, air conditioning use, nutritional status, vaccination status, and access to social and medical infrastructure (Ostro et al. 2010; Bandyopadhyay, Kanji, and Wang 2012). Childhood poverty impacts all of these resources and health statuses, which may result in worsened temperature exposure health outcomes for this specific population. Additionally, urbanization exacerbates extreme heat trends. The urban heat island effect results from a combination of increased absorption of solar radiation, reduced evapotranspiration due to lack of vegetation, net heat storage in urban surfaces, and anthropogenic emissions (Oleson et al. 2015). Continuous monitoring of childhood morbidity and mortality in response to increasing temperatures will be necessary in order to observe increases in vulnerability. This monitoring should include the development of outcome measures that can quantify the impact of temperature extremes on children and the ways in which socioeconomic factors exacerbate the relationship between temperature and children's health (Xu et al. 2012). Specific data on mortality, morbidity, and disability-adjusted life years (DALYs) would contribute to impact quantification.

New York City Hurricane Sandy Case Study

Climate change-related natural disasters can have multi-dimensional public health impacts that overwhelm individual cities' capacities to handle these risks. Hurricane Sandy created a tidal surge in New York City that directly and acutely caused deaths by drowning, but also presented health risks through disruptions to housing, infrastructure, and population-specific emergency response gaps. Flooding and sewage exposure as well as crowding in temporary shelters posed greater risks to infection with vector-borne and water-born illnesses (Bloom et al. 2016; Ridpath et al. 2014). The hurricane caused five hospitals in New York City to shut down. Two million New York City residents lost power, and many residential buildings continued to lack electricity, heat, or running water because of saltwater flood damage. Attempts to restore power or heat to individual homes in unsafe ways led to carbon monoxide poisoning (Kinney et al. 2015).

Malnutrition

Malnutrition is already a leading cause of health loss worldwide, but climate change will cause vulnerable populations across all OECD nations to experience worsened health effects (Costello et al. 2009; Watts et al. 2018; Myers et al. 2017; Phalkey et al. 2015). Prolonged drought is a major determinant of premature mortality because it results in reduced arable land, reduced crop yields, food insecurity, and malnutrition. Malnutrition is particularly harmful to children because it causes stunting, wasting, and mortality (De Onis et al. 1993). Climate change-induced marine food security reductions also exacerbates undernutrition. Sea surface temperatures are rising, which bleaches coral and disrupts marine ecosystems. Recent analysis from *The Lancet* paired increases in ocean temperature and coral bleaching (an indicator of thermal stress) with decreases in per-capita capture-based fish consumption (Watts et al. 2018).

Climate change is predicted to reduce the protein and micronutrient contents of plant foods in the future, which will disproportionately affect nutrition in children (Myers et al. 2017; Taub, Miller, and Allen 2008). Alterations to crop yields and nutrient contents of these staple foods will increase their prices, leading to further increases in nutrient deficiencies in populations that are food insecure (Porter et al. 2015). These changes might prompt further shifts in the eating patterns of populations toward processed food and beverage products that are high in fats, sugars, and sodium and lead to higher risks of obesity, asthma, and chronic disability (An, Ji, and Zhang 2018; Y. C. Wang et al. 2011).

While severe food insecurity and hunger are linked to stunting, wasting, and mortality, moderate undernutrition is paradoxically associated with higher obesity prevalence and associated adverse health consequences in vulnerable child populations. Periodic, moderate food insecurity is associated with higher risk of obesity in high-income countries (Moradi et al. 2019). Thus, obesity, undernutrition, and climate change can be conceptualized as an inter-linked syndemic (Swinburn et al. 2019; McGuire 2015; Gakidou et al. 2017). Malnutrition has multiple forms, not just hunger; therefore, malnutrition is better conceptualized as a physiological condition caused by an unbalanced diet and represented by the combination of child and maternal malnutrition, micronutrient deficiencies, and indicators of obesity. Families and children experiencing poverty in OECD nations are subject to competing demands that often result in processed fast foods becoming the most affordable, convenient, and rational choice for them. Undernutrition and obesity both stem from poor diets and restriction in choice from food deserts that are found most often in high poverty areas.

Flooding

Floods and extreme precipitation present varied health risks; in addition to immediate injury and death from flood water, longer-term impacts on health include spread of infectious disease and mental illness, both of which are exacerbated by the destruction of infrastructure, homes, livelihoods (Zhong et al. 2018; Du et al. 2010). Flooding and storm surges represent increasing health risks as sea levels continue to rise and impact growing populations of people living near coastlines (Lane et al. 2013; Walsh et al. 2014). The pathways by which storms and flooding can impact health are through direct exposure to storm hazards, evacuation, exposure to secondary hazards (especially utility outages and accidents), exposure to contaminated drinking water, and mold growth in housing and and shelter (Lane et al. 2013). Flooding and wind damage from storms can set off widespread power outages that make it impossible to control temperature in homes and shelter, preserve food stores, access water, and operate medical equipment. These effects lead to negative health outcomes from exposure to extreme temperatures as well as carbon monoxide poisoning from backup generators and improper use of cooking equipment (Beatty et al. 2006; G. B. Anderson and Bell 2012). Intense rainfall and wind can compromise water quality via mobilization of pathogens, toxins, and untreated sewage (Rotkin-Ellman et al. 2010; Ruckart et al. 2008). When structures are inundated with water, they engender risks for mold growth and may result in subsequent respiratory symptoms and childhood asthma (Barbeau et al. 2010).

As demonstrated by recent hurricanes and other floods, critical health-care infrastructure can be damaged as a result of coastal storms. This infrastructural damage includes hospitals, nursing homes, primary and mental health care facilities, and pharmacies. In addition, for people who evacuate flood-prone neighborhoods, living for extended periods in shelters is associated with increased risk of communicable diseases and with interruption in medical care that could otherwise prevent complications from chronic health conditions (Arrieta et al. 2009). Loss of medical record information, medications (including information regarding names and dosages), and access to routine medical care can exacerbate health problems.

Air Pollutants and Allergens

People in over 90 percent of global cities are exposed to polluted air that contributes to respiratory and allergic diseases, including asthma, chronic obstructive pulmonary disease, cardiovascular disease, pneumonia, and possibly tuberculosis (Laumbach and Kipen 2012). Air pollution concentrations worsened between 2010 and 2016 in nearly 70 percent of cities worldwide. The incidence and prevalence of allergic respiratory diseases and bronchial asthma appears to be increasing worldwide, and people living in urban areas more frequently experience these conditions than those living in rural areas. Global atmospheric models demonstrate the link between premature mortality and pollution across emission source categories, projecting a doubling in the contribution of air pollution to premature mortality by 2050 (Lelieveld et al. 2015).

Ground-level ozone is produced on hot, sunny days from a combination of nitrogen oxides, carbon monoxide, and volatile organic compounds that are produced from vehicle exhaust, which makes it an air pollutant directly affected by temperature increases and the greenhouse gas effects of climate change (Ebi and McGregor 2008; Tsai et al. 2008). Exposure to ozone results in decreases in lung function, increased mortality, increased cardiovascular issues, and increased hospitalizations (Dennekamp and Carey 2010; Kampa and Castanas 2008). Ozone-related emergency room visits for asthma among children under the age of 18 in New York City have been projected to rise 7 percent in the 2020s compared to the 1980s (Sheffield et al. 2011). Analyses of climate change effects on ozone levels indicate increases in mortality and morbidity (Bell et al. 2007; Sarnat et al. 2013; Halonen et al. 2010). Meta-analyses indicate that while younger people generally have lower mortality risk for ozone exposure than older people, there is a growing association of mortality risk with unemployment, lower occupational and poverty status, and lack of central air conditioning (Bell, Zanobetti, and Dominici 2014). Additionally, there is a need for further research into the risk of ozone exposure in children to higher rates of morbidity and disability.

Exposure to airborne pollen is associated with allergic sensitization, hay fever development, and exacerbation of asthma (Kihlström et al. 2003; Sheffield et al. 2011; Darrow et al. 2012). Rising CO2 concentrations directly increase pollen exposure due to CO2 fertilization, and global warming over the past three decades has specifically advanced the starting date of the tree pollen season by up to three weeks as well as extend the total length of the season across Europe and North America (L. H. Ziska et al. 2003; L. Ziska et al. 2011). The health impact of pollen and other allergens can be worsened by air pollution, especially since ragweed and other allergenic plants will grow more easily from predicted climatic changes (Case and Stinson 2018). Damage to airway mucous membranes caused by air pollution may result in increased access of inhaled allergens to the cells of the immune system, thus promoting sensitization of the airway and more severe response to aeroallergens (Laumbach and Kipen 2012). Urban areas such as New York City may experience further influences on the length and severity of the pollen season from the urban heat island effect and locally higher CO2 concentrations (L. H. Ziska et al. 2003; Salo et al. 2014). As a result, future changes in temperature and CO2 could lead to changes in the dynamics of the pollen season and potentially increase the morbidity of allergic diseases such as asthma. Children's lungs have smaller airway capacity, higher oxygen demand, and cycle proportionately greater volume of air than adults. These limits make children more susceptible to the effects of aeroallergens and pollutants than adults (Babin et al. 2007; I.-J. Wang et al. 2016; Pierse et al. 2006; Qian et al. 2004).

Health Effects of Pollution and Remediation Case Studies

Exposure to air pollution reduces health at birth, reduces cognitive ability and memory, increases medical visits, and increases premature mortality. Electronic toll station implementation that do not require cars to idle and stop for payments led to improvements in birth outcomes for those living close to the toll stations (Currie and Walker 2011). Retrofitting diesel school buses in Georgia resulted in higher physical and mental test scores for students (Austin, Heutel, and Kreisman 2019). A traffic congestion tax reduced air pollution in downtown Stockholm, reducing hospital admissions for asthma in children ages 5 and under (Simeonova et al. 2018). People living upwind of major airports have lower rates of hospitalization for asthma and heart emergencies (Schlenker and Walker 2016).

Vector-borne Diseases

Arboviruses are a category of tropical diseases spread by arthropod vectors, most commonly mosquitoes, and can result in human infection with dengue fever, West Nile virus, Zika fever, yellow fever, chikungunya, and other zoonotic encephalitides. There are an estimated 390 million infections a year with 3.9 billion people at risk across 128 countries for this category of arboviruses. Deforestation results in human encroachment into areas where exposure to zoonotic disease increases (Possas et al. 2018). Climate change is producing a warmer and wetter climate, which broadens suitable mosquito habitats (Monath and Vasconcelos 2015). Increased human mobility and migration also facilitate the spread of illness to previously disease-free areas. Overall, global environmental change, through climate change, deforestation, urbanization, and ecological disruption resulting from human mobility and invasive species, will spur an expansion and intensification of arboviral illnesses throughout the world (Kamal et al. 2018). Multiple species of arbovirus-spreading mosquitoes are likely to begin inhabiting the United States, Europe, and Australia, as these regions are already currently suitable for these mosquito populations after ongoing climate change (Kraemer et al. 2015).

Figure 5. Expansion of Range of Mosquito-Borne Illnesses in 2050 and 2080

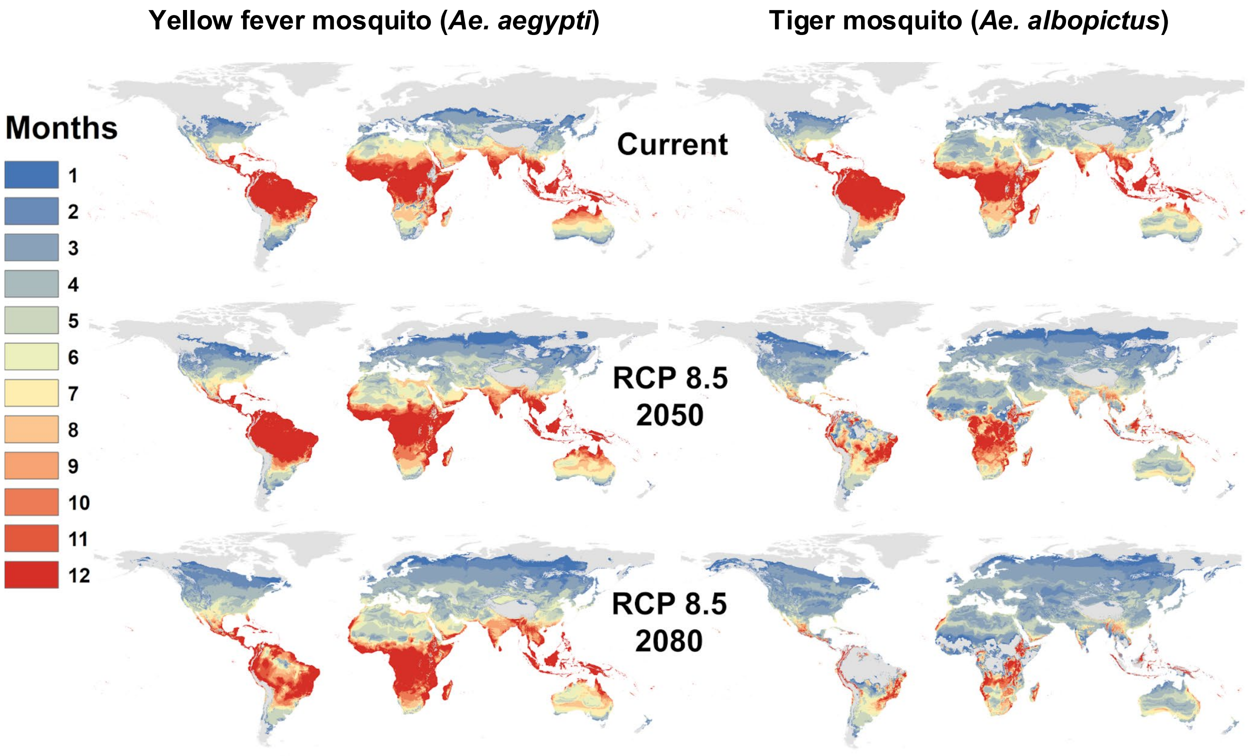


Figure 5. legend: Predicted increase in suitability for transmission by Ae. aegypti *(yellow fever mosquito) and* Ae. albopictus *(tiger mosquito) under Representative Concentration Pathway 8.5 in which emissions will continue to rise through the 21st century. Global range expansion is denoted by addition of coloration onto the gray world map base. Heat map color (blue to red) indicates increasing number of months per year that transmission will be suitable. Adapted from Ryan et al. 2019 under the Creative Commons Attribution License.*

Even small changes to temperature and precipitation patterns can result in large changes in transmission of vector-borne and waterborne diseases (Myers and Patz 2009). Vectorial capacity is a measure of the capacity for vectors to transmit a pathogen to a host and is influenced by vector, pathogen, and environmental factors. Compared to the 1950s as a baseline, climatic changes have increased global vectorial capacity for dengue virus in the 2010s (Liu-Helmersson et al. 2019). Furthermore, the seasonal dynamics of vectorial capacity for dengue virus for both vectors have lengthened and strengthened. Modeling of expected increases in global temperatures indicates that *Aedes aegypti* (yellow fever mosquito) populations will continue to enter European cities and regions over the next century (Liu-Helmersson et al. 2019). Additional modeling of the range of susceptibility to dengue fever identifies the United States, Mexico, and Australia as zones where infection can occur as of 2015, and further expansion northward and southward through 2050 (Messina et al. 2019). Climate change will likely lead to increases in suitability for dengue transmission and will increase the periods of the year in which introductions may lead to outbreaks, particularly in cities that typically have mild winters and warm summers (Robert et al. 2019). Vector-borne diseases like malaria have been predominantly thought of as rural diseases, but pathogens constantly evolve and adapt to environmental conditions. Mosquitoes that transmit malaria and have insecticide resistance adapted to living in highly polluted urban areas in Africa (Donnelly et al. 2005). For a projection of increases to the global expansion of mosquito-borne virus transmission, especially expansion northward into OECD countries, see Figure 3 below (Ryan et al. 2019).

In addition to arboviruses, cholera and other pathogenic Vibrio bacterial species are seeing rising suitability worldwide and especially in northern latitudes, which indicates a growing incidence rate within OECD countries (H. Wang et al. 2017; Martinez-Urtaza et al. 2018). These bacterial species can infect humans and cause vibriosis, which is defined as a constellation of symptoms including gastroenteritis, wound infections, and sepsis. Research has identified an association between increases in sea surface temperature and cases of pathogenic Vibrio infections. The percentage of coastal area suitable for Vibrio infections in the 2010s has increased at northern latitudes compared to baseline levels seen in the 1980s. Over the same period, the Baltic region and northeastern USA serve as high-risk case studies, demonstrating increases of 24 percent and 27 percent, respectively (Watts et al. 2018).

The experience of poverty increases rates of infection with vector-borne diseases spanning viral, bacterial, and parasitic vectors (Hotez and Wilkins 2009; Bottazzi et al. 2011). Disadvantages in housing and overcrowding of spaces, as well as reduced access to clean water and sanitation management, increase rates of chronic infections in populations experiencing poverty. Worsened sanitation and waste management present increasingly conducive environments for mosquitoes to breed and access hosts (Braack et al. 2018). Housing population density and lack of available amenities are also linked to negative health outcomes for a broad range of communicable diseases (Vazquez-Prokopec, Lenhart, and Manrique-Saide 2016; Thomson et al. 2009; Turley et al. 2013). Given this existing susceptibility to vector-borne disease, children in poverty are the population most likely to experience higher disease load as climate change increases the range of disease vectors throughout OECD countries.

Mental Health Effects

Climate change both directly and indirectly harms children through their social support systems, emotional security, and physical environment (Bartlett 2008). None of these categories can be considered in isolation. For example, the social support children receive may impact their early-life emotional security, which in turn may impact their predisposition for mental health conditions later in life. Children's psychological vulnerabilities and resilience have numerous contributing factors, making the direct impact of climate change difficult to measure. Some of these factors include household dynamics, prenatal conditions, individual values, and personalities.

At this time, there is not enough research to present a comprehensive picture on the impact of climate change on children's mental health. The data discussed later in this section is an extrapolation of current knowledge regarding urban health, adult health outcomes, and recent natural disaster aftermaths. This knowledge leads to a broad understanding of potential implications on children. There is not enough data on the long-term effects of slow-moving changes in a child's environment: the loss of social networks, increased long-term stress due to environmental chaos, physical environment changes, and the high uncertainty of the future.

Direct Impacts of Climate Change on Psychological Health

Researchers have found that extreme weather events have a large impact on a child's mental health (Gamble et al. 2016). These extreme weather events that lead to family stress, displacement and changing social support systems cause children to be at further risk of developing diagnosable mental health problems such as post-traumatic stress disorder (PTSD), depression, anxiety, and substance abuse (Burke, Sanson, and Van Hoorn 2018; Weissbecker 2011). Children in poverty are particularly susceptible to future negative outcomes from life stressors (Faravelli 2012). Other symptoms of PTSD can include difficulty in regulating emotions, decreased cognitive development, phobias, sleep disorders, behavioral problems, and adjustment problems (Burke, Sanson, and Van Hoorn 2018).

Children develop within a social and cultural environment that allows them to acquire the proper skills and experiences to live their lives. These experiences include a child's ability to play in order to learn problem solving, cause and effect, their own capabilities to shape the world, and their mastery of skills (Evans 2004). Moreover, children learn the social and cultural norms of their particular environment. When a climate event disrupts a child's community or displaces them, the social networks they rely on can quickly deteriorate. Environmental chaos, a general term that refers to crowding and increased levels of noise, can disrupt the social and daily structure of life (Evans et al. 2005). Overcrowding lowers a child's cognitive development and motivation. When children are displaced, they may lose their sense of place, leading to trauma and issues adjusting to a new environment (Gamble et al. 2016).

Parents can place stress on their child through prenatal exposure and their own mental health state. Maternal intrauterine signals influence fetal brain development and can have long-term effects, including reducing a child's ability to regulate emotion and psychological stress (Glynn and Sandman 2011). Elevated maternal levels of stress due to an extreme weather event can make fetuses more susceptible to schizophrenia, autism, and impaired language development later in life (Garcia and Sheehan 2016; Dancause et al. 2011).

Long-term and recurring extreme weather events have a greater impact on children than one-off events. A one-off event, such as a flood, can trigger short-term PTSD for a child, while a slow-acting event, such as sea level rise, may lead to more serious and long-term mental health conditions such as depression and generalized anxiety disorder (Garcia and Sheehan 2016). When the results of a climatic event are long-term, such as family loss, the child is more heavily impacted compared to only a material possession loss. Early-life stressors, such as repeated extreme weather events, may also lead to adverse mental health outcomes in adulthood (Faravelli 2012).

Hurricane Maria and Puerto Rico Case Study

The impacts of climate change-related events on children's mental health are not well understood, but Hurricane Maria provided evidence of this linkage. In Puerto Rico, 56 percent of children live below the poverty line, while 84 percent of children are living in high poverty areas (Annie E. Casey Foundation 2018). In September 2017, the category four storm, Hurricane Maria, hit Puerto Rico and killed anywhere from 2,975 to 4,645 individuals (Holpuch and Kilani 2019). It was so devastating that more than half of young people in Puerto Rico saw a friend or family member leave the island in the wake of the storm. Puerto Rican children, in the aftermath of Maria, were exposed to damaged homes, shortages of food and water, and threats to their lives (Holpuch and Kilani 2019). 30 percent of Puerto Rican children reported that they perceived their lives and the lives of their loved ones at risk – a strong predictor of PTSD. Nearly half of Puerto Rican students were surveyed six months after the disaster, and 7.2 percent showed clinically significant symptoms of PTSD (Holpuch 2018). Months of school closures left children isolated, many without electricity or communication via telephones or television, furthering the mental health crisis.

Indirect Impact of Climate Change on Psychological Health

In many developed nations, children have begun to express concern about climate change at younger ages. This knowledge may cause worry, anxiety, and fear about the future and their own livelihood (Maibach and Feldman 2010). In a study conducted in the United States, 82 percent of surveyed 10- to 12-year-olds expressed anger, fear, or sadness when discussing environmental problems (Strife 2012). Researchers have classified climate change as a stressor on young individuals, regardless of its direct impact on their well-being.

Research & Policy Priorities

The following policy options provide a few key examples of mitigation strategies and policy research gaps that can be addressed to improve public health from the effects of climate change, especially for vulnerable children (for additional discussion and elaboration of priorities, see Appendix E).

- Develop extreme heat and flooding vulnerability maps at the neighborhood level to understand current and to model potential future areas that are most likely to require intervention, in order to ensure the location and targeting of assistance to vulnerable populations.

- Harden infrastructure and utilities against the effects of flooding and heat waves. Provide access to power, heat, running water, and especially cool indoor spaces during weather crises, while also ensuring that this infrastructure usage does not lead to power outages. Give special consideration and infrastructural resources to populations who cannot travel to get to cooling shelters, including the provision of air conditioning systems.

- Conduct policy research on the relationships between urban tree density, species distribution, pollen concentration, and human health impacts. Efforts to transition to low-carbon cities and strategies to reduce the urban heat island effect often incorporate urban tree-planting programs. However, these programs may then result in worsening of respiratory health outcomes from pollen and plant allergens.

- Develop early warning systems for detection and surveillance of developing epidemics and understanding changing disease patterns. These efforts must take place in areas for which research indicates that disease vectors will expand to as climates change.

- Develop funding structures that provide mental health relief aid packages following natural disasters, both for the short and long-term recovery of children and their families, including repeated visits with health-care and mental health professionals.

VI. The Effects of Climate Policy on Child Poverty

Not only does climate change harm poor children by fueling destructive weather patterns and exacerbating socioeconomic and health disparities, but the policy responses implemented to mitigate climate change disproportionately affect poor children as well. These mitigation policies, while designed to reduce greenhouse gas emissions, have both positive and negative impacts on children in poverty. For example, most mitigation policies generate substantial health co-benefits for poor children. And although some of these policies may have regressive distributional impacts and increase poverty rates, other policies may actually generate economic activity and provide financial benefits for low-income populations. Essentially, the specific blend of costs and benefits for poor children depends on the particular policy in question.

Figure 6. Causal Relationships Between Climate and Child Poverty

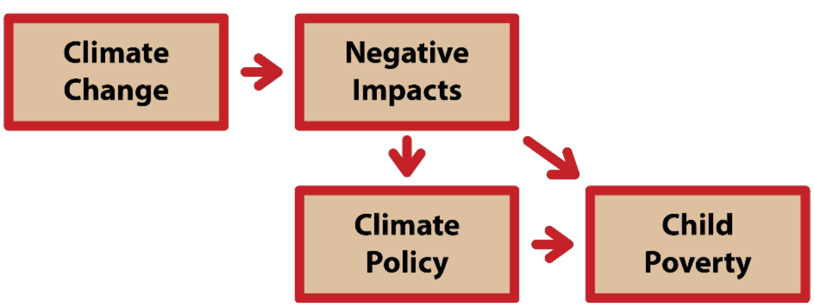
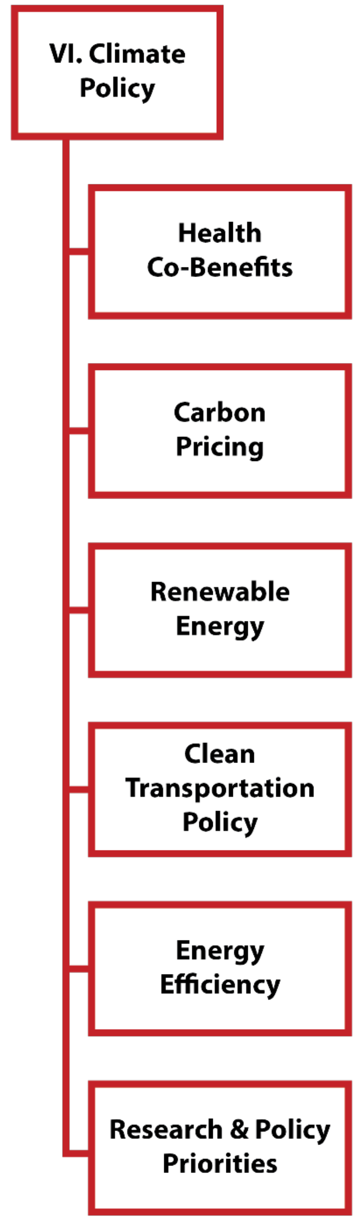


Figure 6: Causal pathways indicating how climate change affects child poverty through climate policy.

In this section, we present a thorough overview of the disparate effects of climate policy on child poverty. After outlining the health co-benefits that most mitigation policies have in common, we individually analyze each type of mitigation policy – carbon pricing schemes, renewable energy subsidies and mandates, clean transportation policies, and energy efficiency programs – to determine its unique consequences on child poverty (see Appendix F for the effects of negative emission technologies). Based on this empirical foundation, we then highlight key policy and research priorities that should guide the development of equitable climate change mitigation strategies – with the goal of alleviating child poverty in addition to informing future research agendas. Ultimately, we argue that mitigating climate change and reducing child poverty are compatible policy objectives that should be pursued together.



Health Co-Benefits

Effective mitigation policies would substantially improve the health of poor children by reducing the harmful burden of fossil fuel-generated air pollution. Currently, outdoor air pollution stemming from power plants, transportation, agriculture, and industry exacts a devastating toll on human health, prematurely killing an estimated 3 to 4 million people worldwide and nearly 500,000 people in OECD countries annually (OECD 2016; Lelieveld et al. 2015; WHO 2018). It also sickens many more, prompting increased hospital admissions and emergency room visits (K. H. Kim, Kabir, and Kabir 2015) and leading to respiratory and cardiovascular diseases, heart attacks, strokes, cancer, cognitive decline, and developmental disorders (WHO 2018; D'Amato et al. 2010; Sanders 2019; Cakmak et al. 2016; J. J. Kim 2004; Urman et al. 2014; Brugha and Grigg 2014; Perera 2017). Exposure to particulate matter, a byproduct of fossil fuel combustion, is especially toxic, substantially raising mortality rates and reducing life expectancies throughout the OECD and the world (WHO 2013; K. H. Kim, Kabir, and Kabir 2015; Zeger et al. 2008). The macroeconomic toll is severe; in fact, OECD countries lose an annual $1.4 trillion in welfare costs due to premature deaths caused by outdoor air pollution (OECD 2016; see Appendix D for information on water and soil pollution-related health problems).

Due to their small size and undeveloped bodies, children are more vulnerable to the detrimental consequences of this type of air pollution (Perera 2008; Cakmak et al. 2016; Confalonieri et al. 2007; Islam et al. 2007; Bunyavanich et al. 2003; Sacks et al. 2011). It can aggravate asthma (Tzivian et al. 2015; Esposito et al. 2014), reduce lung function (K. H. Kim, Kabir, and Kabir 2015), lead to more absences from school (Currie et al. 2009), and even lower test scores and hinder academic performance (Zweig, Ham, and Avol 2009; Stingone, McVeigh, and Claudio 2016; Zhang, Chen, and Zhang 2018; see Appendix E for more information). Fossil fuel-related air pollution also disproportionately harms minorities and low-income groups, as they are more likely to live near pollution sources and often lack access to health care and other resources (Cakmak et al. 2016; Hajat, Hsia, and O'Neill 2015; O'Neill et al. 2003; Bell and Ebisu 2012; see Appendix F for more information on how low-income groups are harmed).

Being both young and poor, children in poverty are thus doubly vulnerable to the adverse consequences of air pollution. Low-income children suffer from elevated rates of asthma and infections (Francis et al. 2018; Zahran et al. 2018), partly because they have higher air pollution exposure rates due to being likelier than their peers to live near power plants and busy roads (Cook et al. 2011; S. Li et al. 2011; Morgenstern et al. 2007; J. Edwards, Walters, and Griffiths 1994; Evans 2004). One study also showed that poor children in urban areas had elevated rates of exposure to the carcinogen benzene, most likely due to vehicle exhaust (Chaudhuri 1998). Rates of childhood cancers, including leukemia, were also higher for children living near high-traffic areas, and respiratory symptoms and asthma were especially high for those children living within 100 meters of a highway (Van Vliet et al. 1997; Pearson, Wachtel, and Ebi 2000; Boothe et al. 2014). And because children in poverty tend to lack access to quality medical care in many OECD nations, especially in the United States due to its lack of universal health care, they often fail to receive treatment for air pollution-related conditions. Furthermore, air pollution can actually perpetuate poverty and have long-lasting ramifications on children's quality of life due to its harmful effects on child development, cognitive ability, academic performance, and school attendance; in fact, higher pollution levels during infancy were associated with significant negative labor market outcomes thirty years later — reducing both earnings and participation (Isen, Rossin-Slater, and Walker 2017).

Figure 7a. Population Exposure to Unhealthy Amounts of Air Pollution

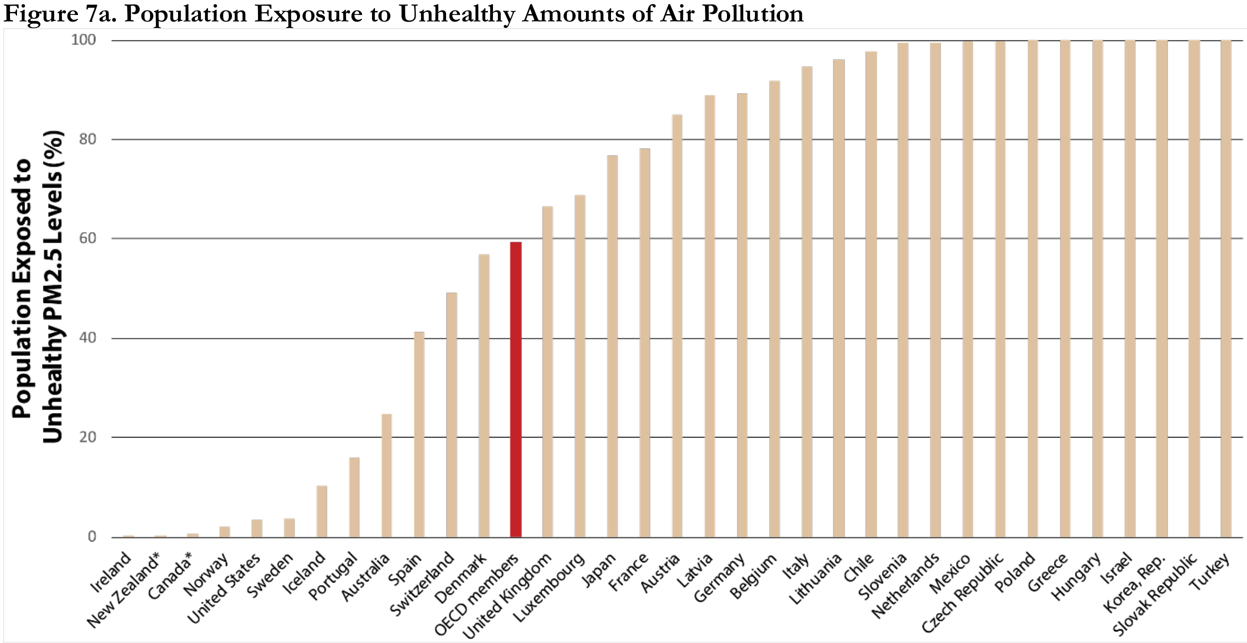


Figure 7a: This graph depicts the percentage of the population of each OECD member state that is, according to WHO standards, exposed to unhealthy levels of PM2.5 air pollution in 2017 (2015 for New Zealand and Canada). Geography and population density largely determine air pollution levels in OECD nations; larger, less dense, and more isolated countries tend to have lower levels (e.g., Australia, New Zealand, Canada, the United States, etc.). Countries on western edges of continents also tend to have lower levels, because of the direction of prevailing winds (e.g., Ireland, Portugal, Spain, etc.). Conversely, increased fossil fuel consumption, greater use of diesel engines, denser levels of industry, less stringent air pollution regulation, and increased population density within valleys or on the west side of obstructive mountain ranges also lead to worse air pollution levels. (World Bank 2020)

Climate change mitigation ameliorates these fossil fuel-related health problems. By reducing anthropogenic greenhouse gas emissions, mitigation measures also induce sharp declines in outdoor air pollution, and reducing air pollution lowers related morbidity and mortality (WHO 2018). Researchers have long emphasized the health co-benefits from such changes, especially the distributional impacts that may help the poorest populations (Nemet, Holloway, and Meier 2010; West et al. 2013; Anenberg et al. 2012; Harlan et al. 2011; Jack and Kinney 2010; WHO 2011; Shaw et al. 2014; Gao et al. 2018). A review found that each ton of carbon dioxide mitigated led to an average of $44 in benefits in developed countries – solely stemming from the health effects of improved air quality (Nemet, Holloway, and Meier 2010). Another review found that, worldwide, the health co-benefits of mitigation were $50 to $380 per ton of carbon dioxide, easily surpassing typical carbon pricing rates (West et al. 2013). In fact, the authors state that they have most likely underestimated the health co-benefits of mitigation because they do not account for morbidity effects, especially for children. A particularly robust systematic review found that greenhouse gas mitigation strategies produce substantial public health co-benefits, from reduced pollution primarily related to energy, transportation, and agricultural sectors (Gao et al. 2018; Scovronick et al. 2019; see Figure 7b below).

A series of natural experiments provide the supporting evidence to substantiate these claims that mitigation will lead to substantial health co-benefits, especially for children in poverty. For example, making use of a recession-induced decline in air pollution, one study found that decreased particulate levels led to a significant reduction in infant mortality (Chay and Greenstone 2003). Similarly, the closing of a steel mill, a significant source of particulate pollution for a nearby town, led to dramatic health gains for children (Ransom and Pope 1995). When it was reopened, hospital admissions for pneumonia, bronchitis, asthma, and other respiratory diseases sharply increased; in particular, children's hospital admissions more than doubled compared to when the mill was closed (Pope 1989).

Figure 7b. The Net Benefits of Climate Policy – Incorporating Health Co-Benefits

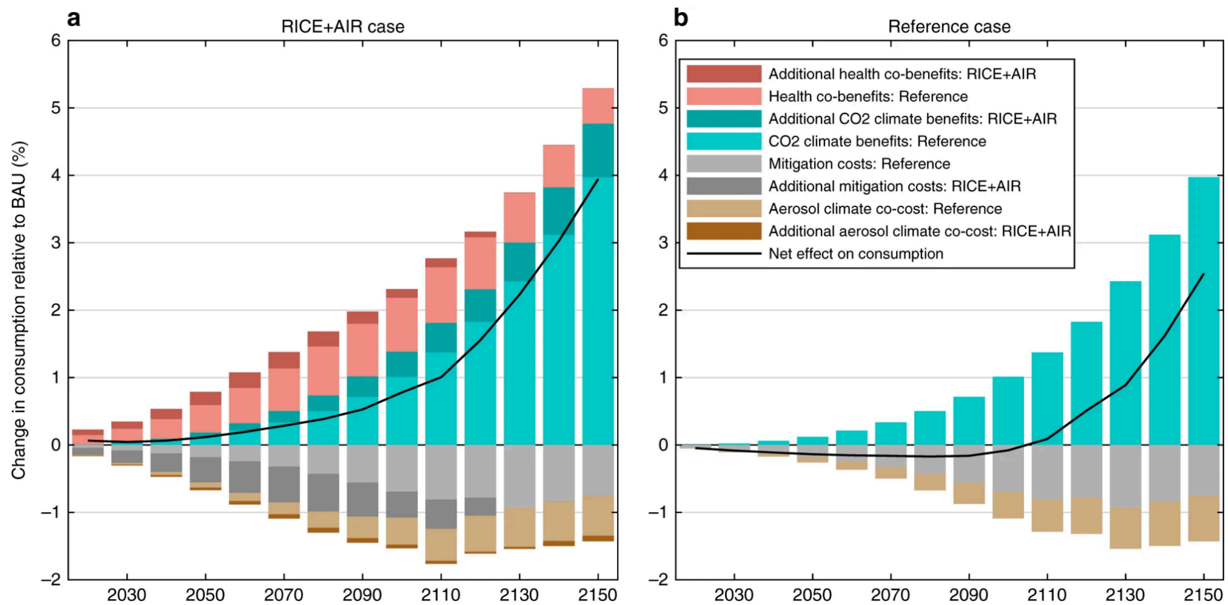


Figure 7b: The chart on the left shows that incorporating the health co-benefits of mitigation (colored in red) into cost-benefit calculations leads to immediately positive total net benefits from mitigation. The chart on the right – depicting the traditional cost-benefit calculation, without considering health co-benefits – indicates that mitigation is net negative until beyond 2100. Adapted from Scovronick et al. 2019.

Transportation-related mitigation policies would also engender substantial health benefits for low-income children. Researchers found that the implementation of electronic highway tolls led to an 11 percent decline in preterm births and a 12 percent drop in low birth weights in nearby areas, due to the reduction in vehicle exhaust-related air pollution (Currie and Walker 2011). Likewise, another study found that retrofitting school buses with less-polluting engines not only improved the respiratory health of children but also raised the children's test scores in English and math (Austin, Heutel, and Kreisman 2019).

Carbon Pricing

One much-discussed, market-based mitigation strategy involves pricing carbon and other greenhouse gases through the imposition of a tax or trading scheme (Rausch, Metcalf, and Reilly 2011). Often touted by prominent economists, a carbon tax functions by increasing the cost of emitting carbon (i.e., internalizing a negative externality), thus incentivizing firms and individuals to reduce their carbon emissions. Many OECD countries, including Finland, Sweden, Norway, Denmark, Switzerland, Poland, Ireland, Japan, and France have already implemented a modest carbon tax that has proven to be moderately effective at reducing carbon emissions (Q. Wang et al. 2016). While they do help mitigate climate change and generate the associated co-benefits, carbon taxes can have inequitable distributional effects because a disproportionate amount of the incidence may fall on low-income households. Thus, they may harm poor children in OECD countries unless measures are taken to counteract these effects, such as using the revenue to bolster social benefits (Tol and

Verde 2009; K. Feng et al. 2010; Callan et al. 2009; Q. Wang et al. 2016; Grainger and Kolstad 2009; Bento et al. 2009; Wier et al. 2005; Gough 2013).

Many studies have demonstrated that, in the absence of redistributive policies and revenue recycling programs, most carbon pricing schemes are regressive – meaning that they disproportionately affect low-income households and thus harm poor children. This regressive effect has been demonstrated across several OECD countries, including Ireland (Callan et al. 2009; Tol and Verde 2009), the US (Grainger and Kolstad 2009; Williams et al. 2014), the UK (K. Feng et al. 2010; Gough et al. 2010), France (Bureau 2011; Berry 2019), Germany (Haug, Eden, and Montes de Oca 2018), Belgium (Vandyck and Van Regemorter 2014), and Denmark (Wier et al. 2005). In the United States, for example, a modest carbon tax would substantially reduce the income of the poorest deciles; a $15 levy per ton of carbon dioxide would result in a 3.5 percent reduction in income (Mathur and Morris 2012).

The explanation for this regressive effect is simple. Electricity use across the income distribution is relatively constant, yet high-income groups have a substantially greater amount of disposable income (Callan et al. 2009). Because poor populations thus must spend a greater proportion of their income on electricity and necessities, they are more adversely affected than their higher-income counterparts (Q. Wang et al. 2016). Essentially, low-income households spend a larger proportion of their income on these taxes. Because carbon pricing schemes raise energy costs, they also send ripples throughout the economy – increasing the cost of food, transportation, heating and cooling, and other goods, which reduces purchasing power for low-income households and lowers their real incomes (K. Feng et al. 2010; Vandyck and Van Regemorter 2014; Tol and Verde 2009). Carbon taxes also have other deleterious ramifications; for example, they raise costs for firms, meaning owners may employ less labor to compensate for the additional tax burden, potentially lowering the incomes of poor families (Haug, Eden, and Montes de Oca 2018). And they penalize consumption more than investment, harming poor consumers but leaving wealthier investors relatively unaffected.

The exact distributional effects depend on the particulars of the tax scheme. Carbon taxes levied directly on households tend to be more regressive than indirect ones imposed on industry (Wier et al. 2005). Some authors have also posited that the more narrowly a carbon tax is levied on energy consumption, as opposed to all emissions, the more regressive it is (Grainger and Kolstad 2009). Additionally, carbon taxation differs from greenhouse gas taxation; a tax only on carbon most affects home energy costs, while greenhouse gas taxation shifts the burden onto food costs as agriculture is likely to be affected, which can increase urban poverty (K. Feng et al. 2010; Tol and Verde 2009; Renner 2018). In Mexico, for example, taxing greenhouse gas emissions without redistributive policies is especially regressive and raises poverty rates (Renner 2018). Several studies have found that carbon tax schemes without revenue recycling will specifically increase fuel poverty (Berry 2019; Gough 2013; Bureau 2011; Dresner and Ekins 2006). Fuel poverty has substantial deleterious effects on health and quality of life (Hills 2012), as it causes households to cut back on other spending (W. Anderson, White, and Finney 2012; Casillas and Kammen 2010; Dresner and Ekins 2006; Howden-Chapman and Chapman 2012) – especially contributing to child poverty and harming children experiencing poverty (McChesney 2013).

Carbon taxes also have disparate impacts on different poor populations. For example, a study investigating the effect of carbon taxation on car users found that a modest carbon tax was regressive, as the poorest households lost 6.3 percent of their income while the wealthiest only lost 1.9 percent (Bureau 2011). But this aggregate effect masks specific geographic disparities. Poor households in peri-urban or rural areas lost nearly twice as much income as their urban and suburban counterparts (Bureau 2011). Additional research supports this finding that carbon taxes can elicit disparate regional impacts; for example, rural populations often are more adversely affected due to higher heating, electricity, and fuel costs (Renner 2018) – and farmers may be especially burdened due to agricultural emissions (Wier et al. 2005; Gough et al. 2010). These findings reveal that the lack of public transit and the degree of reliance on private vehicles mediates the distributional effects of carbon taxation. Furthermore, regions dependent on fossil fuel-generated electricity tend to fare worse in response to carbon taxation, and communities that rely on carbon-intensive industries for income may suffer from rising rates of unemployment and economic turmoil (Haug, Eden, and Montes de Oca 2018). Specifically, those employed in the fossil fuel industry may see job losses and income reductions, which could exacerbate child poverty.

Not all studies, however, have found that carbon taxes in developed countries are regressive. Some have demonstrated carbon taxes, especially fuel taxes, may be proportional or ambiguous (Sterner 2012; Creedy and Sleeman 2006), and others have shown that they may even be mildly progressive because low-income groups derive a larger proportion of their income from unaffected government transfers and tend to spend less on the most carbon-intensive goods (Labandeira, Labeaga, and Rodríguez 2009; Sajeewani, Siriwardana, and McNeill 2015; Oladosu and Rose 2007). For example, researchers found that British Columbia's revenue-neutral carbon tax is progressive even without considering revenue recycling, because the province's low-income residents rely more on government transfers than their higher-income counterparts and because the region has an abundance of electricity generated by hydropower rather than fossil fuels (Beck et al. 2015). Other researchers argue that carbon taxes are less regressive when considering lifetime earnings as opposed to annual earnings (Hassett, Mathur, and Metcalf 2009), and one OECD report illustrated that fuel taxes were, on average, progressive in Europe due to reduced rates of car ownership among low-income households (Flues and Thomas 2015). (For information pertaining to the distributional effects of carbon taxation in developing countries, see Appendix J).

Some economists reject claims that carbon taxes are regressive. Even without considering the potential of revenue recycling, Metcalf (2019) argues that a carbon tax would be progressive in the United States. He contends that a carbon tax would reduce rates of return on capital more than it would reduce wages and therefore would disproportionately affect owners of capital. Other research also suggests factors of production may bear the burden of carbon taxation (Fullerton and Heutel 2007). Additionally, Metcalf claims that some government transfers are indexed to inflation and thus would increase proportionately with rising prices. Not all transfers, however, account for rising prices due to inflation.

Despite the possible regressive effects of a pure carbon tax, there is an overwhelming consensus that carbon pricing schemes that redirect tax revenues toward low-income populations and social programs can be progressive and improve quality of life for the most vulnerable populations, including poor children (Metcalf 2019; Tol and Verde 2009; Haug, Eden, and Montes de Oca 2018; Berry 2019; Bureau 2011). Even progressive carbon taxes can become even more progressive with the addition of revenue recycling schemes (Beck et al. 2015). In fact, often only a small proportion of the revenue raised — as little as 11 percent — needs to be transferred to poor populations to offset the regressive effects of carbon pricing (Mathur and Morris 2012). Studies have shown that redistributive revenue recycling can reduce poverty (Berry 2019). Therefore, carbon pricing and poverty reduction are not mutually exclusive endeavors.

A variety of revenue recycling methods have been proposed for transferring resources to low-income households, including uniform lump sum payments and rebates (Klenert and Mattauch 2016), food subsidies (Gonzalez 2012), wage tax reductions and labor tax swaps (Williams et al. 2014; Chiroleu-Assouline and Fodha 2014), tax credits and exemptions (K. Feng et al. 2010), and welfare services (Callan et al. 2009; Mathur and Morris 2012). Welfare gains and progressivity, however, are strongly contingent on exactly how revenue is recycled (Gonzalez 2012; Renner 2018). For example, some revenue recycling methods would be ineffective to counteract these negative distributional effects, including proportional rebates and linear income tax cuts (Klenert and Mattauch 2016), manufacturing subsidies (Gonzalez 2012), and capital tax cuts (Williams et al. 2014), which all can exacerbate the regressive impacts.

To analyze the potential distributional effects of a moderate carbon tax in the United States, the Urban-Brookings Tax Policy Center, a nonpartisan thinktank, compared different revenue recycling options: directing revenue toward reducing the federal deficit (i.e., no revenue recycling), decreasing payroll taxes, cutting the corporate income tax, or disbursing a per household lump-sum rebate (Rosenberg, Toder, and Lu 2018; see Figure 8 below). It found that – with a carbon tax of $50 per metric ton – only the household rebate benefited households in the bottom quintile, reducing their tax burden by 5.3 percent of their pretax income. (In fact, this rebate overcompensates low-income families for the tax-induced reduction in real incomes and thus would function similarly to an income subsidy of 3.1 percent of their pretax incomes; on the other hand, a rebate of 2.2 percent of their pretax income would compensate them exactly, potentially leaving additional funds to be spent on other programs). The other options were all regressive; the payroll tax reduction mildly increased taxes on the bottom quintile, while the deficit reduction and corporate tax cut raised the bottom quintile's tax burden by as much as 2 percent of their pretax income – and these final two options actually reduced the tax burden of those with higher incomes. Essentially, a carbon tax without appropriate revenue recycling raises the prices of consumer goods and reduces real incomes for low-income populations, but redistributing the revenue through a household rebate may actually overcompensate low-income groups and raise real-incomes. Other organizations have performed comparable analyses and reached similar conclusions (Pomerleau and Asen 2019). Furthermore, the distributional effects also depend on the delivery mechanism by which these cash payments are disbursed; low-income households and children must be able to receive their rebates (Stone 2015).

Figure 8. Distributional Effects of Four Carbon Tax Revenue Recycling Schemes in the United States

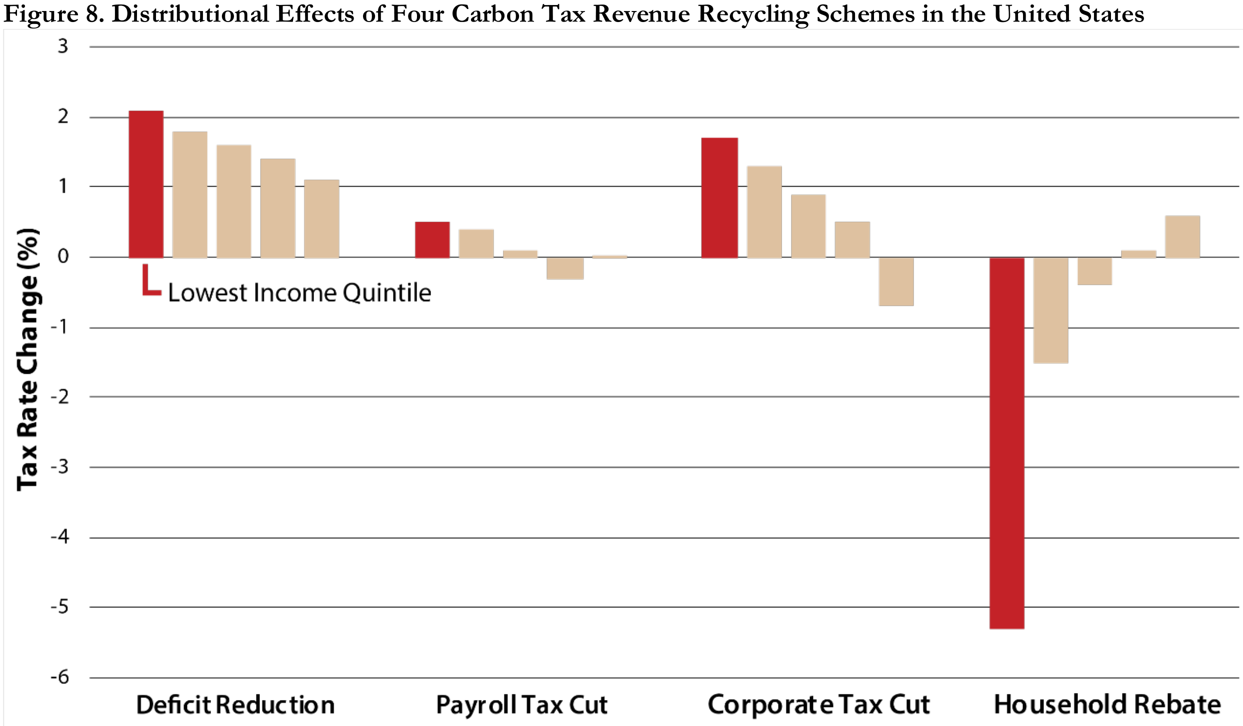


Figure 8: This chart shows the predicted tax change (as a percentage of household pretax income) for four different revenue recycling options after the imposition of a moderate carbon tax in the United States, displayed by median impact on each income quintile, from lowest to highest income quintile. (Rosenberg, Toder, and Lu 2018)

Renewable Energy

While economists have historically emphasized the desirability of a carbon tax to mitigate climate change, subsidies and mandates increasing the deployment of renewable energy sources, as well as industrial policy and government interventions that promote renewables, have recently attracted significant attention. While there is a scarcity of robust research on the subject, this new "green economy" and the increased funding for renewable energy sources (i.e., supply-side subsidies) have the potential to help reduce child poverty by fostering economic growth and generating employment — although some of the current demand-side subsidies and mandates in place are regressive and fail to benefit the most vulnerable.

While the benefits may have previously been overstated, transitioning to renewable energy can lead to net job creation in the short-term and thus provide strong sources of income for those employed in the nascent industry

(IRENA 2011; Blythe et al. 2014; Fankhauser, Sehlleier, and Stern 2008; Dalton and Lewis 2011; Dvořák et al. 2017; Lehr, Lutz, and Edler 2012; Llera et al. 2013). Already, OECD countries have seen tremendous job creation from the deployment of renewables, including in the Czech Republic (Dvořák et al. 2017), Germany (Lehr, Lutz, and Edler 2012), the Netherlands (Bulavskaya and Reynès 2018), Spain (Rodríguez-Huerta, Rosas-Casals, and Sorman 2017), Greece (Lavidas 2019), Turkey (Çetin and Eĝrican 2011), the UK (Blythe et al. 2014), and the US (Wei, Patadia, and Kammen 2010). This job creation can help raise market incomes for low-income families, thus potentially alleviating child poverty.

One primary factor spurring this job growth is that the renewable energy sector, especially solar photovoltaic (PV) and wind energy, is substantially more labor intensive than conventional energy and growing at a faster rate (Blythe et al. 2014; Dalton and Lewis 2011; Wei, Patadia, and Kammen 2010; Singh and Fehrs 2001). Renewable energy employment opportunities include "direct jobs in manufacturing, construction, operation, and management" as well as "indirect jobs" in supply chains and jobs induced in other sectors due to growth (Simas and Pacca 2014). One study found that each $1 million invested in renewable energy creates more than 7.5 jobs, while the equivalent invested in fossil fuels creates only about 2.5 jobs — "thus each $1 million shifted from brown to green energy will create a net increase of 5 jobs" (Garrett-Peltier 2017). In terms of the amount of energy generated, renewables are also more job intensive.

From 2017 to 2030, the International Renewable Energy Agency (IRENA) predicts that 6 million more people will be employed in the renewable sector worldwide (IRENA 2018). By 2050, researchers have predicted that the renewable energy sector — especially solar photovoltaic (PV), batteries, and wind — will contribute to tens of millions of new jobs in the power sector (Ram, Aghahosseini, and Breyer 2020). Additional research has supported this job creation claim; in the EU, a transition to 100 percent renewable energy has the potential to generate 10 million jobs (Connolly, Lund, and Mathiesen 2016), and a transition to 100 percent renewable energy in 129 countries is predicted to generate more than 24 million net long-term, full-time jobs (Jacobson et al. 2017). California alone will see approximately 220,000 net jobs (Jacobson et al. 2014). These additional jobs can help raise market incomes for poor families and reduce child poverty rates.

These new renewable jobs are well distributed geographically and offer higher wages than typical service sector work, so they have the potential to reduce poverty levels — especially if training programs and additional redistributive policies accompany them. There are, however, significant caveats. Accurately measuring job creation and job intensity is notoriously difficult, and current metrics have lacked standardization — meaning it is hard to compare results between studies (Dalton and Lewis 2011; Lambert and Silva 2012). There are also competing methodologies that may produce conflicting results (Llera et al. 2013). Some scholars have also suggested that renewable energy, especially government policies promoting renewables, have hurt economic growth and led to job losses (Frondel et al. 2010).

Regardless, it is important to restate that job creation does not necessarily translate to reduced levels of child poverty (Hull 2009). If renewable energy companies offer low pay or fail to hire low-income parents, renewable energy-related employment gains would not boost the market incomes of poor households and thus fail to decrease child poverty. Additionally, despite net gains, the growth in the renewable sector will lead to concentrated job losses and depressed economic performance in the fossil fuel sector, which could increase child poverty in communities dominated by conventional energy jobs (Haug, Eden, and Montes de Oca 2018; Rausch and Mowers 2014).

Another potential consideration is the regressive effect of current demand-side renewable subsidies (Borenstein and Davis 2016; Rausch and Mowers 2014). Renewable energy subsidies often benefit the rich at disproportionate levels and neglect those experiencing poverty (F. Wang and Zhang 2016). Federal tax credits in the United States are especially regressive: "the bottom three income quintiles have received about 10 percent of all credits, while the top quintile has received about 60 percent" (Borenstein and Davis 2016). Results from a study evaluating the distributional impacts of U.S. energy policy support this conclusion (Metcalf 2019). Renewable energy subsidies, however, were not found to be regressive in the Italian context (Distante, Verdolini, and Tavoni 2017). Mandating that electric utilities consider the social costs of energy generation and consumption when developing new plants or altering old ones could also spur the transition to renewable energy without adversely affecting poorer populations, as electricity sources like wind and solar carry far fewer social costs compared to fossil fuels and would thus be favored (Trabish 2017). In fact, these mandates to incorporate social costs into utility company calculations could even serve as a less regressive alternative to carbon taxation or demand-side renewable subsidies.

Finally, increased energy costs due to more costly renewable energy sources could exacerbate fuel poverty (Frondel, Sommer, and Vance 2015; Neuhoff et al. 2013), but, as the price of renewable electricity plummets and starts to become cheaper than fossil fuel-generated electricity (Nemet 2019; IRENA 2019; Roberts 2018; Lazard 2017), cheaper energy provided by renewables may actually reduce fuel poverty rates. Additionally, because renewable electricity is more decentralized, grids powered by renewables are more resilient to natural disasters.

Clean Transportation Policy

Mitigation often involves efforts to reduce emissions stemming from the transportation sector, especially from cars and trucks. This includes fuel efficiency standards, investment in public transit and regional rail, and subsidies and tax credits for electric vehicles. Clean transportation policies have the potential to improve the health of low-income groups in addition to increasing their levels of mobility, both of which can lead to gains in household income and quality of life.

As previously discussed, low-income groups, especially minorities and children, often suffer the most from transportation-related air pollution (Pearson, Wachtel, and Ebi 2000; Boothe et al. 2014; Van Vliet et al. 1997). Reducing automobile traffic thus can improve health outcomes for children experiencing poverty (Simeonova et al. 2018; Currie and Walker 2011; Austin, Heutel, and Kreisman 2019)). Furthermore, public transit is associated with increased amounts of daily walking and improved health outcomes from the additional exercise (R. D. Edwards 2008; Freeland et al. 2013; Lachapelle and Frank 2009).

Beyond vastly improving health due to reduced air pollution and increased physical activity, public transit acts as a mechanism facilitating sustainable mobility (Wachs 2010) and is also more affordable than owning a private vehicle, meaning increased mobility for children in poverty. Access to public transit has been linked to improved quality of life (Lee and Sener 2016; Cao 2013) and social inclusion (Godard and Olvera 2000). It provides the means for children to get to school (Ferguson, Bovaird, and Mueller 2007), for low-income children to access healthcare (Grant et al. 2014), and for low-income parents to get to work (Hess 2005) and to grocery stores (Grengs 2001). In fact, one study found that "9 percent of children in low-income households miss a [health care] appointment because transportation was not available," compared to 4 percent of the general population (Grant et al. 2016). Not only that, but public transit allows low-income groups and children to visit friends, family, and cultural destinations. It is especially important for children and parents experiencing homelessness, as it is critical for mobility (Jocoy and Del Casino 2008).

Other studies have found that public transit can reduce unemployment: "poor public transportation services [act] as critical obstacles to improving the economic and social conditions of low-income persons" (Sanchez 2008). While access to it has been declining for marginalized groups, in part due to the "suburbanization of poverty" that has pushed low-income families farther away from urban centers (Raphael and Stoll 2010), public transit can offer employment and other opportunities for low-income populations (Mckenzie 2013). Other studies, however, have found that public transit is not associated with increased employment outcomes for welfare recipients (Sanchez, Shen, and Peng 2004). Nevertheless, expanding transit would likely benefit these populations (Giuliano 2005). Pathak et al. (2017) explain the implications of their research on public transit: "The findings underscore the importance of public transportation for low-income households and suggest that improving access to bus transportation may assist in […] creating more equitable and inclusive cities" (p. 198).

Research has demonstrated, however, that some green transportation policies have failed to help low-income groups. Studies have shown that fuel efficiency standards (Borenstein and Davis 2016; Rausch and Mowers 2014) as well as tax credits for electric vehicles (Metcalf 2019) tend to be regressive. For example, in the United States, the top quintile captured 90 percent of the federal income tax credits for fuel-efficient vehicles (Borenstein and Davis 2016). The authors suggest that the nonrefundability of the credits and the lack of liquidity and credit among low-income individuals may explain these regressive effects. Other research has directly compared fuel efficiency standards and gasoline taxes, finding that efficiency standards are more regressive than gasoline taxes with revenues returned lump sum (L. W. Davis and Knittel 2018; Levinson 2016).

Energy Efficiency

State-funded improvements in residential energy efficiency can alleviate poverty by helping low-income families reduce energy expenses (Casillas and Kammen 2010; Hills 2012). Fuel poverty frequently forces poor households to ration energy consumption and therefore endure low temperatures during winter months (W. Anderson, White, and Finney 2012; Hills 2012). Not only do policies that increase residential energy efficiency (at the government's expense) reduce energy costs, but they also help keep homes warm in the winter — which can generate substantial quality of life improvements and health benefits (Howden-Chapman and Chapman 2012).

Urge-Vorsatz & Herrero (2012) have noted the potential synergy between fuel poverty reduction initiatives and climate change mitigation, as both invoke promoting energy efficiency as possible solutions. High-efficiency homes can dramatically reduce heating energy use (L. D. D. Harvey 2010), which can slash fuel costs and reduce fuel poverty rates (Ürge-Vorsatz and Tirado Herrero 2012; Bird and Hernández 2012). Some interventions aiming to reduce fuel poverty through energy efficiency programs have proved successful at increasing warmth and social functioning (Heyman, Harrington, and Heyman 2011). One energy efficiency initiative in England, the Warm Front Program, achieved success at combating both climate change and fuel poverty (Sovacool 2015). From 2000 to 2013, it upgraded 2.3 million "fuel poor" homes by weather-proofing and insulating them, and it "not only lessened the prevalence of fuel poverty" but "cut greenhouse gas emissions, produced an average extra annual income of nearly £2000, and reported exceptional customer satisfaction" (p. 361).

Additionally, aggressive energy efficiency programs can provide job opportunities for low-income parents (ACEEE n.d.; Wei, Patadia, and Kammen 2010; Roland-Holst 2008).

Research & Policy Priorities

We urgently need to enact mitigation policies to combat climate change, but it is imperative for policymakers to examine their impacts – both positive and negative – on children in poverty, an already vulnerable population. Fortunately, climate change mitigation and child poverty reduction are not mutually exclusive goals – they are interlinked and compatible, and we can and should strive for both objectives simultaneously. But, as this section articulates, necessary consideration must be taken to ensure equitable and sustainable outcomes for poor children and the planet.

Having outlined the multiple mechanisms by which climate change mitigation affects child poverty, we now formulate a series of priorities for policymakers and researchers to consider when developing climate policy. We hope these priorities will guide policymakers as they devise equitable mitigation policies that not only will avoid exacerbating the scourge of child poverty but will also help alleviate this dire issue (for additional priorities, see Appendix K).

- Consider the distributional impacts of all potential mitigation policies prior to implementation, especially their impact on child poverty. While many mitigation policies will generate diffuse benefits, some may produce concentrated costs on low-income groups and thus harm poor children. When devising climate policy, preventative measures must be taken to redress any regressive and inequitable impacts.

- Emphasize the health co-benefits of mitigation when crafting and communicating climate policy, as these positive impacts are vast, visible, immediate, and substantial. By reducing emissions of fossil fuel-related pollutants, mitigation will improve the health of children in poverty – reducing the harmful burden of respiratory diseases, lowering hospital admission rates, preventing infant mortality and morbidity, promoting child well-being, improving educational outcomes, and generating long-lasting labor market benefits.

- Ensure that carbon pricing schemes redirect tax revenues toward low-income populations and social services to offset potentially regressive effects that may harm poor children. In addition to combating climate change, this type of redistributive revenue recycling can even bolster social benefits, improve general welfare, and reduce child poverty — if designed properly. In fact, only a relatively small proportion of the revenue needs to be redirected to make carbon taxation progressive. Failure to do so, however, can exacerbate child poverty by raising costs of energy and consumer goods and reducing incomes.

- Protect low-income households reliant on carbon-intensive industries from the imminent yet localized economic devastation triggered by some mitigation measures. Mitigation necessarily entails phasing out the fossil fuel sector, which could produce concentrated pockets of economic hardships and increased child poverty rates. Robust welfare services – including unemployment insurance, child allowances, universal health care, universal basic income, and other measures to bolster the safety net – will be crucial to ease this transition, coupled with job retraining programs and grants as well as subsidized educational opportunities for affected workers.

- Conduct more research into the distributional effects of an augmented renewable energy sector – to investigate its job growth and poverty reduction potential. While most studies have demonstrated that the renewable energy sector has led to net job creation, some have offered dissenting conclusions. Other studies have been conducted by organizations with financial stakes in affected industries, indicating a potential for bias and casting doubts on the accuracy of the findings. We would benefit greatly from systematic reviews or meta-analyses investigating the renewable energy sector's impact on net job creation, income growth, and poverty levels.

VII. Conclusions & Recommendations

By damaging property, disrupting economies, straining welfare services, and impairing human health, climate change magnifies the negative impacts of child poverty and directly harms poor children in OECD countries. Furthermore, the national, regional, and local policies implemented to mitigate climate change often have the unintended consequence of disproportionately harming low-income families. These destructive impacts, however, are not inevitable; they can be minimized through concerted action by policymakers and researchers. To aid in this effort, we synthesize the breadth of policy and research priorities from each of the previous sections into four interlinked recommendations designed to guide policymakers and researchers. In doing so, we have considered the general costs and feasibility of these alternatives and prioritized accordingly, but the ultimate responsibility for translating these broad recommendations to specific contexts lies with the local policymakers themselves, as they are best acquainted to navigate the idiosyncrasies and unique political climates of their respective countries.

While we have devised this four-part typology for analytic utility, we wish to emphasize that these recommendations are inherently interconnected and interdependent; each one builds on another, and the boundaries between them are blurry. We hope researchers and policymakers consider these recommendations not in isolation but as integral components of a holistic agenda that will help alleviate child poverty and combat climate change.

Identify High-Vulnerability Areas

First, OECD nations must investigate climate change's heterogeneous geographic impacts, taking into account the variability and uncertainty of future climate change-related hazards. Before policymakers can develop strategies to counteract climate change's destructive consequences on poor children, they must understand which areas and populations will be most adversely affected. Thus, researchers should develop comprehensive, high-resolution vulnerability maps to identify countries, regions, cities, and even neighborhoods most susceptible to climate change-induced natural disasters, including severe storms, flooding, wildfires, and extreme heat events. These detailed spatial representations must also incorporate ecological and epidemiological data to illustrate how climate change will elevate and expand disease burden and pandemic risk in OECD countries. This information will be crucial in boosting disaster preparedness and allocating resources more effectively to prevent and mitigate crises. But distributional implications must be taken into account as well; these maps should pay specific attention to poor children and how child poverty interacts with climate change-induced natural disasters to exacerbate negative outcomes. Fortunately, this recommendation is relatively inexpensive and politically feasible to implement in most OECD countries, so efforts to address it should begin immediately.

Invest in Resilient Infrastructure

Second, OECD nations must invest in affordable climate-resilient infrastructure – including man-made infrastructure (e.g., seawalls, levees, and hurricane-resistant buildings), natural infrastructure (e.g., wetlands, mangroves, and fire-resistant forests), and social infrastructure (e.g., hospitals, schools, and community centers) – to protect poor children and other vulnerable groups from climate change-related damages. Policymakers must fortify utilities – including electricity, gas, water, sewage, communication (e.g., phone lines, radio towers, and internet cables), transportation, and air conditioning – to adapt to the wide-ranging ramifications of a changing climate and to ensure provision of these essential services during severe weather outbreaks and natural disasters. Policymakers must also construct a legal and regulatory framework to incentivize and mandate climate-resilient development – establishing building codes, retrofitting existing structures, requiring climate assessments, and incorporating climate modeling into planning and service provision. Development should be avoided in the high-risk areas identified using vulnerability maps, including in floodplains, along low-lying coastlines, and in wildfire-prone regions. Most importantly, countries must develop extensive monitoring programs, early warning systems, and contingency plans for when climate-resilient infrastructure fails, as emergency planning is crucial to prevent unnecessary damage and harm to poor children. Political feasibility and public appetite for these massive infrastructure improvements will peak in the immediate aftermath of natural disasters, so policymakers must capitalize on these climate-induced emergencies and "never let a good crisis go to waste."

Increase Access to Welfare and Social Services

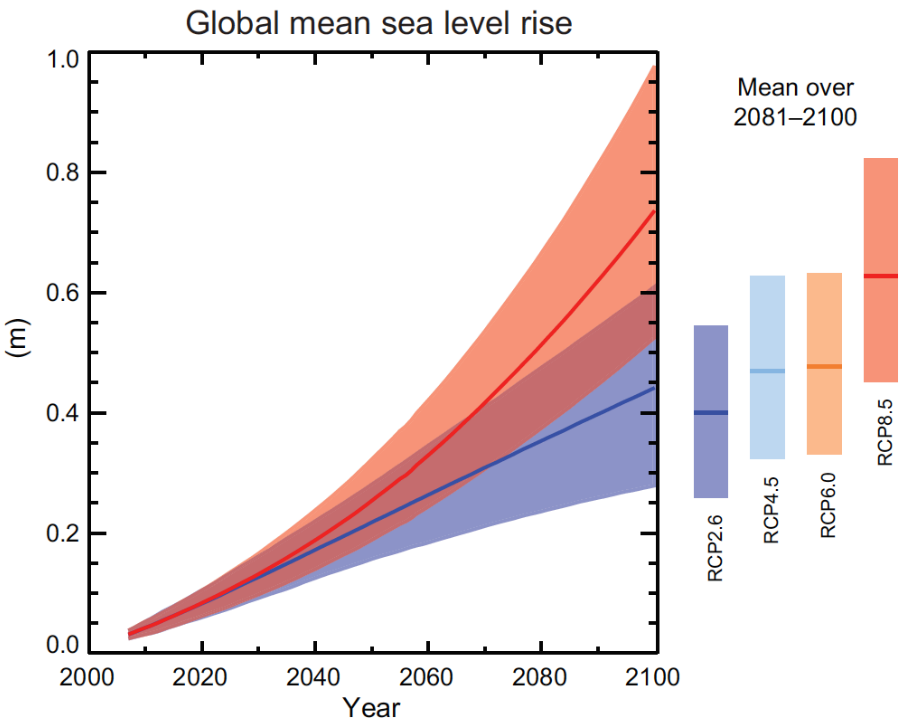
Third, OECD nations must bolster social safety nets and expand access to welfare services to alleviate climate change's disproportionate burden on poor children. These social programs can provide both universal and targeted benefits, including direct cash transfers, unemployment insurance, public employment initiatives, food access policies, and public housing and rehousing programs. Child allowances in particular can serve as an effective strategy to lift children out of poverty and ensure their well-being, and these benefits should be made more generous and expansive to account for the effects of climate change. Proceeds from a carbon tax can even supply some of the necessary revenue for these redistributive policies, in addition to compensating lower income groups for the rising prices of consumer goods and a reduction in real incomes. Health care, including preventative and mental health care, must also be made affordable and accessible to poor children and their families. Additionally, countries must offer legal services, food, and shelter options even during acute environmental crises. In sum, climate change necessitates a reinforced and augmented safety net to protect poor children and reduce child poverty. While these more expensive reforms may be difficult to implement in an era of austerity, welfare state retrenchment, and right-wing populism, they are absolutely essential, and their long-term social and economic benefits clearly outweigh their more immediate costs.

Consider the Distributional Effects of Climate Policies

Fourth, OECD nations must consider the distributional effects of climate policy, especially its impact on poor children. Most importantly, the substantial yet often undervalued health co-benefits of mitigation must be communicated properly and incorporated into cost-benefit analyses in order to more accurately weigh the pros and cons of mitigation measures. These health co-benefits are vast, visible, immediate, and substantial, and they may even eclipse mitigation's main climate-related benefits, especially in the upcoming decades. Additionally, carbon pricing schemes and other mitigation policies must also involve revenue recycling to offset any regressive effects on low-income households and poor children. This redistribution can be accomplished through direct cash transfers or by using tax revenues to enhance and enlarge welfare services. Finally, researchers must conduct studies exploring the potential for the growing renewable energy sector to promote economic activity and lead to net job creation. Its impact on poor children is promising yet poorly studied, so further research is necessary to illuminate these potential distributional implications.

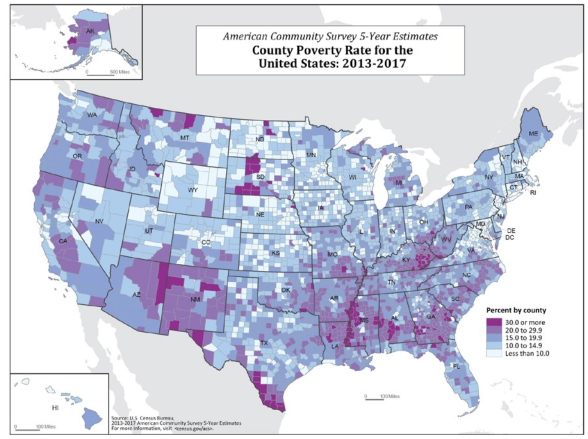
Appendices

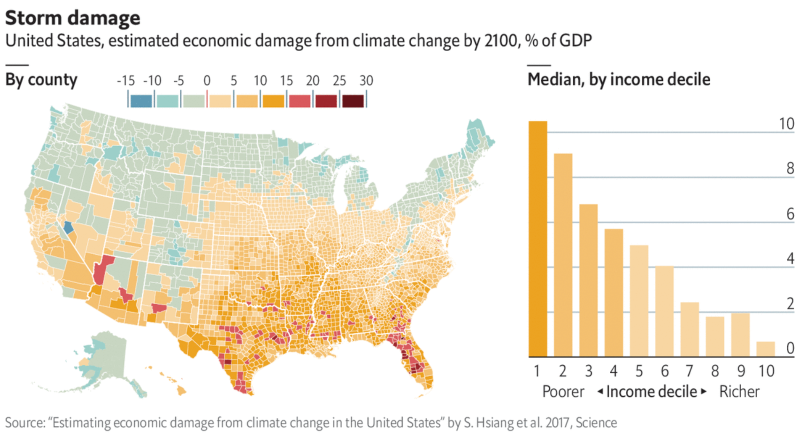
Appendix A: Global Mean Sea Level Rise



Projections of global mean sea level rise over the 21st century relative to 1986–2005 from the combination of the CMIP5 ensemble with process-based models, for RCP2.6 and RCP8.5 (four different IPCC climate models). The assessed likely range is shown as a shaded band. The assessed likely ranges for the mean over the period 2081–2100 for all RCP scenarios are given as colored vertical bars, with the corresponding median value given as a horizontal line. Sea level rise will not be uniform. About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change (Stocker et al. 2013).

Appendix B: Estimated Economic Damage due to Climate Change by 2100

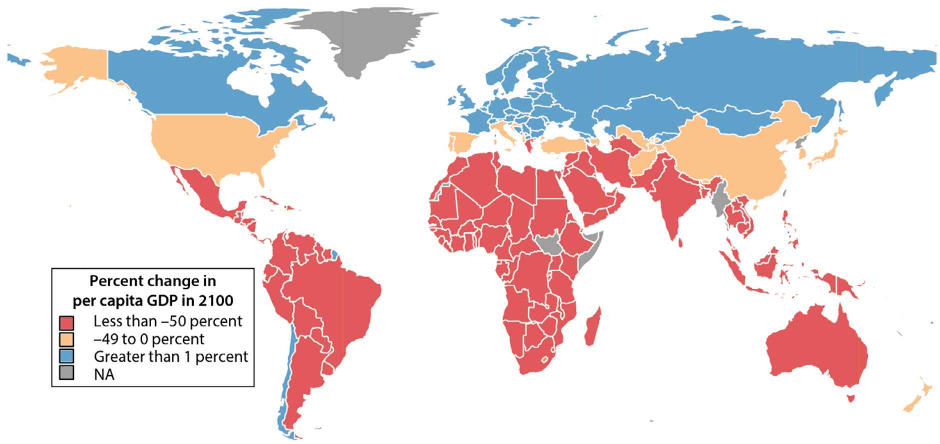




Predicted economic costs of storm damage by 2100 in the United States. As the color increases in intensity, the predicted percent of GDP costs increases due to storm damage. The southern coastal regions of the United States will be most heavily impacted. The middle graph indicates the income decile of the most vulnerable populations to storm damage (Gakidou et al. 2017). The right graph shows the rate of poverty in the United States from 2013-2017 by county. The darker areas indicate greater levels of poverty (Census 2018). When comparing the two graphs, one can observe that the areas with the greatest economic damage due to climate change are also those with the highest poverty rates.

FIGURE 3.

Climate Change Effect on per Capita GDP in 2100 by Country



Source: Burke, Hsiang, and Miguel (2015); authors' calculations.

Note: Country-level estimates for GDP per capita in 2100. Figure assumes RCP 8.5, which corresponds to roughly 3.2°C to 5.4°C of warming. GDP loss is associated with the warming from a baseline of 1980–2010 average temperatures. As explained in Burke, Hsiang, and Miguel (2015), estimates include growth-rate effects over the period through 2100.

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The predicted effect of climate change on per capita GDP by 2100 with RCP8.5. As the color becomes warmer toned, the given country is predicted to have a greater percent decrease in GDP. While the majority of developing nations will be experience a large change in percent GDP, many developed nations GDP will experience changes as well (Burke et al. 2015; Brookings Institution).

Appendix C: Possible Resilient Infrastructure Policy Options

Forest Fires

- Increase funding prevention programs and prescribed control burns to reduce wildfire danger in communities where wildfires are more prevalent due to dry summers and drought (Quinton 2019).
- Develop further technologies to predict wildfires by increasing invisible infrastructure such as high-speed wireless communications and fire monitoring cameras.

Hurricanes and Flooding

- Harden physical infrastructure to be more resilient to high winds and storms through:
    - Developing post-disaster redevelopment plans prior to disasters, in order to shorten the redevelopment timeline, allowing communities to quickly rebuild in place.
    - Increase "safe-to-fail" designs where factors contributing to extreme weather events cannot be anticipated, to lessen the possible danger for communities.
    - Including climate variability into policy, accounting for various different scenarios, including both risk prevention and contingency planning.
    - Ensure the tools and services are available, such as health care, legal affairs, food, and shelters, to help communities in worst case scenario situations.
- Update visual flood risk maps to reflect uncertainty in "safe zones" and "risk zones." This will allow communities to purchase flood insurance based on a full range of possible outcomes.

Drought

- Educate individuals on installing green infrastructure such as rain gardens and green streets to aid in the replenishment of groundwater reserves. On individual properties individuals can use rain barrels and cisterns to reduce their demand of potable water. This is a relatively inexpensive solution that does not overly burden the government, but rather puts the onus on the property owner.
- Incentivize individual-use rainwater harvesting through ordinances, tax incentives and possible educational forums.

Appendix D: Additional Social Policy Priorities

We have formulated additional priorities for policymakers to consider when devising climate policy:

- Implement conditional cash transfer programs to provide risk management and generate better educational outcomes for impoverished children. Programs that provide payments to families for participation in educational seminars and increased school attainment have successfully reduced inequalities throughout development (Engle et al. 2011).

- Expand unemployment insurance caused by climate change to secure a stable household income. Consider public employment programs as an additional strategy to improve households' adaptive capacity (ILO 2018). These efforts should take place in areas research indicates have a larger proportion of jobs relying on ecosystem services.

- Invest in climate action to create jobs in renewable energy and green construction. Ensure communities facing environmental risks have diversified employment opportunities to avert widespread simultaneous unemployment caused by climate change.

- Conduct policy research on how social disruption caused by climatic changes affect children's learning in the long term and how to effectively prepare children for climatic changes without causing mental or emotional harm.

Appendix E: Climate Effects on Health Research & Policy Priorities

The following policy options provide a few key examples of mitigation strategies and policy research gaps that can be addressed to improve public health from the effects of climate change, especially for vulnerable children. In addition to addressing each of these categories individually, research must be conducted on the potential risk of coupled extreme climate events. Health risks could be exacerbated beyond existing surveillance and projections if extreme events happen simultaneously or in succession. Additionally, climate change must be considered as a public health issue. Measures tracking global spending on climate change adaptation estimate that only 4 percent of total development spending is dedicated to human health (Watts et al. 2018). New methodologies and analyses of the direct health impact of climate change are needed. Inclusion of the health co-benefits of climate change policy is also a necessary component of consideration of the development of mitigation strategies.

Extreme Heat

- Conduct heat vulnerability assessments to identify neighborhood-level susceptibilities to extreme heat events.
- Provide access to cool indoor spaces during heat waves while also ensuring that this infrastructure does not lead to power outages. Give special consideration and infrastructural resources to populations who cannot travel to get to cooling shelters, including the provision of air conditioning systems.
- Research, evaluate, and quantify urban heat island mitigation strategies (cool roofing, streets, and other urban surfaces) and their impacts on improving public health.

Malnutrition

- Promote availability, accessibility, and affordability of healthy foods for populations in need. Strengthen food security through safety nets and social cash transfers.
- Constrain the production and marketing of foods and beverages that promote ill-health without reducing vulnerable populations' access to affordable food.
- Support agricultural production systems that are impacted by climate change.

Flooding

- Develop vulnerability maps at the neighborhood level to understand current and model potential future areas that are most likely to require intervention in the case of an emergency weather event.
- Increase the reach of messaging about storm preparation and ongoing climate emergencies to ensure that vulnerable populations are informed about the proper response and available resources.
- Ensure the location and targeting of assistance to vulnerable populations in immediate post-storm door-to-door outreach.
- Harden infrastructure and utilities against the effects of flooding and storms. People who are sheltering in place after a weather emergency and are lacking access to power, heat, air conditioning, and running water are vulnerable to health risks in the immediate aftermath of an emergency.
- Ensure that initiation and continuity of health-care services are maintained after extreme weather events. Health-care systems should consider placement of service areas above flood elevation, creating backups for powering building systems, and developing hospital evacuation plans.

Air Pollutants and Allergens

- Conduct research on the relationships between urban tree density, species distribution, pollen concentration, and human health impacts. Efforts to transition to low-carbon cities and strategies to reduce the urban heat island effect often incorporate urban tree-planting programs. However, these programs may then result in worsening of respiratory health outcomes from pollen and plant allergens.

- Develop interlinked plans to measure and mitigate rising city ambient temperatures, air pollution, and aeroallergens with the understanding that more research is needed and that current methods of mitigation do not come without potential public health drawbacks. Allergenicity should be a consideration in the selection of species in planting programs.

Vector-borne Disease

- Develop early warning systems for detection and surveillance of developing epidemics and understanding changing disease patterns. These efforts must take place in areas for which research indicates that disease vectors will expand to as climates change.
- Train health-care workers and systems about the signs and symptoms of diseases that will occur more often due to expanded ranges of disease vectors.
- Ensure that all have access to mosquito nets, vaccinations, and disease therapies.

Mental Health

- Further research should focus on both acute, short-term mental distress and its long-term impact that may result into the development of chronic conditions, including both single traumatic events and repeated environmental crises.
- Conduct research on the indirect impact climate change may have on children as they learn about environmental disasters at younger ages, regardless of its direct impact on their physical well-being.
- Develop funding structures that provide mental health relief aid packages following natural disasters, both for the short and long-term recovery of communities.

Appendix F: Negative Emission Technologies

Negative emission technologies (NETs) are a diverse assortment of strategies designed to remove carbon dioxide from the atmosphere (Minx et al. 2018). These include afforestation and reforestation, direct air capture, ocean fertilization, soil carbon sequestration, biochar, bioenergy carbon capture and storage, and enhanced weathering. Due to rising global carbon emissions and persistent international inaction, it appears increasingly likely that NETs will need to be deployed to meet IPCC targets (Minx et al. 2018).

While NETs represent an umbrella category of heterogeneous technologies and thus their anticipated impacts on child poverty are varied, many NETs require significant land use changes. For example, afforestation involves planting trees on previously unforested land, and bioenergy with carbon capture and storage entails converting large swaths of land into areas for growing biomass for combustion. These processes can not only displace marginalized populations (Creutzig et al. 2013; Downing 2002) but can also contribute to food insecurity (Pillay 2013; Fuss et al. 2018) by raising food prices (Popp et al. 2014; Reilly et al. 2012). High food prices negatively affect children experiencing poverty — leading to malnutrition, poor health, and school absences (Bronchetti, Christensen, and Hoynes 2019; Bibi et al. 2010; Lustig 2012; Reeves, Loopstra, and Stuckler 2017; Gustafson 2013).

Additionally, many types of NETs could cause water shortages and contribute to water pollution, which disproportionately harms low-income populations — especially poor children (Kohler et al. 2013; L. L. Taylor et al. 2016; Fuss et al. 2018). They also can reduce biodiversity and provoke other detrimental ecological effects that can harm rural populations and indigenous groups that depend on this ecology for sustenance (Fuss et al. 2018; Dale et al. 2010; Wiens, Fargione, and Hill 2011). Air pollution (Schuiling and Krijgsman 2006; L. L. Taylor et al. 2016)as well as disturbances associated with mining and extraction (Williamson 2016; Downing 2002) are other possible effects that could affect child poverty.

Not all the side effects of NETs, however, are negative. Beyond reducing the severity of climate change, NETs also offer co-benefits that may improve the lives of children experiencing poverty, including increased crop yields from biochar and soil sequestration (Pan, Smith, and Pan 2009), and health and ecological benefits stemming from reforestation.

Appendix G: Soil & Water Pollution Effects

Air pollution is not the only health risk stemming from fossil fuel extraction and combustion; water and land pollution also takes a toll on children's health. Coal ash, a byproduct of the combustion process that contains heavy metals and carcinogens, often seeps into groundwater, which is a source of drinking water for a large proportion of people. In fact, a study in the United States found that 91 percent of coal ash sites leaked contaminants into groundwater, and low-income groups were disproportionately affected (EarthJustice 2019). Researchers have found elevated levels of heavy metals such as arsenic, cadmium, lead, and mercury in children in OECD countries, and fossil fuel production is a primary source of exposure (Horton et al. 2013). Fossil fuel combustion also releases mercury into the environment that ultimately contaminates bodies of water and bioaccumulates in fish and other foods (Winner 2010). Children are most susceptible to the deleterious impacts of these heavy metals because of their lower body weights and greater absorption rates (Horton et al. 2013; Stein et al. 2002). Prenatal mercury levels are also harmful; higher maternal blood levels of mercury during pregnancy have been associated with worse cognitive performance in children several years later (Oken et al. 2008). Several studies have shown that pollution stemming from crude oil transportation and hydraulic fracturing harms children's health as well (Ordinioha and Brisibe 2013; Laffon, Pásaro, and Valdiglesias 2016; Aguilera et al. 2010; Currie, Greenstone, and Meckel 2017). Other studies have demonstrated that counties with significant amounts of coal mining have higher rates of mortality and child poverty compared to similar counties without mining (Hendryx 2010).

Appendix H: Harmful Effects of Fossil Fuel-Related Air Pollution on Children

Due to their small size and undeveloped bodies, children are more vulnerable to the detrimental consequences of fossil fuel-related air pollution (Perera 2008; Cakmak et al. 2016; Bunyavanich et al. 2003; Sacks et al. 2011; Confalonieri et al. 2007; Islam et al. 2007). It can aggravate asthma (Esposito et al. 2014; Tzivian et al. 2015), reduce lung function (K. H. Kim, Kabir, and Kabir 2015), lead to more absences from school (Currie et al. 2009), and even lower test scores and hinder academic performance (Zweig, Ham, and Avol 2009; Stingone, McVeigh, and Claudio 2016; Zhang, Chen, and Zhang 2018). The prenatal consequences of fossil fuel-related air pollution are especially devastating and include low birthweight, preterm births, developmental disabilities, asthma, and cancer (Perera 2008; Poursafa and Kelishadi 2011). Air pollution even increases infant mortality rates (Chay and Greenstone 2003; Knittel, Miller, and Sanders 2011).

Appendix I: Harmful Effects of Air Pollution on Low-Income Groups

Outdoor air pollution also disproportionately harms minorities and low-income groups (Cakmak et al. 2016; Hajat, Hsia, and O'Neill 2015; O'Neill et al. 2003; Bell and Ebisu 2012). Poor populations are exposed to more air pollutants as they are more likely to live near pollution sources like major roadways and highways, (Pratt et al. 2015) as well as power plants (NAACP 2016). Living near busy roadways has been linked with cognitive and respiratory diseases (Chen et al. 2017; Schikowski et al. 2005; Garshick et al. 2003), while living near fossil fuel-fired power plants is associated with increased hospitalization rates due to respiratory diseases as well (X. Liu, Lessner, and Carpenter 2012). Additionally, low-income populations often have other risk factors and lack access to quality health care, further exacerbating the harmful effects of air pollution (O'Neill et al. 2003).

Appendix J: Carbon Pricing in Developing Countries

In regard to developing countries, research on the tax incidence and distributional effects of carbon pricing is more mixed, inconsistent, and inconclusive (Q. Wang et al. 2016). Due to different consumption patterns, some studies have suggested that a carbon tax in low-income countries could be proportional or even progressive (Shah and Larsen 1992; Brenner, Riddle, and Boyce 2007; Yusuf and Resosudarmo 2007), while others have refuted those claims and argue the tax would be regressive (Liang, Wang, and Wei 2013; Yusuf and Resosudarmo 2008). One study has found that carbon taxes are progressive for low-income countries, while they are regressive for high income countries due to the carbon-intensive consumption habits of poor households in rich countries; it posits that as countries' incomes rise, the regressivity of a carbon tax increases as well (Dorband et al. 2019).

Appendix K: Additional Climate Policy Priorities

We have formulated additional priorities for policymakers to consider when devising climate policy:

- Supply-side renewable energy subsidies should be prioritized over demand-side consumer-focused subsidies, as they are more equitable. Higher income households tend to receive a disproportionate amount of demand-side subsidies, which are often inaccessible for lower-income households (Borenstein and Davis 2016; Rausch and Mowers 2014; F. Wang and Zhang 2016). Thus, it seems prudent to prevent this regressive impact by focusing on supply-side subsidies that will benefit all income groups, including those in poverty. Furthermore, we also should encourage the growth of public utilities to supply inexpensive electricity to communities. Because they are democratically controlled, constituents can accelerate their transition to renewable energy in addition to enjoying the other benefits.

- Clean transportation policy should emphasize low-cost public transit as opposed to private electric vehicles and ride-sharing services. Policies incentivizing cleaner private transportation, like fuel standards and tax credits for electric vehicles, often fail to benefit low-income families (Borenstein and Davis 2016; Rausch and Mowers 2014; Metcalf 2019)because they often cannot afford private vehicles and instead rely on public transit for mobility (Wachs 2010). Many poor children also depend on public transit to get to school and access health care (Ferguson, Bovaird, and Mueller 2007; Grant et al. 2014), and their parents often need it to get to work and find employment opportunities that can raise their market incomes and reduce poverty ((Hess 2005; Sanchez, Shen, and Peng 2004; Mckenzie 2013). Augmenting public transit systems would reduce greenhouse gas emissions while improving quality of life and promoting social inclusion (Lee and Sener 2016; Cao 2013; Godard and Olvera 2000; Giuliano 2005)

- Because energy efficiency improvements may require substantial upfront costs, they must be state-subsidized to remain equitable. If they are government-funded, they can help alleviate child poverty by helping low-income families reduce energy expenses and enhance quality of life (Casillas and Kammen 2010; Hills 2012)

- It is essential that OECD nations perform tailored country-specific research prior to the implementation of any price on carbon. While clear trends can be gleaned from the literature, sufficient ambiguity remains necessitating additional investigation (Sterner 2012; Creedy and Sleeman 2006), especially for poorer OECD members because preliminary research has indicated a negative relationship between median country income and carbon tax progressivity (Q. Wang et al. 2016; Dorband et al. 2019; see Appendix J). Without conducting specialized and rigorous studies exploring specific carbon pricing schemes in particular locales and contexts, the exact effects of carbon pricing mechanisms on poor children may be difficult to predict.

References

ACEEE. n.d. "How Does Energy Efficiency Create Jobs?" Accessed March 9, 2020. https://www.aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf.

Agnew, Robert. 2011. "Dire Forecast: A Theoretical Model of the Impact of Climate Change on Crime." *Theoretical Criminology* 16 (1): 21–42. https://doi.org/10.1177/1362480611416843.

Aguilera, Francisco, Josefina Méndez, Eduardo Pásaroa, and Blanca Laffona. 2010. "Review on the Effects of Exposure to Spilled Oils on Human Health." *Journal of Applied Toxicology*. https://doi.org/10.1002/jat.1521.

Akresh, Richard. 2016. "Climate Change, Conflict, and Children." *The Future of Children*, 51–71.

Allen, Myles, Mustafa Babiker, Yang Chen, Michael Taylor, Petra Tschakert Australia, Henri Waisman, Rachel Warren, et al. 2018. "IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty ." *Aromar Revi.*

An, R., M. Ji, and S. Zhang. 2018. "Global Warming and Obesity: A Systematic Review." *Obesity Reviews*. https://doi.org/10.1111/obr.12624.

Anderson, G. Brooke, and Michelle L. Bell. 2012. "Lights out: Impact of the August 2003 Power Outage on Mortality in New York, NY." *Epidemiology*. https://doi.org/10.1097/EDE.0b013e318245c61c.

Anderson, G. Brooke, Francesca Dominici, Yun Wang, Meredith C. McCormack, Michelle L. Bell, and Roger D. Peng. 2013. "Heat-Related Emergency Hospitalizations for Respiratory Diseases in the Medicare Population." *American Journal of Respiratory and Critical Care Medicine*. https://doi.org/10.1164/rccm.201211-1969OC.

Anderson, Will, Vicki White, and Andrea Finney. 2012. "Coping with Low Incomes and Cold Homes." *Energy Policy* 49 (October): 40–52. https://doi.org/10.1016/j.enpol.2012.01.002.

Anenberg, Susan C., Joel Schwartz, Drew Shindell, Markus Amann, Greg Faluvegi, Zbigniew Klimont, Greet Janssens-Maenhout, et al. 2012. "Global Air Quality and Health Co-Benefits of Mitigating near-Term Climate Change through Methane and Black Carbon Emission Controls." *Environmental Health Perspectives* 120 (6): 831–39. https://doi.org/10.1289/ehp.1104301.

Annie E. Casey Foundation. 2018. "2018 Kids Count Data Book State Trends in Child Well-Being."

Arnone, William, and William Spriggs. 2020. "Looking at Climate Change from a Social Insurance Perspective | National Academy of Social Insurance." National Academy of Social Insurance. January 16, 2020. https://www.nasi.org/discuss/2020/01/looking-climate-change-social-insurance-perspective.

Arrieta, Martha I., Rachel D. Foreman, Errol D. Crook, and Marjorie L. Icenogle. 2009. "Providing Continuity of Care for Chronic Diseases in the Aftermath of Katrina: From Field Experience to Policy Recommendations." *Disaster Medicine and Public Health Preparedness*. https://doi.org/10.1097/DMP.0b013e3181b66ae4.

Austin, Wes, Garth Heutel, and Daniel Kreisman. 2019. "School Bus Emissions, Student Health and Academic Performance." *Economics of Education Review* 70 (June): 109–26.

https://doi.org/10.1016/j.econedurev.2019.03.002.

Australian Greenhouse Office. 2006. *Climate Change Impacts & Risk Management : A Guide for Business and Government*. Australian Greenhouse Office.

Babin, Steven M., Howard S. Burkom, Rekha S. Holtry, Nathaniel R. Tabernero, Lynette D. Stokes, John O. Davies-Cole, Kerda DeHaan, and Deitra H. Lee. 2007. "Pediatric Patient Asthma-Related Emergency Department Visits and Admissions in Washington, DC, from 2001-2004, and Associations with Air Quality, Socio-Economic Status and Age Group." *Environmental Health: A Global Access Science Source* 6: 9. https://doi.org/10.1186/1476-069X-6-9.

Baccini, Michela, Annibale Biggeri, Gabriele Accetta, Tom Kosatsky, Klea Katsouyanni, Antonis Analitis, H. Ross Anderson, et al. 2008. "Heat Effects on Mortality in 15 European Cities." *Epidemiology* 19 (5): 711–19. https://doi.org/10.1097/EDE.0b013e318176bfcd.

Bandyopadhyay, Sushenjit, Shireen Kanji, and Limin Wang. 2012. "The Impact of Rainfall and Temperature Variation on Diarrheal Prevalence in Sub-Saharan Africa." *Applied Geography*. https://doi.org/10.1016/j.apgeog.2011.07.017.

Barbeau, Deborah N., L. Faye Grimsley, LuAnn E. White, Jane M. El-Dahr, and Maureen Lichtveld. 2010. "Mold Exposure and Health Effects Following Hurricanes Katrina and Rita." *Annual Review of Public Health*. https://doi.org/10.1146/annurev.publhealth.012809.103643.

Bartlett, Sheridan. 2008. "Climate Change and Urban Children: Impacts and Implications for Adaptation in Low- and Middle-Income Countries." *International Institute for Environment and Development*, 12–47. https://doi.org/10.2307/RESREP01256.7.

Basu, Rupa, and Bart D. Ostro. 2008. "A Multicounty Analysis Identifying the Populations Vulnerable to Mortality Associated with High Ambient Temperature in California." *American Journal of Epidemiology*. https://doi.org/10.1093/aje/kwn170.

BBC News. 2019. "Summer Heat Killed Nearly 1,500 in France, Officials Say." BBC News. 2019. https://www.bbc.com/news/world-europe-49628275.

Beatty, Mark E., Scot Phelps, Chris Rohner, and Isaac Weisfuse. 2006. "Blackout of 2003: Public Health Effects and Emergency Response." *Public Health Reports*. https://doi.org/10.1007/s11528-006-0036-y.

Beck, Marisa, Nicholas Rivers, Randall Wigle, and Hidemichi Yonezawa. 2015. "Carbon Tax and Revenue Recycling: Impacts on Households in British Columbia." *Resource and Energy Economics* 41 (August): 40–69. https://doi.org/10.1016/j.reseneeco.2015.04.005.

Begley, Taylor A., Umit G. Gurun, Amiyatosh K. Purnanandam, and Daniel Weagley. 2018. "Disaster Lending: The Distributional Consequences of Government Lending Programs." *SSRN Electronic Journal*, March, 1–53. https://doi.org/10.2139/ssrn.3145298.

Bell, Michelle L., and Keita Ebisu. 2012. "Environmental Inequality in Exposures to Airborne Particulate Matter Components in the United States." *Environmental Health Perspectives* 120 (12): 1699–1704. https://doi.org/10.1289/ehp.1205201.

Bell, Michelle L., Richard Goldberg, Christian Hogrefe, Patrick L. Kinney, Kim Knowlton, Barry Lynn, Joyce Rosenthal, Cynthia Rosenzweig, and Jonathan A. Patz. 2007. "Climate Change, Ambient Ozone, and Health in 50 US Cities." *Climatic Change*. https://doi.org/10.1007/s10584-006-9166-7.

Bell, Michelle L., Antonella Zanobetti, and Francesca Dominici. 2014. "Who Is More Affected by Ozone Pollution? A Systematic Review and Meta-Analysis." *American Journal of Epidemiology*. https://doi.org/10.1093/aje/kwu115.

Bento, Antonio M., Lawrence H. Goulder, Mark R. Jacobsen, and Roger H. Von Haefen. 2009. "Distributional and Efficiency Impacts of Increased US Gasoline Taxes." *American Economic Review* 99 (3): 667–99. https://doi.org/10.1257/aer.99.3.667.

Berry, Audrey. 2019. "The Distributional Effects of a Carbon Tax and Its Impact on Fuel Poverty: A Microsimulation Study in the French Context." *Energy Policy* 124 (January): 81–94. https://doi.org/10.1016/j.enpol.2018.09.021.

Bibi, Sami, John Cockburn, Massa Coulibaly, and Luca Tiberti. 2010. "The Impact of the Increase in Food Prices on Child Poverty and the Policy Response in Mali." In *Child Welfare in Developing Countries*, 247–96. Springer New York. https://doi.org/10.1007/978-1-4419-6275-1_8.

Bird, Stephen, and Diana Hernández. 2012. "Policy Options for the Split Incentive: Increasing Energy Efficiency for Low-Income Renters." *Energy Policy* 48 (September): 506–14. https://doi.org/10.1016/j.enpol.2012.05.053.

Bloom, Michael S., Jillian Palumbo, Nazia Saiyed, Ursula Lauper, and Shao Lin. 2016. "Food and Waterborne Disease in the Greater New York City Area Following Hurricane Sandy in 2012." *Disaster Medicine and Public Health Preparedness* 10 (3): 503–11. https://doi.org/10.1017/dmp.2016.85.

Blythe, Will, Rob Gross, Jamie Speirs, Steven Sorrell, Jack Nicholls, Alexandra Dorgan, and Nick Hughes. 2014. "Low Carbon Jobs: The Evidence for Net Job Creation from Policy Support for Energy Efficiency and Renewable Energy." UK Energy Research Centre. November 5, 2014. http://www.ukerc.ac.uk/publications/low-carbon-jobs-the-evidence-for-net-job-creation-from-policy-support-for-energy-efficiency-and-renewable-energy.html.

Boon, Helen J, and Paul J Pagliano. 2014. "Disaster Education in Australian Schools." *Australian Journal of Environmental Education* 30 (2): 187–97.

Boothe, Vickie L., Tegan K. Boehmer, Arthur M. Wendel, and Fuyuen Y. Yip. 2014. "Residential Traffic Exposure and Childhood Leukemia: A Systematic Review and Meta-Analysis." *American Journal of Preventive Medicine* 46 (4): 413–22. https://doi.org/10.1016/j.amepre.2013.11.004.

Borenstein, Severin, and Lucas W. Davis. 2016. "The Distributional Effects of US Clean Energy Tax Credits." *Tax Policy and the Economy* 30 (1): 191–234. https://doi.org/10.1086/685597.

Bosello, Francesco, Robert J Nicholls, Julie Richards, Roberto Roson, and Richard S J Tol. 2012. "Economic Impacts of Climate Change in Europe: Sea-Level Rise." *Climatic Change* 112: 63–81. https://doi.org/10.1007/s10584-011-0340-1.

Bottazzi, Maria, Eric Dumonteil, Jesus Valenzuela, Miguel Betancourt-Cravioto, Roberto Tapia-Conyer, and Peter Hotez. 2011. "Bridging the Innovation Gap for Neglected Tropical Diseases in México: Capacity Building for the Development of a New Generation of Antipoverty Vaccines." *Boletín Médico Del Hospital Infantil de México*.

Bowen, Natasha K, and Gary L Bowen. 1999. "Effects of Crime and Violence in Neighborhoods and Schools on the School Behavior and Performance of Adolescents." *Journal of Adolescent Research* 14 (3): 319–42.

Braack, Leo, A. Paulo Gouveia De Almeida, Anthony J. Cornel, Robert Swanepoel, and Christiaan De Jager. 2018. "Mosquito-Borne Arboviruses of African Origin: Review of Key Viruses and Vectors." *Parasites and Vectors*. https://doi.org/10.1186/s13071-017-2559-9.

Brenner, Mark, Matthew Riddle, and James K. Boyce. 2007. "A Chinese Sky Trust?. Distributional Impacts of Carbon Charges and Revenue Recycling in China." *Energy Policy* 35 (3): 1771–84. https://doi.org/10.1016/j.enpol.2006.04.016.

Bronchetti, Erin T., Garret Christensen, and Hilary W. Hoynes. 2019. "Local Food Prices, SNAP Purchasing Power, and Child Health." *Journal of Health Economics* 68 (December): 102231. https://doi.org/10.1016/j.jhealeco.2019.102231.

Bronstein, Israel, and Paul Montgomery. 2011. "Psychological Distress in Refugee Children: A Systematic Review." *Clinical Child and Family Psychology Review* 14 (1): 44–56.

Brooks-Gunn, Jeanne, and Greg J. Duncan. 1997a. "The Effects of Poverty on Children." *Future of Children*. Center for the Future of Children. https://doi.org/10.2307/1602387.

Brooks-Gunn, Jeanne, and Greg J Duncan. 1997b. "The Effects of Poverty on Children." *The Future of Children*, 55–71.

Brown, Marilyn A., Jess Chandler, Melissa V. Lapsa, and Benjamin K. Sovacool. 2008. "Carbon Lock-in: Barriers to Deploying Climate Change Mitigation Technologies." *Oak Ridge National Laboratory*.

Brugha, Rossa, and Jonathan Grigg. 2014. "Urban Air Pollution and Respiratory Infections." *Paediatric Respiratory Reviews*. https://doi.org/10.1016/j.prrv.2014.03.001.

Brusentsev, Vera, and Wayne Vroman. 2017. "Floods and Their Consequences." In *Disasters in the United States*, 97–118. Frequency, Costs, and Compensation. W.E. Upjohn Institute. http://www.jstor.org/stable/j.ctvh4zgjh.9.

Bulavskaya, Tatyana, and Frédéric Reynès. 2018. "Job Creation and Economic Impact of Renewable Energy in the Netherlands." *Renewable Energy* 119 (April): 528–38. https://doi.org/10.1016/j.renene.2017.09.039.

Bunyavanich, Supinda, Christopher P. Landrigan, Anthony J. McMichael, and Paul R. Epstein. 2003. "The Impact of Climate Change on Child Health." *Ambulatory Pediatrics* 3 (1): 44–52. https://doi.org/10.1367/1539-4409(2003)003<0044:TIOCCO>2.0.CO;2.

Bureau, Benjamin. 2011. "Distributional Effects of a Carbon Tax on Car Fuels in France." *Energy Economics* 33 (1): 121–30. https://doi.org/10.1016/j.eneco.2010.07.011.

Bureau, US Census. 2018. "County Poverty Rate for the United States: 2013-2017," December.

Burke, Marshall, Solomon M. Hsiang, and Edward Miguel. 2015. "Global Non-Linear Effect of Temperature on Economic Production." *Nature* 527 (7577): 235–39. https://doi.org/10.1038/nature15725.

Burke, Susie E.L., Ann V. Sanson, and Judith Van Hoorn. 2018. "The Psychological Effects of Climate Change on Children." *Current Psychiatry Reports*. Current Medicine Group LLC 1. https://doi.org/10.1007/s11920-018-0896-9.

Butler, Ben. 2020. "Economic Impact of Australia's Bushfires Set to Exceed $4.4bn Cost of Black Saturday." The Guardian. 2020. https://www.theguardian.com/australia-news/2020/jan/08/economic-impact-ofaustralias-bushfires-set-to-exceed-44bn-cost-of-black-saturday.

Cakmak, Sabit, Christopher Hebbern, Jasmine D. Cakmak, and Jennifer Vanos. 2016. "The Modifying Effect of Socioeconomic Status on the Relationship between Traffic, Air Pollution and Respiratory Health in Elementary Schoolchildren." *Journal of Environmental Management* 177 (July): 1–8. https://doi.org/10.1016/j.jenvman.2016.03.051.

Cal Fire. 2020. "2019 Fire Season." Cal Fire, State of California. 2020. https://www.fire.ca.gov/incidents/2019/.

Callan, Tim, Sean Lyons, Susan Scott, Richard S.J. Tol, and Stefano Verde. 2009. "The Distributional Implications of a Carbon Tax in Ireland." *Energy Policy* 37 (2): 407–12. https://doi.org/10.1016/j.enpol.2008.08.034.

Canes, Michael E. 2019. "Protecting Low-Income Housing from Climate Risks." *Cityscape* 21 (3): 347–54. https://doi.org/10.2307/26820663.

Cantillon, Bea, Yekaterina Chzhen, Sudhanshu Handa, and Brian Nolan. 2017. *Children of Austerity: Impact of the Great Recession on Child Poverty in Rich Countries*. *UNICEF*. Oxford, England: Oxford University Press.

Cao, Jason. 2013. "The Association between Light Rail Transit and Satisfactions with Travel and Life: Evidence from Twin Cities." *Transportation* 40 (5): 921–33. https://doi.org/10.1007/s11116-013-9455-8.

Cappucci, Matthew. 2019. "Super Typhoon Halong among Strongest Storms Ever Observed by Weather Satellite." Washington Post. 2019. https://www.washingtonpost.com/weather/2019/11/05/category-super-typhoon-halong-among-strongest-storms-ever-observed-by-satellite/.

Carnevale, Anthony P, Nicole Smith, and Artem Gulish. 2018. "Women Can't Win: Despite Making Educational Gains and Pursuing High-Wage Majors, Women Still Earn Less than Men."

Carter, Michael, and Sarah Janzen. 2015. "Social Protection in the Face of Climate Change Principles and Financing Mechanisms." 7476.

Case, Michael J., and Kristina A. Stinson. 2018. "Climate Change Impacts on the Distribution of the Allergenic Plant, Common Ragweed (Ambrosia Artemisiifolia) in the Eastern United States." Edited by Ben Bond-Lamberty. *PLOS ONE* 13 (10): e0205677. https://doi.org/10.1371/journal.pone.0205677.

Casillas, Christian E., and Daniel M. Kammen. 2010. "The Energy-Poverty-Climate Nexus." *Science*. American Association for the Advancement of Science. https://doi.org/10.1126/science.1197412.

Çetin, Müjgan, and Nilüfer Eĝrican. 2011. "Employment Impacts of Solar Energy in Turkey." *Energy Policy* 39 (11): 7184–90. https://doi.org/10.1016/j.enpol.2011.08.039.

Chappell, Carmin. 2018. "Climate Change Will Hurt Poor People the Most: Federal Report." CNBC. November 28, 2018. https://www.cnbc.com/2018/11/26/climate-change-will-hurt-poor-people-the-most-federal-report.html.

Chaudhuri, N. 1998. "Child Health, Poverty and the Environment: The Canadian Context." *Canadian Journal of Public Health = Revue Canadienne de Sante Publique* 89 Suppl 1: S26-30, S28-33. http://www.ncbi.nlm.nih.gov/pubmed/9654789.

Chay, K. Y., and M. Greenstone. 2003. "The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variation in Pollution Shocks Induced by a Recession." *The Quarterly Journal of Economics* 118

(3): 1121–67. https://doi.org/10.1162/00335530360698513.

Chen, Hong, Jeffrey C. Kwong, Ray Copes, Karen Tu, Paul J. Villeneuve, Aaron van Donkelaar, Perry Hystad, et al. 2017. "Living near Major Roads and the Incidence of Dementia, Parkinson's Disease, and Multiple Sclerosis: A Population-Based Cohort Study." *The Lancet* 389 (10070): 718–26. https://doi.org/10.1016/S0140-6736(16)32399-6.

Chiroleu-Assouline, Mireille, and Mouez Fodha. 2014. "From Regressive Pollution Taxes to Progressive Environmental Tax Reforms." *European Economic Review* 69 (July): 126–42. https://doi.org/10.1016/j.euroecorev.2013.12.006.

Christopher, Karen, Paula England, Sara McLanahan, Katherin Ross, and Timothy M Smeeding. 2001. "Gender Inequality in Poverty in Affluent Nations: The Role of Single Motherhood and the State." *Child Well-Being, Child Poverty and Child Policy in Modern Nations. What Do We Know*, 199–219.

Confalonieri, Ulisses, Andrew Githeko, Pim Martens, Sari Kovats, Jonathan Patz, Alistair Woodword, Andrew Haines, and Akihiko Sasaki. 2007. "Human Health." In *Methodological and Technological Issues in Technology Transfer*, edited by Bert Metz, Ogunlade R. Davidson, Jan-Willem Martens, Sascha N.M. van Rooijen, and Laura Van Wie McGrory, 330–45. Intergovernmental Panel on Climate Change.

Conger, Rand D, Katherine J Conger, and Monica J Martin. 2010. "Socioeconomic Status, Family Processes, and Individual Development." *Journal of Marriage and Family* 72 (3): 685–704.

Connolly, D., H. Lund, and B. V. Mathiesen. 2016. "Smart Energy Europe: The Technical and Economic Impact of One Potential 100% Renewable Energy Scenario for the European Union." *Renewable and Sustainable Energy Reviews*. Elsevier Ltd. https://doi.org/10.1016/j.rser.2016.02.025.

Cook, Angus G., Annemarie J.B.M. Devos, Gavin Pereira, Andrew Jardine, and Philip Weinstein. 2011. "Use of a Total Traffic Count Metric to Investigate the Impact of Roadways on Asthma Severity: A Case-Control Study." *Environmental Health: A Global Access Science Source* 10 (1): 52. https://doi.org/10.1186/1476-069X-10-52.

Corcoran, Mary, and Terry Adams. 1997. "Race, Sex, and the Intergenerational Transmission of Poverty." In *Consequences of Growing Up Poor*, edited by Greg J. Duncan and Jeanne Brooks-Gunn. New York: Russell Sage Foundation. https://doi.org/10.7758/9781610448260.17.

Costello, Anthony, Mustafa Abbas, Adriana Allen, Sarah Ball, Sarah Bell, Richard Bellamy, Sharon Friel, et al. 2009. "Managing the Health Effects of Climate Change. Lancet and University College London Institute for Global Health Commission." *The Lancet*. https://doi.org/10.1016/S0140-6736(09)60935-1.

Creedy, John, and Catherine Sleeman. 2006. "Carbon Taxation, Prices and Welfare in New Zealand." *Ecological Economics* 57 (3): 333–45. https://doi.org/10.1016/j.ecolecon.2005.04.015.

Creutzig, Felix, Simon Bolwig, Esteve Corbera, and Carol Hunsberger. 2013. "Integrating Place-Specific Livelihood and Equity Outcomes into Global Assessments of Bioenergy Deployment." *Environmental Research Letters* 8 (3). https://www.researchgate.net/publication/258310337_Integrating_place-specific_livelihood_and_equity_outcomes_into_global_assessments_of_bioenergy_deployment.

Currie, Janet, Michael Greenstone, and Katherine Meckel. 2017. "Hydraulic Fracturing and Infant Health: New Evidence from Pennsylvania." *Science Advances* 3 (12): e1603021. https://doi.org/10.1126/sciadv.1603021.

Currie, Janet, Eric A. Hanushek, E. Megan Kahn, Matthew Neidell, and Steven G. Rivkin. 2009. "Does Pollution Increase School Absences?" *Review of Economics and Statistics* 91 (4): 682–94. https://doi.org/10.1162/rest.91.4.682.

Currie, Janet, and Reed Walker. 2011. "Traffic Congestion and Infant Health: Evidence from E-Zpass." *American Economic Journal: Applied Economics* 3 (1): 65–90. https://doi.org/10.1257/app.3.1.65.

Curtis, Katherine J, and Annemarie Schneider. 2011. "Understanding the Demographic Implications of Climate Change: Estimates of Localized Population Predictions under Future Scenarios of Sea-Level Rise." *Population and Environment* 33 (1): 28–54.

Cutuli, J J, and Janette E Herbers. 2014. "Opportunities To Encourage Developmental Competence." *Cityscape* 16 (1): 113–40. http://www.jstor.org/stable/26326860.

D'Amato, G., L. Cecchi, M. D'Amato, and G. Liccardi. 2010. "Urban Air Pollution and Climate Change as Environmental Risk Factors of Respiratory Allergy: An Update." *Journal of Investigational Allergology and Clinical Immunology*.

Daily Sabah. 2019. "Heavy Downpours, Flash Floods Hit Istanbul, NW Turkey." Daily Sabah. 2019. https://www.dailysabah.com/istanbul/2019/08/17/heavy-downpours-flash-floods-hit-istanbul-nw-turkey.

Dale, Virginia, Keith Kline, John Wiens, and Joseph Fargione. 2010. "Biofuels: Implications for Land Use and Biodiversity Biofuels: Implications for Land Use and Biodiversity," January.

Dalton, G.J., and T. Lewis. 2011. "Metrics for Measuring Job Creation by Renewable Energy Technologies, Using Ireland as a Case Study." *Renewable and Sustainable Energy Reviews* 15 (4): 2123–33.

Dancause, Kelsey N., David P. Laplante, Carolina Oremus, Sarah Fraser, Alain Brunet, and Suzanne King. 2011. "Disaster-Related Prenatal Maternal Stress Influences Birth Outcomes: Project Ice Storm." *Early Human Development* 87 (12): 813–20. https://doi.org/10.1016/j.earlhumdev.2011.06.007.

Darrow, Lyndsey A., Jeremy Hess, Christine A. Rogers, Paige E. Tolbert, Mitchel Klein, and Stefanie E. Sarnat. 2012. "Ambient Pollen Concentrations and Emergency Department Visits for Asthma and Wheeze." *Journal of Allergy and Clinical Immunology*. https://doi.org/10.1016/j.jaci.2012.06.020.

Davies, Ian P., Ryan D. Haugo, James C. Robertson, and Phillip S. Levin. 2018. "The Unequal Vulnerability of Communities of Color to Wildfire." *PLOS ONE* 13 (11): e0205825. https://doi.org/10.1371/journal.pone.0205825.

Davis, Cassandra. 2020. "Because Hurricanes Aren't Going Away Any Time Soon and Schools Must Continue to Function." Why Social Science? January 28, 2020. https://www.whysocialscience.com/blog/2020/1/28/because-hurricanes-arent-going-away-any-time-soon-and-schools-must-continue-to-function.

Davis, Lucas W., and Christopher R. Knittel. 2018. "Are Fuel Economy Standards Regressive?"

Delgadillo, Natalie. 2016. "Sea-Level Rise in Miami's Low-Income Communities - CityLab." City Lab. October 23, 2016. https://www.citylab.com/environment/2016/10/sea-level-rise-is-affecting-miami-low-income-communities/505109/.

Demetriades, Justina, and Emily Esplen. 2010. "The Gender Dimensions of Poverty and Climate Change

Adaptation." *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World*, 133–43.

Dennekamp, Martine, and Marion Carey. 2010. "Air Quality and Chronic Disease: Why Action on Climate Change Is Also Good for Health." *New South Wales Public Health Bulletin*. https://doi.org/10.1071/NB10026.

Dewey, Kathryn G, and Khadija Begum. 2011. "Long-term Consequences of Stunting in Early Life." *Maternal & Child Nutrition* 7: 5–18.

Diffenbaugh, Noah S, and Marshall Burke. 2019. "Global Warming Has Increased Global Economic Inequality." *Proceedings of the National Academy of Sciences* 116 (20): 9808 LP – 9813. https://doi.org/10.1073/pnas.1816020116.

Distante, Roberta, Elena Verdolini, and Massimo Tavoni. 2017. "Distributional and Welfare Impacts of Renewable Subsidies in Italy." *SSRN Electronic Journal*, June. https://doi.org/10.2139/ssrn.2783675.

Donnelly, Martin J., P. J. McCall, Christian Lengeler, Imelda Bates, Umberto D'Alessandro, Guy Barnish, Flemming Konradsen, et al. 2005. "Malaria and Urbanization in Sub-Saharan Africa." *Malaria Journal*. https://doi.org/10.1186/1475-2875-4-12.

Dorband, Ira Irina, Michael Jakob, Matthias Kalkuhl, and Jan Christoph Steckel. 2019. "Poverty and Distributional Effects of Carbon Pricing in Low- and Middle-Income Countries – A Global Comparative Analysis." *World Development* 115 (March): 246–57. https://doi.org/10.1016/j.worlddev.2018.11.015.

Downing, Theodore E. 2002. "Mining, Minerals and Sustainable Development Avoiding New Poverty: Mining-Induced Displacement and Resettlement."

Dresner, Simon, and Paul Ekins. 2006. "Economic Instruments to Improve UK Home Energy Efficiency without Negative Social Impacts." *Fiscal Studies* 27 (1): 47–74. https://doi.org/10.1111/j.1475-5890.2006.00027.x.

Du, Weiwei, Gerard Joseph Fitzgerald, Michele Clark, and Xiang Yu Hou. 2010. "Health Impacts of Floods." *Prehospital and Disaster Medicine*. https://doi.org/10.1017/S1049023X00008141.

Dvořák, Petr, Stanislav Martinát, Dan Van der Horst, Bohumil Frantál, and Kamila Turečková. 2017. "Renewable Energy Investment and Job Creation; a Cross-Sectoral Assessment for the Czech Republic with Reference to EU Benchmarks." *Renewable and Sustainable Energy Reviews*. Elsevier Ltd. https://doi.org/10.1016/j.rser.2016.11.158.

EarthJustice. 2019. "Mapping the Coal Ash Contamination." November 6, 2019. https://earthjustice.org/features/map-coal-ash-contaminated-sites.

Ebi, Kristie L., and Glenn McGregor. 2008. "Climate Change, Tropospheric Ozone and Particulate Matter, and Health Impacts." *Environmental Health Perspectives*. https://doi.org/10.1289/ehp.11463.

Economist. 2020. "Burning Questions." *The Economist*, 2020.

Edwards, Ben, Matthew Gray, and Boyd Hunter. 2015. "The Impact of Drought on Mental Health in Rural and Regional." *Source: Social Indicators Research* 121 (1): 177–94. https://doi.org/10.1007/sl.

Edwards, John, Sarah Walters, and Rodenc K. Griffiths. 1994. "Hospital Admissions for Asthma in Preschool Children: Relationship to Major Roads in Birmingham, United Kingdom." *Archives of Environmental Health*

49 (4): 223–27. https://doi.org/10.1080/00039896.1994.9937471.

Edwards, Ryan D. 2008. "Public Transit, Obesity, and Medical Costs: Assessing the Magnitudes." *Preventive Medicine* 46 (1): 14–21. https://doi.org/10.1016/j.ypmed.2007.10.004.

Engle, Patrice L, Lia C H Fernald, Harold Alderman, Jere Behrman, Chloe O'Gara, Aisha Yousafzai, Meena Cabral de Mello, Melissa Hidrobo, Nurper Ulkuer, and Ilgi Ertem. 2011. "Strategies for Reducing Inequalities and Improving Developmental Outcomes for Young Children in Low-Income and Middle-Income Countries." *The Lancet* 378 (9799): 1339–53.

Esposito, Susanna, Carlotta Galeone, Mara Lelii, Benedetta Longhi, Beatrice Ascolese, Laura Senatore, Elisabetta Prada, et al. 2014. "Impact of Air Pollution on Respiratory Diseases in Children with Recurrent Wheezing or Asthma." *BMC Pulmonary Medicine* 14 (1): 130. https://doi.org/10.1186/1471-2466-14-130.

Evans, Gary W. 2004. "The Environment of Childhood Poverty." *American Psychologist* 59 (2): 77–92. https://doi.org/10.1037/0003-066X.59.2.77.

Evans, Gary W, Carrie Gonnella, Lyscha A Marcynyszyn, Lauren Gentile, and Nicholas Salpekar. 2005. "The Role of Chaos in Poverty and Children's Socioemotional Adjustment." *Source: Psychological Science*. Vol. 16. https://www-jstor-org.ezproxy.library.wisc.edu/stable/pdf/40064269.pdf?refreqid=excelsior%3Ad6863e5e9b5961ef3c98aaf0c2432fab.

Evins, Brittany. 2020. "Bushfire-Affected Schoolchildren to Find It Tough Going Back to Class This Week." ABC News. 2020. https://www.abc.net.au/news/2020-01-28/schools-go-back-today-in-bushfire-areas/11904056.

Fankhauser, Samuel, Friedel Sehlleier, and Nicholas Stern. 2008. "Climate Change, Innovation and Jobs." *Climate Policy* 8 (4): 421–29. https://doi.org/10.3763/cpol.2008.0513.

Fantuzzo, John W, Whitney A LeBoeuf, Chin-Chih Chen, Heather L Rouse, and Dennis P Culhane. 2012. "The Unique and Combined Effects of Homelessness and School Mobility on the Educational Outcomes of Young Children." *Educational Researcher* 41 (9): 393–402. http://www.jstor.org/stable/23360364.

Faravelli, Carlo. 2012. "Childhood Stressful Events, HPA Axis and Anxiety Disorders." *World Journal of Psychiatry* 2 (1): 13. https://doi.org/10.5498/wjp.v2.i1.13.

Feng, Kuishuang, Klaus Hubacek, Dabo Guan, Monica Contestabile, Jan Minx, and John Barrett. 2010. "Distributional Effects of Climate Change Taxation: The Case of the UK." *Environmental Science and Technology* 44 (10): 3670–76. https://doi.org/10.1021/es902974g.

Feng, Shuaizhang, Alan B Krueger, and Michael Oppenheimer. 2010. "Linkages among Climate Change, Crop Yields and Mexico–US Cross-Border Migration." *Proceedings of the National Academy of Sciences* 107 (32): 14257–62.

Ferguson, HB, S Bovaird, and MP Mueller. 2007. "The Impact of Poverty on Educational Outcomes for Children." *Paediatrics & Child Health* 12 (8): 701–6. https://doi.org/10.1093/pch/12.8.701.

Ferris, Elizabeth, and Sanjula Weerasinghe. 2020. "Promoting Human Security: Planned Relocation as a Protection Tool in a Time of Climate Change." *Journal on Migration and Human Security*, April, 233150242090930. https://doi.org/10.1177/2331502420909305.

Flues, Florens, and Alastair Thomas. 2015. "The Distributional Effects of Energy Taxes." *OECD*. OECD Taxation Working Paper No. 23. https://www.oecd-ilibrary.org/taxation/the-distributional-effects-of-energy-taxes_5js1qwkqqrbv-en.

Francis, Lucine, Kelli DePriest, Marcella Wilson, and Deborah Gross. 2018. "Child Poverty, Toxic Stress, and Social Determinants of Health: Screening and Care Coordination." *Online Journal of Issues in Nursing* 23 (3). https://doi.org/10.3912/OJIN.VOL23NO03MAN02.

Frankenberg, Elizabeth, Bondan Sikoki, Cecep Sumantri, Wayan Suriastini, and Duncan Thomas. 2013. "Education, Vulnerability, and Resilience after a Natural Disaster." *Ecology and Society : A Journal of Integrative Science for Resilience and Sustainability* 18 (2): 16. https://doi.org/10.5751/ES-05377-180216.

Freeland, Amy L, Shailendra N Banerjee, Andrew L Dannenberg, and Arthur M Wendel. 2013. "Walking Associated with Public Transit: Moving toward Increased Physical Activity in the United States." *American Journal of Public Health* 103 (3): 536–42. https://doi.org/10.2105/AJPH.2012.300912.

Frondel, Manuel, Nolan Ritter, Christoph M. Schmidt, and Colin Vance. 2010. "Economic Impacts from the Promotion of Renewable Energy Technologies: The German Experience." *Energy Policy* 38 (8): 4048–56. https://doi.org/10.1016/j.enpol.2010.03.029.

Frondel, Manuel, Stephan Sommer, and Colin Vance. 2015. "The Burden of Germany's Energy Transition: An Empirical Analysis of Distributional Effects." *Economic Analysis and Policy* 45 (March): 89–99. https://doi.org/10.1016/j.eap.2015.01.004.

Fuller, Sarah C. 2014. "The Effect of Prenatal Natural Disaster Exposure on School Outcomes." *Demography* 51: 1501–25. https://doi.org/10.1007/s13524-014-0310-0.

Fullerton, Don, and Garth Heutel. 2007. "The General Equilibrium Incidence of Environmental Taxes." *Journal of Public Economics* 91 (3–4): 571–91. https://doi.org/10.1016/j.jpubeco.2006.07.004.

Fuss, Sabine, William F Lamb, Max W Callaghan, Jerome Hilaire, Felix Creutzig, Thorben Amann, Tim Beringer, Wagner de Oliveira Garcia, Jens Hartmann, and Tarun Khanna. 2018. "Negative Emissions Part 2: Costs, Potentials and Side Effects." *Environmental Research Letters* 13 (6). https://iopscience.iop.org/article/10.1088/1748-9326/aabf9f/meta.

Gakidou, Emmanuela, Ashkan Afshin, Amanuel Alemu Abajobir, Kalkidan Hassen Abate, Cristiana Abbafati, Kaja M. Abbas, Foad Abd-Allah, et al. 2017. "Global, Regional, and National Comparative Risk Assessment of 84 Behavioural, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990-2016: A Systematic Analysis for the Global Burden of Disease Study 2016." *The Lancet*. https://doi.org/10.1016/S0140-6736(17)32366-8.

Gamble, J.L., J. Balbus, M. Berger, K. Bouye, V. Campbell, K. Chief, K. Conlon, et al. 2016. "Ch. 9: Populations of Concern. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment." *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Washington, DC. https://doi.org/10.7930/J0Q81B0T.

Gao, Jinghong, Sari Kovats, Sotiris Vardoulakis, Paul Wilkinson, Alistair Woodward, Jing Li, Shaohua Gu, et al. 2018. "Public Health Co-Benefits of Greenhouse Gas Emissions Reduction: A Systematic Review." *Science of the Total Environment*. Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2018.01.193.

Garcia, Daniel Martinez, and Mary C Sheehan. 2016. "Extreme Weather-Driven Disasters and Children's Health." *International Journal of Health Services : Planning, Administration, Evaluation* 46 (1): 79–105.

https://doi.org/10.1177/0020731415625254.

Garfinkel, Irwin, David Harris, Jane Waldfogel, and Christopher Wimer. 2016. “Doing More for Our Children: Modeling a Universal Child Allowance or More Generous Child Tax Credit.”

Garrett-Peltier, Heidi. 2017. “Green versus Brown: Comparing the Employment Impacts of Energy Efficiency, Renewable Energy, and Fossil Fuels Using an Input-Output Model.” *Economic Modelling* 61 (February): 439–47. https://doi.org/10.1016/j.econmod.2016.11.012.

Garshick, Eric, Francine Laden, Jaime E. Hart, and Amy Caron. 2003. “Residence near a Major Road and Respiratory Symptoms in U.S. Veterans.” *Epidemiology* 14 (6): 728–36. https://doi.org/10.1097/01.ede.0000082045.50073.66.

Gaskin, Cadeyrn J, Davina Taylor, Susan Kinnear, Julie Mann, Wendy Hillman, and Monica Moran. 2017. “Factors Associated with the Climate Change Vulnerability and the Adaptive Capacity of People with Disability.” *Weather, Climate, and Society* 9 (4): 801–14. https://doi.org/10.2307/26389006.

Gibbs, Lisa, Jane Nursey, Janette Cook, Greg Ireton, Nathan Alkemade, Michelle Roberts, H. Colin Gallagher, et al. 2019. “Delayed Disaster Impacts on Academic Performance of Primary School Children.” *Child Development* 90 (4): 1402–12. https://doi.org/10.1111/cdev.13200.

Giuliano, Genevieve. 2005. “Low Income, Public Transit, and Mobility.” *Transportation Research Record: Journal of the Transportation Research Board* 1927 (1): 63–70. https://doi.org/10.1177/0361198105192700108.

Glynn, Laura M, and Curt A Sandman. 2011. “Prenatal Origins of Neurological Development: A Critical Period for Fetus and Mother.” *Psychological Science* 20 (6): 384–89. https://doi.org/10.1177/0963721411422056.

Godard, X, and L D Olvera. 2000. “Poverty and Urban Transport: French Experience and Developing Cities.”

Gonzalez, Fidel. 2012. “Distributional Effects of Carbon Taxes: The Case of Mexico.” *Energy Economics* 34 (6): 2102–15. https://doi.org/10.1016/j.eneco.2012.03.007.

Goosby, Bridget J. 2013. “Early Life Course Pathways of Adult Depression and Chronic Pain.” *Journal of Health and Social Behavior* 54 (1): 75–91. https://doi.org/10.1177/0022146512475089.

Gottfried, Michael A. 2010. “Evaluating the Relationship Between Student Attendance and Achievement in Urban Elementary and Middle Schools: An Instrumental Variables Approach.” *American Educational Research Journal* 47 (2): 434–65. http://www.jstor.org/stable/40645446.

Gough, Ian. 2013. “Carbon Mitigation Policies, Distributional Dilemmas and Social Policies.” *Journal of Social Policy* 42 (2): 191–213. https://doi.org/10.1017/S0047279412001018.

Gough, Ian, James Meadowcroft, John S Dryzek, Richard B Norgaard, and David Schlosberg. 2010. “Decarbonising the Welfare State.”

Grainger, Corbett, and Charles Kolstad. 2009. “Who Pays a Price on Carbon?” *National Bureau of Economic Research*. https://doi.org/10.3386/w15239.

Grant, Roy, Grifin Goldsmith, Delaney Gracy, and Dennis Johnson. 2016. “Better Transportation to Health Care Will Improve Child Health and Lower Costs.” *Advances in Pediatrics*. Academic Press Inc. https://doi.org/10.1016/j.yapd.2016.04.003.

Grant, Roy, Delaney Gracy, Grifin Goldsmith, Morissa Sobelson, and Dennis Johnson. 2014. "Transportation Barriers to Child Health Care Access Remain after Health Reform." *JAMA Pediatrics*. American Medical Association. https://doi.org/10.1001/jamapediatrics.2013.4653.

Grengs, Joe. 2001. "Does Public Transit Counteract the Segregation of Carless Households? Measuring Spatial Patterns of Accessibility." *Transportation Research Record: Journal of the Transportation Research Board* 1753 (1): 3–10. https://doi.org/10.3141/1753-01.

Gustafson, Daniel J. 2013. "Rising Food Costs & Global Food Security: Key Issues & Relevance for India." *The Indian Journal of Medical Research* 138 (3): 398–410. http://www.ncbi.nlm.nih.gov/pubmed/24135190.

Hajat, Anjum, Charlene Hsia, and Marie S. O'Neill. 2015. "Socioeconomic Disparities and Air Pollution Exposure: A Global Review." *Current Environmental Health Reports*. https://doi.org/10.1007/s40572-015-0069-5.

Halonen, Jaana I., Timo Lanki, Pekka Tiittanen, Jarkko V. Niemi, Miranda Loh, and Juha Pekkanen. 2010. "Ozone and Cause-Specific Cardiorespiratory Morbidity and Mortality." *Journal of Epidemiology and Community Health* 64 (9): 814–20. https://doi.org/10.1136/jech.2009.087106.

Harlan, Sharon L, Darren M Ruddell, Patricia Romero Lankao, and David Dodman. 2011. "Climate Change and Health in Cities: Impacts of Heat and Air Pollution and Potential Co-Benefits from Mitigation and Adaptation." *Current Opinion in Environmental Sustainability* 3: 126–34. https://doi.org/10.1016/j.cosust.2011.01.001.

Harnett, Sam. 2018. "Low-Income Communities Struggle To Recover After A Wildfire : NPR." National Public Radio. September 19, 2018. https://www.npr.org/2018/09/19/647606049/low-income-communities-struggle-to-recover-after-a-wildfire.

Harvey, Brian J. 2016. "Human-Caused Climate Change Is Now a Key Driver of Forest Fire Activity in the Western United States." *National Academy of Sciences* 113 (42): 11649–50. https://doi.org/10.2307/26472074.

Harvey, Leslie Daryl Danny. 2010. *Energy and the New Reality. 1, Energy Efficiency and the Demand for Energy Services*. Earthscan.

Hassett, Kevin A., Aparna Mathur, and Gilbert E. Metcalf. 2009. "The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis." *The Energy Journal*. International Association for Energy Economics. https://doi.org/10.2307/41323238.

Haug, Costanze, Alexander Eden, and Mariza Montes de Oca. 2018. "Addressing Distributional Impacts of Carbon Pricing Policies." https://www.adelphi.de/en/publication/addressing-distributional-impacts-carbon-pricing-policies.

Hendryx, Michael. 2010. "Poverty and Mortality Disparities in Central Appalachia." *Journal of Health Disparities Research and Practice* 4 (3). https://digitalscholarship.unlv.edu/jhdrp/vol4/iss3/6/.

Hess, Daniel Baldwin. 2005. "Access to Employment for Adults in Poverty in the Buffalo-Niagara Region." *Urban Studies* 42 (7): 1177–1200. https://doi.org/10.1080/00420980500121384.

Heyman, Bob, Barbara Harrington, and Anna Heyman. 2011. "A Randomised Controlled Trial of an Energy Efficiency Intervention for Families Living in Fuel Poverty." *Housing Studies* 26 (1): 117–32. https://doi.org/10.1080/02673037.2010.512787.

Hills, John. 2012. "Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review."

Holpuch, Amanda. 2018. "Despair and Anxiety: Puerto Rico's 'living Emergency' as a Mental Health Crisis Unfolds." *The Guardian*, August 7, 2018. https://www.theguardian.com/world/2018/aug/07/despair-and-anxiety-puerto-ricos-living-emergency-as-a-mental-health-crisis-unfolds.

Holpuch, Amanda, and Hazar Kilani. 2019. "Hurricane Maria's Lasting Impact on Puerto Rico's Children Revealed in Report." *The Guardian*, April 26, 2019. https://www.theguardian.com/world/2019/apr/26/hurricane-maria-puerto-rico-youth-mental-health-study-report.

Horton, Lindsey M, Mary E Mortensen, Yulia Iossifova, Marlena M Wald, and Paula Burgess. 2013. "What Do We Know of Childhood Exposures to Metals (Arsenic, Cadmium, Lead, and Mercury) in Emerging Market Countries?" *International Journal of Pediatrics* 2013: 872596. https://doi.org/10.1155/2013/872596.

Hotez, Peter J., and Patricia P. Wilkins. 2009. "Toxocariasis: America's Most Common Neglected Infection of Poverty and a Helminthiasis of Global Importance?" *PLoS Neglected Tropical Diseases*. https://doi.org/10.1371/journal.pntd.0000400.

Houser, Trevor, Solomon Hsiang, Robert Kopp, Kate Larsen, Michael Delgado, Amir Jina, Michael Mastrandrea, et al. 2015. "Economic Risks of Climate Change Book." *Columbia University Press*. https://doi.org/10.7312/hous17456.13.

Howden-Chapman, Philippa, and Ralph Chapman. 2012. "Health Co-Benefits from Housing-Related Policies." *Current Opinion in Environmental Sustainability*. Elsevier. https://doi.org/10.1016/j.cosust.2012.08.010.

Howell, Junia, and James R Elliott. 2018. "Damages Done: The Longitudinal Impacts of Natural Hazards on Wealth Inequality in the United States." *Social Problems* 66 (3): 448–67. https://doi.org/10.1093/socpro/spy016.

Hull, Katy. 2009. "Understanding the Relationship between Economic Growth, Employment and Poverty Reduction." *Promoting Pro-Poor Growth: Employment*, January.

ILO. 2018. "The Employment Impact of Climate Change Adaptation."

IPCC. 2014. "Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects."

IRENA. 2011. "Renewable Energy Jobs: Status, Prospects & Policies."

IRENA. 2018. "Renewable Energy and Jobs: Annual Review 2018."

IRENA. 2019. "Renewable Power Generation Costs in 2018." https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf.

Isen, Adam, Maya Rossin-Slater, and W. Reed Walker. 2017. "Every Breath You Take—Every Dollar You'll Make: The Long-Term Consequences of the Clean Air Act of 1970." *Journal of Political Economy* 125 (3): 848–902. https://doi.org/10.1086/691465.

Isensee, Laura. 2017. "Houston Public Schools Open After Delays From Hurricane Harvey : NPR Ed : NPR." National Public Radio. September 11, 2017. https://www.npr.org/sections/ed/2017/09/11/550218485/houston-public-schools-open-after-delays-from-hurricane-harvey.

Islam, Talat, W. James Gauderman, Kiros Berhane, Rob McConnell, Ed Avol, John M. Peters, and Frank D. Gilliland. 2007. "Relationship between Air Pollution, Lung Function and Asthma in Adolescents." *Thorax* 62 (11): 957–63. https://doi.org/10.1136/thx.2007.078964.

Jack, Darby W., and Patrick L. Kinney. 2010. "Health Co-Benefits of Climate Mitigation in Urban Areas." *Current Opinion in Environmental Sustainability*. Elsevier. https://doi.org/10.1016/j.cosust.2010.06.007.

Jacobson, Mark Z., Mark A. Delucchi, Zack A.F. Bauer, Savannah C. Goodman, William E. Chapman, Mary A. Cameron, Cedric Bozonnat, et al. 2017. "100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World." *Joule* 1 (1): 108–21. https://doi.org/10.1016/j.joule.2017.07.005.

Jacobson, Mark Z., Mark A. Delucchi, Anthony R. Ingraffea, Robert W. Howarth, Guillaume Bazouin, Brett Bridgeland, Karl Burkart, et al. 2014. "A Roadmap for Repowering California for All Purposes with Wind, Water, and Sunlight." *Energy* 73 (August): 875–89. https://doi.org/10.1016/j.energy.2014.06.099.

Japan Times. 2019. "57 Dead and 18,000 Taken to Hospitals in One Week amid Japan Heat Wave." The Japan Times. 2019. https://www.japantimes.co.jp/news/2019/08/06/national/57-dead-18000-taken-hospitals-one-week-amid-japan-heat-wave/#.XmXwa6hKiiM.

Jocoy, Christine L, and Vincent J Del Casino. 2008. "The Mobility of Homeless People and Their Use of Public Transit in Long Beach, California."

Johnson, Richard J., Laura G. Sánchez-Lozada, Lee S. Newman, Miguel A. Lanaspa, Henry F. Diaz, Jay Lemery, Bernardo Rodriguez-Iturbe, et al. 2019. "Climate Change and the Kidney." In *Annals of Nutrition and Metabolism*, 74:38–44. S. Karger AG. https://doi.org/10.1159/000500344.

Johnson, Sara B., Anne W. Riley, Douglas A. Granger, and Jenna Riis. 2013. "The Science of Early Life Toxic Stress for Pediatric Practice and Advocacy." *Pediatrics* 131 (2): 319–27. https://doi.org/10.1542/peds.2012-0469.

Kamal, Mahmoud, Mohamed A. Kenawy, Magda Hassan Rady, Amany Soliman Khaled, and Abdallah M. Samy. 2018. "Mapping the Global Potential Distributions of Two Arboviral Vectors Aedes Aegypti and Ae. Albopictus under Changing Climate." *PLoS ONE*. https://doi.org/10.1371/journal.pone.0210122.

Kampa, Marilena, and Elias Castanas. 2008. "Human Health Effects of Air Pollution." *Environmental Pollution*. https://doi.org/10.1016/j.envpol.2007.06.012.

Keller, Richard. 2020. "Europe's Killer Heat Waves Are a New Norm. The Death Rates Shouldn't Be." Washington Post. 2020. https://www.washingtonpost.com/outlook/2019/07/26/europes-killer-heat-waves-are-new-norm-death-rates-shouldnt-be/.

Kenny, Glen P., Jane Yardley, Candice Brown, Ronald J. Sigal, and Ollie Jay. 2010. "Heat Stress in Older Individuals and Patients with Common Chronic Diseases." *CMAJ*. https://doi.org/10.1503/cmaj.081050.

Kihlström, Anne, G. Lilja, G. Pershagen, and G. Hedlin. 2003. "Exposure to High Doses of Birch Pollen during Pregnancy, and Risk of Sensitization and Atopic Disease in the Child." *Allergy: European Journal of Allergy and Clinical Immunology*. https://doi.org/10.1034/j.1398-9995.2003.00232.x.

Kim, Janice J. 2004. "Ambient Air Pollution: Health Hazards to Children Committee on Environmental Health." *Pediatrics*. https://doi.org/10.1542/peds.2004-2166.

Kim, Ki Hyun, Ehsanul Kabir, and Shamin Kabir. 2015. "A Review on the Human Health Impact of Airborne Particulate Matter." *Environment International*. https://doi.org/10.1016/j.envint.2014.10.005.

Kimball, Mandi, Kelli O'Quinn, Edith Rahimian, Bob Sanborn, Anna Hardway, Sara Neumann, Jeremy Soulliere, and Sarah Thompson. 2018. "Still at Risk: Children One Year After Hurricane Harvey."

Kingsley, G. Thomas, Robin Smith, and David Price. 2009. "The Impacts of Foreclosures on Families and Communities." Washington, DC. https://www.urban.org/sites/default/files/publication/30426/411909-The-Impacts-of-Foreclosures-on-Families-and-Communities.PDF.

Kinney, Patrick L., Thomas Matte, Kim Knowlton, Jaime Madrigano, Elisaveta Petkova, Kate Weinberger, Ashlinn Quinn, Mark Arend, and Julie Pullen. 2015. "New York City Panel on Climate Change 2015 Report Chapter 5: Public Health Impacts and Resiliency." *Annals of the New York Academy of Sciences*. https://doi.org/10.1111/nyas.12588.

Kjellstrom, Tord, Ainslie J. Butler, Robyn M. Lucas, and Ruth Bonita. 2010. "Public Health Impact of Global Heating Due to Climate Change: Potential Effects on Chronic Non-Communicable Diseases." *International Journal of Public Health*. https://doi.org/10.1007/s00038-009-0090-2.

Klenert, David, and Linus Mattauch. 2016. "How to Make a Carbon Tax Reform Progressive: The Role of Subsistence Consumption." *Economics Letters* 138 (January): 100–103. https://doi.org/10.1016/j.econlet.2015.11.019.

Knittel, Christopher, Douglas Miller, and Nicholas Sanders. 2011. "Caution, Drivers! Children Present: Traffic, Pollution, and Infant Health." Cambridge, MA. https://doi.org/10.3386/w17222.

Kohler, Peter, Christoph Voelker, Jesse F. Abrams, and Judith Hauck. 2013. "Geoengineering Impact of Open Ocean Dissolution of Olivine on Atmospheric CO2 , Surface Ocean PH and Marine Biology." *Environmental Research Letters* 8 (1). https://www.researchgate.net/publication/235640930_Geoengineering_impact_of_open_ocean_dissolution_of_olivine_on_atmospheric_CO2_surface_ocean_pH_and_marine_biology.

Kolk, Bessel A. van der. 2005. "Developmental Trauma Disorder: Towards a Rational Diagnosis for Children with Complex Trauma Histories." *Psychiatric Annals* 35 (5): 401–408.

Kovats, R. Sari, and Shakoor Hajat. 2008. "Heat Stress and Public Health: A Critical Review." *Annual Review of Public Health*. https://doi.org/10.1146/annurev.publhealth.29.020907.090843.

Kraemer, Moritz U.G., Marianne E. Sinka, Kirsten A. Duda, Adrian Q.N. Mylne, Freya M. Shearer, Christopher M. Barker, Chester G. Moore, et al. 2015. "The Global Distribution of the Arbovirus Vectors Aedes Aegypti and Ae. Albopictus." *ELife*. https://doi.org/10.7554/eLife.08347.

Labandeira, Xavier, José M. Labeaga, and Miguel Rodríguez. 2009. "An Integrated Economic and Distributional Analysis of Energy Policies." *Energy Policy* 37 (12): 5776–86. https://doi.org/10.1016/j.enpol.2009.08.041.

Lachapelle, Ugo, and Lawrence D. Frank. 2009. "Transit and Health: Mode of Transport, Employer-Sponsored Public Transit Pass Programs, and Physical Activity." *Journal of Public Health Policy* 30 (SUPPL. 1): S73–94.

https://doi.org/10.1057/jphp.2008.52.

Laffon, Blanca, Eduardo Pásaro, and Vanessa Valdiglesias. 2016. "Effects of Exposure to Oil Spills on Human Health: Updated Review." *Journal of Toxicology and Environmental Health - Part B: Critical Reviews* 19 (3–4): 105–28. https://doi.org/10.1080/10937404.2016.1168730.

Lambert, Rosebud Jasmine, and Patrícia Pereira Silva. 2012. "The Challenges of Determining the Employment Effects of Renewable Energy." *Renewable and Sustainable Energy Reviews*. Pergamon. https://doi.org/10.1016/j.rser.2012.03.072.

Lane, Kathryn, Kizzy Charles-Guzman, Katherine Wheeler, Zaynah Abid, Nathan Graber, and Thomas Matte. 2013. "Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment." *Journal of Environmental and Public Health*. https://doi.org/10.1155/2013/913064.

Laumbach, Robert J., and Howard M. Kipen. 2012. "Respiratory Health Effects of Air Pollution: Update on Biomass Smoke and Traffic Pollution." *Journal of Allergy and Clinical Immunology*. Mosby Inc. https://doi.org/10.1016/j.jaci.2011.11.021.

Lavidas, George. 2019. "Energy and Socio-Economic Benefits from the Development of Wave Energy in Greece." *Renewable Energy* 132 (March): 1290–1300. https://doi.org/10.1016/j.renene.2018.09.007.

Lazard. 2017. "Levelized Cost of Energy 2017." https://www.lazard.com/perspective/levelized-cost-of-energy-2017/.

Lee, Richard J., and Ipek N. Sener. 2016. "Transportation Planning and Quality of Life: Where Do They Intersect?" *Transport Policy* 48 (May): 146–55. https://doi.org/10.1016/j.tranpol.2016.03.004.

Lehr, Ulrike, Christian Lutz, and Dietmar Edler. 2012. "Green Jobs? Economic Impacts of Renewable Energy in Germany." *Energy Policy* 47 (August): 358–64. https://doi.org/10.1016/j.enpol.2012.04.076.

Lelieveld, J., J. S. Evans, M. Fnais, D. Giannadaki, and A. Pozzer. 2015. "The Contribution of Outdoor Air Pollution Sources to Premature Mortality on a Global Scale." *Nature* 525 (7569): 367–71. https://doi.org/10.1038/nature15371.

Levinson, Arik. 2016. "Energy Efficiency Standards Are More Regressive Than Energy Taxes: Theory and Evidence." NBER Working Paper Series. https://en.wikipedia.org/wiki/Pigou_Club.

Li, Shi, Stuart Batterman, Elizabeth Wasilevich, Robert Wahl, Julie Wirth, Feng Chiao Su, and Bhramar Mukherjee. 2011. "Association of Daily Asthma Emergency Department Visits and Hospital Admissions with Ambient Air Pollutants among the Pediatric Medicaid Population in Detroit: Time-Series and Time-Stratified Case-Crossover Analyses with Threshold Effects." *Environmental Research* 111 (8): 1137–47. https://doi.org/10.1016/j.envres.2011.06.002.

Li, Yinpeng, Wei Ye, Meng Wang, and Xiaodong Yan. 2009. "Climate Change and Drought:: A Risk Assessment of Crop-Yield Impacts." *Research* 39 (1): 31–46. https://doi.org/10.2307/24870421.

Liang, Qiao-Mei, Qian Wang, and Yi-Ming Wei. 2013. "Assessing the Distributional Impacts of Carbon Tax among Households across Different Income Groups: The Case of China." *Energy & Environment* 24 (7–8): 1323–46. https://doi.org/10.1260/0958-305X.24.7-8.1323.

Liu-Helmersson, Jing, Joacim Rocklöv, Macquin Sewe, and Åke Brännström. 2019. "Climate Change May Enable Aedes Aegypti Infestation in Major European Cities by 2100." *Environmental Research* 172 (May):

693–99. https://doi.org/10.1016/j.envres.2019.02.026.

Liu, Xiaopeng, Lawrence Lessner, and David O. Carpenter. 2012. "Association between Residential Proximity to Fuel-Fired Power Plants and Hospitalization Rate for Respiratory Diseases." *Environmental Health Perspectives* 120 (6): 807–10. https://doi.org/10.1289/ehp.1104146.

Liu, Yongqiang, John Stanturf, and Scott Goodrick. 2010. "Trends in Global Wildfire Potential in a Changing Climate." *Forest Ecology and Management* 259 (4): 685–97. https://doi.org/10.1016/j.foreco.2009.09.002.

Llera, E., S. Scarpellini, A. Aranda, and I. Zabalza. 2013. "Forecasting Job Creation from Renewable Energy Deployment through a Value-Chain Approach." *Renewable and Sustainable Energy Reviews*. Elsevier Ltd. https://doi.org/10.1016/j.rser.2012.12.053.

Lustig, Nora. 2012. "Rising Food Prices and Children's Welfare." In *Child Poverty and Inequality: New Perspectives*, edited by Isabel Ortiz, Louise Moreira Daniels, and Solrun Engilbertsdottir, 125–32. UNICEF.

Madrick, Jeffrey G. 2020. *Invisible Americans : The Tragic Cost of Child Poverty*. New York: Alfred A. Knopf.

Maibach, Edward, and Lauren Feldman. 2010. "The Climate Change Generation? Survey Analysis of the Perceptions and Beliefs of Young Americans."

Main, Gill, and Jonathan Bradshaw. 2012. "A Child Material Deprivation Index." *Child Indicators Research* 5 (3): 503–21. https://doi.org/10.1007/s12187-012-9145-7.

Maks-Solomon, Cory, and Robert P. Stoker. 2019. "Weathering the Storm: Social Policy and the Great Recession." *Policy Studies Journal* 47 (S1): S119–37. https://doi.org/10.1111/psj.12318.

Martinez-Urtaza, Jaime, Joaquin Trinanes, Michel Abanto, Antonio Lozano-Leon, Jose Llovo-Taboada, Marta Garcia-Campello, Anxela Pousa, Andy Powell, Craig Baker-Austin, and Narjol Gonzalez-Escalona. 2018. "Epidemic Dynamics of Vibrio Parahaemolyticus Illness in a Hotspot of Disease Emergence, Galicia, Spain." *Emerging Infectious Diseases*. https://doi.org/10.3201/eid2405.171700.

Mathur, Aparna, and Adele C. Morris. 2012. "Distributional Effects of a Carbon Tax in Broader US Fiscal Reform." Brookings Climate and Energy Economic Project. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2212993.

McChesney, Ian. 2013. "Child Poverty: The 'Fuel Poverty' Dimension." *Policy Quarterly* 9 (2). https://doi.org/10.26686/pq.v9i2.4444.

McGee, Tara K., Sarah McCaffrey, and Fantina Tedim. 2020. "Resident and Community Recovery after Wildfires." In *Extreme Wildfire Events and Disasters*, 175–84. Elsevier. https://doi.org/10.1016/b978-0-12-815721-3.00009-6.

McGuire, Shelley. 2015. "FAO, IFAD, and WFP. The State of Food Insecurity in the World 2015: Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress. Rome: FAO, 2015." *Advances in Nutrition*. https://doi.org/10.3945/an.115.009936.

Mckenzie, Brian S. 2013. "Neighborhood Access to Transit by Race, Ethnicity, and Poverty in Portland, OR." *City and Community* 12 (2): 134–55. https://doi.org/10.1111/cico.12022.

McLaughlin, Michael, and Mark R Rank. 2018. "Estimating the Economic Cost of Childhood Poverty in the United States." *Social Work Research* 42 (2): 73–83. https://doi.org/10.1093/swr/svy007.

McMichael, Celia, Jon Barnett, and Anthony J McMichael. 2012. "An Ill Wind? Climate Change, Migration, and Health." *Environmental Health Perspectives* 120 (5): 646–54.

Messina, Jane P., Oliver J. Brady, Nick Golding, Moritz U.G. Kraemer, G. R.William Wint, Sarah E. Ray, David M. Pigott, et al. 2019. "The Current and Future Global Distribution and Population at Risk of Dengue." *Nature Microbiology* 4 (9): 1508–15. https://doi.org/10.1038/s41564-019-0476-8.

Metcalf, Gilbert E. 2019. "The Distributional Impacts of U.S. Energy Policy." *Energy Policy* 129 (June): 926–29. https://doi.org/10.1016/j.enpol.2019.01.076.

Minx, Jan C, William F Lamb, Max W Callaghan, Sabine Fuss, Jerome Hilaire, Felix Creutzig, Thorben Amann, et al. 2018. "Negative Emissions: Part 1—Research Landscape and Synthesis." *Environmental Research Letters* 13.

Missirian, Anouch, and Wolfram Schlenker. 2017. "Asylum Applications Respond to Temperature Fluctuations." *Science* 358 (6370): 1610–14. https://doi.org/10.1126/science.aao0432.

Monath, Thomas P., and Pedro F.C. Vasconcelos. 2015. "Yellow Fever." *Journal of Clinical Virology*. https://doi.org/10.1016/j.jcv.2014.08.030.

Moradi, Sajjad, Atieh Mirzababaei, Alireza Dadfarma, Shahabeddin Rezaei, Hamed Mohammadi, Behrooz Jannat, and Khadijeh Mirzaei. 2019. "Food Insecurity and Adult Weight Abnormality Risk: A Systematic Review and Meta-Analysis." *European Journal of Nutrition*. https://doi.org/10.1007/s00394-018-1819-6.

Morgenstern, V., A. Zutavern, J. Cyrys, I. Brockow, U. Gehring, S. Koletzko, C. P. Bauer, D. Reinhardt, H. Erich Wichmann, and J. Heinrich. 2007. "Respiratory Health and Individual Estimated Exposure to Traffic-Related Air Pollutants in a Cohort of Young Children." *Occupational and Environmental Medicine* 64 (1): 8–16. https://doi.org/10.1136/oem.2006.028241.

Moser, Caroline, and David Satterthwaite. 2008. " Towards Pro-Poor Adaptation to Climate Change in the Urban Centres of Low and Middle-Income Countries."

Murali, Vijaya, and Femi Oyebode. 2004. "Poverty, Social Inequality and Mental Health." *Advances in Psychiatric Treatment* 10 (3): 216–24.

Myers, Samuel S., and Jonathan A. Patz. 2009. "Emerging Threats to Human Health from Global Environmental Change." *Annual Review of Environment and Resources*. https://doi.org/10.1146/annurev.environ.033108.102650.

Myers, Samuel S., Matthew R. Smith, Sarah Guth, Christopher D. Golden, Bapu Vaitla, Nathaniel D. Mueller, Alan D. Dangour, and Peter Huybers. 2017. "Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition." *Annual Review of Public Health*. https://doi.org/10.1146/annurev-publhealth-031816-044356.

NAACP. 2016. "Coal Blooded Putting Profits Before People." www.ienearth.org.

NASA. 2019. "Long-Term Drought Parches Chile." NASA Earth Observatory. 2019. https://earthobservatory.nasa.gov/images/145874/long-term-drought-parches-chile.

NASA. 2020. "Is It Too Late to Prevent Climate Change? – Climate Change: Vital Signs of the Planet." NASA - Global Climate Change. 2020. https://climate.nasa.gov/faq/16/is-it-too-late-to-prevent-climate-change/.

Naser, Mostafa Mahmud. 2011. "Climate Change, Environmental Degradation, and Migration: A Complex Nexus." *William & Mary Environmental Law and Policy Review* 36: 713.

Nemet, Greg F. 2019. *How Solar Energy Became Cheap: A Model for Low-Carbon Innovation*. Routledge.

Nemet, Greg F., T. Holloway, and P. Meier. 2010. "Implications of Incorporating Air-Quality Co-Benefits into Climate Change Policymaking." *Environmental Research Letters* 5 (1). https://ui.adsabs.harvard.edu/abs/2010ERL.....5a4007N/abstract.

Neuhoff, Karsten, Stefan Bach, Jochen Diekmann, Martin Beznoska, and Tarik El-Laboudy. 2013. "Distributional Effects of Energy Transition: Impacts of Renewable Electricity Support in Germany." *Economics of Energy & Environmental Policy*. International Association for Energy Economics. https://doi.org/10.2307/26189443.

Newell, Peter. 2005. "Race, Class and the Global Politics of Environmental Inequality." *Global Environmental Politics* 5 (3): 70–94.

NOAA. 2019. "Active 2019 Atlantic Hurricane Season Comes to an End | National Oceanic and Atmospheric Administration." National Oceanic and Atmospheric Administration. 2019. https://www.noaa.gov/media-release/active-2019-atlantic-hurricane-season-comes-to-end.

NOAA. 2020. "2019 Was 2nd Hottest Year on Record for Earth Say NOAA, NASA | National Oceanic and Atmospheric Administration." National Oceanic and Atmospheric Administration. 2020. https://www.noaa.gov/news/2019-was-2nd-hottest-year-on-record-for-earth-say-noaa-nasa.

Noll, Scott, and Stephanie Kuzydym. 2017. "Months after Harvey, Tens of Thousands of Students Remain Homeless." KHOU 11. 2017. https://www.khou.com/article/news/investigations/months-after-harvey-tens-of-thousands-of-students-remain-homeless/285-494038245.

Nordhaus, William. 2010. "The Economics of Hurricanes and Implications of Global Warming." *Climate Change Economics* 1 (1): 1–20. https://doi.org/10.2307/CLIMCHANECON.1.1.1.

Nunn, Patrick D, Augustine Kohler, and Roselyn Kumar. 2017. "Identifying and Assessing Evidence for Recent Shoreline Change Attributable to Uncommonly Rapid Sea-Level Rise in Pohnpei, Federated States of Micronesia, Northwest Pacific Ocean." *Journal of Coastal Conservation* 21 (6): 719–30. https://doi.org/10.1007/s11852-017-0531-7.

O'Neill, Marie S., Michael Jerrett, Ichiro Kawachi, Jonathan I. Levy, Aaron J. Cohen, Nelson Gouveia, Paul Wilkinson, et al. 2003. "Health, Wealth, and Air Pollution: Advancing Theory and Methods." *Environmental Health Perspectives*. Public Health Services, US Dept of Health and Human Services. https://doi.org/10.1289/ehp.6334.

Obradović, Jelena, Jeffrey D. Long, J. J. Cutuli, Chi Keung Chan, Elizabeth Hinz, David Heistad, and Ann S. Masten. 2009. "Academic Achievement of Homeless and Highly Mobile Children in an Urban School District: Longitudinal Evidence on Risk, Growth, and Resilience." *Development and Psychopathology* 21 (2): 493–518. https://doi.org/10.1017/S0954579409000273.

OECD. 2008. "Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Exposure Estimates." *Environment*.

OECD. 2012. "The Jobs Potential of a Shift towards a Low-Carbon Economy."

http://www.oecd.org/els/emp/50503551.pdf.

OECD. 2016. *The Economic Consequences of Outdoor Air Pollution*. *The Economic Consequences of Outdoor Air Pollution*. OECD. https://doi.org/10.1787/9789264257474-en.

OECD. 2018. "Poor Children in Rich Countries: Why We Need Policy Action." http://oe.cd/idd.

OECD. 2019. "'Poverty Rate' (Indicator)." *Organisation for Economic Co-Operation and Development*, 2017–20. https://doi.org/10.1787/0fe1315d-en.

Oken, Emily, Jenny S Radesky, Robert O Wright, David C Bellinger, Chitra J Amarasiriwardena, Ken P Kleinman, Howard Hu, and Matthew W Gillman. 2008. "Maternal Fish Intake during Pregnancy, Blood Mercury Levels, and Child Cognition at Age 3 Years in a US Cohort." *American Journal of Epidemiology* 167 (10): 1171–81. https://doi.org/10.1093/aje/kwn034.

Oladosu, Gbadebo, and Adam Rose. 2007. "Income Distribution Impacts of Climate Change Mitigation Policy in the Susquehanna River Basin Economy." *Energy Economics* 29 (3): 520–44. https://doi.org/10.1016/j.eneco.2005.09.012.

Oleson, K. W., A. Monaghan, O. Wilhelmi, M. Barlage, N. Brunsell, J. Feddema, L. Hu, and D. F. Steinhoff. 2015. "Interactions between Urbanization, Heat Stress, and Climate Change." *Climatic Change* 129 (3–4): 525–41. https://doi.org/10.1007/s10584-013-0936-8.

Onis, M. De, C. Monteiro, J. Akre, and G. Clugston. 1993. "The Worldwide Magnitude of Protein-Energy Malnutrition: An Overview from the WHO Global Database on Child Growth." *Bulletin of the World Health Organization* 71 (6): 703–12.

Ordinioha, Best, and Seiyefa Brisibe. 2013. "The Human Health Implications of Crude Oil Spills in the Niger Delta, Nigeria: An Interpretation of Published Studies." *Nigerian Medical Journal* 54 (1): 10. https://doi.org/10.4103/0300-1652.108887.

Ostro, Bart, Stephen Rauch, Rochelle Green, Brian Malig, and Rupa Basu. 2010. "The Effects of Temperature and Use of Air Conditioning on Hospitalizations." *American Journal of Epidemiology*. https://doi.org/10.1093/aje/kwq231.

Osypuk, Theresa L, Nicole M Schmidt, Lisa M Bates, Eric J Tchetgen-Tchetgen, Felton J Earls, and M Maria Glymour. 2012. "Gender and Crime Victimization Modify Neighborhood Effects on Adolescent Mental Health." *Pediatrics* 130 (3): 472–81.

Pachauri, Rajendra K, Leo Meyer, Stephane Hallegatte France, World Bank, Gabriele Hegerl, Sander Brinkman, Line van Kesteren, Noëmie Leprince-Ringuet, and Fijke van Boxmeer. 2015. "Climate Change 2014 Synthesis Report." https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf.

Pan, Genxing, Pete Smith, and Weinan Pan. 2009. "The Role of Soil Organic Matter in Maintaining the Productivity and Yield Stability of Cereals in China." *Agriculture, Ecosystems and Environment* 129 (1–3): 344–48. https://doi.org/10.1016/j.agee.2008.10.008.

Pathak, Rahul, Christopher K. Wyczalkowski, and Xi Huang. 2017. "Public Transit Access and the Changing Spatial Distribution of Poverty." *Regional Science and Urban Economics* 66 (September): 198–212. https://doi.org/10.1016/j.regsciurbeco.2017.07.002.

Pearson, Robert L., Howard Wachtel, and Kristie L. Ebi. 2000. "Distance-Weighted Traffic Density in

Proximity to a Home Is a Risk Factor for Leukemia and Other Childhood Cancers." *Journal of the Air and Waste Management Association* 50 (2): 175–80. https://doi.org/10.1080/10473289.2000.10463998.

Perera, Frederica P. 2008. "Children Are Likely to Suffer Most from Our Fossil Fuel Addiction." *Environmental Health Perspectives*. National Institute of Environmental Health Sciences. https://doi.org/10.1289/ehp.11173.

Perera, Frederica P. 2017. "Multiple Threats to Child Health from Fossil Fuel Combustion: Impacts of Air Pollution and Climate Change." *Environmental Health Perspectives*. Public Health Services, US Dept of Health and Human Services. https://doi.org/10.1289/EHP299.

Perlman, Staci, and John Fantuzzo. 2010. "Timing and Influence of Early Experiences of Child Maltreatment and Homelessness on Children's Educational Well-Being." *Children and Youth Services Review* 32 (6): 874–83. https://doi.org/10.1016/j.childyouth.2010.02.007.

Phalkey, Revati K., Clara Aranda-Jan, Sabrina Marx, Bernhard Höfle, and Rainer Sauerborn. 2015. "Systematic Review of Current Efforts to Quantify the Impacts of Climate Change on Undernutrition." *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1409769112.

Pierse, N., L. Rushton, R. S. Harris, C. E. Kuehni, M. Silverman, and J. Grigg. 2006. "Locally Generated Participate Pollution and Respiratory Symptoms in Young Children." *Thorax* 61 (3): 216–20. https://doi.org/10.1136/thx.2004.036418.

Pilkey, Orrin H, Linda Pilkey-Jarvis, and Keith C Pilkey. 2016. "Retreat from a Rising Sea." In *Retreat from a Rising Sea*. Columbia University Press.

Pillay, Ariranga G. 2013. "Economic, Social and Cultural Rights and Climate Change." In *Climate Change: International Law and Governance*, edited by Oliver C. Ruppel, Christian Roschmann, and Katharina Ruppel-Schlichting. Nomos Verlagsgesellschaft.

Pollard, Emma. 2020. "Problem of Poverty Underestimated as Back to School Costs Hit Families under Pressure ." *ABC News*, January 27, 2020. https://www.abc.net.au/news/2020-01-28/back-to-school-highlights-kids-living-in-poverty/11902984.

Pomerleau, Kyle, and Elke Asen. 2019. "Carbon Tax: Revenue, Economic, & Distributional Implications." https://taxfoundation.org/carbon-tax/.

Pope, C A. 1989. "Respiratory Disease Associated with Community Air Pollution and a Steel Mill, Utah Valley." *American Journal of Public Health* 79 (5): 623–28. https://doi.org/10.2105/ajph.79.5.623.

Popp, Alexander, Steven K. Rose, Katherine Calvin, Detlef P. Van Vuuren, Jan Phillip Dietrich, Marshall Wise, Elke Stehfest, et al. 2014. "Land-Use Transition for Bioenergy and Climate Stabilization: Model Comparison of Drivers, Impacts and Interactions with Other Land Use Based Mitigation Options." *Climatic Change* 123 (3–4): 495–509. https://doi.org/10.1007/s10584-013-0926-x.

Porter, John R., Liyong Xie, Andrew J. Challinor, Kevern Cochrane, S. Mark Howden, Muhammad Mohsin Iqbal, David B. Lobell, et al. 2015. "Food Security and Food Production Systems." In *Climate Change 2014 Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects*. https://doi.org/10.1017/CBO9781107415379.012.

Possas, Cristina, Ricardo Lourenço-de-Oliveira, Pedro Luiz Tauil, Francisco de Paula Pinheiro, Alcides Pissinatti, Rivaldo Venâncio da Cunha, Marcos Freire, Reinaldo Menezes Martins, and Akira Homma.

2018. "Yellow Fever Outbreak in Brazil: The Puzzle of Rapid Viral Spread and Challenges for Immunisation." *Memorias Do Instituto Oswaldo Cruz*. https://doi.org/10.1590/0074-02760180278.

Poursafa, Parinaz, and Roya Kelishadi. 2011. "What Health Professionals Should Know about the Health Effects of Air Pollution and Climate Change on Children and Pregnant Mothers." *Iranian Journal of Nursing and Midwifery Research* 16 (3): 257–64. http://www.ncbi.nlm.nih.gov/pubmed/22224116.

Pratt, Gregory C., Monika L. Vadali, Dorian L. Kvale, and Kristie M. Ellickson. 2015. "Traffic, Air Pollution, Minority and Socio-Economic Status: Addressing Inequities in Exposure and Risk." *International Journal of Environmental Research and Public Health* 12 (5): 5355–72. https://doi.org/10.3390/ijerph120505355.

Qian, Zhengmin, Robert S. Chapman, Wei Hu, Fusheng Wei, Leo R. Korn, and Junfeng Zhang. 2004. "Using Air Pollution Based Community Clusters to Explore Air Pollution Health Effects in Children." *Environment International* 30 (5): 611–20. https://doi.org/10.1016/j.envint.2003.11.003.

Quinton, Sophie. 2019. "To Control Forest Fires, Western States Light More of Their Own." *Governing*, May 16, 2019. https://www.governing.com/topics/transportation-infrastructure/sl-western-states-try-to-control-forest-fires.html.

Raleigh, Clionadh. 2010. "Political Marginalization, Climate Change, and Conflict in African Sahel States." *International Studies Review* 12 (1): 69–86.

Ram, Manish, Arman Aghahosseini, and Christian Breyer. 2020. "Job Creation during the Global Energy Transition towards 100% Renewable Power System by 2050." *Technological Forecasting and Social Change* 151 (February). https://doi.org/10.1016/j.techfore.2019.06.008.

Ransom, Michael R, and C Arden Pope. 1995. "External Health Costs of a Steel Mill." *Contemporary Economic Policy* 13 (2): 86–97. https://doi.org/10.1111/j.1465-7287.1995.tb00745.x.

Raphael, Steven, and Michael Stoll. 2010. "Job Sprawl and the Suburbanization of Poverty." https://www.brookings.edu/research/job-sprawl-and-the-suburbanization-of-poverty/.

Rausch, Sebastian, Gilbert Metcalf, and John Reilly. 2011. "Distributional Impacts of Carbon Pricing: A General Equilibrium Approach with Micro-Data for Households." Cambridge, MA. https://doi.org/10.3386/w17087.

Rausch, Sebastian, and Matthew Mowers. 2014. "Distributional and Efficiency Impacts of Clean and Renewable Energy Standards for Electricity." *Resource and Energy Economics* 36 (2): 556–85. https://doi.org/10.1016/j.reseneeco.2013.09.001.

Reeves, Aaron, Rachel Loopstra, and David Stuckler. 2017. "The Growing Disconnect between Food Prices and Wages in Europe: Cross-National Analysis of Food Deprivation and Welfare Regimes in Twenty-One EU Countries, 2004-2012." *Public Health Nutrition* 20 (8): 1414–22. https://doi.org/10.1017/S1368980017000167.

Rege, Mari, Kjetil Telle, and Mark Votruba. 2011. "Parental Job Loss and Children's School Performance." *The Review of Economic Studies* 78 (4): 1462–89. http://www.jstor.org/stable/41407068.

Reilly, John, Jerry Melillo, Yongxia Cai, David Kicklighter, Angelo Gurgel, Sergey Paltsev, Timothy Cronin, Andrei Sokolov, and Adam Schlosser. 2012. "Using Land to Mitigate Climate Change: Hitting the Target, Recognizing the Trade-Offs." *Environmental Science and Technology* 46 (11): 5672–79. https://doi.org/10.1021/es2034729.

Renaud, Fabrice G, Janos J Bogardi, Olivia Dun, and Koko Warner. 2007. *Control, Adapt or Flee: How to Face Environmental Migration?* UNU-EHS.

Renner, Sebastian. 2018. "Poverty and Distributional Effects of a Carbon Tax in Mexico." *Energy Policy* 112 (January): 98–110. https://doi.org/10.1016/j.enpol.2017.10.011.

Reuveny, Rafael. 2007. "Climate Change-Induced Migration and Violent Conflict." *Political Geography* 26 (6): 656–73.

Ricketts, Lowell R, and Emily A Gallagher. 2020. "Hidden Financial Devastation Followed Hurricane Hurricane Harvey : A Tempest like No Other."

Ridpath, Alison D., Brooke Bregman, Lucretia Jones, Vasudha Reddy, Haena Waechter, and Sharon Balter. 2014. "Challenges to Implementing Communicable Disease Surveillance in New York City Evacuation Shelters after Hurricane Sandy, November 2012." *Public Health Reports* 130 (1): 48–53. https://doi.org/10.1177/003335491513000106.

Rigaud, Kanta, Alex de Sherbinin, Bryan Jones, Jonas Bergmann, Viviane Clement, Kayly Ober, Jacob Schewe, et al. 2018. *Groundswell : Preparing for Internal Climate Migration.*

Rinat, Zafrir. 2019. "Rainfall Hits High after Five-Year Drought, Raising Level of Sea of Galilee." Haaretz. 2019. https://www.haaretz.com/israel-news/.premium-rainfall-hits-high-after-five-year-drought-raising-level-of-sea-of-galilee-1.7003382.

Robert, Michael A., Rebecca C. Christofferson, Paula D. Weber, and Helen J. Wearing. 2019. "Temperature Impacts on Dengue Emergence in the United States: Investigating the Role of Seasonality and Climate Change." *Epidemics*. https://doi.org/10.1016/j.epidem.2019.05.003.

Roberts, David. 2018. "Renewable Energy Is Catching up to Natural Gas Much Faster than Anyone Thought." *Vox*, October 26, 2018. https://www.vox.com/energy-and-environment/2018/7/13/17551878/natural-gas-markets-renewable-energy.

Roder, G, G Sofia, Z Wu, and P Tarolli. 2017. "American Meteorological Society Assessment of Social Vulnerability to Floods in the Floodplain of Northern Italy." *Weather, Climate and Society* 9 (4): 717–37. https://doi.org/10.2307/26389000.

Rodríguez-Huerta, Edgar, Martí Rosas-Casals, and Alevgul H. Sorman. 2017. "A Societal Metabolism Approach to Job Creation and Renewable Energy Transitions in Catalonia." *Energy Policy* 108 (September): 551–64. https://doi.org/10.1016/j.enpol.2017.06.024.

Rojas, Maisa. 2019. "Global Heating plus Inequality Is a Recipe for Chaos – Just Look at Chile." The Guardian. 2019. https://www.theguardian.com/commentisfree/2019/dec/08/un-conference-global-heating-cop25-chile-madrid-climate-crisis.

Roland-Holst, David W. 2008. "Energy Efficiency, Innovation, and Job Creation in California." 1069. CUDARE Working Papers. https://doi.org/10.22004/AG.ECON.46718.

Rosenberg, Joseph, Eric Toder, and Chenxi Lu. 2018a. "Distributional Implications of a Carbon Tax." https://www.taxpolicycenter.org/publications/distributional-implications-carbon-tax/full.

Rosenzweig, Cynthia, and Martin L Parry. 1994. "Potential Impact of Climate Change on World Food Supply."

Nature 367 (6459): 133–38.

Rotkin-Ellman, Miriam, Gina Solomon, Christopher R. Gonzales, Lovell Agwaramgbo, and Howard W. Mielke. 2010. "Arsenic Contamination in New Orleans Soil: Temporal Changes Associated with Flooding." *Environmental Research*. https://doi.org/10.1016/j.envres.2009.09.004.

Ruckart, Perri Zeitz, Maureen F. Orr, Kenneth Lanier, and Allison Koehler. 2008. "Hazardous Substances Releases Associated with Hurricanes Katrina and Rita in Industrial Settings, Louisiana and Texas." *Journal of Hazardous Materials*. https://doi.org/10.1016/j.jhazmat.2007.07.124.

Ruckstuhl, K E, E A Johnson, and K Miyanishi. 2008. "The Boreal Forest and Global Change." *Philosophical Transactions: Biological Sciences* 363 (1501): 2245–49. https://doi.org/10.1098/rstb.2007.2196.

Ryan, Sadie J., Colin J. Carlson, Erin A. Mordecai, and Leah R. Johnson. 2019. "Global Expansion and Redistribution of Aedes-Borne Virus Transmission Risk with Climate Change." Edited by Barbara A. Han. *PLOS Neglected Tropical Diseases* 13 (3): e0007213. https://doi.org/10.1371/journal.pntd.0007213.

Sacks, Jason D., Lindsay Wichers Stanek, Thomas J. Luben, Douglas O. Johns, Barbara J. Buckley, James S. Brown, and Mary Ross. 2011. "Particulate Matter-Induced Health Effects: Who Is Susceptible?" *Environmental Health Perspectives*. https://doi.org/10.1289/ehp.1002255.

Sajeewani, Disna, Mahinda Siriwardana, and Judith McNeill. 2015. "Household Distributional and Revenue Recycling Effects of the Carbon Price in Australia." *Climate Change Economics* 6 (3). https://doi.org/10.1142/S2010007815500128.

Salo, Päivi M., Samuel J. Arbes, Renee Jaramillo, Agustin Calatroni, Charles H. Weir, Michelle L. Sever, Jane A. Hoppin, et al. 2014. "Prevalence of Allergic Sensitization in the United States: Results from the National Health and Nutrition Examination Survey (NHANES) 2005-2006." *Journal of Allergy and Clinical Immunology*. https://doi.org/10.1016/j.jaci.2013.12.1071.

Sampson, Natalie R., Carina J. Gronlund, Miatta A. Buxton, Linda Catalano, Jalonne L. White-Newsome, Kathryn C. Conlon, Marie S. O'Neill, Sabrina McCormick, and Edith A. Parker. 2013. "Staying Cool in a Changing Climate: Reaching Vulnerable Populations during Heat Events." *Global Environmental Change* 23 (2): 475–84. https://doi.org/10.1016/j.gloenvcha.2012.12.011.

Sanborn, Robert, Mandi S Kimball, Katie McConnell, Chanel Brown, Genesis Herrera, Rebecca Harms, Champale Watkins, Mira Dani, and Patrick Gill. 2019. "Texas Continues to Recover: Two Years After Harvey."

Sanchez, Thomas W. 2008. "Poverty, Policy, and Public Transportation." *Transportation Research Part A: Policy and Practice* 42 (5): 833–41. https://doi.org/10.1016/j.tra.2008.01.011.

Sanchez, Thomas W., Qing Shen, and Zhong-Ren Peng. 2004. "Transit Mobility, Jobs Access and Low-Income Labour Participation in US Metropolitan Areas." *Urban Studies* 41 (7): 1313–31. https://doi.org/10.1080/0042098042000214815.

Sanders, Nicholas J. 2019. "Clearing the Air on the Costs of Pollution." https://econofact.org/clearing-the-air-on-the-costs-of-pollution.

Sarnat, Jeremy A., Stefanie Ebelt Sarnat, W. Dana Flanders, Howard H. Chang, James Mulholland, Lisa Baxter, Vlad Isakov, and Halûk Özkaynak. 2013. "Spatiotemporally Resolved Air Exchange Rate as a Modifier of Acute Air Pollution-Related Morbidity in Atlanta." *Journal of Exposure Science and Environmental*

Epidemiology 23 (6): 606–15. https://doi.org/10.1038/jes.2013.32.

Save the Children. 2020. "Australian Bushfires: Facts, FAQs, and How to Help." Save the Children. 2020. https://www.savethechildren.org/us/what-we-do/emergency-response/australian-bushfires-how-to-help-facts-faq.

Schikowski, Tamara, Dorothea Sugiri, Ulrich Ranft, Ulrike Gehring, Joachim Heinrich, H. Erich Wichmann, and Ursula Krämer. 2005. "Long-Term Air Pollution Exposure and Living Close to Busy Roads Are Associated with COPD in Women." *Respiratory Research* 6 (1): 152. https://doi.org/10.1186/1465-9921-6-152.

Schlenker, Wolfram, and W. Reed Walker. 2016. "Airports, Air Pollution, and Contemporaneous Health." *Review of Economic Studies*. https://doi.org/10.1093/restud/rdv043.

Schuiling, R. D., and P. Krijgsman. 2006. "Enhanced Weathering: An Effective and Cheap Tool to Sequester CO 2." *Climatic Change* 74 (1–3): 349–54. https://doi.org/10.1007/s10584-005-3485-y.

Scovronick, Noah, Mark Budolfson, Francis Dennig, Frank Errickson, Marc Fleurbaey, Wei Peng, Robert H. Socolow, Dean Spears, and Fabian Wagner. 2019. "The Impact of Human Health Co-Benefits on Evaluations of Global Climate Policy." *Nature Communications* 10 (1): 1–12. https://doi.org/10.1038/s41467-019-09499-x.

Shaefer, H Luke, Sophie Collyer, Greg Duncan, Kathryn Edin, Irwin Garfinkel, David Harris, Timothy M Smeeding, Jane Waldfogel, Christopher Wimer, and Hirokazu Yoshikawa. 2018. "A Universal Child Allowance: A Plan to Reduce Poverty and Income Instability Among Children in the United States." *The Russell Sage Foundation Journal of the Social Sciences : RSF* 4 (2): 22–42. https://doi.org/10.7758/RSF.2018.4.2.02.

Shah, Anwar, and Bjorn Larsen. 1992. "Carbon Taxes, the Greenhouse Effect, and Developing Countries." World Development Report Policy Research Working Papers. https://books.google.com/books?hl=en&lr=&id=zh2juroPPfgC&oi=fnd&pg=PA1&dq=shah+and+larson+1992+carbon+tax&ots=xX0bk941M1&sig=D066RBtz3KamjVMqS5pLPpSUoLA#v=onepage&q=shah and larson 1992 carbon tax&f=false.

Shaw, Caroline, Simon Hales, Philippa Howden-Chapman, and Richard Edwards. 2014. "Health Co-Benefits of Climate Change Mitigation Policies in the Transport Sector." *Nature Climate Change* 4 (6): 427–33. https://doi.org/10.1038/nclimate2247.

Sheffield, Perry E., Kim Knowlton, Jessie L. Carr, and Patrick L. Kinney. 2011. "Modeling of Regional Climate Change Effects on Ground-Level Ozone and Childhood Asthma." *American Journal of Preventive Medicine*. https://doi.org/10.1016/j.amepre.2011.04.017.

Sheffield, Perry E., Simone A.M. Uijttewaal, James Stewart, and Maida P. Galvez. 2017. "Climate Change and Schools: Environmental Hazards and Resiliency." *International Journal of Environmental Research and Public Health* 14 (11). https://doi.org/10.3390/ijerph14111397.

Simas, Moana, and Sergio Pacca. 2014. "Assessing Employment in Renewable Energy Technologies: A Case Study for Wind Power in Brazil." *Renewable and Sustainable Energy Reviews*. Elsevier Ltd. https://doi.org/10.1016/j.rser.2013.11.046.

Simeonova, Emilia, Janet Currie, Peter Nilsson, and Reed Walker. 2018. "Congestion Pricing, Air Pollution and Children's Health." Cambridge, MA. https://doi.org/10.3386/w24410.

Singer, Merrill. 2017. "Heat Waves Will Particularly Threaten Minorities and the Poor." *Slate*, August 8, 2017. https://slate.com/technology/2017/08/heat-waves-threaten-minorities-and-the-poor.html.

Singh, Virinder, and Jeffrey Fehrs. 2001. "The Work That Goes into Renewable Eneregy." http://www.repp.org.

Skoufias, Emmanuel, Mariano Rabassa, Sergio Olivieri, and Milan Brahmbhatt. 2011. "The Poverty Impacts of Climate Change."

Sovacool, Benjamin K. 2015. "Fuel Poverty, Affordability, and Energy Justice in England: Policy Insights from the Warm Front Program." *Energy* 93 (December): 361–71. https://doi.org/10.1016/j.energy.2015.09.016.

Spring, Ursula Oswald. 2009. "Social Vulnerability and Geopolitical Conflicts Due to Socio-Environmental Migration in Mexico." In *IOP Conference Series: Earth and Environmental Science*, 6:562005. IOP Publishing.

Stein, Jill, Ted Schettler, David Wallinga, and Maria Valenti. 2002. "In Harm's Way: Toxic Threats to Child Development." *Journal of Developmental and Behavioral Pediatrics*. https://doi.org/10.1097/00004703-200202001-00004.

Sterner, Thomas. 2012. "Distributional Effects of Taxing Transport Fuel." *Energy Policy* 41 (February): 75–83. https://doi.org/10.1016/j.enpol.2010.03.012.

Stingone, Jeanette A., Katharine H. McVeigh, and Luz Claudio. 2016. "Association between Prenatal Exposure to Ambient Diesel Particulate Matter and Perchloroethylene with Children's 3rd Grade Standardized Test Scores." *Environmental Research* 148 (July): 144–53. https://doi.org/10.1016/j.envres.2016.03.035.

Stocker, Thomas F., Dahe Qin, Gian Kasper Plattner, Melinda M.B. Tignor, Simon K. Allen, Judith Boschung, Alexander Nauels, Yu Xia, Vincent Bex, and Pauline M. Midgley. 2013. *Climate Change 2013 the Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. *Climate Change 2013 the Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. https://doi.org/10.1017/CBO9781107415324.

Stone, Chad. 2015. "The Design and Implementation of Policies to Protect Low-Income Households under a Carbon Tax." https://www.cbpp.org/research/climate-change/the-design-and-implementation-of-policies-to-protect-low-income-households.

Strife, Susan Jean. 2012. "Children's Environmental Concerns: Expressing Ecophobia." *Journal of Environmental Education* 43 (1): 37–54. https://doi.org/10.1080/00958964.2011.602131.

Ström, Sara. 2003. "Unemployment and Families: A Review of Research." *Social Service Review* 77 (3): 399–430. https://doi.org/10.1086/375791.

Swinburn, Boyd A., Vivica I. Kraak, Steven Allender, Vincent J. Atkins, Phillip I. Baker, Jessica R. Bogard, Hannah Brinsden, et al. 2019. "The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission Report." *The Lancet*. Lancet Publishing Group. https://doi.org/10.1016/S0140-6736(18)32822-8.

Tacoli, Cecilia., Budoor. Bukhari, Susannah. Fisher, and International Institute for Environment and Development. Human Settlements Programme. 2013. "Urban Poverty, Food Security and Climate Change." International Institute for Environment and Development.

Taub, Daniel R., Brian Miller, and Holly Allen. 2008. “Effects of Elevated CO2 on the Protein Concentration of Food Crops: A Meta-Analysis.” *Global Change Biology*. https://doi.org/10.1111/j.1365-2486.2007.01511.x.

Taylor, Lyla L., Joe Quirk, Rachel M.S. Thorley, Pushker A. Kharecha, James Hansen, Andy Ridgwell, Mark R. Lomas, Steve A. Banwart, and David J. Beerling. 2016. “Enhanced Weathering Strategies for Stabilizing Climate and Averting Ocean Acidification.” *Nature Climate Change* 6 (4): 402–6. https://doi.org/10.1038/nclimate2882.

Taylor, Matthew, Jonathan Watts, and John Bartlett. 2019. “Climate Crisis: 6 Million People Join Latest Wave of Global Protests | Environment | The Guardian.” The Guardian. 2019. https://www.theguardian.com/environment/2019/sep/27/climate-crisis-6-million-people-join-latest-wave-of-worldwide-protests#maincontent.

Tesselaar, Max, W. J. Wouter Botzen, and Jeroen C.J.H. Aerts. 2020. “Impacts of Climate Change and Remote Natural Catastrophes on EU Flood Insurance Markets: An Analysis of Soft and Hard Reinsurance Markets for Flood Coverage.” *Atmosphere* 11 (2). https://doi.org/10.3390/atmos11020146.

Thévenon, Olivier, Thomas Manfredi, Yajna Govind, and Ilya Klauzner. 2018. “Child Poverty in the OECD: Trends, Determinants and Policies to Tackle It.” https://doi.org/10.1787/c69de229-en.

Thomson, Hilary, Sian Thomas, Eva Sellstrom, and Mark Petticrew. 2009. “The Health Impacts of Housing Improvement: A Systematic Review of Intervention Studies from 1887 to 2007.” *American Journal of Public Health*. https://doi.org/10.2105/ajph.2008.143909.

Tol, Richard S. J., and Stefano F. Verde. 2009. “The Distributional Impact of a Carbon Tax in Ireland.” *The Economic and Social Review* 40 (3). https://www.researchgate.net/publication/227349803_The_Distributional_Impact_of_a_Carbon_Tax_in_Ireland.

Tol, Richard S J, Thomas E Downing, Onno J Kuik, and Joel B Smith. 2004. “Distributional Aspects of Climate Change Impacts.” *Global Environmental Change* 14 (3): 259–72. https://doi.org/https://doi.org/10.1016/j.gloenvcha.2004.04.007.

Trabish, Herman K. 2017. “Carbon Calculus: More States Are Adding Carbon Costs to Utility Planning Guidelines.” *Utility Dive*, August 31, 2017.

Tsai, Dai Hua, Jia Lin Wang, Chieh Heng Wang, and Chang Chuan Chan. 2008. “A Study of Ground-Level Ozone Pollution, Ozone Precursors and Subtropical Meteorological Conditions in Central Taiwan.” *Journal of Environmental Monitoring*. https://doi.org/10.1039/b714479b.

Tucker, Jasmine, and Caitlin Lowell. 2016. “National Snapshot: Poverty among Women & Families, 2015.” *National Women’s Law Center*.

Turley, Ruth, Ruhi Saith, Nandita Bhan, Eva Rehfuess, and Ben Carter. 2013. “Slum Upgrading Strategies Involving Physical Environment and Infrastructure Interventions and Their Effects on Health and Socio-Economic Outcomes.” *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD010067.pub2.

Tzivian, Lilian, Angela Winkler, Martha Dlugaj, Tamara Schikowski, Mohammad Vossoughi, Kateryna Fuks, Gudrun Weinmayr, and Barbara Hoffmann. 2015. “Effect of Long-Term Outdoor Air Pollution and Noise on Cognitive and Psychological Functions in Adults.” *International Journal of Hygiene and Environmental*

Health. Elsevier GmbH. https://doi.org/10.1016/j.ijheh.2014.08.002.

UNFCCC. 2020. "What Do Adaptation to Climate Change and Climate Resilience Mean?" UN Framework Convention on Climate Change. 2020. https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean.

Ürge-Vorsatz, Diana, and Sergio Tirado Herrero. 2012. "Building Synergies between Climate Change Mitigation and Energy Poverty Alleviation." *Energy Policy* 49 (October): 83–90. https://doi.org/10.1016/j.enpol.2011.11.093.

Urman, Robert, Rob McConnell, Talat Islam, Edward L. Avol, Frederick W. Lurmann, Hita Vora, William S. Linn, Edward B. Rappaport, Frank D. Gilliland, and W. James Gauderman. 2014. "Associations of Children's Lung Function with Ambient Air Pollution: Joint Effects of Regional and near-Roadway Pollutants." *Thorax* 69 (6): 540–47. https://doi.org/10.1136/thoraxjnl-2012-203159.

USDA. 2019. "Key Statistics & Graphics." 2019. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx.

USGCRP. 2018. "Fourth National Climate Assessment."

Vandyck, Toon, and Denise Van Regemorter. 2014. "Distributional and Regional Economic Impact of Energy Taxes in Belgium." *Energy Policy* 72: 190–203. https://doi.org/10.1016/j.enpol.2014.04.004.

Vazquez-Prokopec, Gonzalo M., Audrey Lenhart, and Pablo Manrique-Saide. 2016. "Housing Improvement: A Novel Paradigm for Urban Vector-Borne Disease Control?" *Transactions of the Royal Society of Tropical Medicine and Hygiene*. https://doi.org/10.1093/trstmh/trw070.

Verbeek, Jos, and Israel Osorio Rodarte. 2015. "Increasingly, Inequality within, Not across, Countries Is Rising." World Bank. 2015. https://blogs.worldbank.org/developmenttalk/increasingly-inequality-within-not-across-countries-rising.

Vliet, Patricia Van, Mirjam Knape, Jeroen De Hartog, Nicole Janssen, Hendrik Harssema, and Bert Brunekreef. 1997. "Motor Vehicle Exhaust and Chronic Respiratory Symptoms in Children Living near Freeways." *Environmental Research* 74 (2): 122–32. https://doi.org/10.1006/enrs.1997.3757.

Voight, Adam, Marybeth Shinn, and Maury Nation. 2012. "The Longitudinal Effects of Residential Mobility on the Academic Achievement of Urban Elementary and Middle School Students." *Educational Researcher* 41 (9): 385–92. http://www.jstor.org/stable/23360363.

Wachs, Martin. 2010. "Transportation Policy, Poverty, and Sustainability." *Transportation Research Record: Journal of the Transportation Research Board* 2163 (1): 5–12. https://doi.org/10.3141/2163-01.

Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, et al. 2014. "Chapter 2: Our Changing Climate." In *Climate Change Impacts in the United States: The Third National Climate Assessment*. https://doi.org/10.7930/J0KW5CXT.On.

Wang, Feng, and Bing Zhang. 2016. "Distributional Incidence of Green Electricity Price Subsidies in China." *Energy Policy* 88 (January): 27–38. https://doi.org/10.1016/j.enpol.2015.09.035.

Wang, Hongling, Xiaoyang Tang, Yi Cheng Su, Jiabei Chen, and Jianbo Yan. 2017. "Characterization of Clinical Vibrio Parahaemolyticus Strains in Zhoushan, China, from 2013 to 2014." *PLoS ONE*. https://doi.org/10.1371/journal.pone.0180335.

Wang, I.-Jen, Tao-Hsin Tung, Chin-Sheng Tang, and Zi-Hao Zhao. 2016. "Allergens, Air Pollutants, and Childhood Allergic Diseases." *International Journal of Hygiene and Environmental Health* 219 (1): 66–71. https://doi.org/10.1016/j.ijheh.2015.09.001.

Wang, Qian, Klaus Hubacek, Kuishuang Feng, Yi Ming Wei, and Qiao Mei Liang. 2016. "Distributional Effects of Carbon Taxation." *Applied Energy* 184 (December): 1123–31. https://doi.org/10.1016/j.apenergy.2016.06.083.

Wang, Y. Claire, Klim McPherson, Tim Marsh, Steven L. Gortmaker, and Martin Brown. 2011. "Health and Economic Burden of the Projected Obesity Trends in the USA and the UK." *The Lancet*. Lancet Publishing Group. https://doi.org/10.1016/S0140-6736(11)60814-3.

Watts, Nick, Markus Amann, Nigel Arnell, Sonja Ayeb-Karlsson, Kristine Belesova, Helen Berry, Timothy Bouley, et al. 2018. "The 2018 Report of the Lancet Countdown on Health and Climate Change: Shaping the Health of Nations for Centuries to Come." *The Lancet*. https://doi.org/10.1016/S0140-6736(18)32594-7.

Wei, Max, Shana Patadia, and Daniel M. Kammen. 2010. "Putting Renewables and Energy Efficiency to Work: How Many Jobs Can the Clean Energy Industry Generate in the US?" *Energy Policy* 38 (2): 919–31. https://doi.org/10.1016/j.enpol.2009.10.044.

Weissbecker, Inka. 2011. "Introduction: Climate Change and Human Well-Being." In *Climate Change and Human Well-Being*, 1st ed., 1–15. Springer-Verlag New York. https://doi.org/10.1007/978-1-4419-9742-5_1.

Wessells, M, and Kathleen Kostelny. 2012. "Everyday Distress: Psychosocial and Economic Impact of Forced Migration on Children and Families." *Oxford Library of Psychology. The Oxford Handbook of Poverty and Child Development*, 640–55.

West, J. Jason, Steven J. Smith, Raquel A. Silva, Vaishali Naik, Yuqiang Zhang, Zachariah Adelman, Meridith M. Fry, Susan Anenberg, Larry W. Horowitz, and Jean Francois Lamarque. 2013. "Co-Benefits of Mitigating Global Greenhouse Gas Emissions for Future Air Quality and Human Health." *Nature Climate Change* 3 (10): 885–89. https://doi.org/10.1038/nclimate2009.

WHO. 2011. *Health Co-Benefits of Climate Change Mitigation: Transport Sector*.

WHO. 2013. *Health Effects of Particulate Matter*. http://www.euro.who.int/pubrequest.

WHO. 2018. "Ambient (Outdoor) Air Pollution." https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

Wiens, John, Joseph Fargione, and Jason Hill. 2011. "Biofuels and Biodiversity." *Ecological Applications* 21 (4): 1085–95. https://doi.org/10.1890/09-0673.1.

Wier, Mette, Katja Birr-Pedersen, Henrik Klinge Jacobsen, and Jacob Klok. 2005. "Are CO2 Taxes Regressive? Evidence from the Danish Experience." *Ecological Economics* 52 (2): 239–51. https://doi.org/10.1016/j.ecolecon.2004.08.005.

Williams, Roberton C., Hal G Gordon, Dallas Burtraw, Jared C. Carbone, and Richard D. Morgenstern. 2014. "The Initial Incidence of a Carbon Tax Across Income Groups." *SSRN Electronic Journal*, December. https://doi.org/10.2139/ssrn.2537839.

Williamson, Phil. 2016. "Emissions Reduction: Scrutinize CO2 Removal Methods." *Nature*. Nature Publishing

Group. https://doi.org/10.1038/530153a.

Winner, Cherie. 2010. "How Does Toxic Mercury Get into Fish?" Oceanus Magazine. October 2010.

WMO. 2018. "Drought and Heat Exacerbate Wildfires." World Meteorological Organization. 2018. https://public.wmo.int/en/media/news/drought-and-heat-exacerbate-wildfires.

WMO. 2019. "The Global Climate in 2015 - 2019." *World Meteorological Organization*.

WMO. 2020. "Australia Suffers Devastating Fires after Hottest, Driest Year on Record | World Meteorological Organization." World Meteorological Organization. 2020. https://public.wmo.int/en/media/news/australia-suffers-devastating-fires-after-hottest-driest-year-record.

World Bank. 2020. "WDI - Environment." The World Bank. 2020. http://datatopics.worldbank.org/world-development-indicators/themes/environment.html#air-pollution.

Wright, Travis, and Sharon K Ryan. 2014. "Toddlers Through Primary Grades: Too Scared to Learn: Teaching Young Children Who Have Experienced Trauma." *YC Young Children* 69 (5): 88–93. http://www.jstor.org/stable/ycyoungchildren.69.5.88.

Xu, Zhiwei, Ruth A. Etzel, Hong Su, Cunrui Huang, Yuming Guo, and Shilu Tong. 2012. "Impact of Ambient Temperature on Children's Health: A Systematic Review." *Environmental Research*. https://doi.org/10.1016/j.envres.2012.07.002.

Yeung, Jessie. 2020. "Australia Wildfires: Here's What You Need to Know about the Deadly Blazes ." *CNN*, January 13, 2020. https://www.cnn.com/2020/01/01/australia/australia-fires-explainer-intl-hnk-scli/index.html.

Yusuf, Arief Anshory, and Budy P. Resosudarmo. 2008. "Mitigating Distributional Impact of Fuel Pricing Reform: The Indonesian Experience." *Asean Economic Bulletin* 25 (1): 32–47. https://doi.org/10.1355/ae25-1d.

Yusuf, Arief Anshory, and Budy P Resosudarmo. 2007. "On the Distributional Effect of Carbon Tax in Developing Countries: The Case of Indonesia."

Zahran, Hatice S., Cathy M. Bailey, Scott A. Damon, Paul L. Garbe, and Patrick N. Breysse. 2018. "Vital Signs: Asthma in Children — United States, 2001-2016." *Morbidity and Mortality Weekly Report* 67 (5): 149–55. https://doi.org/10.15585/mmwr.mm6705e1.

Zeger, Scott L., Francesca Dominici, Aidan McDermott, and Jonathan M. Samet. 2008. "Mortality in the Medicare Population and Chronic Exposure to Fine Particulate Air Pollution in Urban Centers (2000-2005)." *Environmental Health Perspectives* 116 (12): 1614–19. https://doi.org/10.1289/ehp.11449.

Zhang, Xin, Xi Chen, and Xiaobo Zhang. 2018. "The Impact of Exposure to Air Pollution on Cognitive Performance." *Proceedings of the National Academy of Sciences of the United States of America* 115 (37): 9193–97. https://doi.org/10.1073/pnas.1809474115.

Zhong, Shuang, Lianping Yang, Sam Toloo, Zhe Wang, Shilu Tong, Xiaojie Sun, David Crompton, Gerard FitzGerald, and Cunrui Huang. 2018. "The Long-Term Physical and Psychological Health Impacts of Flooding: A Systematic Mapping." *Science of the Total Environment*. https://doi.org/10.1016/j.scitotenv.2018.01.041.

Ziska, Lewis H., Dennis E. Gebhard, David A. Frenz, Shaun Faulkner, Benjamin D. Singer, and James G. Straka. 2003. "Cities as Harbingers of Climate Change: Common Ragweed, Urbanization, and Public Health." *Journal of Allergy and Clinical Immunology*. https://doi.org/10.1067/mai.2003.53.

Ziska, Lewis, Kim Knowlton, Christine Rogers, Dan Dalan, Nicole Tierney, Mary Ann Elder, Warren Filley, et al. 2011. "Recent Warming by Latitude Associated with Increased Length of Ragweed Pollen Season in Central North America." *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1014107108.

Zou, Jie Jenny. 2020. "Climate Change and FEMA Flood Insurance Reforms Could Trigger Another Mortgage Crisis - Vox." *Vox*, February 25, 2020. https://www.vox.com/2020/2/25/21146896/climate-change-fema-flood-insurance-mortgage-crisis.

Zweig, Jacqueline S, John C Ham, and Edward L Avol. 2009. "Air Pollution and Academic Performance: Evidence from California Schools."