THE CLIMATE GAP

Inequalities in How Climate Change Hurts Americans & How to Close the Gap

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Acknowledgments

Work for this project was supported by: The Annenberg Foundation, The Energy Foundation, and the William and Flora Hewlett Foundation.

Table of Contents

Introduction 05

Methodology 05

Key Findings 07

The Climate Gap in Health Consequences

Heat Waves 07

Increased Air Pollution 13

The Climate Gap in Economic Consequences

Paying More for Basic Necessities 14

Reduced Job Opportunities 15

No Extreme Weather Insurance 17

How to Close the Climate Gap

Ensure Climate Policy Leaves No One Behind 19

Why We Can't Afford to Focus Only on Regional Greenhouse Gas Reductions 20

Other Key Recommendations to Close the Climate Gap 22

Conclusions 25

Appendix 26

Analysis of California's Climate Policy and The Climate Gap

References 28

List of Figures

Figure 1 07
Percent change in mortality associated with a 10°F increase in mean daily temperature by age group in nine California counties, May through September, 1999–2003

Figure 2 07
Percent change in mortality associated with a 10°F increase in mean daily temperature by race/ethnicity in nine California counties, May through September, 1999–2003

Figure 3 09
Land cover characteristics by percent of households living below the poverty line

Figure 4 09
Land cover characteristics by percent of residents of color living in the neighborhood

Figure 5 10
Map showing relative risk of emergency department visit for heat-related illnesses during the summer 2006 heat wave

Figure 6 10
Geographic location of deaths due to California 2006 heat wave

Figure 7 11
Relative heat-wave mortality rates by race/ethnicity for Los Angeles

Figure 8 14
Household expenditures on water, electricity, and food by income bracket

Figure 9 16
Percent of people of color in tourism-generated jobs, by sector

List of Tables

Table 1 12
Percent of households without access to any air conditioning by race and poverty level

Table 2 27
Estimates of California air quality-related health benefits in 2020 if AB Implementation Measures are implemented

INTRODUCTION

Climate change is real. The climate gap is real.

What we used to think was tomorrow's climate crisis is here today. Heat waves, wild fires and floods are making headlines more often. **What hasn't made headlines—yet—is the climate gap: the disproportionate and unequal impact the climate crisis has on people of color and the poor.** Unless something is done, the consequences of America's climate crisis will harm all Americans—especially those who are least able to anticipate, cope with, resist and recover from the worst consequences. This analysis is of California, which in many ways is a microcosm of the entire United States.

Climate change is an issue of great importance for human rights, public health, and social fairness because of its profound consequences overall and the very real danger that poor neighborhoods and people of color will suffer even worse harms and hazards than the rest of Americans. This "climate gap" is of special concern for California, home to one of the most ethnically and economically diverse populations in the country.

The climate gap means that communities of color and the poor will suffer more during extreme heat waves. For instance, African Americans in Los Angeles are nearly twice as likely to die from a heat wave than other Los Angeles residents, and families living below the poverty line are unlikely to have access to air conditioning or cars that allow them to escape the heat.

The climate gap means that communities of color and the poor will breathe even dirtier air. For example, five of the smoggiest cities in California also have the highest densities of people of color and low-income residents. These communities are projected to suffer from the largest increase in smog associated with climate change.

The climate gap means that communities of color and the poor will pay more for basic necessities. Low-income and minority families already spend as much as 25 percent of their entire income on just food, electricity and water—much more than most Americans.

The climate gap is likely to mean fewer job opportunities for communities of color and the poor. The climate crisis may dramatically reduce or shift job opportunities in sectors such as agriculture and tourism, which predominantly employ low-income Americans and people of color.

This report—an analysis and synthesis of available data—explores disparities in the impacts of climate change and the abilities of different groups to adapt to it. It also offers concrete recommendations for closing the climate gap, starting with insuring that climate solutions don't leave anyone behind.

METHODOLOGY

This report analyzes currently available data on the disparate impacts of climate change and climate change mitigation policies on low socioeconomic status (SES) groups in the United States that is relevant to the California context (Shonkoff, Morello-Frosch et al. 2009). We have also drawn information from climate change policy, human health, and environmental justice literature to provide background and context for these issues. Our goal was to address some of the prominent public health, equity, and regulatory issues that are pertinent to the policy deliberations surrounding the implementation of AB 32, The Global Warming Solutions Act as well as federal climate change policy.

There is a Climate Gap

KEY FINDINGS

There is a climate gap. The health consequences of climate change will harm all Americans—but the poor and people of color will be hit the worst.

The Climate Gap in Extreme Heat Waves

Extreme weather events, such as heat waves, droughts, and floods are expected to increase in their frequency and intensity in the next hundred years due to climate change (IPCC 2007), which could increase the risk of illnesses and deaths linked to extreme heat.

Extreme Heat Leads to Increased Illnesses and Deaths—Particularly Among the Elderly, Infants and African Americans.

In a study on nine California counties from May through September of 1999–2003, researchers found that for every 10°F (5.6°C) increase in temperature, there is a 2.6 percent increase in cardiovascular deaths. The risks were higher for persons at least 65 years of age, infants one year of age or less (Figure 1), and African Americans (Figure 2).

A study on the 2006 California heat wave (July 15–August 1, 2006) showed that emergency room visits increased by 16,166 and that there were 1,182 additional hospitalizations statewide, compared to a similar time period when there was no heat wave. In particular, the magnitude of heat-related illnesses on emergency department visits was dramatic. Statewide, there was a six-fold increase in heat-related emergency department visits and a more than 10-fold increase in heat-related hospitalizations (Knowlton et al. 2009). Another study on seven counties impacted by the 2006 heat wave indicated a nine percent (95 percent CI = 1.6, 16.3) increase in daily mortality per 10 degrees Fahrenheit change in apparent temperature for all counties combined. This estimate is almost three times larger than the effect estimated for the full warm season and 1.3 times higher than during July in previous years (non heat wave years 1999 to 2003). The estimates indicate that actual mortality during the July 2006 heat wave was two or three times greater than initial coroner estimates of 147 deaths (Ostro et al. 2009).

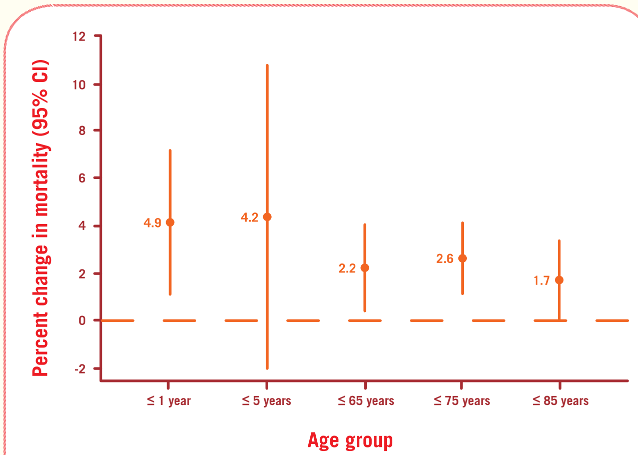


Figure 1. Percent change in mortality associated with 10˚F increase in mean daily temperature by age group in nine California counties. May through September, 1999–2003 (Source: Basu and Ostro 2008).

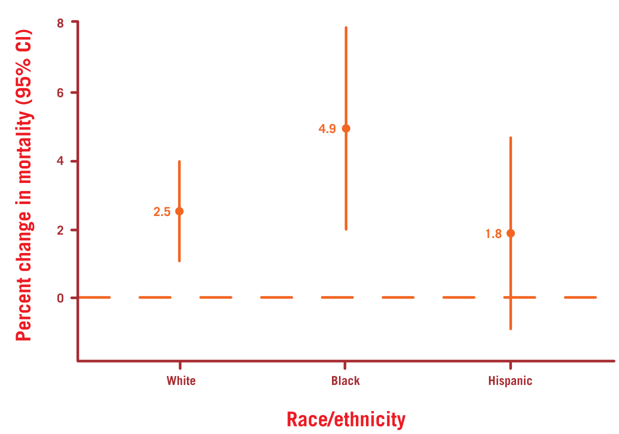


Figure 2. Percent change in mortality associated with 10˚F increase in mean daily temperature by race/ethnicity in nine California counties. May through September, 1999–2003 (Source: Basu and Ostro 2008).

Emergency department visits for heat-related illnesses increased across California, especially in the Central Coast, including San Francisco. Further, emergency department visits showed statistically significant increases in acute renal failure, diabetes, cardiovascular diseases, electrolyte imbalance, and nephritis (Knowlton et al. 2009). Children (0–4 years of age), the elderly (≥ 65 years of age) (Knowlton et al. 2009), and low-income African Americans (Basu and Ostro 2008) appear more likely to get sick or die from heat wave effects than others.

Risk Factors for Heat-Related Illness and Death Are Higher for Low-Income Neighborhoods and People of Color.

Although heat exposure alone can cause illness or death, physiological, social and economic factors are integral in explaining the uneven distribution among diverse populations (Epstein and Rodgers 2004). Risk factors for heat-associated illness and death can be categorized as natural factors (i.e., age, disability) or external factors resulting from social or economic conditions (e.g., housing quality, access to cooling centers, transportation).

In terms of natural factors, people suffering from chronic medical conditions have a greater risk of dying during heat waves (Epstein and Rodgers 2004; Kovats and Hajat 2008; Kilbourne 1997). In fact, a study on the heat-specific mortality during the 2003 heat wave in France reported that over 70 percent of the home victims had medical pre-conditions, particularly cardiovascular and/or psychological illness (Poumadere et al. 2005). Low-income individuals are disproportionately affected by medical conditions due to their lack of access to technological, informational, and social resources to cope with these conditions (Phelan et al. 2004). Further, epidemiologic studies of heat-associated mortality show an increased risk among the elderly; especially among those older than 50 years of age (Kovats and Hajat 2008).

THE HEAT ISLAND EFFECT: The increased heat created by a lack of tree cover in an urban area exacerbated by an abundance of dark-colored materials used to construct roads and buildings. The roads and buildings absorb the heat, creating a heat island effect.

In terms of external factors, low-income urban neighborhoods and communities of color are particularly vulnerable to increased frequency of heat waves and higher temperatures because they are often segregated in the inner city (Schultz et al. 2002; Williams and Collins 2001), which is more likely to experience the "heat-island" effect. The heat-island effect occurs in urban areas because dark-colored materials used to construct roads, buildings, and other structures absorb heat and do not allow it to dissipate at the same rate as soil, grass, forests, and other less-industrial materials (Oke 1973).

Research has shown a positive relationship between the presence of concrete, heat-trapping surfaces and community poverty, and a negative relationship between the amount of tree cover and the level of community poverty in four California urban areas (Figure 3). This suggests the potential for a disproportionate burden of heat-island exposure to low-income populations compared with higher-income populations. This trend is extended to people of color that reside in a given neighborhood: there is a positive relationship between the proportion of people of color and proportion of concrete, heat-trapping surfaces and a negative relationship between proportion of people of color and amount of tree cover (Figure 4). (Morello-Frosch and Jesdale 2008)

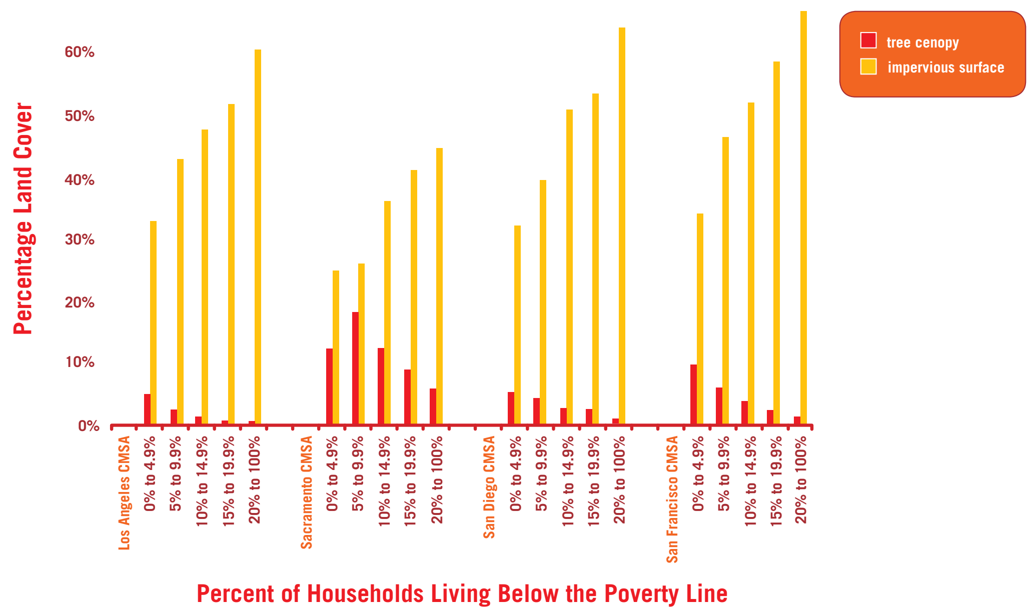


Figure 3. Land cover characteristics by percent of households living below the poverty line (Los Angeles, Sacramento, San Diego, San Francisco metro areas). Adapted from: Morello-Frosch and Jesdale 2008.

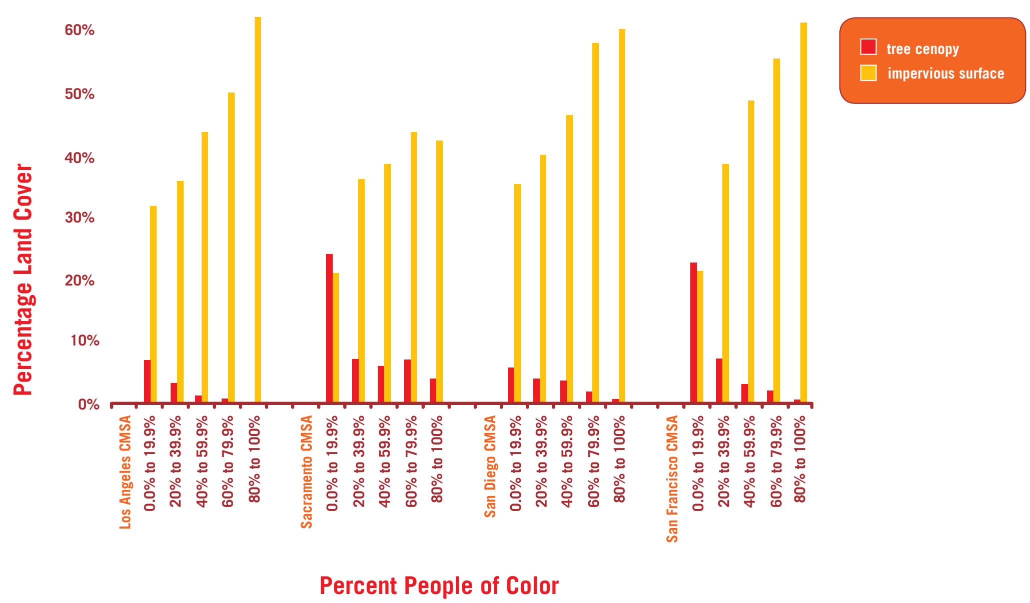


Figure 4. Land cover characteristics by percent of residents of color living in the neighborhood (Los Angeles, Sacramento, San Diego, San Francisco metro areas Adapted from: Morello-Frosch and Jesdale 2008.

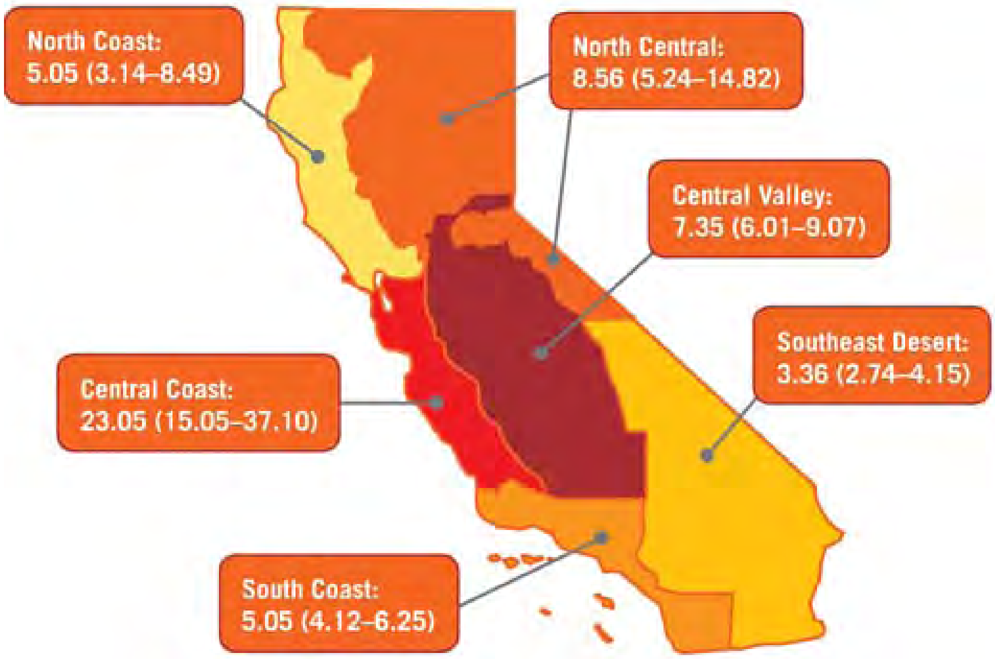


Figure 5. Map showing realtive risk of emergency department visit for heat-related illnesses during the summer 2006 heat wave (July 15–August 1 2006) compared with a reference period (July 8–14 and August 12–22, 2006) for six California regions (Source: Knowlton et al. 2009).

Figure 6. Geographic location of deaths due to heat wave. July 2006 (Source: English et al 2007)

African Americans in Los Angeles Nearly Twice as Likely to Die from a Heat Wave

Another indicator that African Americans may bear a disproportionate burden of heat-wave mortality is the fact that African American Los Angeles residents have a projected heat-wave mortality rate that is nearly twice that of the Los Angeles average (Figure 7).

Agricultural and Construction Workers also at Increased Risk of Death

California's agricultural and construction workers have experienced severe heat-related illness and death with data pointing towards possible increasing trends in recent years (English et al. 2007; Luginbuhl 2008). The socioeconomic status of predominantly Mexican and Central American immigrants who come to California to work in the agricultural and construction sectors makes them particularly vulnerable because of the cumulative impacts of their long workdays under strenuous conditions, limited capacity to protect their rights, and exposure to chemicals such as pesticides. Between the

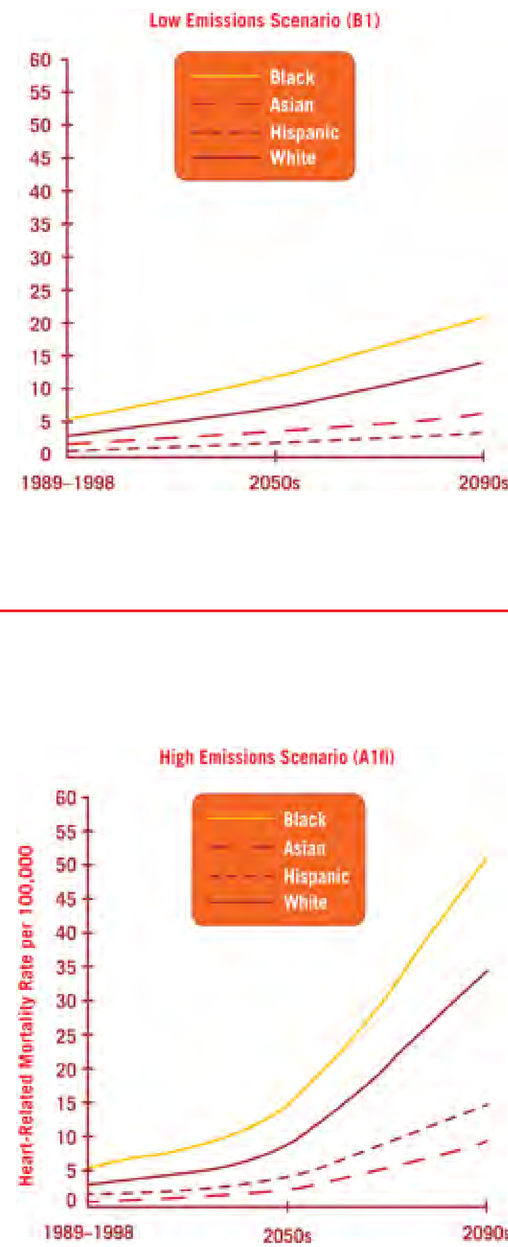


Figure 7. Relative heat-wave mortality rates by race/ethnicity for Los Angeles* (Source: cited from Cordova et al. 2006)

* Actual historical values (1989–1998) and projected future values (2050s and 2090s) for high-emissions (A1fi) and low-emissions (B1) scenarios. (HadCM3 projections only.)

years 1992–2002, 40 percent of the crop workers who died due to heat-associated complications were identified as Mexican or Central or South American (Luginbuhl 2008) and 72 percent of these deaths were among adults aged 20–54 years, a population typically considered to be at low-risk for heat illnesses (Luginbuhl 2008). A recent study of the 2006 California heat wave found significantly increased rates of emergency department visits and hospitalizations for cardiac-related illnesses statewide only among Latinos/Hispanics (Knowlton et al. 2009), which may be related to occupational heat exposures among Latino/Hispanic crop workers (Luginbuhl et al. 2008). As heat-wave incidence and intensity increases with climate change, these disparities will persist, if not increase.

Air Conditioning a Critical Coping Tool for Heat Waves—but Not Everyone Has Access

Studies have documented that lack of access to air conditioning is linked to the disproportionate risk of heat-related illness and death among the urban elderly in the United States—particularly those who are low-income or of color (Kovats and Hajat 2008; Semenza et al. 1996).

Overall, low-income families and people of color are less likely to have access to air-conditioning (English et al. 2007). In the Los Angeles-Long Beach Metropolitan Area, for example, many more African American households do not have access to air conditioning compared to the general population. Similar trends hold for Latinos and communities living below the poverty line (UCSB 2004) (Table 1). This disparity is important particularly because some communities are instructed to stay indoors and avoid outdoor pollution exposures on particularly hot days.

Moreover, a thorough analysis based on several different studies using heat-wave data from Chicago, Detroit, Minneapolis, and Pittsburgh shows that for each 10 percent increase in central air conditioner (AC) prevalence, heat-associated mortality decreased by 1.4 percent. The overall effect of heat on mortality was a 10.2 percent increase. African Americans were found to have a 5.3 percent higher prevalence of heat-related mortality than Whites and 64 percent of this disparity is potentially attributable to disparities in prevalence of central AC technologies (O'Neil, Zanobetti et al. 2005).

Transportation Is also a Critical Coping Tool During a Heat Wave—but African Americans, Latinos and Asians Less Likely to have Access to a Car

In the Los Angeles-Long Beach Metropolitan Area, higher proportions of African-American (20 percent), Latino (17.1 percent), and Asian (9.8 percent) households do not have access to a car (UCSB 2004), compared to White households (7.9 percent), thus restricting their capacity to move to cooler areas and government-sponsored cooling stations during extreme heat events.

	Total Number of Households	Total Occupied Units	Black (not Hispanic)	Hispanic	Elderly (65 years or older)	Below Poverty Level
All Occupied Units	3,131,000	39.7%	58.5%	54.6%	37.5%	51.5%
Renters	1,608,900	48.1%	59.1%	58.4%	38.7%	56.3%
Homeowners	1,522,100	30.9%	57.4%	48.9%	36.8%	38.8%

Table 1. Percent of households without access to any air conditioning by race and SES – Los Angeles-Long Beach Metropolitan Area, California (2003)*

* Percentages are likely an underestimate of the true value due to the fact that more than one category may apply to a single unit in the dataset.

Adapted from: American Housing Survey for the Los Angeles-Long Beach Metropolitan Area 2004 (USCB 2004).

The Climate Gap in Health Hazards from Increased Air Pollution

Research suggests that the majority of the health effects due to air pollution are caused by ozone (O3) and particulate matter (PM) (Drechsler et al. 2006). However, it should be noted that many other pollutants that are associated with climate change, such as nitrogen dioxide, sulfur dioxide, and carbon monoxide, also have health consequences (Drechsler et al. 2006).

Five of the ten most ozone-polluted metropolitan areas in the United States (Los Angeles, Bakersfield, Visalia, Fresno, and Sacramento) are in California (Cordova et al. 2006; ALA 2008). Because of this, Californians already suffer a relatively high disease burden from air pollution – including 18,000 premature deaths each year and tens of thousands of other illnesses (CARB 2008a).

But climate change threatens to exacerbate California's dirty air problem. Higher temperatures hasten chemical interactions between nitrogen oxide, volatile organic gases and sunlight that lead to increases in ambient ozone concentrations in urban areas (Jacobson 2008). In California, five of the smoggiest cities are also the locations with the highest projections of ambient ozone increases associated with climate change, as well as the highest densities of people of color and low-income residents.

People of color and the poor in these urban areas are likely to lack health insurance (Cordova et al. 2006). A lack of health insurance among vulnerable populations that are exposed to elevated levels of air pollutants may lead to greater health impacts from air pollution—particularly compared with those who have health insurance.

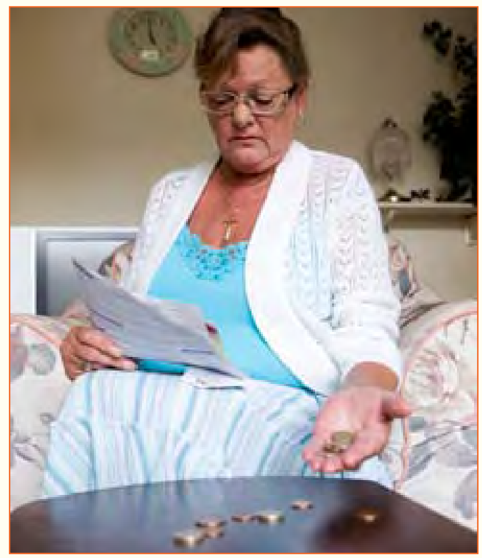
Moreover, a recent study found that for each 1 degree Celsius (1°C) rise in temperature in the United States, there are an estimated 20–30 excess cancer cases, as well as approximately 1000 (CI: 350–1800) excess air-pollution-associated deaths (Jacobson 2008). About 40 percent of the additional deaths may be due to ozone and the rest to particulate matter annually (Jacobson 2008; Bailey et al. 2008). Three hundred of these annual deaths are thought to occur in California (Bailey et al. 2008).

There is a climate gap. The economic consequences of climate change will hit low-income neighborhoods and minorities the hardest.

The Climate Gap in How Much Some People Pay for Basic Necessities

Prices for Basic Necessities Expected to Skyrocket as a Result of Climate Change

The Natural Resources Defense Council (NRDC) estimates that under a business-as-usual scenario, between the years 2025 and 2100, the cost of providing water to the western states in the United States will increase from $200 billion to $950 billion dollars per year, representing an estimated 0.93–1 percent of the United States' gross domestic product (GDP) (Ackerman and Stanton 2008). Further, it is predicted that, under the same scenario, annual U.S. energy expenditures (excluding transportation) will be $141 billion higher in 2100 than they would be if today's climate conditions continued throughout the century. This increase is equal to approximately 0.14 percent of the United State's GDP (Ackerman and Stanton 2008). Four climate change impacts—hurricane damage, energy costs, real estate losses, and water costs—alone are projected to cost 1.8 percent of the GDP of the United States, or, just under $1.9 trillion in 2008 U.S. dollars by the year 2100 (Ackerman and Stanton 2008).



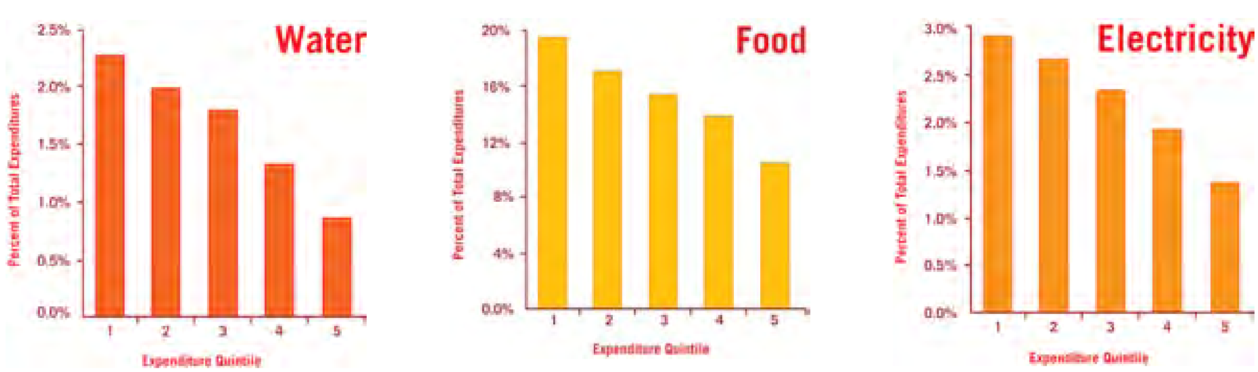


Figure 8. Household expenditures on water, electricity, and food by income bracket (as percentage of total expenditures)* (Source: Adapted From BLS 2002 and cited from Cordova et al. 2006)

* Expenditure quintile is a proxy for income with quintile 1 representing the lowest-income households and quintile 5 representing the highest-income households.

Low-Income Families Already Spend a Bigger Proportion of Their Income on Food, Energy and Other Household Needs Than Higher-Income Families. With Climate Change, That Spending Gap Will Grow.

These price increases will disproportionately impact groups that spend the highest proportion of their income on these necessities (BLS 2002). There is a nearly three-fold difference in the proportion of the sum of expenses allocated to water between the lowest- and the highest-income brackets. Households in the lowest income bracket use more than twice the proportion of their total expenditures on electricity than do those households in the highest income bracket. Similarly, food, the commodity that represents the largest portion of total spending out of all the basic necessities in the expenditure brackets, shows a two-fold discrepancy between the lowest and the highest income households (Figure 2) (Cordova et al. 2006). Because in the coming decades climate change impacts are projected to increase the prices of necessities (Ackerman and Stanton 2008), low-income people who already are paying a higher proportion of their income for necessities will potentially be subjected to increasingly disproportionate economic impacts of climate change.

The Climate Gap in Job Opportunities

Climate Change Will Dramatically Reduce Job Opportunities or Cause Major Employment Shifts in Sectors that Predominately Employ Low-Income People of Color.

The majority of jobs in sectors that will likely be significantly affected by climate change, such as agriculture and tourism, are held by low-income people of color (UCSB 2005; EDD 2004). These workers would be the first to lose their jobs in the event of an economic downturn due to climatic troubles.

Fewer and Also More Dangerous Agriculture Jobs

Impacts on the agricultural sector will fuel the climate gap in California. Latinos comprise 77 percent of the workforce in this sector and the majority of these men and women are also categorized as low-income (EDD 2004). In California, as of 2003, agriculture provided approximately 500,000 jobs with 315,000 of them being held by Latinos (EDD 2004). The majority of these jobs are seasonal, do not pay more than $7.50 per hour, and do not provide health insurance or job security. Because of the low wages and the seasonality of the work, agricultural counties are among the poorest in the state (Cordova, Gelobter et al. 2006).

Research suggests that climate change will affect employment within the agricultural sector in three main ways:

1. Increases in the frequency and the intensity of extreme weather events will expose agriculture to greater productivity risks and (Lee et al. 2009) possible revenue losses that could lead to abrupt layoffs.

2. Changing weather and precipitation patterns could require expensive adaptation measures such as relocating crop cultivation, changing the composition or type of crops and increasing inputs such as pesticides to adapt to changes in ecological composition that lead to economic denigration and job loss (Cordova et al. 2006).

3. As climate change adversely affects agricultural productivity in California, laborers will be increasingly affected by job loss. For example, the two highest-value agricultural products in California's $30 billion agriculture sector are dairy products (milk and cream, valued at $3.8 billion annually) and grapes ($3.2 billion annually) (CASS 2002). Climate change

is expected to decrease dairy production by between 7–22 percent by the end of the century (Pittock 2001). It is also expected to adversely affect the ripening of wine grapes, substantially reducing their market value (Hayhoe 2004).

Communities in the Central Valley, where agriculture is most concentrated and with a significant proportion of low-income Latino residents, would be the hardest hit by these projected declines in agricultural productivity linked to climate change.

Fewer Jobs in Tourism, an Industry Employing a High Number of Low-Income People of Color

Tourism is already quite vulnerable to market conditions because the ability to travel is heavily based on access to disposable income. Although there are no formal predictions of changes to leisure travel that exist beyond the year 2020 (UNWTO 2007), there is concern that climate change may lead to jobs being retracted and downsized (Cordova et al. 2006; UNWTO 2007). Effects of climate change on the tourism industry could be seen in the form of shorter employment periods and lower wages as the industry struggles to deal with physical, temporal, economic, and climatic issues.

In California, sea-side destinations and mountainous regions are likely to be particularly impacted (IPCC 2007; UNWTO 2007). Because of shifts in the types of recreational opportunities that will likely remain available in California due to climate change, the jobs of current tourism laborers may be at risk. In all of the major industries that have been generated by tourism—with the exception of the entertainment industry—people of color make up the majority of the workforce and could be vulnerable to layoffs and decreased pay (Figure 9) (Cordova et al. 2006). The tourism employment category comprised of the greatest proportion of people of color is “traveler accommodations” which consists of hotel and motel

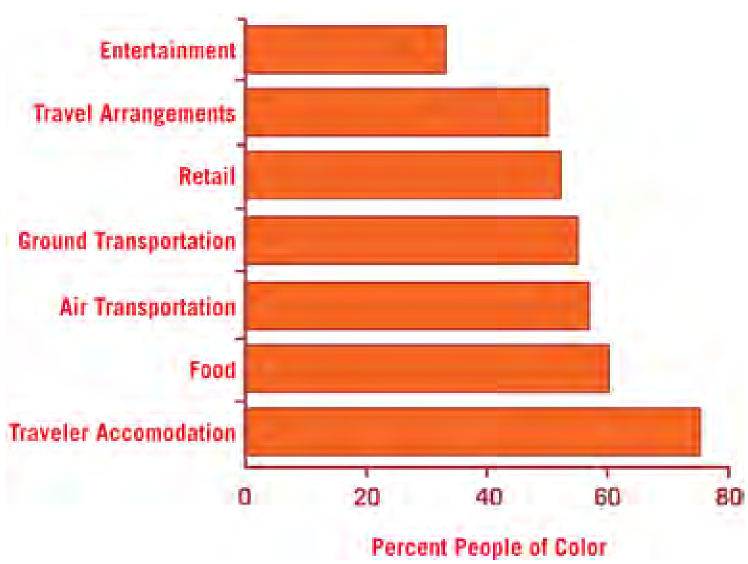


Figure 9. Percent of people of color in tourism-generated jobs, by sector, 2003 (Source: cited from Cordova 2006).

workers. It is uncertain whether these same workers, or these same demographics in general, would be hired to work in new tourism activities if the industry shifts to other geographic locations or shrinks in size.

Even excluding agriculture and tourism, industries in California that are considered heavy emitters of greenhouse gases have a workforce that is sixty percent people of color; the non-heavy emitting industries are fifty-two percent workers of color. These heavy emitting industries tend to pay slightly higher wages and be more unionized. Addressing greenhouse gas emissions without an adequate transition plan for incumbent workers and targeting opportunities for communities of color in the new "green jobs" sector could widen the racial economic divide (Buffa, et. al).

The Climate Gap in Extreme Weather Insurance

As extreme weather events such as wildfires, hurricanes and floods become more common, severe damage and destruction to homes will also increase. Swiss Re (2006) indicates that insurance losses have been on an upward trend since 1985. During the years 1987–2004 property insurance losses due to natural disasters averaged $23 billion per year and in 2005, losses rose to $83 billion, of which $60 billion was due to hurricanes Katrina, Rita, and Wilma alone (Swiss Re 2006).

Households that have home or renters' insurance can, relatively rapidly, recuperate and resume living much in the same way as prior to the disaster. In contrast, low-income communities—which are often under-insured—may spend the rest of their lives struggling to recover from property damage related to an extreme weather event (Fothergill and Peek 2004; Blaikie et al. 1994; Thomalla et al. 2006).

Further, the frequency and intensity of extreme weather events due to climate change will increase the price of disaster insurance, making it prohibitively expensive for low-income people and decreasing their ability to cope with future losses.

Finally, the disproportionate impact of extreme weather events on low-income families and people of color could exacerbate homelessness, especially in urban areas. This would be largely due to the lack of access to insurance and emergency credit, less savings, fewer personal resources, and disproportionate suffering from previous economic stress and problems (Fothergill and Peek 2004; Bolin and Bolton 1986; Tierney 1988). Moreover, increased governmental spending on infrastructure protection could directly affect low-income communities because funds may be diverted away from education, social programs, public transportation programs, health, and other economic sectors (CRAG 2002; Cordova et. al).

How to Close the Climate Gap

HOW TO CLOSE THE CLIMATE GAP

Closing the Climate Gap Begins with Policy that Leaves No One Behind.

At the federal and state level, the United States is developing comprehensive strategies to reduce climate change. Currently, the primary goal of such policy is strictly to reduce carbon emissions, the leading cause of our deteriorating atmosphere. Yet closing the climate gap also needs to be a priority. Implementing policies that protect the most vulnerable communities will better protect all Americans.

Currently, federal and state policymakers appear to be moving forward with a framework that includes capping the total amount of greenhouse gas emissions, lowering the cap over time and issuing permits as a way to ensure no one goes over the limit. Yet few of the most prominent climate change mitigation strategies close the climate gap, and in some cases, policies may potentially widen the gap.

For example, one major concern with carbon emission reduction policies is that they will be regressive because the burden of rising costs will fall disproportionately on lower-income households (Walls and Janson 1996; Hassett et al. 2008). A study by the Congressional Budget Office (2007a) shows how a program implemented to cut carbon dioxide (CO2) emissions by 15 percent would cost 3.3 percent of the average income of households in the lowest income bracket as opposed to only 1.7 percent of the average income of households in the top income bracket.

Other policies that raise substantial climate gap issues are pollution credits allocated to facilities as well as how revenues generated from fees on carbon emissions or the auctioning of emission credits will be distributed to society and individual consumers.

Close the Climate Gap by Auctioning Permits or Establishing a Fee and Invest in Communities That Will be Hardest Hit

If emission credits are allocated for free, there is concern that these policies will be regressive. (Dutzik et al. 2007). Alternatively, under cap-and-auction or fee-based strategies, the sale of emission credits to polluters could generate sizable revenues that could be used to offset higher costs—particularly for those who can least afford it (Hepburn et al. 2006). Revenues could be distributed to the public through tax cuts, investments in clean energy, high-value investments such as transportation, or through direct periodic dividends to consumers (CBO 2007a).

Other reasons auctioning permits or establishing fees helps close the climate gap:

- Eliminates the need for emissions trading in comparison to free-allocation programs because industry is likely to buy only what it needs (Hepburn et al. 2006).
- Decreases financial incentives to keep old polluting facilities open by eliminating the grandfathering of old facilities.
- Decreases the problem of over-allocation and excessive banking and trading of emission credits.

Close the Climate Gap by Maximizing Reductions in Greenhouse Gas Emissions and Toxic Air Pollution in Neighborhoods with the Dirtiest Air.

There is enormous potential to get more for our investments in climate change reduction by focusing on the dirtiest sources that cause both climate change and health problems locally. These sources are often concentrated in neighborhoods with the highest populations of low-income families and people of color with local toxic air emissions that contribute to poor health. Policymakers have an opportunity to be efficient and effective stewards of taxpayer dollars by focusing on climate polluters disproportionately responsible for regional greenhouse gas emissions and dirtying the air in highly impacted neighborhoods.

Right now, most policymakers at the federal and state levels are missing this opportunity to close the climate gap, and may even exacerbate inequalities between affluent and poor neighborhoods by instituting greenhouse gas reduction policies that clean up the air in some places while unintentionally leaving the most vulnerable behind.

In certain circumstances, cap-and-trade, the most prominent climate policy under consideration, may reduce climate emissions and toxic pollution regionally. Yet there are no guaranteed reductions at any one source (O'Neill 2004). Communities with the dirtiest air are concerned that with the wrong approach, some polluters may maintain or increase their emissions, creating localized dirty-air hotspots even if there are regional greenhouse gas reductions overall.

Instead, if directed in the right way, measures to reduce climate emissions could also reduce other types of dangerous pollution in the neighborhoods that need it most. In California, efforts should be directed to neighborhoods in close proximity to highways, ports and other sections of the transportation and goods-movement corridors where air quality has been noted as among the worst in the state (CARB 2006; CARB 2008c; Morello-Frosch and Jesdale 2006; Morello-Frosch and Lopez 2006).

Low-income families and communities of color have a lot to gain from greenhouse gas reduction strategies because of the added local benefit of lowering toxic pollution from those same sources—but only if greenhouse gas reductions are targeted to those facilities that are located in these neighborhoods. More careful studies should be conducted to assess which climate policies would hold the greatest benefits for communities that suffer most from local air pollution (Elliott et al. 2005).

Additionally, research should characterize patterns of population exposure resulting from local sources of pollution in a variety of settings, especially in urban areas. Although methodologically difficult to develop, this could include analytical tools to track where carbon credits are being allocated and traded in order to assess the subsequent amounts of co-pollutant emissions that may increase or decrease at the local level.

Such an approach might complicate the planning and implementation of market or fee systems but the benefits for fairness and public health far outweigh the modest costs of extra complexity in the system. To facilitate this, a starting point would be developing mapping and analytical tools that allow policymakers to identify the neighborhoods with the greatest opportunities to maximize greenhouse gas emission reductions while also cleaning up toxic air pollution.

Why We Can't Afford to Focus Only on Regional Greenhouse Gas Reductions

Today, most climate policy strategies focus exclusively on lowering greenhouse gases, without regard to what other benefits we can achieve if we focus on reducing greenhouse gases from sources that also emit dangerous and toxic pollutants. In a struggling economy where most Americans continue to rank air pollution as a leading concern, working to get more health and environmental benefits from one policy protection should be a goal of efficient, effective governments.

Failure to take under strong consideration sources that contribute to both climate change and toxic air pollution can also lead to a widening of the climate gap between the health benefits achieved by some and the health consequences faced by others. It can mean that while regional air improves, the air in some neighborhoods gets dirtier.

For example, a study of the Regional Clean Air Incentives Market (RECLAIM), an emission trading system designed to lower nitrogen oxide emissions in Southern California, indicates that the program may have increased nitrogen oxide emissions in Wilmington, California, while region-wide emission levels declined (Lejano and Hirose 2005). Further, under one of the rules, licensed car scrappers were allowed to purchase old, polluting vehicles and destroy them, and in return receive emission credits by the South Coast Air Quality Monitoring District (SCAQMD) that could be sold to oil refineries (Drury et al. 1999). The majority of the emission credits were purchased by four oil companies: Unocal, Chevron, Ultramar, and GATX to avoid the cost of installing pollution-reduction technologies. The trading program led to a situation where workers and local residents of these communities were unnecessarily exposed to benzene, a known human carcinogen, and other volatile organic compounds that were contained in the emissions and that these emissions could have been remediated by pollution reduction technologies that were already in widespread use in similar port operations along the West Coast (Drury et al. 1999).

Ensuring New Fuels Don't Increase Pollution in Low-Income and Minority Communities

The lesson learned in California from the experiment with MTBE—a fuel additive that reduced air pollution, but was quickly banned after research found that it polluted drinking water—has critical implications for how we can close the climate gap.

Similarly, ethanol—a biofuel proposed for broader use by California and federal policymakers to help combat climate change—could reduce our dependence on oil. However, biofuel refineries could harm the health of adjacent communities by exposing them to the chemical and microbial byproducts of the distillation processes necessary for fuel production (Madsen 2006).

Research also predicts that some ethanol fuels may increase ozone-related deaths, hospitalization, and asthma by 9 percent in Los Angeles and 4 percent nationwide if used to power vehicles (Jacobson 2007). Low-income and minority communities, which are disproportionately clustered near highways and goods transport corridors, would bear the majority of the burden.

Lastly, it should be noted that growing crops for fuel will likely raise prices of food crops (Tenenbaum 2008). This would be most damaging to low-income consumers and low-income agricultural laborers who are most vulnerable to job loss and hunger (Tenenbaum 2008).

Other Key Recommendations to Close the Climate Gap

More research is needed to look at the rates and impacts of climate change events that are projected to occur. Identifying possible mitigation and adaptation strategies that would reduce climate-related illnesses and deaths, particularly in the most vulnerable communities, should be a priority for the regulatory community as well as policymakers.

1. **Close the Health Impacts Gap Between People of Color and the Poor, and the Rest of the Population.**

- **Focus Planning and Intervention in Poor and Minority Neighborhoods.** Because burdens of heat-related illness are borne disproportionately by groups of older residents, children, and those of low socioeconomic status (Knowlton et al. 2009; English 2007; Basu and Ostro 2008), preparedness strategies should include messages and information about avoiding extreme heat exposure that are disseminated and targeted toward parents and caregivers of young children, and the elderly (Knowlton et al. 2009). Climate change interventions to address the built environment should prioritize vulnerable groups who live in neighborhoods with high risks of heat island effects, poor housing quality and a lack of access to transportation to escape extreme weather events. These proactive strategies could go a long way to reduce the disproportionate burden of heat-related health effects on the poor and communities of color.

- **Use New Mapping Technologies to Identify Vulnerable Neighborhoods.** Differential exposures to the health-damaging impacts of climate change, such as excessive heat and extreme weather events could be examined from a geographical equity perspective by using GIS maps overlaid with vulnerability models and current socioeconomic, racial/ethnicity, and cultural group distributions in California. Interaction of these data layers should be taken into account when developing climate change policy (Elliott et al. 2005), so as to reduce the likelihood that future policies would create disproportionate burdens on already vulnerable populations.

- **Research the Potential Benefits and Harms of New Fuels.** Policymakers must take steps to better assess the effects of exposure to new fuels (i.e., ethanol) as well as increased emissions of other pollutants during combustion (Jacobson 2007) and production on those already feeling the negative impact of the climate gap. More studies must also focus on the dangers of food shortages and food price increases associated with the production of ethanol and other biofuel crops (Tenenbaum 2008). Obtaining this information could illuminate whether biofuels are a viable solution or would simply widen the climate gap.

- **Measure the Success of Mitigation Strategies by Whether They Protect Everyone.** Runaway climate change, where positive feedback loops drive warming irrespective of human mitigation actions, could occur (NRC 2002; Gjerde et al. 1999; Pizer 2003). As we enact policies to reduce the chances that full scale global warming will occur, we must also develop downstream adaptation strategies such as infrastructure protection, efficient and effective air-cooling technologies, and better surveillance for emerging infectious diseases. If we don't pay close attention to the climate gap from the beginning, disparities between populations of differing socioeconomic status will likely increase.

- **Design Research That Identifies Opportunities for Targeting Greenhouse Gas Reductions to Reduce Toxic Air Emissions in Highly Polluted Neighborhoods.** In order to design proper policies and monitor the efficacy of climate policies, future research should: (1) explore how to characterize, quantify, and maximize reducing both climate and toxic pollution in existing or new "toxic hotspots"; (2) determine the geographic scale at which these evaluations can take place given the data available; and (3) identify the data necessary to improve future evaluations.

2. Develop Policies that Close the Gap Between the Economic Disparities Faced by People of Color and the Poor, and the Rest of the Population.

Because climate change and climate solutions are likely to negatively impact certain economic sectors more than others, policies must take into account how low-income families and people of color will be affected and what more can be done to help them adjust to major economic shifts. Some important policy directions include:

- Examine which greenhouse gas source sectors hold the most pollution reduction promise without economic disruption, both in terms of overall emission reductions and environmental health benefits (Prasad 2008);
- Anticipate and address inevitable job shifts and retraining needs to maximize opportunities for low-income communities and communities of color to successfully transition to and benefit from a new, clean energy economy;
- Ensure that revenue generated from climate policy will help high-poverty neighborhoods absorb the higher prices for energy and other basic necessities.

3. Close the Conversation Gap.

Because climate change will affect some populations more than others, it is important to capture the specific vulnerabilities of different neighborhoods. Local expertise, community wisdom, and other contextual information are important to supplement technical knowledge. Researchers hoping to generate climate change-impact knowledge that is sensitive to community-specific concerns should integrate community participation in their studies (Morello-Frosch et al. 2005; Minkler and Wallerstein 2003; Coburn J. 2009). To proactively address the climate gap, ensure the effectiveness of preparedness and adaptation strategies and alleviate environmental health inequalities, agency officials and policymakers must ensure that vulnerable communities play a prominent role in shaping future solutions to climate change in California (Elliott et al. 2005).

But it's more than just the regulatory agencies and affected communities. Policy differences between those who favor "cap and trade" vs. those who support carbon fees have led to tensions between advocates that share the goals of protecting the planet and protecting the poor. Concerns about whether climate policy will cost or create jobs have led to strains between those working to recover the economy and those working to save the planet. These tensions have led to a conversation gap.

One of the first steps to addressing the climate gap is addressing this conversation gap. Working together — across sectors and constituencies—and insuring that the effects of climate change and climate policy are not unequally felt by the poor and communities of color is exactly the recipe we need to cool the planet and create economic opportunities and health benefits for everyone.

CONCLUSIONS

This analysis of available data connects the dots between some facts we've known and others we haven't to reveal a hidden climate gap.

The climate gap means that climate change will more seriously affect the health of communities that are least likely to cope with, resist, and recover from the impacts of extreme weather events and potential increases in air pollution compared to the rest of the population (Knowlton et al. 2004). Further, low-income and minority communities could be more seriously harmed by the economic shocks associated with climate change both in price increases for basic necessities (i.e., water, energy, and food) and by threats of job loss due to economic and climatic shifts that affect industries such as agriculture and tourism (Stern 2006).

Policymakers have a clear choice: ignoring the climate gap could reinforce and amplify current as well as future socioeconomic and racial disparities. On the other hand, policymakers can proactively close the climate gap through strategies that address the regressive economic and health impacts of climate change, and that lift all boats by ensuring that everyone shares equally in the benefits of climate solutions, and no one is left bearing more than their fair share of the burdens.

APPENDIX

California's Climate Policy: Moving in the Right Direction, but Room for Improvement on Reducing Climate and Toxic Pollution in the Dirtiest Neighborhoods

Two critically dangerous sources of air pollution that will be addressed through greenhouse gas reduction measures in California are nitrogen oxide (NOx), a precursor of ozone formation and particulate matter, which contributes to 3,500 premature deaths every year, along with a handful of illnesses (Bailey et al. 2008).

Thanks to California's climate policy, nitrogen oxide is expected to be reduced by 86,000 tons by 2020, more than three quarters of which will be achieved through regulatory requirements for cleaner cars and trucks (Bailey et al. 2008). Projected particulate matter and nitrogen oxide reductions together are estimated to prevent approximately 780 premature deaths, 11,000 fewer cases of asthma-related and other lower respiratory symptoms, 980 fewer cases of acute bronchitis, and 77,000 fewer work days lost in California (CARB 2008b). These health benefits are projected to be valued at $1.4 billion to $2.3 billion in 2020 (Bailey et al. 2008). Moreover, actual health and economic benefits of these climate change policies may be underestimated because many emission reduction measures and public health benefits such as reduced cancer risks have not been accounted for (Bailey et al. 2008).

Known carcinogens that may be reduced are benzene, formaldehyde, and toluene, predominantly produced directly and indirectly by mobile sources and by the refining and combustion of fossil fuels (EPA 2005). These air toxics are important to closing the climate gap, as several studies indicate that communities of color and the poor bear a disproportionate burden of health risks associated with air toxics exposures (CARB 2008c; Morello-Frosch and Jesdale 2006; Morello-Frosch et al. 2002; Morello-Frosch and Shenasa 2006).

California's Early Action Measures Could Go a Long Way to Closing the Climate Gap

The California Air Resources Board's plans also include Early Action Measures (EAMs) that could be enforceable on or before 2010 (HSC §38560.5, Health and Safety Code Section 38560–38565). These policies include regulations affecting landfills, motor vehicle fuels, refrigerant in cars, port operations, and many other sources in 2007, including nine Discrete Early Action measures for which the CARB will adopt regulations by the end of 2009 (CARB 2007; CARB 2008b). It is estimated that if all Early Action Measures are adopted together with the additional proposed measures, 52,000 tons of nitrogen oxide and particulate matter pollution would be removed from the air, which would lead to a further decrease in exposure to unhealthy local pollution. It would also prevent an additional $1.1 billion to $1.8 billion in health costs in the year 2020 alone (Bailey et al. 2008).

These measures could potentially benefit poor and minority neighborhoods that tend to host significant industrial and transportation emission sources. However, these projected benefits have only been quantified at the state level, and more work needs to be done by the Air Resources Board and other researchers to examine more closely how regional greenhouse gas reductions will impact the distribution of toxic air pollution reductions in neighborhoods struggling w ith the dirtiest air. This assessment will be essential to closing the climate gap in California.

Health Endpoint	Health Benefits of Existing Measures and 2007 SIP *mean*	Health Benefits of Recommendations in the Proposed Scoping Plan *mean*
Avoided Premature Death	3,700	400
Avoided Hospital Admissions for Respiratory Causes	770	84
Avoided Hospital Admissions for Cardiovascular Causes	1,400	150
Avoided Asthma and Lower Respiratory Symptoms	110,000	11,000
Avoided Acute Bronchitis	8,700	910
Avoided Work Loss Days	620,000	67,000
Avoided Minor Restricted Activity Days	3,600,000	380,000

Table 2. Estimates of California air quality-related health benefits in 2020 if AB 32 Implementation Measures are Implemented. (Source: CARB 2008c)

References

Ackerman, F., and E. Stanton. 2008. *The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked*. NRDC: New York, New York.

ALA (American Lung Association). 2008. State of the Air: 2008. American Lung Association: New York.

American Community Survey. 2007. 2007 American Community Survey 1-Year Estimates. Washington, D.C.

Bailey, D., K. Knowlton, and M. Rotkin-Ellman. 2008. *Boosting the Benefits: Improving air quality and health by reducing global warming pollution in California*. Natural Resources Defense Council: New York, New York.

Basu, R., and B. D. Ostro. 2008. "A Multicounty Analysis Identifying the Populations Vulnerable to Mortality Associated with High Ambient Temperature in California." *Am J Epidemiol* 168(6): 632–637.

Basu, R., and J. M. Samet. 2002. "Relation between elevated ambient temperature and mortality: A review of the epidemiologic evidence." *Epidemiol Rev* 24(2): 190–202.

Bernard, S. M., J. M. Samet, A. Grambsch, K. L. Ebi, and I. Romieu. 2001. "The potential impacts of climate variability and change on air pollution-related health effects in the United States." *Environ Health Perspect* 109 Suppl 2: 199–209.

Blaikie, P., T. Cannon, I. Davis, and B. Wisner. 1994. *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. Routledge, New York.

BLS (Bureau of Labor Statistics). 2002. Consumer expenditure survey. Washington D.C.

Bolin, R., and P. Bolton. 1986. *Race, religion, and ethnicity in disaster recovery, program on environment and behavior*. University of Colorado, Institute of Behavioral Science, Natural Hazards Research and Applications Information Center: Boulder, Colorado.

Boyce, J., and M. Riddle. 2007. *Cap and Dividend: How to Curb Global Warming While Protecting the Incomes of American Families*. Political Economy Research Institute.

Buffa, Andrea, Zabin, Carol, Brown, Cheryl and Graham-Squire, Dave. 2008. *California's Global Warming Solutions Act of 2006: A Background Paper for Labor Unions* (2008 University of California, Berkeley Center for Labor Research and Education. Available at: http://laborcenter.berkeley.edu/greenjobs/AB32_background_paper08.pdf

CARB (California Air Resources Board). 2006. Quantification of the Health Impacts and Economic Valuation of Air Pollution from Ports and Goods Movement in California. Appendix A in Emission Reduction Plan for Ports and Goods Movement (GMERP).

CARB. 2007. Expanded list of early action measures to reduce greenhouse gas emissions in California recommended for board consideration. California Air Resources Board. Sacramento, California.

CARB. 2008a. *Methodology for Estimating Premature Deaths Associated with Long-term Exposure to Fine Airborne Particulate Matter in California*. California Air Resources Board. Sacramento, California.

CARB. 2008b. *Climate change proposed scoping plan: A framework for change*. California Air Resources Board. Sacramento, California.

CARB. 2008c. *Diesel particulate matter health risk assessment for the West Oakland community: Preliminary summary of results*. California Environmental Protection Agency, Air Resources Board, Sacramento, California.

CASS. 2002. California agriculture statistical review. Sacramento, California. California Agriculture Statistics Service.

CBO (Congressional Budget Office). 2007a. *Trade-offs in allocating allowances for CO2 emissions*. Washington, D.C.

CBO. 2007b. Trade-offs in allocating allowances for CO2 emissions, in *A series of Issue Summaries*. Congressional Budget Office. Congressional Budget Office: Washington, D.C.

Cifuentes. L., V. H. Borja-Aburto, N. Gouveia, G. Thurston, and D. L. Davis. 2001. "Assessing the health benefits of urban air pollution reductions associated with climate change mitigation (2000–2020): Santiago, Sao Paulo, Mexico City, and New York City." *Environ Health Perspect* 109(Suppl 3): 419–425.

Confalonieri, U., and B. Menne. 2007. Human health. Climate Change 2007. *Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, O. F. C. M. L. Parry, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, eds. Cambridge, UK.: Cambridge University Press 391–431.

Cordova, R., M. Gelobter, A. Hoerner, J. R. Love, A. Miller, C. Saenger, and D. Zaidi. 2006. *Climate Change in California: Health, Economic and Equity Impacts*. Redefining Progress: Oakland, California.

CRAG (California Regional Assessment Group). 2002. *Preparing for a changing climate: The potential consequences of climate variability and change for California*. Washington, D.C.: U.S. Global Change Research Program.

Donoghue, E., M. Nelson, G. Rudis, R. I. Sabogal, J. T. Watson,and G. Huhn. 2003. "Heat-related deaths - Chicago, Illinois, 1996–2001, and United States, 1979–1999." *MMWR Morb Mortal Wkly Rep* 52: 610–613.

Corburn J. (2009) Cities, climate change and urban heat island mitigation: Localizing global environmental science. Urban Studies 47(2) In press.

Curriero, F. C., K. S. Heiner, J. M. Samet, S. L. Zeger, L. Strug, and J. A. Patz. 2002. "Temperature and mortality in 11 cities of the eastern United States." *Am J Epidemiol* 155(1): 80–87.

Drechsler, D., N. Motallebi, M. Kleema, D. Cayan, K. Hayhoe, L. S. Kalkstein, N. Miller, S. C. Sheridan, J. Jin, and R. A. VanCuren. 2006. *Public health-related impacts of climate change in California*. California Energy Commission.

Dutzik, T., R. Sargent, and F. Figdor. 2007. *Cleaner, cheaper, smarter: The case for auctioning pollution allowances in a global warming cap-and-trade program*. U.S. PIRG Education Fund.

Drury R, Belliveau M, Kuhn J, Bansal S. 1999. "Pollution trading and environmental injustice: Los Angeles' failed experiment in air quality." *Duke Environmental Law and Policy Forum* 9:231–289.

EDD (California Employment Development Department). 2004. Occupational Employment (2002) and Wage (2003) Data, Occupational Employment Statistics Survey Results. Sacramento, California.

EDD. 2004. "Occupational Employment (2002) and Wage (2003) Data, Occupational Employment Statistics Survey Results." 2004, from www.calmis.cahwnet.gov/file/occup$/oeswages/Cal$oes2003.htm.

Elliott, M., C. Saenger, and A. Hoerner. 2005. *Latinos and climate change: A scoping report*. Redefining Progress: Oakland, California.

English, P., K. Fitzsimmons, S. Hoshiko, T. Kim, H. G. Margolis, T. E. McKone, M. Rotkin-Ellman, G. Solomon, R. Trent, and Z. Ross. 2007. *Public health impacts of climate change in California: Community vulnerability assessments and adaptation strategies*. Climate Change Public Health Impacts Assessment and Response Collaborative, California Department of Public Health Institute, Richmond, California.

EPA. 2005. *Toxics release inventory (TRI) basis of OSHA carcinogens*. United States Environmental Protection Agency, Washington, D.C.

Epstein, P., and C. Rodgers. 2004. *Inside the greenhouse: The impacts of CO2 and climate change on public health in the inner city*. Center for Health and the Global Environment: Boston, Massachusetts.

Hajat, S., B. Armstrong, M. Baccini, A. Biggeri, L. Bisanti, and A. Russo. 2006. "Impact of high temperature on mortality: Is there an added heat wave effect?" *Epidemiology* 17: 632–638.

Hayhoe, K., D. Cayan, C. B. Field, P. C. Frumhoff, E. P. Maurer, N. L. Miller, S. C. Moser, S. H. Schneider, K. N. Cahill, E. E. Cleland, L. Dale, R. Drapek, R. M. Hanemann, L. S. Kalkstein, J. Lenihan, C. K Lunch, R. P. Neilson, S. C. Sheridan, and J. H. Verville. 2004. "Emissions pathways, climate change, and impacts on California." *Proc Natl Acad Sci U S A* 101(34): 12422–12427.

Fothergill, A., and L. Peek. 2004. "Poverty and disasters in the United States: A review of recent sociological findings." *Natural Hazards Journal* 32(1): 89–110.

Frumkin, H., A. J. McMichael, and J. J. Hess. 2008a. "Climate change and the health of the public." *Am J Prev Med* 35(5): 401–402.

Frumkin H., J. Hess, G. Luber, J. Malilay, and M. McGeehin. 2008b. "Climate change: The public health response." *Am J Public Health* 98(3): 435–445.

Gage, K. L., T. R. Burkot, R. J. Eisen, and E. B. Hayes. 2008. "Climate and vectorborne diseases." *Am J Prev Med* 35(5): 436–450.

Gjerde, J., S. Grepperud, and S. Kverndokk. 1999. "Optimal climate policy under the probability of a catastrophe." *Resource and Energy Economics* 21: 289–317.

Goulder, L. 1995. "Environmental taxation and the double dividend: A reader's guide." *International Tax and Public Finance* 2:157–183.

Greenberg, J. H., J. Bromberg, C. M. Reed, T. L. Gustafson, and R. A. Beauchamp. 1983. "The epidemiology of heat-related deaths, Texas—1950, 1970–79, and 1980." *Am J Public Health* 73(7): 805–807.

Greenough, P. G., and T. D. Kirsch. 2005. "Hurricane Katrina. Public health response—assessing needs." *N Engl J Med* 353(15): 1544–1546.

Hassett, K., A. Mathur, and G. Metcalf. 2008. *The incidence of a U.S. carbon tax: A lifetime and regional analysis*. Cambridge, Massachusetts: American Enterprise Institute for Public Policy Research.

Hepburn, C., M. Grubb, K. Neuhoff, F. Matthes, and M. Tse. 2006. "Auctioning of EU ETS phase II allowances: How and why?" *Climate Policy* 6(1): 137–160.

HSC §38560.5, Health and Safety Code Section 38560–38565: Sacramento, California.

IPCC (Intergovernmental Panel on Climate Change). 2007. *Working Group I Report: The Physical Science Basis.*

Jacobson, M. Z. 2007. "Effects of ethanol (E85) versus gasoline vehicles on cancer and mortality in the United States." *Environ Sci Technol* 41(11): 4150–4157.

Jacobson, M. 2008. "On the causal link between carbon dioxide and air pollution mortality." *Geophys Res. Let.* 35(L03809).

Juhwan Lee, Steven De Gryze, and Johan Six "Effect of Climate Change on Field Crop Production in the Central Valley of California." Report from California Climate Change Center, March 2009, Draft Paper CEC-500-2009-041-D. Available at: http://www.energy.ca.gov/2009publications/CEC-500-2009--041-D.PDF

Kilbourne, E. 1997. Heat waves and hot environments. *In The Public Health Consequences of Disasters.* E. Noji, Editor. New York, New York: Oxford University Press.

Kinney, P. L., M. S. O'Neill, M. L. Bell, and J. Schwartz. 2008. "Approaches for estimating effects of climate change on heat-related deaths: Challenges and opportunities." *Environmental Science & Policy* 11(87–96).

Knowlton, K., J. E. Rosenthal, C. Hogrefe, B. Lynn, S. Gaffin, R. Goldberg, C. Rosenzweig, K. Civerolo, J. Y. Ku, and P. L. Kinney. 2004. "Assessing ozone-related health impacts under a changing climate." *Environ Health Perspect* 112(15): 1557–1563.

Knowlton, K., M. Rotkin-Ellman, G. King, H. G. Margolis, D. Smith, G. Solomon, R. Trent, and P. English. 2009. The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits. *Environ Health Perspect* 117(1): 61–67.

Kovats, R. S., and S. Hajat. 2008. "Heat stress and public health: A critical review." *Annu Rev Public Health* 29: 41–55.

Kunzli, N., R. McConnell, D. Bates, T. Bastain, A. Hricko, F. Lurmann, E. Avol, F. Gilliland, and J. Peters. 2003. "Breathless in Los Angeles: The exhausting search for clean air." *Am J Public Health* 93(9): 1494–1499.

Lejano, R., and R. Hirose. 2005. "Testing the assumptions behind emissions trading in non-market goods: The RECLAIM program in Southern California." *Environmental Science & Policy* 8:367–377.

Madsen, A. M. 2006. "Exposure to airborne microbial components in autumn and spring during work at Danish biofuel plants." *Ann Occup Hyg* 50(8): 821–831.

Medina-Ramon, M., A. Zanobetti, D. P. Cavanagh, and J. Schwartz. 2006. "Extreme temperature and mortality: Assessing effect modification by personal characteristics and specific cause of death in a multi-city case only analysis." *Environ Health Perspect* 114:1331–1336.

Minkler, M., and N. Wallerstein. 2003. *Community-based Participatory Research for Health*. San Francisco, California: Jossey-Bass.

Luginbuhl RC, Jackson LL, Castillo DN, Loringer KA. 2008. Heat-related deaths among crop workers—United States, 1992–2006. MMWR Morb Mortal Wkly Rep 57:649–653.

Morello-Frosch, R. A., and B. Jesdale. 2006. "Separate and Unequal: Residential Segregation and Estimated Cancer Risks Associated with Ambient Air Toxics in U.S. Metropolitan Areas." *Environmental Health Perspectives* 114(3): 386–393.

Morello-Frosch, R., and B. Jesdale. 2008. Unpublished impervious surface and tree cover data. Data for this analysis was derived from: U.S. Geological Survey's National Land Cover Dataset 2001. www.mrlc.gov/nlcd.php, accessed on June 20, 2007; and ESRI's ArcMap census boundary files www.census.gov/geo/www/cob/bdy_files.html, accessed June 6, 2008.

Morello-Frosch, R., and R. Lopez. 2006. "The riskscape and the color line: Examining the role of segregation in environmental health disparities." *Environmental Research* 102: 181–196.

Morello-Frosch, R., and E. Shennasa. 2006. "The Environmental 'Riskscape' and Social Inequality: Implications for Explaining Maternal and Child Health Disparities." *Environmental Health Perspectives* 114(8): 1150–1153.

Morello-Frosch, R., M. Pastor Jr., C. Porras, and J. Sadd. 2002. "Environmental Justice and Regional Inequality in Southern California: Implications for Future Research." *Environmental Health Perspectives* 110(supplement 2): 149–154.

Morello-Frosch, R., M. Pastor, J. Sadd, C. Porras, and M. Prichard. 2005. Citizens, Science, and Data Judo: Leveraging Community-based Participatory Research to Build a Regional Collaborative for Environmental Justice in Southern California. In *Methods for Conducting Community-Based Participatory Research in Public Health*, B. Israel, et al., editors. University of Michigan, Jossey-Bass Press.

Naughton, M. P., A. Henderson, M. C. Mirabelli, R. Kaiser, J. L. Wilhelm, S. M. Kieszak, C. H. Rubin, and M. A. McGeehin. 2002. "Heat-related mortality during a 1999 heat wave in Chicago." *Am J Prev Med* 22(4): 221–227.

NRC (National Research Council). *Abrupt Climate Change: Inevitable Surprises*. Committee on Abrupt Climate Change. Washington, D.C.: National Academy Press.

Oke, T. 1973. "City size and the urban heat island." *Atmos. Environ*. 7:769–779.

O'Neill, C. 2004. "Mercury, risk and justice." *ELR News and Analysis* 34: 11070–11115.

O'Neill, M. S., P. L. Kinney, and A. J. Cohen. 2008. "Environmental equity in air quality management: Local and international implications for human health and climate change." *J Toxicol Environ Health* A 71(9-10): 570–577.

O'Neill, M. S., A. Zanobetti, and J. Schwartz. 2003. "Modifiers of the temperature and mortality association in seven US cities." *Am J Epidemiol* 157(12): 1074–1082.

O'Neill, M. S., A. Zanobetti, and J. Schwartz. 2005. "Disparities by race in heat-related mortality in four US cities: The role of air conditioning prevalence." *J Urban Health* 82(2): 191–197.

Ostro BD, Roth LA, Green RA, Basu R (2009) Estimating the Mortality Effect of the July 2006 Heat Wave. A Report from the Climate Change Center, Draft Paper. March 2009, CEC-500-2009-036-D. Available at: http://www.energy.ca.gov/2009publications/CEC-500-2009-036/CEC-500-2009-036-D.PDF

Patz, J. A., and S. H. Olson. 2006. "Climate change and health: Global to local influences on disease risk." *Ann Trop Med Parasitol* 100(5-6): 535–549.

Poumadere, M., C. Mays, S. Le Mer, and R. Blong. 2005. "The 2003 heat wave in France: Dangerous climate change here and now." *Risk Anal* 25(6): 1483–1494.

Phelan, J. C., B. G. Link, A. Diez-Roux, I. Kawachi, and B. Levin. 2004. "Fundamental causes' of social inequalities in mortality: A test of the theory." *J Health Soc Behav* 45(3): 265–285.

Pittock, B., D. Wratt, R. Basher, B. Bates, M. Finlayson, H. Gitay, A. Woodward, A. Arthington, P. Beets, B. Biggs, et al. 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Cambridge, U.K.: Cambridge University Press.

Pizer, W. 2003. Climate change catastrophes. Resources for the Future Discussion Paper.

Prasad, S. 2008. Environmental Justice: Draft CEC PIER-EA Discussion Paper. California Energy Commission, Public Interest Energy Research: Sacramento, California.
Redefining Progress. 2006. *Climate Change in California: Health, Economic and Equity Impacts.*

Reiter, P. 2001. "Climate change and mosquito-borne disease." *Environ Health Perspect* 109(Suppl 1): 141–161.

Rogot, E., P. D. Sorlie, and E. Backlund. 1992. "Air-conditioning and mortality in hot weather." *Am J Epidemiol* 136(1): 106–116.

Schulz, A. J., D. R. Williams, B. A. Israel, and L. B. Lempert. 2002. "Racial and spatial relations as fundamental determinants of health in Detroit." *The Milbank Quarterly* 80(4): 677–707.

Shonkoff S, Morello-Frosch R, Pastor M, Sadd J (2009) Environmental Health and Equity Impacts from Climate Change and Mitigation Policies in California: A Review of the Literature. Publication # CEC-500-2009-038-D Available at: http://www.climatechange.ca.gov/publications/cat/index.html

Semenza, J. C., C. H. Rubin, K. H. Falter, J. D. Selanikio, W. D. Flanders, H. L. Howe, and J. L. Wilhelm. 1996. "Heat-related deaths during the July 1995 heat wave in Chicago." *N Engl J Med* 335(2): 84–90.

Stern, N. 2006. *Stern Review on the Economics of Climate Change*. London.

Swiss Re. 2006. *Natural catastrophes and man-made disasters 2005: High earthquake casualties, new dimension in windstorm losses*.

Tenenbaum, D. 2008. "Food vs. fuel: Diversion of crops could cause more hunger." *Environ Health Perspect* 116(6): A254–A257.

Thomalla, F., and T. Downing, E. Spanger-Siegfried, G. Han, and J. Rockström. 2006. "Reducing hazard vulnerability: Towards a common approach between disaster risk reduction and climate adaptation." *Disasters* 30(1): 39–48.

Tierney, K. 1988. "The Whittier Narrows, California earthquake of October 1, 1987 – Social aspects." *Earthquake Spectra* 4(1): 11–23.

UNWTO (United Nations World Tourism Organization). 2007. Climate Change and Tourism: Proceedings of the 1st International Conference on Climate Change and Tourism, Djerba, Tunisia, 9–11 April 2003.

USCB (U.S. Census Bureau). 2004. Current Housing Reports, American Housing Survey for the Los Angeles-Long Beach Metropolitan Area: 2003.

USCB. 2005. California — County. Percent of People Below Poverty Level in the Past 12 Months (For Whom Poverty Status is Determined). Washington, D.C.: United States Census Bureau.

Vandentorren, S., F. Suzan, S. Medina, M. Pascal, A. Maulpoix, J. C. Cohen, and M. Ledrans. 2004. "Mortality in 13 French cities during the August 2003 heat wave." *Am J Public Health* 94(9): 1518–1520.

Walls, M., and J. Hanson. 1996. Distributional Impacts of an Environmental Tax Shift: The Case of Motor Vehicle Emissions Taxes. Resources for the Future: Washington, D.C.

Whitman, S., G. Good, E. R. Donoghue, N. Benbow, W. Shou, and S. Mou. 1997. "Mortality in Chicago attributed to the July 1995 heat wave." *Am J Public Health* 87(9): 1515–1518.

Williams, D. R., and C. A. Collins. 2001. "Racial residential segregation: A fundamental cause of racial disparities in health."

*Public Health Report*s 116: 404–416.

The Climate Gap Report